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ABSTRACT

The rate training manual has been prepared for enlisted personnel of the Navy and Naval Reserve who are studying for advancement in the Aviation Boatswain's Mate E rating. It is primarily based on the professional requirements or qualifications for ABE 1 and ABE C, as contained in the Manual of Qualifications for Advancement NavPers 18068 (series). Chapter 1 discusses the various requirements for advancement in the Boatswain's Mate E rating. Chapters 2 through 8 consist of information on: leading petty officers, shop supervision and administration, steam catapults, catapult deck gear and accessories, shipboard arresting and barricade gear, visual landing aids, and special tests and test procedures. Numerous illustrations and diagrams are interspersed throughout the document. A subject index is appended. (BP)

AVIATION

BOATSWAIN'S MATE E 1 & C

NAVAL EDUCATION AND TRAINING COMMAND

RATE TRAINING MANUAL NAVEDTRA 10305-C

PREFACE

This Rate Training Manual is one of a series of training manuals prepared for enlisted personnel of the Navy and Naval Reserve who are studying for advancement in the Aviation Boatswain's Mate E rating. As indicated by the title, the manual is based on the professional qualifications for ABE1 and ABEC, as set forth in the Manual of Qualifications for Advancement, NavPers 18068 (Series).

Combined with the necessary practical experience, this manual will greatly assist the ABE2 and ABE1 in preparing for advancement exams.

This manual was prepared by the Naval Education and Training Program Development Center, Pensacola, Florida, for the Chief of Naval Education and Training. Credit for technical assistance is given to the Aviation Boatswain's Mate School, Lakehurst, New Jersey, and the Naval Air Engineering Center, Philadelphia, Pennsylvania.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

CONTENTS

CHAPTER 1

AVIATION BOATSWAIN'S MATE E RATING

This Rate Training Manual is designed to assist the ABE2 and ABE1 in performing the tasks associated with their rates and to aid them in preparing for advancement—the ABE2 to ABE1 and the ABE1 to ABEC. It is primarily based on the professional requirements or qualifications for ABE1 and ABEC, as contained in the Manual of Qualifications for Advancement, NavPers 18068 (Series). To prepare for an advancement examination, this Rate Training Manual should be studied in conjunction with Military Requirements for Petty Officers 1 & C, NavPers 10057 (Series). The latter covers the Military Requirements for all first class and chief petty officers.

ENLISTED RATING STRUCTURE

The present enlisted rating structure includes two types of ratings. general ratings and service ratings.

GENERAL RATINGS are designed to provide paths of advancement and career development. A general rating identifies a broad occupational field of related duties and functions requiring similar aptitudes and qualifications. General ratings provide the primary means used to identify billet requirements and personnel qualifications. Some general ratings include service ratings, others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

Subdivisions of certain general ratings are identified as SERVICE RATINGS. These service ratings identify areas of specialization within the scope of a general rating. Service ratings are established in those general ratings in which specialization is essential for efficient utilization of personnel. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

ABE RATING

The ABE rating is a service rating and is included in Navy Occupational Group IX (Aviation). The general rating, AB, applies at the E-8 and E-9 levels.

Figure 1-1 illustrates all paths of advancement for an Airman Recruit to Master Chief Aviation Boatswain's Mate, Warrant Officer (W-4), or Limited Duty Officer. Shaded areas indicate career stages where qualified enlisted personnel may advance to Warrant Officer (W-1) and selected Warrant Officers may advance to Limited Duty Officer. Personnel in enlisted rates and warrant ranks not in a shaded area may advance only as indicated by the lines.

The Manual of Qualifications for Advancement, NavPers 18068 (Series), states that ABE's are responsible for the operation and maintenance of catapults, barricades, arresting gear, arresting gear engines, and associated equipment ashore and afloat.

One or more ABEC's are generally assigned to the catapults aboard a carrier. An ABE1 is normally assigned to each catapult as catapult captain. Senior ABE's assigned to catapults supervise lower rated ABE's and nonrated men in the operation and maintenance of the catapults and associated equipment.

An ABEC is assigned as arresting gear chief and is in overall charge of the operation and maintenance of arresting and barricade gear and the operation of visual landing aids. The arresting gear chief is generally assisted by two ABE1's—one who supervises the operation and maintenance of the arresting gear, and one who supervises the operation and maintenance of the barricade gear. Either one of these men may

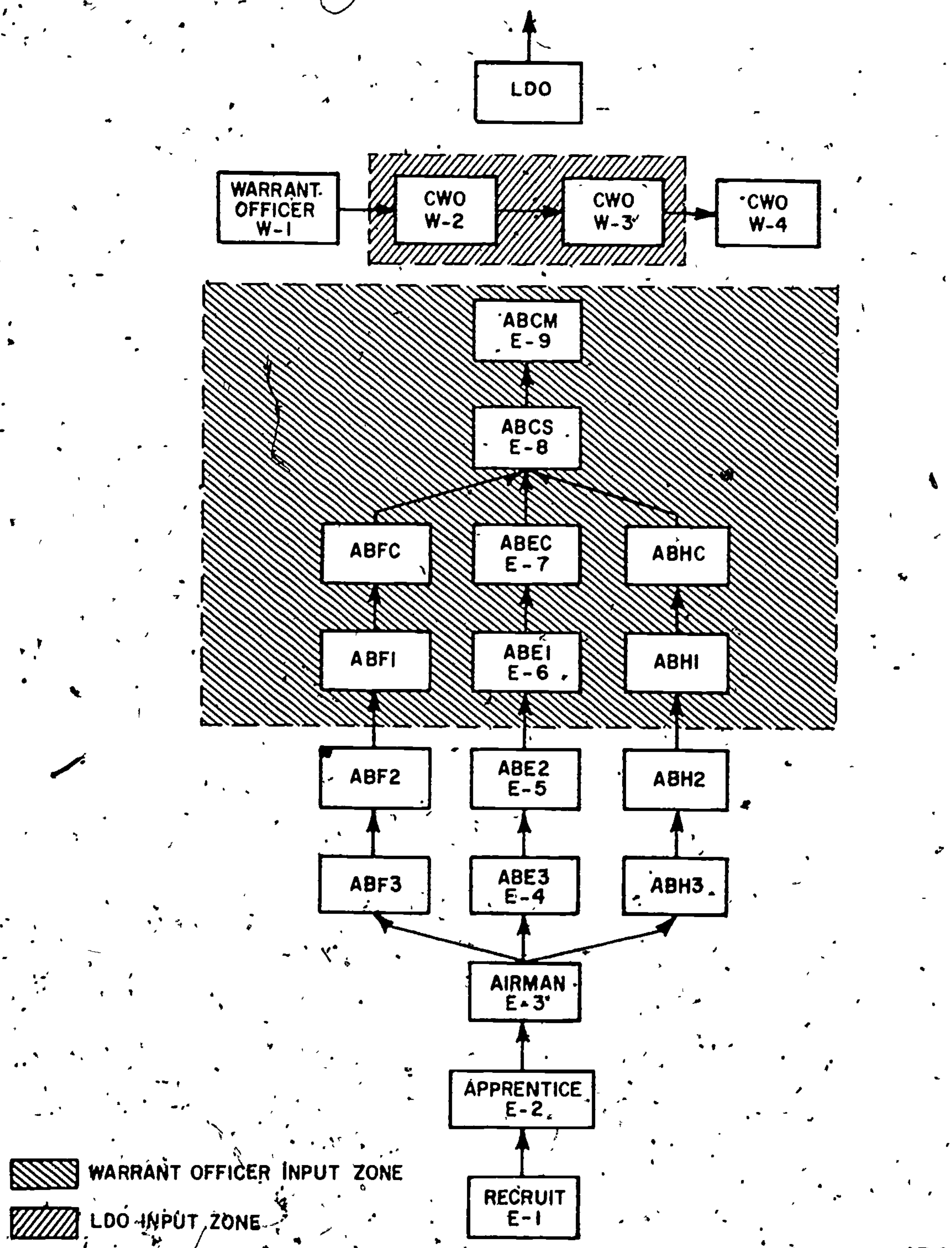

Figure 1-1.—Paths of advancement.

supervise the operation of the visual landing aids. Maintenance of landing aids is normally performed by personnel of the IC rating.

In order to properly perform his duties, the ABE1 must be able to analyze malfunctions of catapults and arresting gear and associated equipments; disassemble and replace defective parts; and supervise lower rated ABE's in routine maintenance procedures for the above mentioned equipment.

In addition to the above listed requirements for ABE1, the ABEC must be qualified to inspect and evaluate the operation of repaired and newly installed parts and components; interpret results of dye penetrant and magnetic particle inspections; and supervise lower rated ABE's in the various maintenance procedures.

A wide variety of assignments ashore is available to the ABE1 and ABEC. In addition to the routine AB type billets, the ABE1 and ABEC are eligible for assignment to instructor duty as well as a number of other desirable billets. Most of these billets are under the management control of the Bureau of Naval Personnel and are directly associated with training. Others are associated with research, testing, or evaluation. Some of the more desirable billets to which the ABE1 and ABEC may be assigned are described in the following paragraphs.

1. Instructor duty is available to both the ABE1 and ABEC in the ABE Schools at NATTC, Lakehurst, N. J. Another possibility for instructor duty is with the Aviation Fundamentals Course at Orlando, Florida.

In addition to the above mentioned instructor billets, the ABE1 and ABEC may be assigned to instructor duty at Millington, Tennessee.

Instructor billets are normally filled on a voluntary basis. Detailed information concerning assignment to instructor duty is contained in the Enlisted Transfer Manual, NavPers 15909 (Series).

2. ABEC's are also eligible for assignment to duty with the Naval Education and Training Support Command headquartered at Pensacola, Florida, as a Technical Writer to assist in the preparation of Rate Training Manuals and Nonresident Career Courses (formerly called Enlisted Correspondence Courses) for the AB ratings, and as an item writer in the preparation of Navy-wide advancement-in-rating examinations for enlisted personnel.

3. Senior ABE's may be assigned to the development and testing units at Lakehurst, New Jersey; Patuxent River, Maryland; or Naval Air Engineering Center (NAEC), Philadelphia, Pennsylvania.

For a listing of other special programs and projects, reference should be made to the Enlisted Transfer Manual. Others are also announced from time to time in BuPers Notices.

Personnel may indicate their desire for assignment to a specific program or project by indicating it in the "remarks" block of their Rotation Data Card.

In today's modern Navy there is an awesome array of weapons and ships. Who can say which one is the most important? It is a known fact, however, that our modern carrier force is one of the big deterrents to any world power thinking of armed conflict. The striking power and the maneuverability of our carriers are what make them so important in the defense of the free world.

But one factor concerning our aircraft carriers must always be understood: How useful would they be without the catapults and arresting gear units installed aboard them? Also, how could an aircraft carrier fulfill its mission if either of these components were inoperative? The truth of the matter is, "The carrier would be inoperative."

This is why you as senior men in the ABE rating should realize the importance of your position. You, as ABE's, play a very important part in keeping your ship a fighting ship.

As a result of the Naval Leadership Program, a considerable amount of material related to naval leadership for the senior petty officer is available. Studying this material will make you aware of your many leadership responsibilities as a senior petty officer and will also be of great help in developing leadership qualities. It will not in itself, however, make you a good leader. Leadership principles can be taught, but a good leader acquires that quality only through hard work and practice.

As you study this material containing leadership traits, keep in mind that probably none of our most successful leaders possessed all of these traits to a maximum degree, but a weakness in some traits was more than compensated for by strength in others. Critical self-evaluation will enable you to realize the traits in which you are strong, and to capitalize on them. At the same time you must constantly strive to improve on the traits in which you are weak.

Your success as a leader will be decided, for the most part, by your achievements in inspiring others to learn and perform. This is best accomplished by personal example.

ADVANCEMENT

By this time, you are probably well aware of the personal advantages of advancement—higher pay, greater prestige, more interesting and challenging work, and the satisfaction of getting ahead in your chosen career. By this time, also, you have probably discovered that one of the most enduring rewards of advancement is the training you acquire in the process of preparing for advancement.

The Navy also profits by your advancement. Highly trained personnel are essential to the functioning of the Navy. By advancement, you increase your value to the Navy in two ways. First, you become more valuable as a person who can supervise, lead, and train others and second, you become more valuable as a technical specialist and thus make far-reaching contributions to the entire Navy.

Since you are studying for advancement to PO1 or CPO, you are probably already familiar with the requirements and procedures for advancement. However, you may find it helpful to read the following sections. The Navy does not stand still. Things change all the time, and it is possible that some of the requirements have changed since the last time you went up for advancement. Furthermore, you will be responsible for training others for advancement, therefore, you will need to know the requirements in some detail.

HOW TO QUALIFY FOR ADVANCEMENT

To qualify for advancement, a person must:

1. Have a certain amount of time in grade.
2. Complete the required military and professional training manuals.
3. Demonstrate the ability to perform all the PRACTICAL requirements for advancement by completing applicable portions of the Record of Practical Factors, NavEdTra 1414/1.
4. Be recommended by his commanding officer.
5. Demonstrate his KNOWLEDGE by passing a written examination on (a) military requirements, and (b) professional qualifications.

Remember that the requirements for advancement can change. Check with your educational services office to be sure that you know the most recent requirements.

When you are training lower rated personnel, it is a good idea to point out that advancement is not automatic. Meeting all the requirements makes a person ELIGIBLE for advancement. Such factors as the score made on the written examination, length of time in service, performance marks, and quotas enter into the final determination of who will actually be advanced.

HOW TO PREPARE FOR ADVANCEMENT

Preparation for advancement includes studying the qualifications, working on the practical factors, studying the required Rate Training Manuals, and studying any other material that may be specified. To prepare yourself for advancement or to help others prepare for advancement, you will need to be familiar with (1) the "Quals" Manual, (2) the Record of Practical Factors, NavEdTra 1414/1, (3) a NavEdTra publication called Bibliography for Advancement Study, NavEdTra 10052 (Series) and (4) Rate Training Manuals. The following sections describe these materials and give some information on how to use them to the best advantage.

"Quals" Manual

The Manual of Qualifications for Advancement, NavPers 18068 (Series), gives the minimum requirements for advancement to each rate within each rating. This manual is usually called the "Quals" Manual, and the qualifications are of two general types: (1) military requirements, and (2) professional or technical qualifications. Military requirements apply to all ratings rather than to any one rating alone. Professional qualifications are technical or professional requirements that are directly related to the work of each rating.

Both the military requirements and the professional qualifications are divided into subject matter groups. Then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS.

The qualifications for advancement and a bibliography of study materials are available in your educational services office. The "Quals" Manual is changed more frequently than Rate Training Manuals are revised. By the time you are studying this training manual, the "quals" may have been changed. Never trust any set of "quals" until you have checked the change number against an UP-TO-DATE copy of the "Quals" Manual.

In training others for advancement, emphasize these three points about the "quals":

1. The "quals" are the MINIMUM requirements for advancement. Personnel who study MORE than the required minimum will have a great advantage when they take the written examinations for advancement.

2. Each "qual" has a designated rate level—chief, first class, second class, or third class. You are responsible for meeting all "quals" specified for the rate level to which you are seeking advancement AND all "quals" specified for lower rate levels.

3. The written examinations for advancement will contain questions relating to the practical factors AND to the knowledge factors of BOTH the military requirements and the professional qualifications.

Record of Practical Factors

A special form known as the Record of Practical Factors, NavEdTra 1414/1, is used to record the satisfactory performance of the practical factors. This form lists all military and all professional practical factors. Whenever a person demonstrates his ability to perform a practical factor, appropriate entries must be made in the DATE and INITIAL columns. As a PO1 or CPO, you will often be required to check the practical factor performance of lower rated personnel and to report the results to your supervising officer.

As changes are made periodically to the "Quals" Manual, new NavEdTra forms 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the "Quals" Manuals. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rate but which are not identified as minimum qualifications for advancement. Keep this in mind when you are training and supervising other personnel. If a person demonstrates proficiency in some skill which is not listed in the "quals" but which is within the general scope of the rate, report this fact to the supervising officer so that an appropriate entry can be made in the Record of Practical Factors.

When you are transferred, the Record of Practical Factors should be forwarded with your service record to your next duty station. It is a good idea to check and be sure that this form is actually inserted in your service record before you are transferred. If the form is not in your record, you may be required to start all over again and requalify in practical factors that have already been checked off. You should also take some responsibility for helping lower rated personnel keep track of their practical factor records when they are transferred.

A second copy of the Record of Practical Factors should be made available to each man in pay grades E-3 through E-8 for his personal record and guidance.

NavEdTra 10052

Bibliography for Advancement Study, NavEdTra 10052 (Series) is a very important publication for anyone preparing for advancement. This publication lists required and recommended Rate Training Manuals and other reference material to be used by personnel working for advancement. NavEdTra 10052 (Series) is revised and issued once each year by the Naval Education and Training Support Command. Each revised edition is identified by a letter following the NavEdTra number. When using this publication, be SURE you have the most recent edition.

The required and recommended references are listed by rate level in NavEdTra 10052 (Series).

It is important to remember that you are responsible for all references at lower rate levels, as well as those listed for the rate to which you are seeking advancement.

Rate Training Manuals that are marked with an asterisk (*) in NavEdTra 10052 (Series) are MANDATORY at the indicated rate levels. The completion requirements of a mandatory training manual may be satisfied by (1) passing the appropriate Nonresident Career Course that is based on the mandatory training manual, (2) passing locally prepared tests based on the information given in the mandatory training manual, or (3) in some cases, successfully completing an appropriate Navy school.

When training personnel for advancement, do not overlook the section of NavEdTra 10052 (Series) which lists the required and recommended references relating to the military requirements for advancement. All personnel must complete the mandatory military requirements training manual for the appropriate rate level before they can be eligible to advance. Also, make sure that personnel working for advancement study the references which are listed as recommended but not mandatory in NavEdTra 10052 (Series). It is important to remember that ALL references listed in NavEdTra 10052 (Series) may be used as source material for the written examinations, at the appropriate levels.

Rate Training Manuals

There are two general types of Rate Training Manuals. Manuals (such as this one) are prepared for most enlisted rates and ratings, giving information that is directly related to the professional qualifications for advancement. Basic manuals give information that applies to more than one rate and rating.

Rate Training Manuals are revised from time to time to bring them up-to-date. The publication, List of Training Manuals and Correspondence Courses, NavEdTra 10061 (Series), which is revised annually, contains a listing of current Rate Training Manuals and their identifying numbers. The letter following the number identifies the latest revision; for example, –A indicates first revision, –B indicates second revision, etc.

Rate Training Manuals are designed for the special purpose of helping naval personnel prepare for advancement. By this time, you have probably developed your own way of studying these manuals. Some of the personnel you train, however, may need guidance in the use of Rate Training Manuals. Although there is no single "best" way to study a training manual, the following suggestions have proved useful for many people:

1. Study the military requirements and the professional qualifications for your rate before you study the training manual, and refer to the "quals" frequently as you study. Remember, you are studying the training manual primarily to meet these "quals."

2. Before you begin to study any part of the training manual intensively, get acquainted with the entire manual. Read the preface and the table of contents. Check through the index. Thumb through the manual without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

3. Look at the training manual in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the manual.

4. When you have a general idea of what is in the training manual and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

5. In studying each unit, write down questions as they occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

6. As you study, relate the information in the training manual to the knowledge you already have. When you read about a process, a skill, or a situation, ask yourself some questions. Does this information tie in with past experience? Is this something new and different? How does this information relate to the qualifications for advancement?

7. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Without looking at the training manual, write down the main ideas you have learned from studying this unit. Do not just quote the manual. If you cannot give these ideas in your own words, the chances are that you have not really mastered the information.

8. Use Nonresident Career Courses whenever you can. These courses are based on Rate Training Manuals or other appropriate texts. As mentioned before, completion requirements of a mandatory Rate Training Manual can be satisfied by passing a Nonresident Career Course based on the training manual. You will probably find it helpful to take other courses, as well as those based on mandatory training manuals. Such courses help you to master the information given in the training manuals, and also give you an idea of how much you have learned.

INCREASED RESPONSIBILITIES

When you assumed the duties of a PO3, you began to accept a certain amount of responsibility for the work of others. With each advancement, you accept an increasing responsibility in military matters and in matters relating to the professional work of your rate. When you advance to PO1 or CPO, you will find a noticeable increase in your responsibilities for leadership, supervision, training, working with others, and keeping up with new developments.

As your responsibilities increase, your ability to communicate clearly and effectively must also increase. The simplest and most direct means of communication is a common language. The basic requirement for effective communication is therefore a knowledge of your own language. Use correct language in speaking and in writing. Remember that the basic purpose of all communication is understanding. To lead, supervise, and train others, you must be able to speak and write in such a way that others can understand exactly what you mean.

Leadership and Supervision

As a PO1 or CPO, you will be regarded as a leader and supervisor. Both officers and enlisted personnel will expect you to translate the general orders given by officers into detailed, practical, on-the-job language that can be understood and followed by relatively inexperienced personnel. In dealing with your juniors, it is up to you to see that they perform their jobs correctly. At the same time, you must be able to explain to officers any important problems or needs of enlisted personnel. In all military and professional matters, your responsibilities will extend both upward and downward.

Along with your increased responsibilities, you will also have increased authority. Officers and petty officers have POSITIONAL authority—that is, their authority over others lies in their positions. If your CO is relieved, for example, he no longer has the degree of authority over you that he had while he was your CO, although he still retains the military authority that all seniors have over subordinates. As a PO1, you will have some degree of positional authority; as a CPO, you will have even more. When exercising your authority, remember that it is positional—it is the rate you have, rather than the person you are, that gives you this authority.

A Petty Officer conscientiously and proudly exercises his authority to carry out the responsibilities he is given. He takes a personal interest in the success of both sides of the chain of command . . . authority and responsibility. For it is true that the Petty Officer who does not seek out and accept responsibility, loses his authority and then the responsibility he thinks he deserves. He must be sure, by his example and by his instruction, that the Petty Officers under him also accept responsibility. In short, he must be the leader his title—Petty Officer—says he is.

Training

As a PO1 or CPO, you will have regular and continuing responsibilities for training others. Even if you are lucky enough to have a group of subordinates who are all highly skilled and well trained, you will still find that training is necessary. For example, you will always be responsible for training lower rated personnel for advancement. Also, some of your best workers may be transferred, and inexperienced or poorly trained personnel may be assigned to you. A particular job may call for skills that none of your personnel have. These and similar problems require that you be a training specialist—one who can conduct formal and informal training programs to qualify personnel for advancement, and one who can train individuals and groups in the effective execution of assigned tasks.

In using this training manual, study the information from two points of view. First, what do you yourself need to learn from it? And second, how would you go about teaching this information to others?

Training goes on all the time. Every time a person does a particular piece of work, some learning is taking place. As a supervisor and as a training expert, one of your biggest jobs is to see that your personnel learn the RIGHT things about each job so that they will not form bad work habits. An error that is repeated a few times is well on its way to becoming a bad habit. You will have to learn the difference between oversupervising and not supervising enough. No one can do his best work with a supervisor constantly supervising. On the other hand, you cannot turn an entire job over to an inexperienced person and expect him to do it correctly without any help or supervision.

In training lower rated personnel, emphasize the importance of learning and using correct terminology. A command of the technical languages of your occupational field enables you to receive and convey information accurately and to exchange ideas with others. A person who does not understand the precise meaning of terms used in connection with his work is definitely at a disadvantage when he tries to read official publications relating to his work. He is also at a great disadvantage when he takes the examinations for advancement. To train others in the correct use of technical terms, you will need to be very careful in your own use of words. Use correct terminology and insist that personnel you are supervising use it too.

You will find the Record of Practical Factors, NavEdTra 1414/1, a useful guide in planning and carrying out training programs. From this record, you can tell which practical factors have been checked off and which ones have not yet been done. Use this information to plan a training program that will fit the needs of the personnel you are training.

On-the-job training is usually controlled through daily and weekly work assignments. When you are working on a tight schedule, you will generally want to assign each person to the part of the job that you know he can do best. In the long run, however, you will gain more by assigning personnel to a variety of jobs so that each person can acquire broad experience. By giv[illegible] a chance to do carefully supervised w[illegible] in which they are relatively i[illegible]nced, you will increase the range of skills of each person and thus improve the flexibility of your working group.

Working with Others

As you advance to PO1 or CPO, you will find that many of your plans and decisions affect a large number of people, some of whom are not even in your own occupational field. It becomes increasingly important, therefore, for you to understand the duties and the responsibilities of personnel in other ratings. Every petty officer in the Navy is a technical specialist in his own field. Learn as much as you can about the work of others, and plan your own work so that it will fit into the overall mission of the organization.

Keeping Up With New Developments

Practically everything in the Navy—policies, procedures, publications, equipment systems—is subject to change and development. As a PO1 or CPO, you must keep yourself informed about changes and new developments that affect you or your work in any way.

Some changes will be called directly to your attention, but others will be harder to find. Try to develop a special kind of alertness for new information. When you hear about anything new in the Navy, find out whether there is any way in which it might affect your work. If so, find out more about it.

SOURCES OF INFORMATION

As a PO1 or CPO, you must have an extensive knowledge of the references to consult for accurate, authoritative, up-to-date information on all subjects related to the military and professional requirements for advancement.

Publications mentioned in this chapter are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to revision, make sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made.

Training manuals that are applicable are available through your educational services officer. In addition to training manuals and publications, training films furnish a valuable source of supplementary information. Films that may be helpful are listed in the U. S. Navy Film Catalog, NavAir 10-1-777.

ADVANCEMENT OPPORTUNITIES FOR PETTY OFFICERS

Making chief is not the end of the line as far as advancement is concerned. Advancement to Senior (E-8) and Master (E-9) Chief, Warrant Officer, and Commissioned Officer are among the opportunities that are available to qualified petty officers. These special paths of advancement are open to personnel who have demonstrated outstanding professional ability, the highest order of leadership and military responsibility, and unquestionable moral integrity.

PROFICIENCY PAY

The determination as to which Navy ratings, NEC's, and Special Duty Assignments are authorized proficiency pay is accomplished through an annual review, within the Bureau of Naval Personnel, of all Navy ratings, NEC's, and Special Duty Assignments. Those ratings, NEC's or special duty assignments which fulfill the Department of Defense criteria for an award of proficiency pay are included in a proposed fiscal year Proficiency Pay Program submitted to the Secretary of Defense for approval.

The Secretary of Defense has authorized two categories of Proficiency Pay for Navy:

1. Shortage Specialty (Proficiency Pay). A monthly amount of pay in addition to any pay and allowances to which otherwise entitled that may be awarded to an eligible enlisted member who possesses a critical rating or NEC. Shortage Specialty (Proficiency Pay) is designed to assist in attaining and sustaining adequate career manning levels in critical ratings and NEC's.

2. Special Duty Assignment (Proficiency Pay). A monthly amount of pay in addition to any pay and allowances to which otherwise entitled that may be awarded to an eligible enlisted member who is assigned to certain special duties. Special Duty Assignment (Proficiency Pay) is designed to assist in attaining and sustaining an adequate volunteer manning level in the critical special duty assignments.

ADVANCEMENT TO SENIOR AND MASTER CHIEF

Chief petty officers may qualify for the advanced grades of Senior and Master Chief which are now provided in the enlisted pay structure. These advanced grades provide for substantial increases in pay, together with increased responsibilities and additional prestige. The requirements for advancement to Senior and Master Chief are subject to change but, in general, include a certain length of time in grade, a certain length of time in the naval service, a recommendation by the commanding officer, and a sufficiently high mark on the Navy-wide examination. The final selection for Senior and Master Chief is made by a regularly convened selection board.

Examination Subjects

Qualifications for advancement to Senior Chief Petty Officer and Master Chief Petty Officer have been developed and published in the Manual of Qualifications for Advancement, NavPers 18068 (Series). They officially establish minimum military and professional qualifications for Senior and Master Petty Chief Officers.

The Bibliography for Advancement Study, NavEdTra 10052 (Series) contains a list of study references which may be used to study for both military and professional requirements.

The satisfactory completion of the nonresident career course titled Military Requirements for Senior and Master Chief Petty Officer, NavTra 91209, is mandatory for advancement to E-8 and E-9.

ADVANCEMENT TO WARRANT AND COMMISSIONED OFFICER

The Warrant Officer program provides opportunity for advancement to warrant rank for E-6 and above enlisted personnel. E-6's, to be eligible, must have passed an E-7 rating exam prior to selection.

The LDO program provides a path of advancement from warrant officer to commissioned officer. LDO's are limited, as are warrants, in their duty, to the broad technical fields associated with their former rating.

If interested in becoming a warrant or commissioned officer, ask your educational services officer for the latest requirements that apply to your particular case.

CHAPTER 2
LEADING PETTY OFFICERS

Senior petty officers of the Aviation Boatswain's Mates E rating have one of the most responsible jobs aboard an aircraft carrier. They must handle large groups of men, supervise the operation of catapult and arresting gear machinery, and perform many other jobs with a maximum of safety. Their ability as leaders and supervisors has earned them the respect of their seniors and also the men under them. It has taken much thought, study, planning, manual labor, and an unsurpassed attention to details to earn this respect.

Each of these leading petty officers has played an important part in the formation of plans of action, has taken direct steps to insure that these plans were explicitly carried out, and has exercised great care to treat the men under him with fairness, respect, and consideration.

LEADING PETTY OFFICERS' DUTIES

The most important duty of any petty officer is leadership. Leadership is the art of influencing human behavior or the ability to handle men. The leading ABE began developing this art at the time he was given his first responsible job before being advanced to ABE3. It may have been an unconscious effort on his part at this time or he may have actually realized that he was being given an opportunity to develop certain leadership qualities. ABE's seeking advancement to the higher rates must show continuing improvement in their leadership abilities and techniques.

Military leadership, like any other form of leadership, requires that certain factors or elements be exhibited to make it a vital and driving force. The leading ABE, by virtue of his position, must demand discipline from his men. Permitting undisciplined actions on the part of his men actually marks him as a poor leader in their eyes although he may not realize it at the time.

The morale of the men under him is of vital importance to the leading petty officer. Only when his men exhibit zeal in their work, have pride in their accomplishments, show confidence in their leading petty officer, and possess efficient work habits is the leading ABE certain that his leadership is of the highest quality.

Another element directly connected with the art of leadership is that of ethics. Here, ethics is thought of as the exercise of duty along moral lines. The leading ABE must have developed a strong sense of what is right and wrong by the time he reaches the leading petty officer status. His ability to stand firmly by his convictions concerning correct moral ethics, sometimes in the face of poorly concealed disbelief on the part of his men, is a factor which will ultimately win for him the confidence of his men. By adhering to a high standard of honor and integrity, he wins the confidence not only of his men, but also that of his superiors.

Two other important characteristics of a conscientious leading petty officer are his ability to train and to supervise the men under him. Leading ABE's must employ various techniques in the training and supervision of the men under them. These techniques may have been acquired in formal training schools, or through experience since their striker days. Regardless of how they were attained, good techniques are essential in the effective and proficient training and supervision of men. If a leading petty officer will evaluate himself on how effectively he is using the better techniques which he has learned through the years, he will realize his value to the Navy.

This question is often asked: "Why do some leading ABE's with equal time in the Navy make better instructors and supervisors than others?"

There are several reasons. Some of these men have a natural flair for teaching and an innate ability to supervise men, others do not. Some will have had more experience in supervision and instruction than others due to the nature of their past billets. Moreover, some actually enjoy teaching and supervising; others have not developed this liking. However, it has been found that most reasonably intelligent persons may become proficient instructors and supervisors provided they apply themselves and receive the proper training, either through schooling or through personal experience on the job.

There are many First Class and Chief Aviation Boatswain's Mates E doing excellent jobs in the Navy today who have acquired their excellence in these two areas through personal experience alone. These petty officers have advanced through reading, self-study, and observing closely the effects of their supervision and instruction on the men placed in their charge. They have also changed their techniques when they found the old ones to be ineffective, and have generally kept an alert and open mind regarding their responsibilities as an instructor and supervisor.

TRAINING

In order for the leading ABE to give the most effective instruction to his men, he must devote considerable thought to the planning of his presentation, including the type and kind of instruction to be used. Maximum use must be made of all available instructional aids and demonstration models. The advisability of using instructional aids and demonstration models cannot be overemphasized, particularly when the actual piece of equipment is not available or is totally unfit for classroom use due to size, cost, or complexity. Often times, demonstrations may be made clearer through the use of models than with the actual equipment. This is especially true in instances involving the giving of instruction to large numbers of men simultaneously. They are able to see the model when properly displayed, whereas they might not all be able to see the actual piece of equipment clearly enough to observe the details.

The first step in setting up any effective program of instruction in any field is planning. The instructor performs his job much more precisely and the trainee learns more quickly and accurately when the instruction is given in a logical sequence. For this reason a lesson plan is needed which sets down the various steps of instruction. For example, the instructor cannot always afford to trust to memory while explaining the procedures for checking a control station. He should have a prepared lesson plan at his disposal which notes the various steps in detail.

METHODS OF INSTRUCTION

Three commonly employed methods of instruction are the lecture, the discussion, and the demonstration. Each has its advantages and disadvantages. Quite often one or more of these methods may be combined to be advantageous in certain types of instruction. In other instances, one of these methods may work better if employed by itself. However, too much dependence should not be placed in any one of these methods for all occasions.

The lecture method is considered to be the least effective of the three for most purposes. However, the leading ABE may effectively use the lecture method when instructing a large class.

A large portion of the teaching performed in the Navy is accomplished through the discussion method. This method requires student participation to a degree not found in the other methods, and for that reason is a much more effective method of instruction in many situations.

The leading ABE will find the discussion method to be a great help in "getting across" to a class, or informal group, the knowledge necessary to safely and effectively remove and install various types of packing. By commencing the session with a brief summary of what is to be learned, the instructor sets the stage for utilizing the discussion method of instruction. He can create trainee interest by drawing out automatic answers to his carefully planned questions on the topic. The leading petty officer never calls on his students in any set pattern but at random. This procedure keeps the trainees more alert, as they are never certain when they may be called upon to answer a question.

The demonstration method of instruction is probably the most effective method known, whereby trainees learn exact methods of performance in technical work. This method succeeds where others fail, because it attracts the attention of the trainee and arouses his direct interest. Trainees will want to try their skill at doing the job.

The demonstration method may be used effectively in teaching principles of operation, maintenance, testing, inspection, and other phases connected with the equipment operated by ABE's. Leading petty officers find this an excellent method in the training of strikers and men in the lower rates on how to calibrate gages using the calibrating instrument. The instructor calibrates a gage, showing the procedure. He then lets each trainee calibrate a gage. Through demonstrations the instructor is able to insure that his students are capable of performing the required work in a shorter length of time.

LEARNING AND LEARNING PROCESSES

The instructor's role in the learning process is to expedite learning by causing it to take place in the trainee's mind more effectively and in a shorter period of time. It is found, however, that there are certain learning processes which take place in the mind of the trainee with a minimum of guidance from the instructor. Examples of these processes include learning by trial and error, by observation, by transfer, and by doing.

The trial and error method lends itself to waste of time and energy with respect to learning. The period of learning under this method is necessarily longer than under guided instruction. Once an error is made in the learning process, progress halts, and a new start must be undertaken. Gross negligence would be involved in allowing an inexperienced man to attempt to repair a delicate and costly pressure gage. It might even be dangerous to him and others nearby, as well as damaging the gage beyond repair. The trial and error method should be used with discretion.

Learning by means of observation is infinitely better than trying to acquire knowledge by trial and error. However, there are a number of disadvantages to this method. Even when an experienced man is being closely observed at work, many of the finer points as well as some of the basic points of the performance are missed by the observer. He simply cannot observe them all; there is too much to be seen. An example of this is a man not familiar with the dye penetrant inspection watching an experienced man interpreting results. He must have the techniques explained to him prior to commencing the performance and as the performance progresses. This helps the trainee because "he knows what to look for" and "understands what is going on," even though he may not be able to see it all. The trainee should then practice all phases of the performance himself.

The transfer of learning is the reuse of previously gained knowledge in new situations. For example, a man who has worked on one type of arresting gear would find it easier to learn another type of arresting gear than would a man who has no experience in arresting gear at all. He would be able to transfer some of his earlier learning to the new situation. The components with which he previously worked and those he now uses have something in common. Therefore, it may be said that a transfer of learning has taken place, thus facilitating learning in the new situation.

One of the most expeditious and effective methods of learning is that of learning by doing. This is not a self-teaching method; it requires that the instructor's services be utilized. The instructor and the trainee must work together. Learning takes place under this method in the following manner: The instructor first performs what is to be done and tells the trainee what he is doing while he works. Next, the trainee attempts to tell what is being done while the instructor once again performs the work. Now it becomes the trainee's turn to perform the work and at the same time tell what he is doing. Finally, the trainee practices what he has learned while the instructor closely supervises the work.

Learning by doing is the basic method for most types of on-the-job training in the Navy. For example, the leading petty officer has an easier time teaching an ABE striker how to disassemble and reassemble a control valve by using the learning by doing method of instruction. Conversely, it is easier for the striker to learn disassembly and reassembly of this valve in a minimum of time by working closely with the instructor.

CONDITIONS, ATTITUDES, AND HABITS

Many factors affect the efficiency with which the trainee will learn. The physical conditions under which instruction is given is a major consideration in determining its effectiveness. It is reasonably certain that a discussion conducted by an instructor would be less than successful under adverse conditions of temperature, lighting, noise, and other distracting elements.

The alert instructor will think of and do something about the mental conditions and conditioning of his trainees. He must know how to cope with the various types of mental distresses and take positive action to remedy them. His approach to the problem should be from a sympathetic viewpoint rather than one of rebuff or anger.

In some cases the instructor assigns his students specific homework when time does not permit all of the technical data to be adequately covered in regular study periods, either ashore or afloat. He should test the men periodically on this outside work to insure that they understand what they have accomplished on their own. For instance, if the subject being covered is a catapult control valve, he may assign outside reading in Fluid Power, NavPers 16193 (Series) to cover the basic theory. Other areas of theory and all possible practical work are discussed in class.

By questioning the trainees during the study periods and giving tests on the areas assigned in the collateral reading, the instructor may check on their study habits and their total progress. He must constantly review the basic concepts of good work habits and study habits with the trainees. Through repetition, they should become second nature to the trainees.

A more detailed discussion on the factors involved in learning and the methods of instructing is contained in the Manual for Navy Instructors, NavPers 16103 (current edition).

PRINCIPLES OF SUPERVISION

United States Navy Regulations (1948) states that Navy petty officers "shall aid to the utmost of their ability, and to the extent of their authority, in maintaining good order and discipline, and in all that concerns the efficiency of the command." This is a major responsibility of the petty officer. It is likewise a major duty. To comply with Navy Regulations, a leading ABE (supervisor) must direct the activities of the men being supervised in a manner to cause them to take pride in jobs that they have performed well.

Further, in order to direct activities competently, it is necessary for the supervisor to have a working knowledge of the principles of supervision. Supervision consists of exercising commonsense and good judgment, the application of certain basic principles, an understanding of human nature to the greatest extent possible, ability to make decisions, the practicing of impartial treatment to all, and an intense loyalty to both superiors and the men being supervised. By the time an ABE becomes a leading petty officer he has already developed many of these attributes and needs only to concentrate on those few that he has not entirely grasped.

The military and specialty duties and responsibilities of the leading ABE go hand in hand. Certain areas of the ABE's responsibility are inherent by the nature of his work, others as a result of his being a petty officer in the Navy.

His duties lie, to a great extent, in accomplishments in the areas of work for which he is responsible. The leading PO must perform the related functions of a military leader and a technical man simultaneously. He may not work at one to the exclusion of the other. The leading petty officer must know the technical aspects of the ABE rating; otherwise his usefulness as a supervisor and as a technical man will be severely curtailed. He must have the attributes of a good military leader; otherwise his usefulness as a supervisor and leader will be equally limited. Thus, he is definitely limited in the fields of leadership and supervision, as well as his usefulness to the Navy, if for instance, he is unable to explain the operation of a fluid cooler, or is unable to effectively supervise a group of men hooking up an aircraft to a catapult.

By definition, a supervisor is one who is responsible for and directs the work of others. This means that the leading ABE must actually oversee and instruct the men under his supervision. A mere inspection of the work of the men under him is not supervision. The function of supervision is not considered to have been fulfilled until positive action has been taken to improve a program, to expedite a process, or otherwise to improve a given situation. The supervisor has a tremendous job when all facets are considered. He must satisfy the demands of his superiors, he must keep his men busy and content in their work, and, as a check on himself, he must constantly analyze his abilities in the job to determine if he is successfully accomplishing the goals of an instructor and leader.

PERSONNEL RELATIONSHIPS

The everyday contacts of the supervisor with the men under him and others associated with him constitute personnel relationships. The leading ABE is concerned with the everyday contacts, as well as trying to maintain and improve personnel relationships. He realizes that when the men under his supervision are generally satisfied with their working conditions, a sense of good personnel relationship exists. Although this condition exists, he must strive to improve the relationships on a continuing basis. He also realizes that the manner in which he personally handles his own contacts influences the attitude of his men toward his supervision. It matters not whether these contacts are on a group or on an individual basis. It requires just as much tact, interest, enthusiasm, and effort in making one working contact as in making many at one time. Effecting good personnel relationships constitutes a great portion of the responsibility and duty of a supervisor and military leader.

One of the factors influencing the supervisor's ability to maintain good personnel relationships is the manner in which he gives orders. Quite often there is a failure on the part of the supervisor to note the close connection existing between discipline, cooperation, and giving orders. Orders given in connection with military drill, etc., should invariably be given in a clear crisp voice devoid of excitement and slowly enough for their meaning to be understood clearly. Orders given to a trainee or a group of trainees by a supervisor normally take the form of directions, assignments, requests for performance of certain work, etc. The only military implication in these orders is that of obedience on the part of the trainee. Otherwise, there is little similarity in the two types of orders. However, the supervisor must exhibit consideration in any type of order that he gives. He must have the military and supervisory qualities that will enable him to carry out his duties and responsibilities in the most advantageous manner and insure that his subordinates do likewise.

QUALITIES OF A GOOD SUPERVISOR

To attain the status of a good supervisor, one must possess a number of qualities and traits which directly or indirectly influence the men supervised. A definite relationship exists between the supervisor, the instructor, and the leader. Each might be said to occupy one point of a triangle; so closely are they related. The traits and qualities normally attributed to a supervisor are equally applicable to an instructor or leader. Each employs the same techniques and adheres to the same principles in a broad sense. By the time that the leading ABE becomes qualified as a supervisor, he will have attained the desirable qualities and traits of an instructor and leader.

It is neither feasible nor desirable to detail in this manual all of the traits and qualities intimately associated with the good supervisor, instructor, and leader. However, it is important that the leading ABE, through self-appraisal, constantly remind himself of these traits and qualities in order to maintain and improve his value to the Navy. A review of supervision, instruction, and leadership may be found in Military Requirements for Petty Officers 1 & C, NavPers 10057 (Series).

DIVISION ORGANIZATION

Although the organization of a V-2 division varies slightly with the type of ship and the amount of launching and recovery equipment on board, this chapter covers the fundamental setup for a CVA. You will see that we go into detail only in the functions of the V-2 division officer, leading chief, other chiefs assigned, and the leading petty officers. In later chapters, the duties of the other men assigned to a V-2 division are broken down.

To get a better idea of the function of a V-2 division the following is quoted:

"The mission of the V-2 division of the air department is to conduct launching and landing operations and to operate and maintain the catapults, arresting gear, and visual landing aids so that the embarked aircraft squadrons and detachments can most effectively conduct air operations in the application of their military potential."

V-2 DIVISION OFFICER

The basic functions of the V-2 division officer are the supervision of the operation and upkeep of the ship's catapults and arresting gear, and directing operations in the Fly One area during flight quarters. He has cognizance over catapult and arresting gear personnel. He also performs the functions of arresting gear officer in the absence of an assistant catapult and arresting gear officer. Other duties and responsibilities are to:

1. Supervise the operation of the catapults in the launching of aircraft as follows:

   a. Designate catapult pressure/constant steam valve (CSV) setting to be used during each launch and such changes in pressures as may be required during launching operations.

   b. Supervise the spotting of aircraft on the catapults.

   c. Check catapult hookup and aircraft alinement.

   d. Visually check aircraft to insure that wing flaps are in the desired position and wings locked in position.

   e. Give the signal for firing the catapult after ascertaining that the pilot, aircraft, and catapult machinery are in all respects ready for the launch.

2. Insure that safety precautions are observed by catapult personnel in the launching area and catapult machinery spaces.

3. Insure the readiness of catapult engines, controls, and other pertinent apparatus by means of frequent tests and inspections and by insuring that necessary repairs and preventive maintenance procedures are performed.

4. Initiate action in case of crash, fire, or other damage forward on the flight deck until relieved by the flight deck officer, or aircraft crash and salvage officer.

5. Insure the upkeep of spaces and shops assigned to catapult and arresting gear, including the posting and enforcement of operating instructions and safety precautions.

6. Insure that spare parts required are requisitioned, and sign the requisition form.

7. Insure that logbooks and records are maintained and that pertinent information is properly recorded and reported as required by higher authority.

8. Maintain current files of pertinent publications, bulletins, operating instructions, and other directives of higher authority.

9. Supervise the training of assigned personnel in the operation and maintenance of the catapults and brief all pilots on catapult procedures.

10. Request permission of the air officer or primary fly control to activate or deactivate catapults.

11. Act as division officer in the administration of the V-2 division.

12. Prepare requisitions for general supplies and material for transmittal to the aircraft handling officer.

13. Insure the preservation and cleanliness of assigned spaces.

14. Perform such other duties as may be required.

LEADING CHIEF PETTY OFFICER

The leading CPO has authority over all enlisted personnel of the V-2 division and insures that the material upkeep and maintenance of the arresting gear and catapult systems are properly performed. He is also responsible for the cleanliness of the spaces assigned to the division, to conform with the high standards established for the ship. The leading CPO is the senior CPO of the division. All other CPO's of the division are subordinate to him.

Specific duties are to:

1. Pursue a vigorous training program in accordance with departmental and divisional policies.

2. Maintain logs and submit reports as required.

3. Control the personal appearance of all personnel of the division.

4. Muster the division daily and make a report of this muster to the division officer.

5. Maintain an up-to-date watch, quarter, and station bill for the division.

6. Supervise the upkeep, repair, and cleaning of all assigned spaces and machinery.

7. Recommend to the division officer the assignment of men to billet numbers.

8. Screen special requests and indicate approval or disapproval in the prescribed form.

9. Assist the division officer in the preparation of reports of Enlisted Performance Evaluation (NavPers 1616/5 for personnel assigned to the division in pay grades E-1 through E-6, and NavPers 1616/8 for other CPO's assigned to the division).

10. Advise the division officer of the need for an extension of the normal working day, when necessary, in order to maintain material upkeep and cleanliness of his spaces to conform to division standards.

11. Disable vital machinery only after permission has been obtained from the division officer.

12. Perform such other duties as directed by proper authority.

Other CPO's are assigned to the V-2 division, depending upon the total number of catapults and arresting gear units installed aboard ship. These CPO's aid the leading CPO in all of the above duties and one of them acts as the leading CPO in his absence.

LEADING PETTY OFFICER

The leading petty officer is primarily responsible for the administrative functioning of the division. During operations, he acts as a roving supervisor to coordinate the activities of the entire division. The leading petty officer is the senior petty officer (other than CPO's) assigned to the division. All other petty officers are subordinate to him.

The specific duties and responsibilities of the leading petty officer correspond closely with those of the leading CPO. These duties may be considered to be performed on a more personal basis, in that the leading petty officer deals directly with the junior petty officers and men in the division, and serves as liaison between them and the leading CPO.

Some of the more important responsibilities of the leading petty officer are the maintenance of the training program; enforcement of safety regulations; and the upkeep of the division watch, quarter, and station bill. The leading petty officer also prepares the division daily watch list and insures that all personnel standing the aviation security watches are properly qualified.

OTHER ADMINISTRATIVE PERSONNEL

Other key billets of a V-2 division include the education and training petty officer, the safety petty officer, the damage control petty officer, and the police petty officer. These billets are generally filled by ABE2's and ABE3's and may be assigned as collateral duty. When assigning personnel to these billets, the senior ABE should choose the most qualified personnel available and insure that they are properly trained and checked out in their assigned duties. This helps assure a smooth-running division and relieves the senior petty officers of many small details in order that their attention may be directed to the more important duties.

GENERAL SAFETY PRECAUTIONS

Safety in itself is a subject that covers just about every phase of the ABE's work. Safety must become second nature to a man working around launching and recovery equipment. It makes no difference whether he is working above or below decks; many lives including his own depend on how thoroughly and safely he does his assigned task.

The following are considerations and practices that are fundamental to a good safety program for aircraft launching and recovery personnel:

1. Use tools properly. For many years special tools have been designed for specific catapult

repair jobs. At the present time more and more special tools are being designed and used for the repair and maintenance of both catapults and arresting gear. These tools have frequently resulted from problems met and ideas conceived by ABE's both ashore and in the fleet. They were designed to make it easier to do specific jobs properly and safely. Use them wisely—use these tools for the jobs for which they were designed.

2. Many jobs done by V-2 personnel are done under less than ideal conditions; however, no matter what the job is, safe working conditions can be set up. It is your responsibility as a senior petty officer to insure they are set up and followed. In seeing that safe working conditions are carried out, always keep a close watch on men performing hazardous jobs, for fatigue is always a problem in carrier operations; therefore, be alert for its first symptoms. No matter how good your safety program is, the physical condition of the personnel doing the job must always be taken into consideration.

3. Insure that the proper uniforms are worn on the flight deck, including helmets, goggles, sound attenuators, and life jackets.

4. Enforcement of all safety precautions on the flight deck is a major responsibility of senior petty officers. It should also be kept in mind that the accident potential is greatly increased during periods of darkness. Inexperienced personnel should not be used for night operations until they are thoroughly familiar with daytime operations.

5. Insure that all maintenance and repair work is done correctly as prescribed in the applicable MRC or maintenance manual. There are many publications that can be followed so that a job can be made easier and safer. Maintenance manuals are always helpful. Also, catapult and arresting gear repair procedures are prepared by the Naval Air Engineering Center to show methods of repair for specific pieces of launching and recovery equipment. Study these publications and make application of the information contained therein, for it will save you time and effort, and will get the job done safely. As a responsible petty officer, you should make these and other suitable publications available to your men to assist them in the job of maintaining their equipment in the best condition possible.

CHAPTER 3

SHOP SUPERVISION AND ADMINISTRATION

A supervisor is one who is responsible for and directs the work of others. When you first became a petty officer you also became a supervisor. As you advance up the ladder in the chain ~~of command~~ you will be responsible for the supervision of more and more men. You will not only be responsible for the supervision of the men assigned to your division or crew, but will also plan, organize, direct, and coordinate the many jobs ABE's are required to perform. How well a petty officer plans and distributes the work load within the scope of his responsibility is a determining factor in analyzing his ability as a successful supervisor.

MANAGEMENT OF SHOP AND PERSONNEL

As an ABE1 or ABEC, you will have increased supervisory duties which require greater knowledge and ability in administrative duties and procedures. The job of supervising is a many-sided task. It involves the procurement of equipment, repair parts, and other materials, planning, scheduling, and directing work assignments, maintaining an adequate file of applicable technical publications; maintaining required logs and records; making reports; and carrying on an effective training program.

Some typical duties and responsibilities are as follows:

1. Getting the right man on the job.
2. Using and placing materials economically.
3. Preventing accidents and controlling hazards.
4. Keeping morale at a high pitch.
5. Maintaining quality and quantity of work accomplished.
6. Maintaining accurate and up-to-date records and reports.
7. Maintaining discipline.
8. Planning and scheduling work.
9. Procuring tools and equipment to do the work intended.
10. Giving orders, making decisions.
11. Checking and inspecting work.
12. Promoting good teamwork.

Some of the above techniques will have been learned through past experience; others will have to be learned during the actual supervision of the division. Still other techniques may be learned from self-study courses and technical publications. The purpose of this chapter is to acquaint the new ABE1/ABEC with some of the more important aspects of supervision.

Briefly, the objectives of shop supervision are as follows:

1. To operate with maximum efficiency and safety.
2. To operate with minimum expense and waste.
3. To operate free from interruption and difficulty.

Personnel who are under your supervision must always be made aware of the dangers involved while working around the machinery or the aircraft aboard a carrier. They must move quickly, efficiently, and safely.

While these are the primary objectives of supervision, it is well for the ABE1 or ABEC who may be assigned these duties to keep in mind the fact that his assignment is important to him personally. It affords him an excellent opportunity to gain practical experience toward eventual advancement to ABCS and ABCM.

A supervisor should know his men's limitations and capabilities in order to get the most work out of them. He should utilize the capabilities of his best men in a twofold manner. If at all possible he should assign a well-qualified man to do a certain job and add to the team other individuals who are less qualified, but who are professionally ready for advanced on-the-job training.

The supervisor must anticipate the eventual loss of his most experienced workers through transfers, discharges, etc., and offset this by the establishment of an effective and continuing training program. In addition to raising the skill level of his division, the training program will insure that personnel, otherwise qualified, will be ready for the advancement examination.

A safety program must be organized and administered if the division is to function efficiently. Current Navy directives and local policies are quite specific as to the establishment of safety training programs.

The keeping of accurate and complete records is another factor in the efficient operation of a division. This includes records of usage data, work accomplished, and personnel progress. The most efficient recordkeeping is one who has enough records without having his files bulging with useless and outdated material.

The supervisor has responsibility for ordering and accounting for spare parts and material. He must impress upon his men the need for being thrifty in the use of these materials. The efficiency of any operation is directly related to the relative expense involved. There are many ways to economize, and the supervisor and his senior petty officers should always be on the alert for opportunities to point out these ways to the less experienced individuals.

Methods of avoiding waste and unnecessary expense should be included in the training program.

MAINTENANCE SHOP

A smoothly run maintenance program depends largely upon the extent to which the maintenance shop files and equipment are maintained. Equipment in good working order, tools in good shape and of the proper type and quantity, and an up-to-date file of applicable publications are all important factors indicating a smoothly run maintenance shop.

The shop functions may be further smoothed by the judicious delegation of authority to individuals next in seniority to the supervisor. The delegation of authority does not relieve the supervisor of the final responsibility for work accomplishment. It is primarily a means of relieving the supervisor of details. A supervisor who allows himself to become too involved with details loses his effectiveness as a supervisor.

A system of stowing tools must be devised. An efficient system cannot be set up without first determining from allowance lists what tools will be required for satisfactory operation of the shop. The place for all tools should be marked or otherwise specified, and those not being used should be kept in that place.

The shop layout plan should make provisions for an information or bulletin board upon which may be posted safety posters, maintenance posters, instructions and notices, plans-of-the-day, and such other information as is appropriate. The bulletin board should be located in a prominent place in the shop, preferably near the entrance where everyone assigned will have to pass it at some time during the day. Material on the bulletin board should be changed frequently, expired notices promptly removed, the current plan-of-the-day posted early, and other posters and material rotated periodically. If the same material is presented in the same format every day, it will not be long before the men begin to ignore the bulletin board and the purposes for having it will have been defeated. New arrangements are noticed and interest is stimulated with variety.

PERSONNEL WORK ASSIGNMENTS

Work assignments should be rotated so that each man will have an opportunity to develop his skills in all phases of the ABE work. When assignments are rotated, the work becomes more interesting for the men. Another good reason for rotating work assignments is that if one highly skilled man performs all the work of a certain type, the supervisor and the division would be at a great disadvantage in the event the man is transferred. Less experienced personnel should be assigned to work with him in order to become proficient in his particular skill. Also, to broaden his knowledge of his rate, the expert on one job should be rotated to other tasks. This will make him more valuable to his division and to the Navy in general.

Strikers should be assigned to various tasks so that they will acquire experience on all kinds of jobs. A special consideration for the assignment of strikers to jobs is that they should be assigned progressively to jobs of ascending levels of difficulty. A striker may be a useful assistant on a complicated job, but he may not understand what he is doing unless he has worked his way up from basic tasks.

ALLOWING FOR PLANNED INTERRUPTIONS

During an average workday, occasions will arise when personnel have to leave their working spaces for one reason or another, thereby delaying the completion of the scheduled work. Some delays can be anticipated, some cannot. Among the delays which can be anticipated are training lectures, immunization schedules, flight operations, rating examinations, meals, and watches or other military duties.

Before making personnel work assignments, the supervisor should determine what delays can be anticipated. It may be possible to arrange assignments so that work interruption is held to a minimum. When estimating the completion time of a maintenance task, the supervisor should allow for these predictable delays.

INSPECTION OF COMPLETED WORK

All work completed by the division is subject to inspection. This fact in no way relieves the supervisor of the responsibility for checking on the quality of work accomplished by his division. Frequent inspections should be made during the progress of the work as well as after completion. The supervisor's inspection should provide affirmative answers to the following questions:

1. Is the work being done according to current directives?
2. Do the materials used conform to specifications?
3. Is the job complete in all respects?
4. Does the workmanship measure up to desired standards?

SETTING UP SAFE WORKING CONDITIONS

Operational readiness of the maximum number of catapult or arresting gear engines is necessary if naval aviation is to successfully perform its mission. Keeping all machinery in top operating condition is the principal function of Aviation Boatswain's Mate E personnel. It is essential that maintenance work be performed without injury to personnel and damage to equipment.

Maintenance is, to some extent, naturally hazardous due to the nature of the work, the equipment and tools involved, and the variety of materials required to perform many repairs and maintenance functions. Factors which can function to increase or decrease these hazards are (1) the experience levels and mental attitudes of assigned personnel, and (2) the quality of supervision of the maintenance tasks. Thorough indoctrination of new personnel and a continuing safety program are the most important steps in maintaining safe working conditions.

The concept of maintenance safety should extend beyond concern for injury to personnel and damage to equipment. Safe work habits go hand-in-hand with flight operation safety. Tools left adrift, improper torquing of fasteners, and poor housekeeping around machinery can cause conditions which may claim the lives of personnel as well as cause strike damage to aircraft. Safety in machinery spaces is equally as important as safety on the flight deck.

While the increased complexity of our modern equipment is a factor, it is noted that a large number of accidents and incidents are due, not to complexity of equipment, but to lack of supervision and technical knowledge. Many mistakes are simple ones in routine maintenance.

Safety in maintenance depends largely upon the supervisory personnel. The standards of quality which they establish are directly reflected in the quality of the preventive maintenance. The primary duty of the senior petty officers is to supervise and instruct others rather than to become totally engrossed in actual production. Attempts to perform both functions invariably result in inadequate supervision and greater chance of error. Supervisors must exercise mature judgment when assigning personnel to maintenance jobs. Consideration must be given to each man's experience, training, and ability.

Sometimes overlooked in a maintenance program are the considerations generally grouped under the term "human factors." These factors are important in that they determine if an individual is ready and physically able to do the work safely and with quality. Supervisory personnel should be constantly aware of conditions such as general health, physical and mental fatigue, unit and individual morale, training and experience levels of personnel, and other conditions which can contribute in varying degrees to unsafe work. Not only is it important that proper tools, protective clothing, and equipment are available for use, but also the insistence by maintenance supervisors that they are used is of utmost importance. For example, maintenance personnel are sometimes negligent in the wearing of sound attenuation devices in high noise areas.

Technical knowledge also plays a large part in a good maintenance safety program. The complexity of our modern equipment demands the attention of well-informed and expert maintenance personnel; otherwise, the machinery cannot be operated and maintained properly. Technical knowledge is a function of education and training which, incidentally, does not end with graduation from Class A school. Graduation is only the beginning. Any ABE worthy of the rating is continually training and learning through self-study and application, and through a personal desire for proficiency and self-betterment. Technical knowledge by itself is not sufficient, but must be coupled with gratification and keen satisfaction in doing any job well. The ABE who wishes to contribute to safety and reliability improvement must know his job and must develop professional pride in the quality of his work.

It is a continuing duty of every person connected with maintenance to try to discover and eliminate unsafe work practices. Accidents which are caused by such practices may not take place until a much later date and their severity cannot be predicted. The consequences may range from simple material failure to a major accident resulting in serious injuries or fatalities.

There are several areas in which the shop supervisor can effectively work to minimize accidents due to maintenance. Among these are continuing inspections of work areas, tools, and equipment, organization and administration of safety programs, correct interpretation of safety directives and precautions, and energetic and imaginative enforcement of them.

INSPECTION OF WORK AREAS, TOOLS, AND EQUIPMENT

Most accidents can be prevented if the full cooperation of personnel is gained and vigilance is exercised to eliminate unsafe acts. The supervisor should diligently inspect work areas, tools, and equipment to detect potentially hazardous and unsafe conditions and take appropriate corrective action. The ABE may be working in the shop, in the machinery space, or on the flight deck—all of these areas should be included in the supervisor's inspection. He should check for explosion and inhalation hazards due to improper ventilation of working spaces, or careless handling of materials.

Fire hazards present another serious problem. "No Smoking" rules should be strictly enforced. Spilled oil, grease, and chemicals should be wiped up promptly, and all rags used should be disposed of in approved containers.

Handtools should be in good shape, of the proper type, and used only for the purpose for which they were designed.

Insure that equipment is operated only by qualified personnel, and that safety devices and guards are installed and in good condition. The equipment should also be inspected for broken or damaged components. Check to see that periodic maintenance, servicing, and/or calibration are performed as required.

ORGANIZATION AND ADMINISTRATION OF SAFETY PROGRAMS

In accordance with the Navy policy of conserving manpower and material, all naval activities are required to conduct effective and continuous accident prevention programs. The organization and administration of a safety program are part of the requirements of the supervisor. The safety program must be in accordance with local instructions and based on information contained in official United States Navy safety precautions. Work methods must be adopted which do not expose personnel unnecessarily to injury or occupational health hazards. Instructions in appropriate safety precautions are required and disciplinary action should be taken in cases of willful violations.

The shop safety program will generally involve three areas of attention—the posting of the most important safety precautions in appropriate places, the incorporation of safety lessons in the formal training program, and frequent checks for understanding during the day-to-day supervision of work.

Posted safety precautions are more effective if they may be easily complied with. For example, a sign on a tool grinder reads "goggles required," so one or more pairs of safety goggles should be hanging in close proximity of the machine. Similarly, the protective clothing poster in the shop should be backed up with readily available aprons, gloves, shields, etc.

Fixed posters and signs should be renewed frequently and not allowed to become rusty, faded, or covered with dust and dirt. General safety posters on bulletin boards and other places should be rotated often to stimulate interest.

The formal safety training sessions should utilize films, books, visual aids, or any other suitable technical material. The men should be told more than just what to do or what not to do. Each safety subject should be explained in detail. Causes of accidents and contributing factors should be reviewed and analyzed. Many good ideas for accident prevention have been developed in training sessions devoted to such analysis.

An extensive series of lessons may be developed over a period of time as latent hazards are recognized. The dramatization of the results of unsafe acts around catapults and arresting gear is usually a very effective method of emphasizing the danger of such acts. This will aid in keeping the sessions interesting while avoiding too frequent repetition.

It may be well to mention the new man in the division at this point. A separate safety indoctrination lesson which covers all the major hazards of the work should be given to a new man as soon as he reports for work. No supervisor will expose the new man to air operations without pointing out the dangers involved.

In the third area of safety program administration, followup, the supervisor will do well to delegate authority to his subordinate petty officers to assist him in monitoring the program. Also included in the followup area is the responsibility of the supervisor to inquire as quickly and thoroughly as possible into the circumstances of accidents and reports of unsafe practices, followed by appropriate action to correct any deficiencies uncovered.

TECHNICAL PUBLICATIONS

Technical publications used by ABE's in the operation, inspection, and maintenance of all launching, recovery, and related equipment are published in two forms—manual type publications and letter type publications. It is extremely important that senior ABE's know how to supervise the use, filing, and maintenance of these publications.

LETTER TYPE

The letter type technical publications of interest and of prime concern to the ABE are Launching Bulletins, Recovery Bulletins, Service Changes, Service Bulletins, Catapult Repair Procedures, and Recovery Equipment Repair Procedures. These publications are prepared by NAEC (SI), Philadelphia, and subsequently distributed by Naval Air Systems Command (NavAirSysCom) to all ships, stations, and units having need for them. A list of those bulletins and changes in force is provided in the Ships Installations section of letter publications in the most recent issue of NavSup Publication 2002, Section VIII, Part D.

In addition, Type Commanders issue Aircraft Launching and Recovery Bulletins. These bulletins set forth increased maintenance/operations procedures. They are issued as a result of an accident/incident, covering areas not clearly defined in operation/maintenance manuals.

In short, there are applicable letter type technical publications concerning all aspects of the equipment related to ABE's. Every effort should be made by the supervisor to acquire and maintain a complete and up-to-date file of these publications concerning the equipment under his cognizance.

Descriptions and illustrations of the various letter type publications of interest to the ABE are presented on the following pages.

Recovery Bulletins

Recovery bulletins are published to furnish the governing instructions for recovering aircraft. All arresting gear officers must be thoroughly familiar with the contents of all recovery bulletins pertaining to their particular equipment. Senior ABE's should also be familiar with the information found in recovery bulletins. There are recovery bulletins covering landing operations with Mark 7 Mod 1, 2, and 3 arresting gear, and also bulletins that give instructions for operations using the Fresnel Lens Optical Landing System or the Manually Operated Visual Landing Aid System (MOVLAS).

Some of the information found in recovery bulletins for shipboard arresting gear is listed below. (See fig. 3-1.) The sample aircraft bulletin shown in the figure is an actual Mark 7 Mod 1 aircraft recovery bulletin, and is included in this manual for training purposes only. During recovery operations, refer only to the current recovery bulletin that is applicable to the equipment being used. Data of the following type can be obtained.

1. Aircraft model, see column 1 of figure 3-1.
2. Actual aircraft landing weight in pounds.
3. Recommended airspeed of the approaching aircraft in knots. (Note that the recommended approach airspeed is different for the same aircraft at different weights.)
4. Columns 4 and 5 show the maximum engaging speeds of aircraft and the recommended recovery headwind (RHW) for the speeds in column 3 when operating with a 4.0-degree glide slope setting.
5. Columns 6 and 7 provide the same information as columns 4 and 5 for operations when a 3.5-degree glide slope setting is used.

NOTE: The maximum engaging speeds in columns 4 and 6 are for deck pendant arrestments; column 8 gives the maximum engaging speeds for barricade arrestments.

6. Arresting engine control valve settings for pendant and barricade engines.
7. Special conditions. What action is to be taken when an adverse condition arises.

Aircraft Launching Bulletins

The purpose of the Aircraft Launching Bulletin is to set forth uniform instructions for launching with safety within the performance capability of the aircraft and the catapults. The bulletin establishes the MINIMUM conditions which must exist prior to the launch. These conditions enable operational commanders to know the ultimate capability of the launch, and to provide a measure of safety involved in launches made above minimum conditions. Every known precaution has been included. To insure additional safety, operations should always be conducted above minimum conditions whenever possible.

Aircraft launching bulletins contain the governing instructions for launching specified aircraft from specified catapults. An aircraft launching bulletin does not authorize the launching of aircraft, but sets forth the minimum conditions under which the aircraft can be launched when authorization is received. Authority to launch and other restrictions for launching aircraft are found in the applicable flight manuals. Adherence to the provisions of both aircraft launching bulletins and flight manuals is mandatory for safety of operations, and an activity must consult both documents prior to commencement of aircraft launching.

A numbering system is used to identify aircraft launching bulletins. Some aircraft launching bulletins pertain to a specific type catapult or type catapult and ship. The number preceding the dash is the type catapult designator. For example, an aircraft launching bulletin with the identification number 6-13 pertains to almost all C-11-1 catapults; exceptions are the few that differ in operation from all other

AIRCRAFT ENGAGING SPEED LIMITS

MARK 7 MOD 1 ARRESTING GEAR 95' SPAN WITH OPERATING DECK SHEAVE DAMPERS

TYPE OF ARRESTMENT			DECK PENDANT				BARRICADE
GLIDE SLOPE SETTING			4.0 DEGREES		3.5 DEGREES		
AIRCRAFT MODEL	ACTUAL AIRCRAFT LANDING WEIGHT (POUNDS)	RECOMMENDED APPROACH AIRSPEED (KNOTS)	MAXIMUM ENGAGING SPEED (KNOTS)	MINIMUM WOD RECOMMENDED FOR SPEEDS OF COLUMN 3 (KNOTS)	MAXIMUM ENGAGING SPEED (KNOTS)	MINIMUM WOD RECOMMENDED FOR SPEEDS OF COLUMN 3 (KNOTS)	MAXIMUM PERMISSIBLE ENGAGING SPEED AND AIRCRAFT GROSS WEIGHT
COL. 1	COL. 2	COL. 3	COL. 4	COL. 5	COL. 6	COL. 7	COL. 8
A-3 Series	Up to 47,000 47,100-50,000	128 132	110(C) 110(CD)	18 22	111(D) 110(D)	17 22	100 knots up to 50,000 lb
A-4 Series	Up to 12,000 12,100-13,750 13,800-14,500	120 127 130	109(B) 114(A) 113(AJ)	11 13 17	109(B) 114(A) 113(AJ)	11 13 17	105 knots up to 14,500 lb (I)
RA-5C	Up to 47,000 47,100-50,000	143(F) 148(F)	105(R) 105(AJ)	38 43	105(R) 105(AJ)	38 43	(E)
A-6 Series T.O.Flaps/Slats Extended,	Up to 30,000 30,100-33,500 33,600-36,061	109 115 120	88(L) 88(L) 94(AT)	21 27 26	88(L) 88(L) 94(AT)	21 27 26	105 knots up to 33,000 lb
A-7 Series	Up to 25,300	135	125(D)	10	125(D)	10	110 knots up to 25,300 lb (Q)
C-1A Series	Up to 24,200	93	85(A)	8	85(A)	8	85 knots up to 23,500 lb
C-2A	Up to 40,000 40,100-46,000	95 105	74(K) 81(A)	19 24	74(K) 81(A)	19 24	(E)
E-1B	Up to 25,200	95(G)	82(A)	13	82(A)	13	85 knots up to 24,700 lb
E-2A/-2B	Up to 38,000 39,100-41,200	95 99	74(U) 74(A)	21 25	74(U) 74(A)	21 25	(E)
F-4B Series	Up to 34,000 34,100-38,000	140 146	102(M) 106(MO)	38 42	102(M) 106(MO)	38 42	105 knots up to 33,000 lb
F-4B Series with AFC-218	Up to 34,000 34,100-38,000	131 139	102(M) 108(MO)	29 33	102(M) 108(MO)	29 33	105 knots up to 33,000 lb
A-6 Series NO FLAPS/ NO SLATS	Up to 28,000 28,100-30,000	133 138	88(H) 88(H)	45 50	88(H) 88(H)	45 50	105 knots up to 33,000 lb
A-7 Series FLAPS UP	Up to 25,300	164	125(D)	39	125(D)	39	110 knots up to 23,300 lb (Q)
F-8 Series WING INCIDENCE DOWN	Up to 19,000 19,100-22,000 22,100-24,000	154 164 171	117(S) 125(S) 126(DN)	37 39 45	117(S) 125(S) 126(DN)	37 39 45	115 knots up to 22,000 lb

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Figure 3-1.—Aircraft Recovery Bulletin

Key to figure 3-1.

(A) Maximum engaging speed limited by aircraft arresting hook strength.
(B) Maximum engaging speed limited by aircraft limit horizontal drag load factor (mass item limit "G").
(C) Maximum engaging speed limited by aircraft landing gear strength.
(D) Maximum engaging speed limited by arresting gear capacity.
(E) Emergency recovery of aircraft with this gear not recommended.
(F) Recommended approach speed based on 40 degree flap setting. For 50 degree flap setting, subtract 5 knots from recommended approach speed and minimum recovery head wind.
(G) Single engine approach speed has been recommended to maintain control and provide wave-off capability in the event of engine failure during the approach. However, normal twin engine approach airspeeds specified in NATOPS Manual are permitted when operational commitments demand.
(H) Maximum engaging speed based on a control valve single weight setting. Maximum permissible engaging speed is 104 knots up to 28,000 pounds and 100 knots up to 30,000 pounds when control valve is set to actual aircraft gross landing weight.
(I) Incorporation of ASC No. 191 is mandatory for models A-4B/–4C for gross weights between 13,750 and 14,500 pounds.
(J) Incorporation of complete AFC No. 117 is mandatory for maximum arrested weight of 50,000 pounds.
(K) Maximum engaging speed based on a control valve single weight setting. Maximum permissible engaging speed is 89 knots when control valve is set to actual aircraft gross landing weight.
(L) Maximum engaging speed based on a control valve single weight setting. Maximum permissible engaging speed is 100 knots up to 30,000 pounds and 93 knots up to 33,500 pounds when control valve is set to actual aircraft gross landing weight.
(M) Maximum engaging speed based on a control valve single weight setting. Maximum permissible engaging speed is 118 knots up to 34,000 pounds and 110 knots up to 38,000 pounds when control valve is set to actual aircraft gross landing weight.
(N) For F-8D/E with ASC No. 439, and F-8K/L, the maximum arrested landing weight is 22,500 pounds. The maximum arrested landing weight for the F-8J with BLC off and the F-8H is 24,000 pounds.
(O) Total fuselage fuel for carrier arrested landings shall not exceed 5,100 pounds. AFC No. 230 must be incorporated for arrested landings above 34,000 pounds.
(P) Maximum arrested landing weight for aircraft without wing tanks with full internal and no tip tank fuel is 11,174 pounds. Aircraft with wing tanks with full internal fuel and no tip tank fuel, the maximum arrested weight is 12,000 pounds.
(Q) Barricade clearance recommended only if wing pylons are installed.
(R) Maximum engaging speed based on a control valve single weight setting. Maximum permissible engaging speed is 109 knots when control valve is set to actual aircraft gross landing weight.
(S) Maximum engaging speed based on a control valve single weight setting. Maximum permissible engaging speed is 128 knots when control valve is set to actual aircraft gross landing weight.
(T) A-6A/B, KA-6D must have AFC 244 incorporated for arrested landing weights above 33,500 pounds.
(U) Maximum engaging speed based on a control valve single weight setting. Maximum permissible engaging speed is 78 knots when control valve is set to actual aircraft gross landing weight.
(V) Maximum engaging speed based on a control valve single weight setting. Maximum permissible engaging speed is 85 knots when control valve is set to actual aircraft gross landing weight.

NOTE: When operations permit, recommend ten (10) knots be added to RHW in columns 5 and 7. To compensate for a hot day (90 degrees), variation in WOD velocity and direction, pilot technique, approach speeds, turbulence, and to minimize loads on the aircraft and/or arresting gear.

C-11-1 catapults. As an example, the C-11-1 catapults installed aboard U.S.S. Ticonderoga CVA-14, and U.S.S. Hancock CVA-19, are equipped with the wet accumulator system. The launching bulletins that pertain to the C-11-1 catapults aboard these two ships have a 10 preceding the dash. Aircraft launching bulletin 9-13 pertains to many, but not all, C-13 type catapults.

Launching bulletins that are applicable to all types of catapults begin with zero dash (0-). The zero dash is followed by a two-digit number which identifies the subject matter of the publication. The subject matter identification number is the same for all catapults. The information contained in the 0- aircraft launching bulletins is listed below.

1. (-10) General data on preparation and use of aircraft launching bulletins for all catapults.
2. (-11) A status bulletin that provides a list of aircraft launching bulletins in effect, superseded, or canceled. Also, makes changes to the -12 accessory bulletin. The -11 bulletin is issued monthly.
3. (-12) Provides a list of aircraft launching accessories required for all aircraft. Any changes that arise prior to revision to the -12 bulletin will be found in the -11 bulletin.
4. (-13) Provides data used in the preparation of aircraft launching bulletins for all aircraft.
5. (-14) Provides data used for operation of steam catapults with reduced receiver volume.
6. (-15) Provides information pertaining to preparation, philosophy, and use of the data for cross-wind operations.
7. (-16 through -20) are reserved for issuance of special or general launching instructions.
8. (-21 and subsequent) contain information for launching specific aircraft.

The MINIMUM takeoff airspeed for launching is determined by the Flight Test Division of the Naval Air Test Center while conducting the carrier suitability portion of the Board of Inspection and Survey Trials. The minimum is determined for the selected configurations by successive launches with decreasing air-speeds until a limit is approached or reached. This minimum takeoff airspeed may be limited by aerodynamic stall, excess thrust available for acceleration after launch, loss of aileron, elevator, or rudder control, time required to rotate to flying attitude after launch, control effectiveness and pitching rates resulting in accelerated stall; overly stringent pilot technique required, or stick forces or movements beyond limits in event of failure of an air-craft system. Further, the minimum takeoff airspeed is reduced to a standard 59°F day and is established with the following conditions existing at the time of launch:

1. Deck steady.
2. Wind-over-deck steady and from dead ahead of catapult in use.
3. Sea calm.
4. Catapult performance normal.
5. Operation unhurried.
6. Skilled pilot qualified in type.
7. Engine delivering full takeoff power.
8. Maintenance condition of aircraft excellent.
9. Immediate clearing turns not attempted.
10. Pilot trained in minimum techniques and mentally prepared for minimum launch.
11. Accurate aircraft weight known.
12. Wind-over-deck measuring device yielding accurate indications.
13. Highly trained personnel available to immediately advise on any and all phases of the operation.
14. Prediction of aircraft performance under atmospheric conditions existing for the test.
15. Aircraft spotted on center.

Restrictions are necessary when launching certain critical aircraft from waist catapults. The applicable Aircraft Launching Bulletins specify these restrictions. The factors which cause these restrictions are the proximity of ships structure ahead of the waist catapults, the airflow discontinuity caused by ship's structure, sink off the flight deck, and the possibility of overrotating and damaging the tail due to the fact that the waist catapult has more deck ahead of it than the bow catapult. Due to these factors the minimum takeoff airspeed required must be higher for waist catapults than bow catapults when launching the critical aircraft.

For the critical aircraft, the offcenter spotting limits are more restricted for waist catapults than for bow catapults. The combination of postlaunch oscillations and proximity of ships structure may be hazardous. This off-center limit for waist catapults is indicated in the applicable Aircraft Launching Bulletin.

The Aircraft Launching Bulletin is established on the basis of the best performance that should be anticipated under essentially ideal conditions. The margin that must be provided to maintain this minimum degree of safety, under other than ideal conditions, can only be determined by weighing all of the factors involved in light of the environment existing just before the launch.

The operation commander is logically responsible for the degree of safety involved in a launch, since this is the one command to which all the required information is immediately available.

The figures in the operating bulletins provide tables of minimum wind requirements as a function of accumulator launching pressure and aircraft gross weight. Values in the tables which are preceded by a minus sign indicate that the catapult end speed of the aircraft (catapult dead-load end speed plus speed due to aircraft thrust) is that many knots in excess of the minimum required aircraft takeoff airspeed. (Total excess airspeed is this value (without minus sign) plus actual WOD from dead ahead.)

Some of the points that must be kept in mind when using Aircraft Launching Bulletins and when launching aircraft are:

1. Selection of the Launching Pressure. The table in the operating bulletin is normally entered with the aircraft gross weight and wind available from which data the minimum launching pressure is determined. If actual gross weight is between the values shown in the table, use the next higher gross weight value in the table. The maximum launching pressure is that value for which a minimum wind is shown in the gross weight column. A single launching pressure, which falls within the acceptable range for each type, may be selected for several different types of aircraft.

2. Aircraft Strength Requirements. At a given gross weight, the aircraft and pendant or bridle have adequate strength for catapulting at any accumulator launching pressure for which a minimum wind requirement is shown.

3. Minimum Wind Requirements. The minimum wind data listed are the results of Naval Air Test Center and shipboard tests and are considered to be safe minimums for well-qualified pilots. HOWEVER, IT IS RECOMMENDED THAT WHENEVER PRACTICABLE, WIND IN EXCESS OF THAT LISTED BE USED AS A SAFETY PRECAUTION—the maximum excess air speeds along with the recommended excess air speeds are listed in individual aircraft launching bulletins. Minimum takeoff airspeeds on which this bulletin is based are listed in the operating bulletin figures.

4. Signals. Know the routine exchange of signals. The catapult officer must stand at the correct station on the deck to enable the pilots to clearly see the catapult officer's signals.

5. Headrest. The headrest should be used when catapulting. An uncomfortable neck jerk, possibly producing temporary loss of control, results if the head is not held firmly against the headrest during the launching run.

6. Aircraft Equipment. Looseness of the throttle and similar controls must be avoided by a check of adjustments to ascertain that they are sufficiently stiff to prevent easing back during launching.

7. The wind-over-deck from dead ahead available for any given launching condition must be equal to or greater than the minimum requirements for that condition listed in the figures.

8. LAUNCHING THE AIRCRAFT UNDER CONDITIONS FOR WHICH A MINIMUM WIND REQUIREMENT IS NOT SHOWN IN THE FIGURES MAY RESULT IN DAMAGE TO THE AIRCRAFT OR CATAPULT MACHINERY OR BOTH; AND IS PROHIBITED.

9. Horizontal shuttle tensioning is to be as required by launching bulletin.

10. Catapult Hook Inspection. After aircraft is tensioned on the catapult, examine the aircraft catapult hook or hooks and shuttle tow hook to insure proper seating of the launching pendant or bridle. EXTREME PRECAUTIONS MUST BE TAKEN AT ALL TIMES.

11. Aircraft Arresting Hook. Prior to launching aircraft, check the arresting hook to insure that it is securely locked.

12. CONSULT APPLICABLE CATAPULT BULLETINS FOR LIMIT LAUNCHING PRESSURES WHICH AFFORD RUNAWAY SHOT PROTECTION.

13. MAINTAIN CATAPULT CYLINDER ELONGATION IN ACCORDANCE WITH CURRENT OPERATING INSTRUCTIONS

Figure 3-2 shows a typical Aircraft Launching Bulletin (C13).

With figure 3-2 as an example, the following problem shows how a launching bulletin is used to set up launching pressures for aircraft of a certain weight and a known wind over the deck:

1. Optimum Condition and Qualifications. Gross weight 22,000 pounds, WOD 25 knots.

Recommended use of 180- to 200-psi accumulator launching pressure. At 22,000 pounds, the end speed would then be 11 to 16 knots above minimum takeoff airspeed required.

2. Limit Excess Airspeed Condition. Gross weight 23,000 pounds, WOD available 35 knots. The maximum allowable excess airspeed for this example is 30 knots.

A launch could be made at an accumulator launching pressure of 240 psi. The excess airspeed would then be 30 knots (35 knots WOD available minus 5 knots WOD required) which is the maximum allowable for this aircraft. Recommend the use of 160 to 180 psi which would result in 9 to 15 knots excess airspeed.

3. Optimum Condition With Temperature Correction. Gross weight 21,000 pounds, WOD available 35 knots, temperature 89°F.

a. Aircraft thrust not critical.

b. Temperature correction due to air density is that for each 10°F above standard free air temperature of 59°F, the minimum WOD should be increased 1 knot.

Recommend the use of 140 to 160 psi. At 21,000 pounds the excess end airspeed appears to be 14 to 20 knots. However, 3 knots are needed for temperature correction, therefore the excess airspeed is 11 to 17 knots.

With thrust critical, full flaps down, the typical thrust correction due to temperature is as follows:

For launches with flaps in FULL DOWN position, the following correction is added to the WOD requirements of figure 3-2:

GROSS WEIGHT (lb)	CORRECTION
21,000	1 knot for each degree above 75°F

Catapulting of the subject aircraft is limited by the following condition:

GROSS WEIGHT (lb)	TEMPERATURE (°F)
21,000	90

Temperature is below 90°F for the given weight; therefore, the launch is permissible. Recommend the use of 180 to 200 psi. At 21,000 pounds the excess end airspeed appears to be 26 to 31 knots. However, 3 knots are needed for temperature correction due to air density, and 14 knots are needed for thrust corrections due to temperature; therefore, the excess airspeed is 9 to 14 knots.

4. Optimum Launch for Minus Wind Condition. Gross weight 22,000 pounds, WOD available 5 knots.

Recommend the use of 260 to 280 psi. At 22,000 pounds the minimum takeoff airspeed required is -5 to -9; therefore, the excess airspeed is 10 to 14 knots.

Recovery and Launching Equipment Service Bulletins and Repair Procedures

The purpose of these publications is to provide pertinent information concerning the operation, malfunctioning, and checking of a certain gear or component. They are issued by NavAirSysCom in series for each type of catapult. They result from investigations and experiments conducted by fleet units, test sites, and development projects at the Naval Air Engineering Center test units. Whenever discrepancies or unsafe conditions are found during operations, a service bulletin is published.

A service bulletin contains the following information:

1. The identity of the type of equipment to which the bulletin pertains.

2. The purpose and reason for information contained in the bulletin.

3. The method of remedying such malfunctions, including precautions that should be observed.

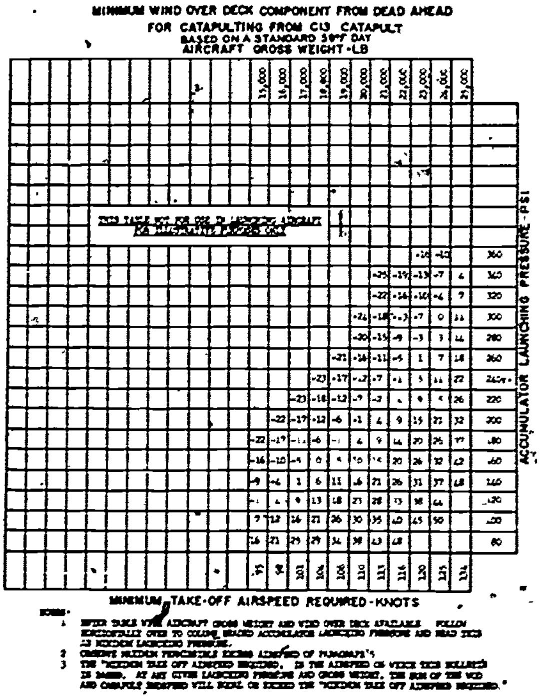

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Figure 3-2.—Aircraft Launching Bulletin.

4. Information as to when to comply with the procedure outlined in the bulletin.

5. Any special information that may be needed.

These bulletins are sent to all applicable ships, stations, and units.

Catapult Deck Gear and Accessories Bulletins and Changes

Catapult deck gear and accessories bulletins and changes are issued in the same manner as the catapult and arresting gear bulletins and changes. There is a status bulletin issued that lists all the bulletins and changes that have been issued and the ones that are still in effect. It is identified by the calendar year preceded by a "0." Examples of status bulletins would be 0-72, 0-73, etc., for the years 1972, 1973, etc.

Changes furnish information for the modification of existing machinery. Included will be such information as which type catapult accessory is to be modified, for example, bow bridle arresters, waist bridle arresters, and changes to be made to the nose gear launch equipment. A catapult deck gear and accessories change informs the personnel concerned as to who will make the change. If the change is within the capability of the ship's force, it is so stated, and if it must be made by a shipyard at the next yard availability, this is noted.

The purpose of the catapult deck gear and accessories bulletins is to make available to all hands concerned correct procedures for the hookup of the different bridle and pendant arrester lanyards. The lanyard hookup will vary for each type aircraft, necessitating a specific bulletin for all the current carrier aircraft. There are bulletins issued for different holdback securing assemblies if they are deemed necessary. Special information, whether it is for bridle arresters or for nose gear launch equipment, is issued. Safety precautions, securing instructions, and any new or additional information that is not yet published in the applicable handbook for that specific type of equipment are made available through catapult and deck gear accessories bulletins.

Recovery and Launching Equipment Service Changes

Experimentation at the test center and experience in the field often make it necessary to make changes to recovery and launching equipment. NAEC (SI) directs and provides the necessary information for effecting these changes to the concerned activities, and the service changes are published by NavAirSysCom. Included in each service change is such information as the following:

1. Type and model of equipment to which the change applies.
2. Reason for making the change.
3. Information applicable to the change.
4. When the change is to be accomplished.
5. Who is to make the change—ship's force or shipyard personnel.
6. Description and installation instructions.
7. Source of necessary parts.
8. Distribution of technical drawings.

9. Disposition of materials or parts removed in effecting change.
10. Weight and moment change information.
11. Change record.
12. Acknowledgement.
13. Address for correspondence.

Instructions and Notices

The Navy Directives System is used throughout the Navy for the issuance of nontechnical directive type releases. These directives may establish policy, organization, methods, or procedures. They may require action to be taken or contain information affecting operations or administration. This system provides a uniform plan for issuing and maintaining directives. Conformance to the system is required of all bureaus, offices, activities, and commands of the Navy. Two types of releases are authorized under the plan—Instructions and Notices.

Information pertaining to action of a continuing nature is contained in Instructions. An Instruction has permanent reference value and is effective until the originator supersedes or cancels it. Notices contain information pertaining to action of a one-time nature. A Notice does not have permanent reference value and contains provisions for its own cancellation.

For purposes of identification and accurate filing, all directives can be recognized by the originator's abbreviation, the type of release (whether an Instruction or Notice), a subject classification number, and, in the case of Instructions only, a consecutive number. Because of their temporary nature, the consecutive number is not assigned to Notices. This information is assigned by the originator and is placed on each page of the directive.

ABE's will be most concerned with NavAirSysCom Instructions and Notices. These are issued to aviation commands and concern aircraft or aviation equipment.

MANUAL TYPE

The technical manual type publication makes available information necessary for the proper operation and maintenance of the particular equipment about which it is written, and also gives the applicable safety precautions. This type publication serves as a reference for operating, maintaining, and correcting the malfunctions of the equipment. It also serves as a textbook for studying optimum operation and maintenance procedures which have been established by past experiments and experiences.

New and recently revised manuals do not contain detailed descriptions or procedures concerning preventive maintenance since this information is now contained on MRC's.

Technical manuals do contain the following:

1. Description of equipment.
2. Theory of operation.
3. Troubleshooting techniques.
4. Corrective maintenance information.
5. Specific safety requirements.
6. Parts breakdown and numbers.
7. Sketches, diagrams, schematic, operating and design limits, etc.

All manual type publications pertaining to catapults and arresting gear and associated equipment are assigned a code number (NavAir 51 series) and listed in the Navy Stock List of Forms and Publications, NavSup 2002, Section VIII, Part C, when available for issue. (This stock list (index) is discussed in more detail later in this chapter.)

Listed below are some examples of manual type publications of interest to the ABE.

NavAir 51-15ABB-1, Operating Instructions, C-13 Catapult.

NavAir 51-15ABB-2, Maintenance and Overhaul Instructions, C-13 Catapult.

NavAir 51-15ABB-3, Illustrated Parts Breakdown, C-13 Catapult.

NavAir 51-5BAA-1, Operation, Maintenance, and Overhaul Instructions with Illustrated Parts Breakdown, Mark 7 Mod 1 Aircraft Recovery Equipment.

NavAir 51-25-7, Operation, Maintenance, and Overhaul Instructions with Illustrated Parts Breakdown, Mark 1 Nose Gear Launch Equipment.

In the above list of manuals, it will be noted that there are three separate manuals for the C-13 Catapult, while only one for the Mark 7 Mod 1 Arresting Gear. There is also only one for Mark 1 Nose Gear Launch Equipment. The determining factor is generally the complexity of the equipment – the more complex the item, the more manuals required.

PUBLICATIONS INDEX (NAVSUP 2002)

NavSup Publication 2002 is a 13-section index of all the forms and publications used throughout the Navy. Of the 13 sections, the ABE is most concerned with sections VI and VIII. All required publications that these two sections list are issued directly to new vessels about 6 months prior to commissioning. Requests for commissioning allowances should not be submitted unless the publications are desired at a date earlier than automatic distribution will satisfy, or unless they have not been received a month before the commissioning date.

Section VI (NavShips Publications)

Section VI of NavSup Publication 2002 is a basic list of all Naval Ship Systems Command Publications. This section is further subdivided into six parts–A, B, C, D, E, and F. Parts A, B, C, and F are of little interest to ABE's because they contain lists of publications that are of primary interest to other departments and divisions of the ship.

The ABE is primarily interested in parts D and E of section VI which lists all NavShips manufacturers' technical manuals. In part D, all publications are listed in numerical order according to stock number. Part E lists the same publications in alphabetical order according to title/nomenclature.

Section VIII (NavAir Publications)

Section VIII of NavSup Publication 2002 is a basic index of the Naval Air Systems Command publications and contains a numerical listing of all aeronautical publications by code number, title, security classification, and the date of the latest issue.

Section VIII of the index is further subdivided into four parts – A, B, C, and D. Part C is the numerical listing of manual type publications, and Part D contains listings of letter type publications. (Parts A and B contain listings of ordnance publications and are of no interest to the ABE.)

Part C of the index (manual type/publications) is divided into subject matter groups, and all publications within a group are then listed in numerical order according to code number. For example, all manuals in the 00 series (Aircraft, General) are listed first then followed by the 01, 02, 03, etc., through the 51 series (Ships Installations). All catapults and recovery equipment manuals are listed under the 51 series by code number, federal stock number, title, and date of issue. (A complete listing of the various subject groups is given in the front of the index.)

Part D of the index (letter type publications) is further divided into a number of subsections, one of which is titled Ships Installations. The Ships Installations section is further divided into the following subject matter groups: Landing Aids, Arresting Gear, Catapults, and Aircraft Launching. All letter type directives of interest to the ABE are listed under the applicable subject matter group by code number, title, and date of issue.

PROCUREMENT OF PUBLICATIONS

Manual type publications may be obtained by properly preparing and submitting DOD Single Line Item Requisition System Document (DD Form 1348 or 1348m) to the nearest supply point (indicated on the inside front cover of NavSup Publication 2002, Section VIII, Part C). List the publications code number, federal stock number, and title of each manual desired.

Letter type publications should be ordered using DD Form 1149, in accordance with the instructions given on the cover page of NavSup 2002, Section VIII, Part D.

Requests to be placed on the mailing list for NavSup 2002, Section VIII, Parts C and D, and supplements should be submitted to NATSF, 700 Robbins Avenue, Philadelphia, Pennsylvania 19111. NavSup 2002 is revised and reissued semiannually. During the interval between issues, supplements are issued containing listings of publications distributed or canceled since the last issue.

MAINTENANCE AND FILING OF PUBLICATIONS

There are four mandatory requirements to be met in maintaining an allowance of publications. These requirements are as follows:

1. That the prescribed publications be on board.
2. That the publication be corrected up-to-date.
3. That they be ready for immediate use.
4. That applicable security provisions be observed.

Changes to publications are issued either in the form of looseleaf pages, pen-and-ink changes, or complete revisions. When changes are issued in the form of numbered pages, the old page with the corresponding number is removed and the new replacement page inserted in its place. Specific instructions are normally given with each change on the method to be used in incorporating the change. Changes should be made immediately upon receipt.

A checklist of pages that are to remain in the publication after the change has been incorporated is provided with changes issued for some publications. This checklist should be compared against pages remaining in the publication to insure they agree. Extra pages are removed and missing pages ordered to bring the publication up to date. Obsolete pages removed should be secured together and retained until the next change is received. Sometimes the wrong pages are removed from a publication when a change is entered and the error is not discovered, even with the checklist, until the next change is entered.

When pen-and-ink changes are made, the change number and date should be entered with each change for future reference. Sometimes it is convenient to cut out pen-and-ink changes and insert them in their proper place in a publication by fastening them with transparent tape or glue.

A complete file of manuals, bulletins, changes, and repair procedures is maintained in looseleaf binders aboard ship for the catapult machinery and arresting gear. Letter type directives should be filed numerically in binders with the newest bulletin or change filed on top. This means that as the binder is opened, the latest publication is always the first one. An annual status bulletin is issued, listing all bulletins and changes currently in effect.

LOGS AND REPORTS

It is necessary that catapult and recovery reports and records be properly maintained to insure that changes are promptly incorporated, proper history of the equipment is maintained, and responsibility is properly placed.

Senior petty officers in charge of the various stations in the catapult must maintain a day-to-day record of their respective stations and/or equipment.

Recordkeeping in relation to launch and recovery equipment is as important as operation of machinery or maintenance procedures. Due to the many 3-M maintenance schedules that must be adhered to and periodic reports that must be made, the importance of accurate logs, reports, and records should be emphasized. Senior ABE's charged with the responsibility of maintaining machinery or equipment are also responsible for maintaining and submitting proper and correct catapult and recovery records.

Activities engaged in launching aircraft from steam catapults must maintain Catapult Launching Log Sheets, NavAir Form 13820/1 for steam catapults. (See fig. 3-3.) It is also recommended that a Catapult Daily Maintenance Logbook be kept.

STEAM CATAPULT LAUNCHING LOG SHEETS

Steam catapult launching log sheets are available in pad form of 100 sheets per pad. They can be requisitioned from the forms and publications segment of the Naval Supply System in accordance with instructions found in NavSup Publication 2002. Not more than 1 year's supply of log sheets shall be stocked.

A steam catapult log, NavAir Form 13820/1 shall be kept by all activities operating steam catapults for all launches, including no-load and deadload launches. Each log sheet has space to record data for 21 launches. Completed log sheets are retained for a period of 1 year. Those more than a year old are discarded.

STEAM CATAPULT WORK (ROUGH) LOGBOOK

A catapult work (rough) logbook is maintained for each catapult in service. All pertinent information acquired daily during operation, testing, and repair of the catapult is recorded in the logbook. This is a ledger type book with a hard-cover and ruled pages. A logbook that has been filled with entries shall be kept for a period of 2 years and then discarded.

RECOVERY LOG

The recovery log (fig 3-4) is maintained by arresting gear personnel assigned to Pri-Fly to provide a uniform system of recording invaluable arresting gear data. With the exception of the "remarks" column, an entry must be made in each column for every recovery, excluding barricade arrestments.

The number recorded in the "recovery number" column must be an accurate running total of arrestments. It is imperative that all information be recorded accurately at the time of arrestment.

Particular care must be exercised to be as accurate as possible when making entries in the "distance-off-center" and "landing type" columns. Refer to footnotes 1 and 2 on the recovery log sheet (fig. 3-4) for information as to the nature and requirements of the entries.

Any unusual aspect of a recovery is to be noted accordingly in the "remarks" column. If a lengthy explanation is necessary, explain on a separate sheet of paper and attach it to the log sheet. Entries made in the "engine weight setting" and "ram travel" columns shall be obtained from the engineroom.

Recovery log sheets come in pads of noncarbon reproducible paper. When entering data on the log sheets, it is necessary to remove the number of sheets required or place a hard spacer under the proper number of sheets to prevent reproducing more than the desired number of copies.

Additional copies of the recovery log sheets (NavAir 13810/4) can be obtained from the forms and publications segment of the Navy supply department, in accordance with NavSup Publication 2002.

RECOVERY WIRE ROPE HISTORY CHART

A wire rope history chart (fig. 3-5) is kept for each arresting gear serving a deck pendant. This chart provides a uniform system of recording invaluable information pertaining to the wire rope used on recovery equipment.

When making each entry on the chart, be sure to include the last recovery number of the applicable arresting gear. This information can be obtained from the recovery log (fig. 3-4).

An entry is to be made on the wire rope history chart each time one or more of the following occurs:

1. After regularly required inspections of the purchase cable.
2. After replacement of the purchase cable.
3. After replacement of the deck pendant.
4. After torque removal in the cable system.
5. After cropping of the purchase cable due to stretch, recession of wires in the terminals, defective terminal, etc.

The rope gap and rope diameter shall be measured as instructed by a representative from the carrier and field service unit (CAFSU). Those columns on the wire rope history chart that require a specific type of entry are so noted by footnotes.

The wire rope history chart forms, like the recovery log forms, come in pads of noncarbon reproducible paper.

FLIGHT DECK OPERATIONS REPORT

This report is the responsibility of the commanding officer, however, the responsibility for its completion is usually delegated to the arresting gear officer. It is to be submitted quarterly on NavAir basic form 13810/1. The Flight Deck Operations Report is sent to NavAirSysCom, with copies to the Type Commander, Commanding Officer, NAEC (SI), and to the Naval Safety Center, Norfolk, Virginia. Quarterly reports are required even when there have been no recovery operations.

The fixed wing information required is as follows:

1. Type aircraft.
2. Number of landings for each type.
3. Number of crashes.

NAVAIR FORM 13820/1 (5/69)
S/N 0102-623-9010

STEAM CATAPULT LOG

U.S.S. America CVA-66

CATAPULT TYPE C13-1 CATAPULT NO. 3

MONTH February, 73

AMBIENT TEMPERATURE 75 °F

STEAM RECEIVER LAUNCHING PRESSURE ____ PSI. (FOR CONSTANT RECEIVER PRESSURE SYSTEM)

SHOT NO.	DATE AND TIME	AIRCRAFT DATA			WIND OVER DECK	CYLINDER ELONGATION (INCHES)		LAUNCHING STEAM PRESS. (PSI) OR CAPACITY SELECTOR VALVE SETTING	STEAM RECEIVER DATA				LAUNCH VALVE TIMERS		END SPEED	BRIDLE ARRESTER DATA		REMARKS
		TYPE	WEIGHT (LBS)	SIDE NO.		LEFT	RIGHT		PRESS. AFTER (PSI)	STEAM TEMP °F	WATER TEMP °F	WATER LEVEL (INCHES)	CLOCK 1	CLOCK 2		PRI. PRESS.	DECK RUNOUT	
000	8/1200	A5	45,000	250698	25	7.2	7.3	700	565	522	—	—	2.67	3.48	130	350	40	

SIGNATURE (Catapult Officer) Lt. Willie R. Jones

DATE 8 February 1973

D-33576

NOTE
DATA SHOWN FOR SAMPLE PURPOSES ONLY AND NOT INTENDED TO INDICATE ACTUAL OR SUGGESTED VALUES.

AB.321

Figure 3-3.—Steam catapult launching log sheet.

RECOVERY LOG (FOR USE IN PRI-FLY)

USS AMERICA CVA/ 66

3/19/72

RECOVERY NO	PENDANT NO	DATE AND TIME	AIRCRAFT DATA TYPE	SIDE NO	WEIGHT	AIR SPEED (SPN-12)	WIND OVER DECK	DISTANCE OFF CENTER ①	LANDING TYPE ②	ENGINE WT. SETTING ③	RAM TRAVEL	REMARKS
1919	3	0915	F4B	124	33,000	140	35	0	ROLL IN	33,000	171	
1920	2	0916	F4B	121	33,500	140	35	25	ROLL IN	33,500	171	
1921	3	0917	F4A	103	32,500	138	35	0	ROLL IN	32,500	169	
1922	4	0918	F4A	101	32,000	138	35	0	ROLL IN	32,000	168	HOOK BOUNCE
1923	2	0919	A3A	607	40,000	139	34	3P	ROLL IN	40,000	171	
1924	2	0920	A5A	601	39,000	139	33	0	FREE FLIGHT	39,000	171	
1925	3	0921	A5A	619	39,500	139	30	0	ROLL IN	39,500	171	
1926	2	0925	E2A	773	23,000	95	28	0	ROLL IN	23,000	165	

① IF ON-CENTER WRITE "O" IN BOX; INDICATE WHETHER OFF-CENTER PORT OR STBD: I.E. "12S" = 12 FT OFF-CENTER TO STBD.

② WRITE "FREE FLIGHT" OR "ROLL-IN."

③ AS OBTAINED FROM ENGINE COMPT.

AB.327

Figure 3-4.—Recovery log sheet.

4. Was the aircraft a strike, major overhaul, or other damage.
5. Total landings this report.
6. Total landings to date.
7. Total landings by deck pendent.
8. Number of catapult launches this report.
9. Number of catapult launches to date.
10. Any pertinent remarks.

In addition to the above information the following is required:

1. Deck pendant service life.

a. The number replaced during the period of this report.

b. The number of engagements on each pendant prior to replacement.

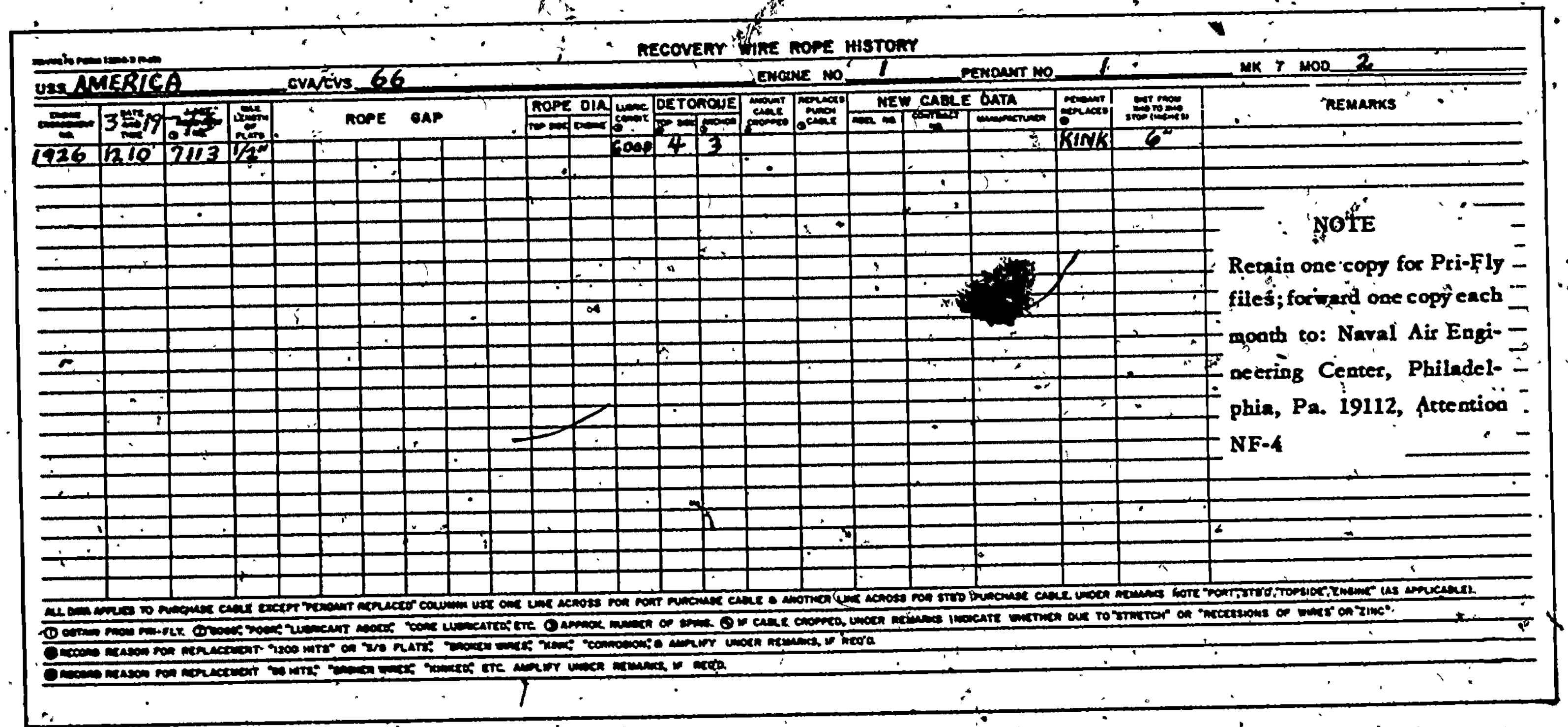
2. Helicopter landing data such as:

a. Under aircraft model, list helicopter model.

b. Under touch and go or helicopter landings, list helicopter landings in the appropriate space; i.e., night or day.

c. Under column landing crashes (deck), list crash information if any, such as major or minor.

NOTE: Helicopter landings must NOT be included in the tally or total arrested landings this report, or total arrested landings to date.



RECOVERY WIRE ROPE HISTORY

USS AMERICA CVA/CVS 66 ENGINE NO 1 PENDANT NO 1 MK 7 MOD 2

ENGINE [illegible] NO.	DATE AND TIME 3/19	[illegible]	MAX LENGTH OF FLATS	ROPE GAP	ROPE DIA TOP SIDE	ROPE DIA ENGINE	LUBRIC CONDIT ②	DETORQUE TOP SIDE ③	DETORQUE ANCHOR ③	AMOUNT CABLE CROPPED ⑤	REPLACES PURCH CABLE ④	NEW CABLE DATA REEL NO.	CONTRACT NO.	MANUFACTURER	PENDANT REPLACES ⑥	DIST FROM [illegible] STOP (INCHES)	REMARKS
1926	12.10	7113	1/2"				GOOD	4	3						KINK	6"	

NOTE

Retain one copy for Pri-Fly files; forward one copy each month to: Naval Air Engineering Center, Philadelphia, Pa. 19112, Attention NF-4

ALL DATA APPLIES TO PURCHASE CABLE EXCEPT "PENDANT REPLACED" COLUMN. USE ONE LINE ACROSS FOR PORT PURCHASE CABLE & ANOTHER LINE ACROSS FOR STB'D PURCHASE CABLE. UNDER REMARKS NOTE "PORT", "STB'D", "TOPSIDE", "ENGINE" (AS APPLICABLE).

① OBTAIN FROM PRI-FLY. ② "GOOD", "POOR", "LUBRICANT ADDED", "CORE LUBRICATED", ETC. ③ APPROX. NUMBER OF SPINS. ⑤ IF CABLE CROPPED, UNDER REMARKS INDICATE WHETHER DUE TO "STRETCH" OR "RECESSIONS OF WIRES" OR "ZINC".

④ RECORD REASON FOR REPLACEMENT: "1200 HITS" OR "3/8 FLATS", "BROKEN WIRES", "KINK", "CORROSION", & AMPLIFY UNDER REMARKS, IF REQ'D.

⑥ RECORD REASON FOR REPLACEMENT "96 HITS", "BROKEN WIRES", "KINKED", ETC. AMPLIFY UNDER REMARKS, IF REQ'D.

AB.322

Figure 3-5.—Recovery wire rope history chart.

UNSATISFACTORY MATERIAL/ CONDITION REPORT

The Unsatisfactory Material/Condition Report (UR) was created to obtain service experience information from the most reliable sources. The major aspects of the program are the collecting, compiling, and analyzing of service experience with aeronautical materials to determine areas of immediate failures and trends of impending failures, and to coordinate efforts to correct material deficiencies, and improve flight safety, operational utility; and logistic support for operating aircraft.

The rapid collection and dissemination of service experience data to cognizant governmental activities are necessary in order to rapidly initiate appropriate action to insure more reliable equipment in fleet service. In this regard, the assignment of competent personnel to supervise and review Unsatisfactory Material/Condition Report preparation is mandatory.

The basic form used for reporting failures, deficiencies, or malfunctions of equipment is the Unsatisfactory Material/Condition Report (UR), NavAir Form 13070/5. (See fig. 3-6.)

The UR provides for submission of specific information considered essential to conduct a complete evaluation and analysis of problem areas associated with catapults or arresting gear. The UR is required in order that complete statistical data and records concerning unsatisfactory material and failures may be compiled and appropriate corrective action taken. The reports include sudden failures (broken parts, etc.) as well as gradual failures (due to corrosion, foreign particles, stress, cracks, etc.). Conscientious reporting and submission of detailed opinions and observations on failed or unsatisfactory items will greatly help in the processing of this data.

The UR form has provision for the originator to submit a report in various categories. Space 5 of the UR must indicate the category as determined by the reporting activity. Guides for this selection are as follows:

1. SPECIAL—indicates that the particular condition is a result of discrepancies in design, maintenance, technical data, quality control (new manufacture or overhaul), or foreign object damage, but the condition was not itself critical in nature. Other special situations, such as not meeting expected performance life or other parameters which require reporting, fall into this category.

2. SAFETY—indicates a priority over all other reports. The originator selects this category when reporting deficient material conditions which, if not corrected, would result in fatal or serious injury to personnel or extensive damage or destruction to equipment; or for conditions that contribute to or could contribute to an accident or incident. A SAFETY Unsatisfactory Material/Condition Message should be initiated on the date the trouble occurs. The message must be assigned a "priority" rating. The SAFETY UR message must be followed up by a SAFETY UR.

The UR is provided in a carbon backed four-page set. To obtain legible copies, it is recommended that either typewriten uppercase letters or a ball-point pen be used.

The instructions for preparation of the Unsatisfactory Material/Condition Report (UR), printed on the first page of the four-page UR set, must be followed completely. Read all instructions thoroughly before filling in the UR.

The UR set is prepared in all cases when an accountable part is removed and replaced by a part drawn from supply, or when a part is delivered to a supporting maintenance activity for repair or replacement. The purpose of each section is as follows:

1. The first sheet in the set is the ORIGINAL document which is transmitted to the UR Center, NATSF (MR). Pertinent data from the UR is entered on the other parts of the UR set by the carbon backed sheets.

2. The FILE copy is retained by the UR report originator for record purposes. A file copy should be retained for 6 months by the reporting activity or the supporting maintenance activity, as appropriate.

3. The TAG copy (hard copy) is a complete carbon copy of the UR that is attached to material being turned in to supply or released for investigation.

Failed material should be retained at the field site with a legible TAG copy (hard copy) of the UR report securely attached to it. ALL ORIGINAL UR's or first sheet of UR sets, with

UR (Use typewriter or ball point pen.)

UNSATISFACTORY MATERIAL/CONDITION REPORT
(See Instructions For Preparation of Form in OPNAVINST 4790-2)

Report Symbol OPNAV 4790-6 UR

1. REPORTING ACTIVITY	2. LOCATION	3. SER. NO	4. DATE OF TROUBLE	5. REPORT CATEGORY	6. MSG DTG
USS RANGER (CVA 61)		0090	3-10-73	☐ SPECIAL ☒ SAFETY	

7. INSTALLED ON (Type Aircraft/Ship/Support Equip., etc.)	8. BUREAU/SERIAL/HULL NO.	9. TECHNICAL DATA DEFICIENCY-TECHNICAL DATA IDENTIFICATION
Mk 7 MOD 2 ARRESTING GEAR		☐ YES ☐ NO

10. JOB CONTROL NUMBER (ORG. / DATE / SEQ. NO. / SUF)	11. MAINT. CONTROL NUMBER	12. WUC/EIC	13. TYPE EQUIP.	14.
				☐ FOLLOW UP REPORT

DEFICIENT ITEM DATA

15. MANUFACTURER'S PART NO.	16. NOMENCLATURE	17. SERIAL NO.	18. QUANTITY
NAEC 607969-9	CABLE GUIDE		1

19. FEDERAL STOCK NO. (FSN)	20. FEDERAL MFR'S CODE	21. CONTRACT NO.	22. MILITARY/COMMERCIAL OVERHAUL ACT.
R1710-601-0715-RCAG	80020		

23. TIME COUNT SINCE NEW	24. TIME COUNT SINCE OVERHAUL	25. NUMBER OF EVENTS (Cycles, starts, etc.)
		600 ARR.

26 INSTALLED ON (Indicate major component and end item on which defective item is installed or applicable to)

	PART NUMBER	NOMENCLATURE	TYPE/MODEL & SERIES	SERIAL NUMBER
SYSTEM/ EQUIPMENT/ ENGINE, ETC.	NAEC 612602-1	ARR. ENG. INSTL.	MK 7 MOD 2	
UNIT/ COMPONENT OR EQUIPAGE				
SUBASSEMBLY				

27. REASON FOR REPORT (Place X in proper box): 1 ☐ FAILURE/SUSPECTED FAILURE OR MALFUNCTION 2 ☐ DAMAGED DUE TO IMPROPER MAINTENANCE/ OPERATION/ TEST 3 ☐ DAMAGED OR DEFECTIVE ON RECEIPT 4 ☐ CAN BE INSTALLED WRONG

28. DISPOSITION (Place X in proper box): 1 ☐ HOLDING 90 DAYS FOR INVESTIGATION 2 ☐ RELEASED FOR INVESTIGATION (Amplify in space 29) 3 ☐ REPAIRED MADE RFI (Amplify in space 29) 4 ☐ RETURNED TO SUPPLY/ DISPOSED OF (Amplify in space 29)

29 AMPLIFYING DETAILS: 1. Circumstances existing prior to difficulty. 2. Description of difficulty 3. Cause 4. Action Taken 5. Recommended disposition instructions (if applicable). 6. Recommendations 7. List specific activity that is holding the material.)

THE MIDDLE CABLE GUIDE BROKE DURING A NORMAL ARRESTED LANDING.

(If additional space is required, tear out and reverse carbons. Use reverse side. Use typewriter or ball point pen.)

30. PREPARED BY D. Mendenhall D. Mendenhall RANK/RATE ABCM DATE 3/10/73

APPROVED BY W. R. Jones W. R. Jones RANK/RATE CDR DATE 3/11/73

UNSATISFACTORY MATERIAL/CONDITION REPORT OPNAV FORM 4790/47 (10-69) S/N 0107-770-5000

Forward ORIGINAL to Naval Air Technical Services Facility, 700 Robbins Ave., Phila., Pa. 19111
Retain one FILE copy for record purposes.
Attach TAG copy (hard copy) to material being turned in to supply or released for investigation.

AB.323

Figure 3-6.—UR report form.

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photographs and/or drawings, are forwarded to the Naval Air Technical Services Facility (MR); 700 Robbins Avenue, Philadelphia, Pennsylvania, 19111.

SUPPLY

It is essential that the ABE1 and ABEC know certain phases of supply in order to procure and maintain equipments in accordance with current regulations. They must be familiar with the publications used in identifying material, equipment, and spare parts utilized in the performance of the duties of their rate. In addition, the ABE1 and ABEC must be familiar with the quantities of material and equipment authorized, and the authorization for these allowances. They must also know procedures used in procuring, expending, inventorying, and maintaining custody of material.

IDENTIFICATION OF SPARE PARTS AND EQUIPAGE

In order to procure the desired material or to properly conduct an inventory of materials on hand, the ABE must be able to identify the material or equipment concerned. The nameplate attached to some equipment furnishes data helpful in identifying the equipment. However, when procurement requests are initiated, it is very important that the correct federal stock number, complete nomenclature, part number, and reference be furnished the supply officer to prevent ordering unsuitable material. This information can normally be obtained from Navy stock lists and applicable technical manuals, parts lists, NavAirSysCom change bulletins, and allowance lists.

FLEET ORIENTED CONSOLIDATED STOCK LIST

The Fleet Oriented Consolidated Stock List (FOCSL) is prepared by the Navy Fleet Material Support Office and is designed to afford relief of workload for shipboard personnel. The many stock catalogs are impractical for shipboard use because they are bulky in size, differ in format, include much data never used aboard ship, and require an excessive amount of time to maintain. The FOCSL was developed in order to substantially reduce the number of supply catalogs required to be maintained by reducing and tailoring catalog information to those items of interest to Navy personnel.

Prior to the development of the FOCSL, it was necessary to search through several cross-reference listings published by the various inventory managers to cross-reference a manufacturer's part number of a federal stock number. Part number for Navy interest items are now consolidated into the MASTER CROSS-REFERENCE LIST section of the FOCSL regardless of the controlling inventory manager. This section is a one-way listing from part numbers to Federal Item Identification Numbers (FIINs) and includes the federal supply code for manufacturers. The part numbers are arranged in alphanumerical sequence.

Bimonthly CHANGE BULLETINS are published to update the Price and Management Data section and the Master Cross-Reference List section; a separate bulletin is issued for each. These change bulletins are cumulative and list necessary current information to update the applicable FOCSL sections. The information is presented in the same format as the basic section.

CURRENT WEAPONS EQUIPMENT LIST (WEL 1090)

This List contains FSN (Federal Stock Number) to P/N (Part No.) and P/N to FSN cross-reference listings. This List is invaluable to the ABE.

NAVY STOCK LIST OF AVIATION SUPPLY OFFICE

The Navy Stock List of the Aviation Supply Office lists and identifies material under the inventory management of the Aviation Supply Office (ASO). This material is identified by the cognizance symbol E or R prefixing the federal stock number of the item. The Navy Stock List of ASO is published in four parts.

Cross-Reference C0009
(FSN to Manufacturer's Part Number and Code)

One part of the ASO stock list publication is a cross-reference from federal stock numbers to manufacturer's part numbers and code.

Price and Management Data Section

The second ASO stock list publication contains the following information: the federal stock number of the item, its unit price, unit of issue and accountability code; new items; and deleted items. All classes of material are included in these sections.

Descriptive Sections

The third ASO stock list publication contains a cross-reference from the characteristics of items to the federal stock numbers.

Parts List Sections

The fourth ASO stock list publication contains a cross-reference from part number to stock number, supersedure of numbers, additional model applications, equivalents, change of design information, maintenance and overhaul percentages, accountability codes, perishability and salvageability information, and indications as to whether items are included on allowance list.

REQUEST FOR ISSUE

The ABE may encounter a variety of local requisitioning channels, all designed to satisfy material requirements. Procedures at the consumer level are somewhat flexible. Normally, the single line item requisition, DD Form 1348, is the form on which material is procured from the supply department. It is important that the correct stock number, manufacturer's part number, and nomenclature be included on all requests in order to expedite identification and issue. Incorrect or omitted information can lead only to confusion and delay in issue, or possibly the wrong part or material may be issued.

Afloat, the request document is presented to the aviation stores division for technical aeronautical material or to the supply office for other than aeronautical material. While individual ships may employ different procedures, such as a credit card system, the DD Form 1348 is normally the request document. When it is necessary for the ABE to draw parts or material from supply, he prepares a DD Form 1348 and presents it to the air officer or his authorized representative for signature. The DD Form 1348 is then presented to the supply department for processing and receipt of material.

Ashore, the requisition may be presented directly to a supply warehouse or to an established retail issue outlet. Procedures may differ between shore stations, because of assigned levels of maintenance, geographical location of shops relative to supply facilities, and other factors. Normally the DD Form 1348 is the proper request document which is prepared and submitted in accordance with local instructions.

Requests for In-excess Material

Aboard ship requisitions for the following are considered as in-excess:

1. Equipage not on the ship's allowance list.
2. Equipage on the allowance list but in greater quantities than allowed.
3. Repair parts not listed with quantities in ship's allowances for which a request can be justified.

Request for in-excess material must be accompanied by a complete justification as to why the item is required and why authorized material will not suffice. If the item is required for use by all similar type activities, a recommendation should be made to include the item in an applicable allowance list. Except in an emergency, in-excess material cannot be issued by the supply officer until the request has been approved by competent authority.

Ashore, the ABE is not normally confronted with in-excess requirements. Accountable (plant account) material requirements are included in the activity's budget submission to the management bureau, and the granting of funds normally constitutes approval of the requirement.

Requests for Nonstandard Material

Nonstandard material is material for which a federal stock number has not been assigned. When preparing a DD Form 1348 for nonstandard material, it is imperative that complete information be furnished in order that the supply officer may positively identify the exact material, equipment, or part that is required. The following information should be furnished, if possible, when requesting nonstandard material:

1. Complete name of item.
2. Complete nomenclature of item.
3. Manufacturer's name.
4. Manufacturer's part or drawing number.
5. Name and address of a dealer where the material can be obtained.
6. The document or publication authorizing issue of the item.
7. Justification as to why standard material will not suffice.

Requests for nonstandard material are prepared on DD Form 1348 and forwarded to the supply officer in the same manner as a request for standard material.

SURVEYS

The Survey Request, Report, and Expenditure (NavSup Form 154) is the document used to reevaluate or expend lost, damaged, deteriorated, or worn material from the records of the accountable officer as required by U.S. Navy Regulations. Rules and regulations governing surveys and the responsibility connected with the accounting for government property are of primary importance to every man in the naval service.

The survey request provides a record showing the cause, condition, responsibility, recommendation for disposition, and authority to expend material from the records. Rough survey requests are prepared by the person or department head responsible for the material to be expended or reevaluated.

Types of Surveys

There are two types of surveys with which the ABE should be familiar - formal and informal. Each activity normally prepares local regulations outlining the circumstances which will determine whether a formal or informal survey will be made. However, the commanding officer will order a formal survey in any case he deems it necessary.

Formal Survey

A formal survey is required for those classes of materials or articles so designated by the bureau or office concerned, or when specifically directed by the commanding officer. A formal survey is made by either a commissioned officer or a board of three officers, one of whom, and as many as practicable, must be commissioned, appointed in either instance by the commanding officer.

Neither the commanding officer, the officer on whose records the material being surveyed is carried, nor the officer charged with the custody of the material being surveyed may serve on the survey board.

Informal Survey

Informal surveys are made by the head of the department having custody of the material to be surveyed. Informal surveys are used in cases when a formal survey is not required or directed by the commanding officer.

PREPARATION OF A REQUEST FOR SURVEY

A request for survey may be originated by a department, division, or section head, or a designated subordinate, as prescribed by local regulations. Normally, requests for survey are originated in the department having custody of the material being surveyed. The initial survey is made on a rough copy of Form 154. A statement by the originator is placed on or attached to the request for survey. Included in this statement is information relative to the condition of material; cause or condition surrounding the loss, damage, deterioration, or obsolescence of material; responsibility for cause or condition of material, or reason why responsibility cannot be determined, and recommendation for disposition of material or action to be taken.

Upon receipt of the rough copy, the designated group or section prepares a sufficient number of smooth copies of the request for distribution in accordance with local regulations. The smooth survey request is filled in down to the caption "Action by Commanding Officer or Delegate." It is then forwarded to the commanding officer who will determine whether the survey will be formal or informal. If formal, the survey request is forwarded to the designated surveying officer(s); if informal, it is forwarded to the HEAD of department for survey action.

The statement by the originator as to the cause, condition, etc., is attached to the smooth request for survey for evaluation by the surveying officer(s). After the survey has been completed by the head of department or surveying officer(s), it is returned to the commanding officer for review action. After approval by the commanding officer, the survey request is forwarded to the cognizant fleet command and/or bureau for final review and approval when so required. In the absence of specific instructions, surveys are not forwarded to the Naval Air Systems Command for final review and approval.

After approval, the supply officer expends items as directed by the approved survey.

Requests for replacement of surveyed items must be made with DD Form 1348, and must be accompanied by a certified copy of the approved survey request.

Culpable Responsibility

When a person in the naval service is found to be culpably responsible by a surveying officer or board, the reviewing officer will refer the entire matter to such a person for a statement. The reviewing officer must then take such disciplinary action as the circumstances require. He will note on the survey the action taken and inform the Chief of Naval Personnel and the bureau concerned as to the disciplinary action taken. In the case of officers, he must make recommendations as to the inclusion of a statement of the action taken in the record of the person concerned and inform that person of the final decision in the matter. Action on the survey in respect to the material involved must NOT, however, be withheld pending disciplinary action. (See art. 1953, U.S. Navy Regulations.)

INVENTORIES

In the first quarter of each fiscal year an annual inventory of equipage is conducted. The supply officer coordinates and sets up the beginning and ending annual inventory dates with the approval of the commanding officer. Each department is advised of these inventory dates in writing by the supply officer. It is the responsibility of each department head to inventory the equipage assigned to his department. ABE's are normally required to physically inventory all equipage assigned to them on a custody receipt from the air officer or their division officer. When equipage is inventoried, special care should be taken to note if it is serviceable, properly preserved and stowed, and to ascertain if it is still required by the department to perform its assigned mission. The ABE using the equipage is the person in the best position to determine this. Therefore, he should make recommendations to the division officer or to the air officer as to the need for survey, expenditure, disposition, or acquisition of additional equipage.

The most important inventory is the one held within the division. There is no answer in the event a certain spare part is needed and it suddenly comes to light that one is not available. Not one piece of equipment under the cognizance of ABE's can be allowed to be inoperative at any time. Therefore, if something is in a down status due to the lack of a proper inventory of spare parts, someone is in trouble; and as a senior ABE, there is no need to point out who it is.

To operate efficiently and to insure that spare parts are properly stowed and inspected, an inventory is held every 30 days. There should always be a 90-day supply of spare parts aboard; therefore, inspect your spares as often as necessary to see that you have a complete stock and that it is in good condition.

When storing spare parts they should be properly preserved to prevent damage from rust or corrosion. They should be stowed in as clean and dry a space as possible. Spare webbings must be stored in a clean, dry, well-ventilated space to prevent dry rot and mildew. Always store spares to provide easy accessibility. Time is usually important when replacement parts are required. If possible, spares should be distributed in several storerooms to prevent loss of all spares in event of bombing or if a fire should break out in a storeroom. Try to store spares near the area where they are to be used.

CUSTODY CARDS

Equipage is the term normally used to identify nonexpendable material for which custodial responsibility is designated by means of custody cards. An inventory count of equipage on hand must be brought into agreement with the amount shown on the custody cards. Any items missing at inventory, or found to be unserviceable, must be surveyed and expended from the custody record cards. Equipage, on which custody cards must be maintained, is defined as those items having an accountability code designation of D, E, R, or L. Code D and E items are maintained on a custodial signature basis. Code R and L items, depending on the use of the item, are in some cases maintained on a custodial basis. All of these four coded items are normally exchanged on an item-for-item basis. There are two designations of custody record cards, NavSup Form 306 or 460.

Equipage is issued by the supply officer to the head of the applicable using department. The department is held accountable to the commanding officer for this material. It is apparent that the head of a department cannot personally keep track of all equipage for which he is held accountable. Therefore, he must delegate custodial responsibility to the division officers and/or leading petty officers using or having the material in their custody. When an ABE is assigned custodial responsibility, he is required to sign a memorandum receipt to his division officer or department head for the material for which he is held responsible.

The ABE should keep strict control over and know the location of his equipment at all times. He can be held culpably responsible for material lost or damaged due to his negligence.

CARRIER AND FIELD SERVICE UNITS

The Carrier and Field Service Unit (CAFSU) was established in 1953. The need for experienced and highly trained personnel was recognized by the Bureau of Aeronautics (currently Naval Air Systems Command), in order to provide technically experienced personnel on a continuing basis to span the 2-year military rotational policies. This specialized group of technicians provides continuity of service, even though military personnel are transferred frequently.

CAFSU technicians are usually selected from Navy military personnel who have a wealth of experience and have distinguished themselves through years of operational experience. Most of the present technicians are retired officers and petty officers who service the fleet and shore-based activities throughout the world. All technicians are under the administrative control of the Naval Air Engineering Center (SI), Philadelphia, Pa. 19112. These technically qualified and diversified technicians are on call 24 hours a day to furnish technical assistance as requested by naval message, letter, or other method. Such requests should be referred to commands as follows: COMNAVAIRLANT, COMNAVAIR-PAC, and the Naval Air Engineering Center. The Type Commands should be action addressee for fleet requests, and the Naval Air Engineering Center (SI), for shore activity requests. Occasionally, problems of routine nature can be solved by a personal visit to the nearest CAFSU field office, located as follows:

1. Naval Air Station, Norfolk, Virginia.
2. Naval Station, Mayport, Florida.
3. Naval Air Facility, Naples, Italy.
4. Naval Air Station, San Diego, California.
5. Naval Shipyard, San Francisco, California.
6. Ship Repair Facility, Yokosuka, Japan.
7. Naval Air Engineering Center, Philadelphia, Pa.
8. Puget Sound Naval Shipyard, Code 275, Bremerton, Wash.
9. Ship Repair Facility, Subic Bay, R. P.

CAFSU technicians provide technical assistance to shorebased and shipboard personnel who operate and maintain catapults, arresting gear, Fresnel lens, PLAT systems, and flight deck lighting. Various types of technical assistance are available to activities—for example, training of personnel, routine operational and maintenance procedures and problems, troubleshooting, analysis of equipment casualties, and emergency repairs at sea and in port. During major and minor overhaul of launching and recovery equipment, CAFSU representatives monitor the progress and workmanship to assure compliance with Bulletins, Changes, plans, and applicable instructions.

CHAPTER 4
STEAM CATAPULTS

The modern aircraft carrier is one of the most versatile weapons our country possesses, being able to launch as well as recover some of the world's largest and fastest combat aircraft. The modern aircraft carrier also has the ability to travel quickly to operational areas anywhere on the high seas, which allows the carrier to attack or defend almost any selected target in the world.

Catapult equipment is just one of many systems vital to the operational status of the aircraft carrier. Without this equipment, the heavy attack and fighter aircraft could not become airborne with the variety of payloads required As carrier based aircraft became larger and heavier, catapult development moved along, resulting in larger launching weight capabilities. Since 1951, when the United States tested and evaluated the British type steam catapult and found that it could be modified to work with the higher steam pressures developed by the boilers of American ships, our engineers have progressively improved the basic design and launching capacity of our catapults.

Senior ABE's assigned to the steam catapult divisions are charged with the responsibility of maintaining the machinery in accordance with applicable Maintenance Requirements Cards (MRC's), and of organizing, supervising, and training crews in a manner that will insure SAFE and efficient operation of the catapult.

To perform this continuous and demanding task in an exemplary manner, senior ABE's must strive to maintain versatile, knowledgeable crews with the use of training manuals, Maintenance Management and Material (3-M) procedures, on-the-job training, and duty rotation on a scheduled basis whenever possible, so that each individual will be qualified in as many duties concerning the operation and maintenance of steam catapults as time allows. Ultimately, every man should know and be able to perform any duty at any time called upon.

CAPABILITIES AND LIMITATIONS

The C-13 catapult is a steam-powered, direct-drive, flush-deck catapult. As can be seen from table 4-1, it is capable of launching an aircraft weighing 74,000 pounds at an end speed of 128 knots. The steam pressure is greater than that normally used in any of the previous catapults. The C-13 catapult has an energy potential of 60 million foot-pounds, which makes it capable of launching any of the present or planned carrier aircraft with an adequate margin of safety. You will find as you proceed through this chapter that there are many differences between the C-13 catapult and all the others in the fleet today.

This chapter deals chiefly with the C-13; however, the newer rotary retraction and drive system used with the C-13-1, installed on CVA-41 and CVA-67 and subsequent carriers, are briefly discussed. The principal differences between the C-13 and the C-11 are also presented.

DESCRIPTION OF COMPONENTS

Each C-13 type catapult consists basically of eight major systems:

1. Launching system. This system may be defined as those components to which access can be gained at the flight deck level. These components include:
   a. Trough covers and track assembly.
   b. Power cylinders.
   c. Cylinder covers.
   d. Sealing strip and spring tensioner.
   e. Launching shuttle.
   f. Launching pistons.

Table 4-1.—Types of steam catapults

Item	C-7	C-11 & C-11-1	C-13	C-13-1
Power stroke (in feet)	253	211	249'10"	309' 8 3/4"
Track length (in feet)	267	225	264'10"	324'10"
End speed (in knots)	115	108	128	140
Maximum operational aircraft weight in pounds	73,000	68,000	74,000	80,000

2. Steam systems.
 a. CVA-63 through CVA-66. (See fig. 4-1.)
  (1) Flow control valve system.
  (2) Steam receivers.
  (3) Launching valves and assemblies.
  (4) Exhaust valve.
  (5) Steam preheating systems.
  (6) Steam smothering system.
  (7) Orifice elbow assembly.
  (8) Steam operated pressure switch.
 b. CVA-67.
  (1) Steam charging valves.
  (2) Steam wet receiver (constant pressure source). (See fig. 4-2.)
  (3) Launching valves and assemblies.
  (4) Exhaust valve.
  (5) Thrust-exhaust unit.
  (6) Steam preheating systems.
  (7) Steam smothering system.
  (8) Orifice elbow assembly.
  (9) Steam operated pressure switch.

3. Retraction system. The two retraction engine systems in use are the linear and the rotary. The majority of catapults installed aboard carriers are equipped with the linear retraction engine. Rotary retraction engines are installed aboard CVA-41, CVA-67, and subsequent carriers. The rotary is the newest of the two retraction systems and will be installed on all future carriers.

The retraction engine provides the power to retract the shuttle and the launching engine pistons after the catapult has been fired. It is also used to advance and maneuver the grab forward and aft.

 a. Linear retraction engine system.
  (1) Retraction engine cylinder and piston.
  (2) Advance stroke buffer.
  (3) Retract stroke buffer.
  (4) Main hydraulic accumulator.
  (5) Sheaves.
  (6) Cable equalizers (retract and advance).
 b. Rotary retraction engine system (fig. 4-3).
  (1) Retraction engine hydraulic motor.
  (2) Cable tensioner assembly.
  (3) Screw and traverse carrage installation.
  (4) Sheaves.

4. Drive system. This system provides the means of transferring the motion of the retraction engine to the grab for advance and retraction of the shuttle and piston assemblies.
 a. Linear retraction system.
  (1) Grab.
  (2) Advance and retraction cables.
  (3) Fairlead sheaves.
 b. Rotary retraction system (fig. 4-4).
  (1) Grab.
  (2) Advance and retraction cables.
  (3) Fairlead sheaves.
  (4) Drum assembly.
  (5) Screw and traverse carriage (fig. 4-5).

The screw and traverse assembly physically prevents the advance and retract cables from being crossed or tangled on the drum when the retraction engine is in operation. The traverse

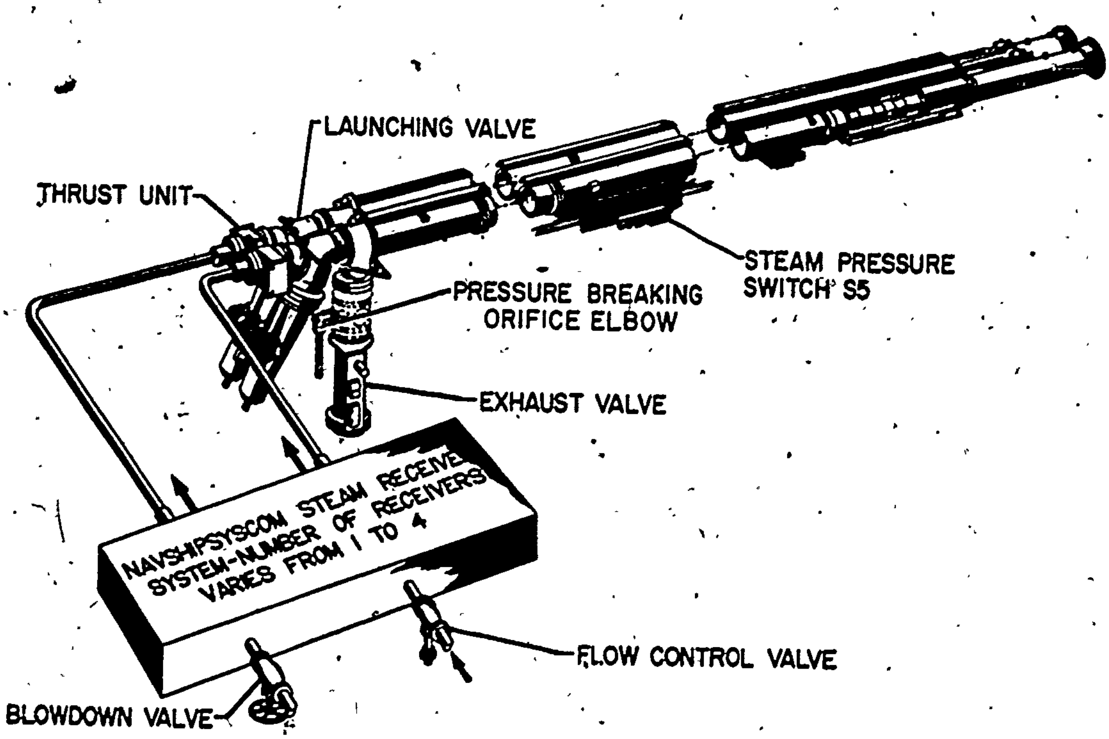

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Figure 4-1.—Steam system (typical) CVA-63-CVA-66.

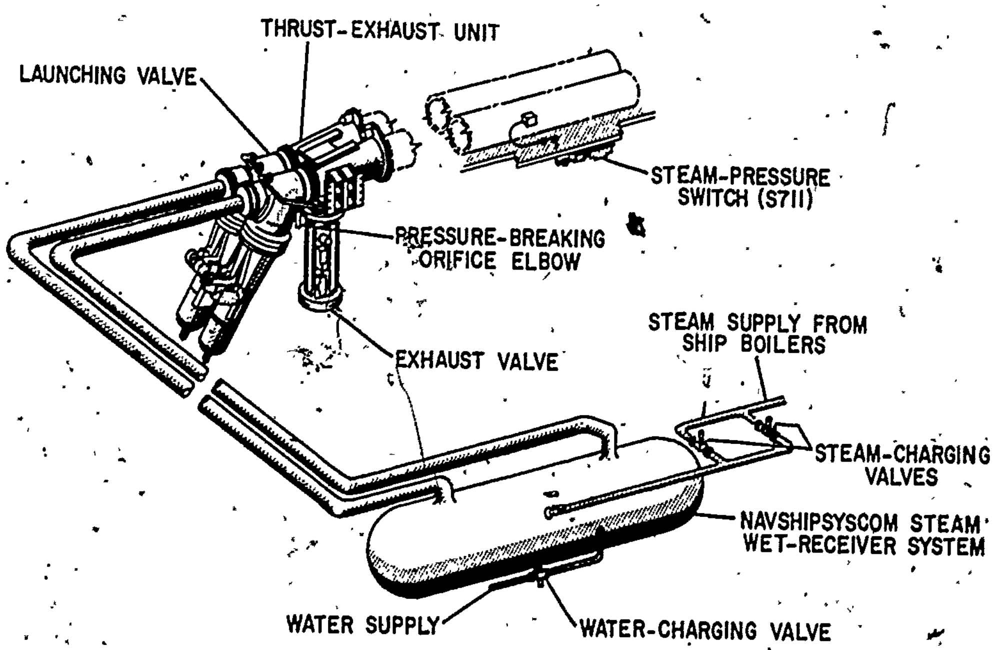

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Figure 4-2.—Steam wet receiver (CVA-67 and future).

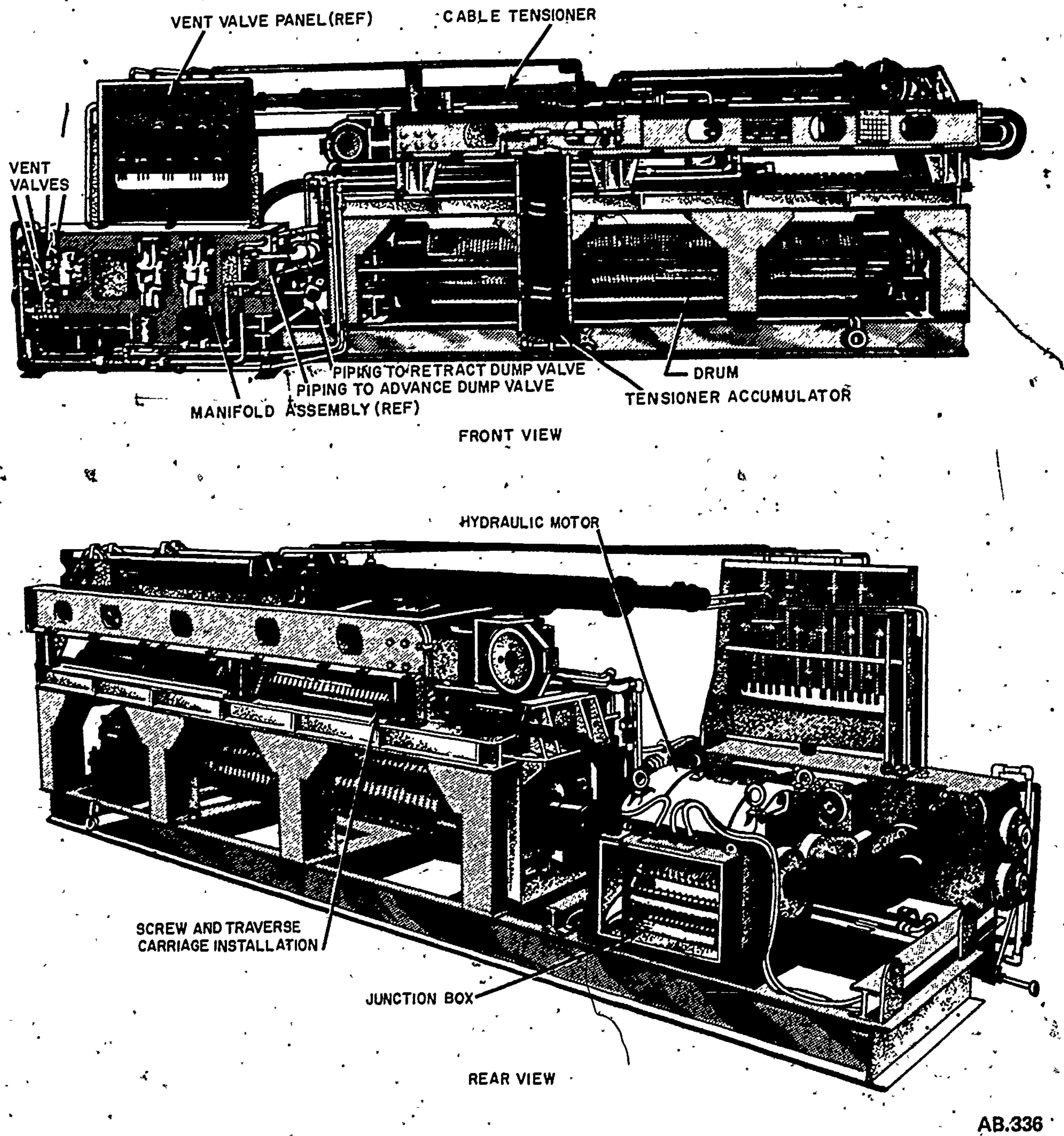

Figure 4-3.—Rotary retraction engine.

carriage, driven by the screw, slides in tracks mounted on the retraction engine frame.

The screw is geared to and driven by the drum. Rotation of the drum causes one set of the cables to wind on the drum while the other set pays out or unwinds. When the drum and screw rotate, the carriage moves slowly along the tracks that are mounted near the top of the engine frame, guiding the cables on and off the drum.

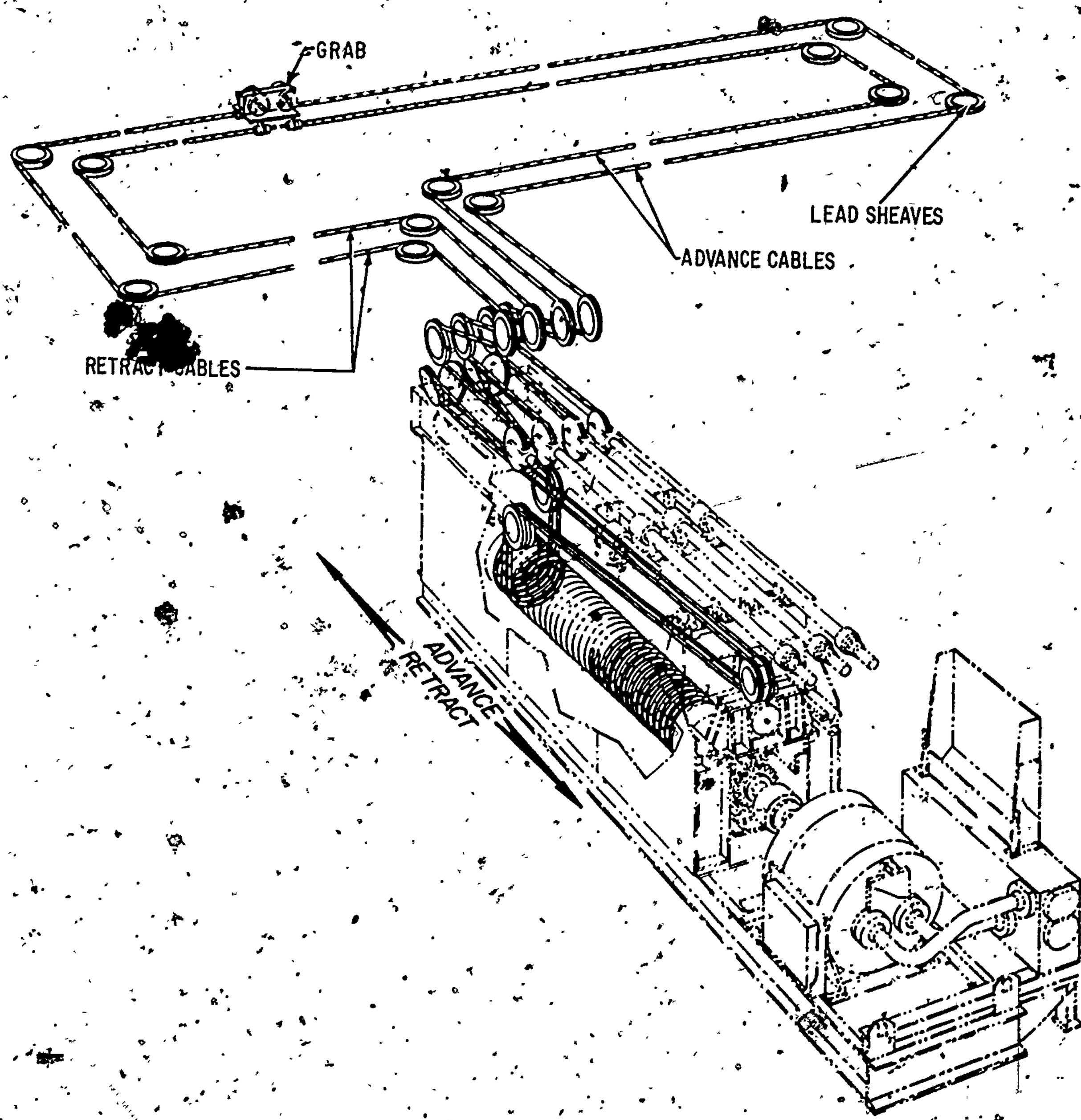

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Figure 4-4.—Drive system (rotary retraction system).

5. Hydraulic system.
   a. Linear system.
      (1) Two main hydraulic pumps.
      (2) A circulating pump.
      (3) A drain pump.
      (4) A gravity tank and external cooler.
      (5) The associated piping and control valves.
      (6) The main hydraulic accumulator.
      (7) An air flask.

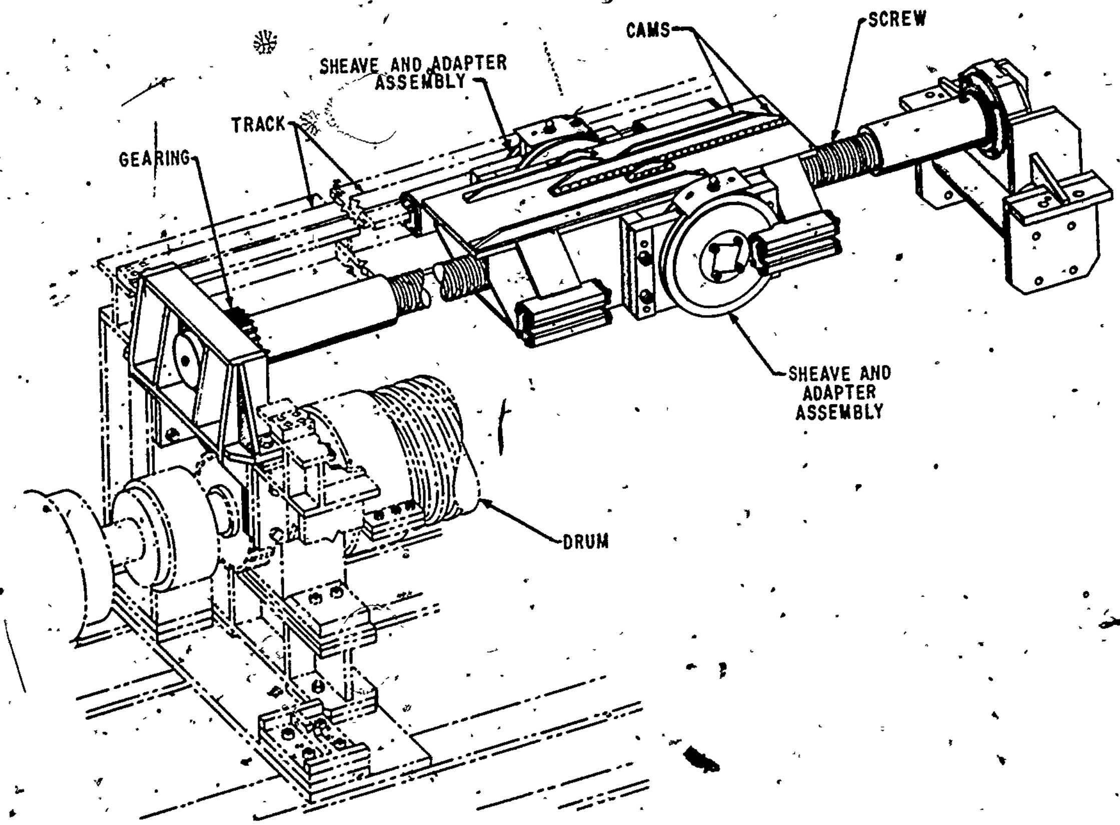

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Figure 4-5.—Screw and traverse carriage.

(8) The retraction engine manifold assembly.

(9) An auxiliary tank

b. Rotary system (fig. 4-6).

(1) Three main pumps.

(2) A circulating pump.

(3) A gravity tank and external cooler.

(4) An auxiliary tank.

(5) A main hydraulic accumulator.

(6) An air flask.

(7) The associated piping and control valves.

(8) A drain pump.

(9) The retraction engine manifold assembly.

The hydraulic system supplies pressurized fluid to the hydraulic components of the catapult. The main pumps of the hydraulic system draw fluid from the gravity tank and pressurize it. The fluid is then directed into the main hydraulic accumulator where the fluid is kept at a relatively constant pressure. The circulating pump draws hydraulic fluid from the gravity tank and circulates it through the cooling jackets of the launching-valve operating cylinder. This continuous flow of cooled hydraulic fluid prevents overheating of the operating cylinders during catapult operations. The circulating pump is also used to fill the gravity tank with hydraulic fluid from the auxiliary tank. The external cooler is located near the gravity tank, and when the hydraulic pumps are not pumping fluid to the accumulator, the fluid passes through the external cooler to the gravity tank, thus maintaining the fluid at a constant temperature. The drain pump transfers the hydraulic fluid from supply drums to the auxiliary tank.

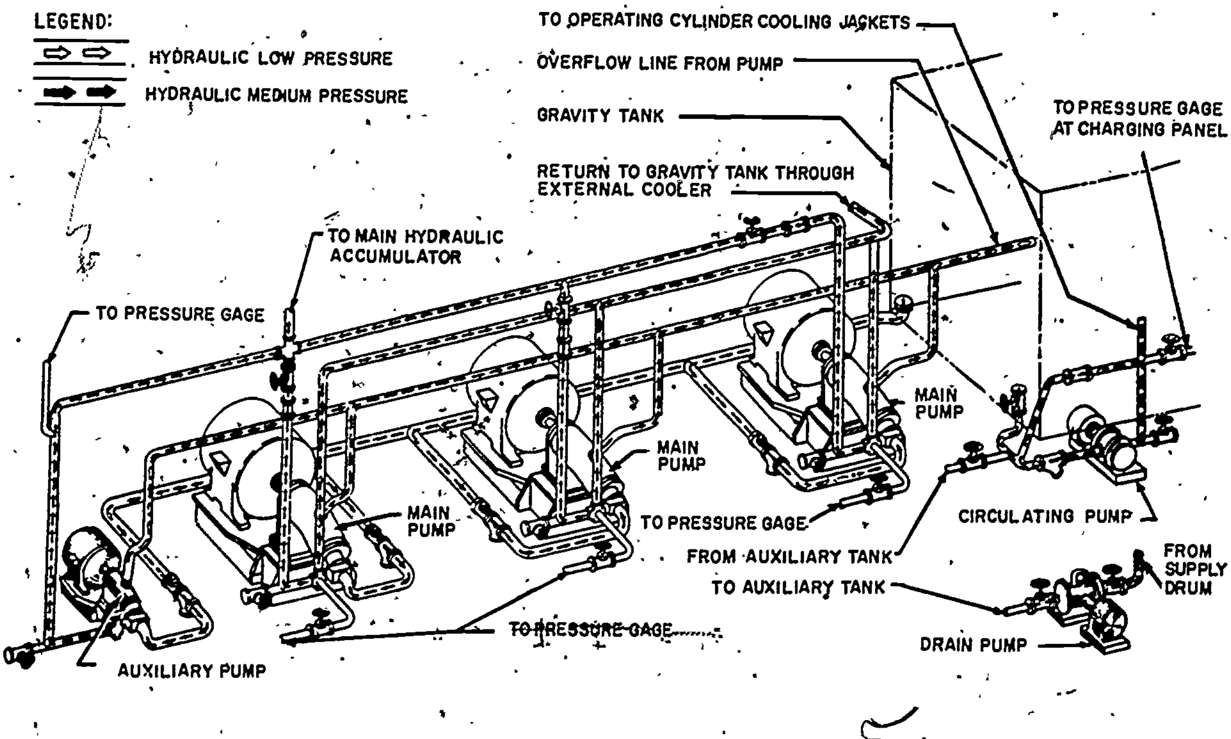

Figure 4-6.—Hydraulic system (rotary retraction engine).

The auxiliary pump runs continuously and is in parallel with the main pumps. The auxiliary pump is used to take care of leakage in the system so that the main pumps will not have to run for that purpose.

The main hydraulic pumps (fig. 4-6) run continuously during launching operations and supply high-pressure fluid to the catapult hydraulic system. The hydraulic output from the pumps is controlled by operation of the delivery control unit. The delivery control unit is operated by the stroke control actuator located at the main hydraulic accumulator. When the volume of hydraulic fluid in the accumulator is less than normal, the pumps go on-stroke and fluid is supplied to the accumulator. When the accumulator is filled to the proper level, the delivery control unit shifts and causes the main hydraulic pumps to go off-stroke. When the pumps go off-stroke, the hydraulic fluid is no longer supplied to the main accumulator, but rather is pumped back to the gravity tank.

The main hydraulic accumulator (fig. 4-7) consists mainly of a cylinder and a free piston. The accumulator maintains a relatively constant pressure in the hydraulic system. Hydraulic fluid on one side of the piston is maintained in a pressurized condition by air pressure on the other side. As hydraulic fluid is used, air pressure causes the piston to move toward the fluid end of the accumulator cylinder, maintaining pressure on the fluid. Fluid used from the accumulator is replenished by the main hydraulic pumps or the auxiliary pump.

A stroke control actuator is mounted in the bottom of the accumulator cylinder. The actuator is a lever operated cam which operates a limit switch. When the piston reaches the top of its normal operating stroke, the actuator causes the hydraulic pumps to pump hydraulic fluid (go on-stroke) to the accumulator. When the piston reaches the bottom of its normal operating stroke, the actuator causes the delivery control unit to shift and cause the main hydraulic pumps to go off stroke. (See fig. 4-7.)

A volume normal actuator is located in the top of the cylinder. When the piston reaches a position near the top of the cylinder, it actuates a lever which operates the hydraulic-accumulator-volume limit switch. This breaks the interlock to prevent firing of the catapult when there is insufficient hydraulic fluid in the accumulator to operate the launch valves.

The air flask (fig. 4-8) is a container of compressed air which is used to maintain nearly constant hydraulic fluid pressure in the accumulator. As the fluid in the accumulator is used, the air pressure forces the piston upward, displacing the fluid. Because of the large volume of air in the air flask, the pressure change in the accumulator is relatively small.

6. Bridle Tension System. The major components of the bridle tension system are:
   a. Tensioner cylinder and piston.
   b. Holdback cleat.
   c. Solenoid-operated air valves.
   d. Control valves.
   e. Air charging and blow down valves.
   f. Reducing valve.
   g. Surge accumulator.

7. Lubrication System. All lubrication on the C-13 catapult is accomplished through nozzles located in the cylinder covers. The components that make up the system are:
   a. Injector nozzles.
   b. Metering injectors.
   c. Solenoid-operated air valve.
   d. Control valve.
   e. Pump motor set.
   f. Supply tank.
   g. Gage and piping arrangement.

8. Control System. The control system (CVA-63 through CVA-66) allows for control of the catapult during all phases of operation. It is divided into seven major panels:
   a. Control console (fig. 4-9).
   b. Deck edge control panel (fig. 4-10).
   c. Auxiliary deck edge light panel (fig. 4-11).
   d. Primary fly panel.
   e. Retraction control panel.
   f. Water brake panel.
   g. Boilerroom panel (optional).

The C-13 and C-11 catapults differ in several areas. Following is a listing of the major differences areas and some comparisons between the two catapults:

1. Launching system, C-13.
   a. Increased cylinder sections.
   b. Longer track and power run.
   c. Longer sealing strip.
2. Steam system, C-13.
   a. Higher pressure and steam temperature.
   b. Different control system for launching and exhaust valves.
3. Retraction system differences.
   a. The length and construction of the main engine cylinder and piston.
   b. Main hydraulic accumulator.

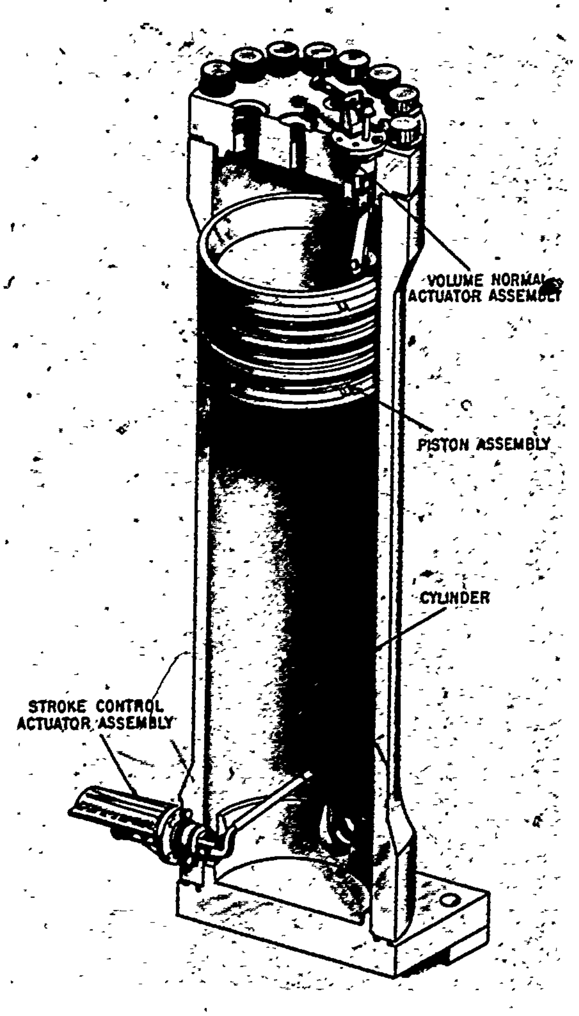

Figure 4-7.—Main hydraulic accumulator.

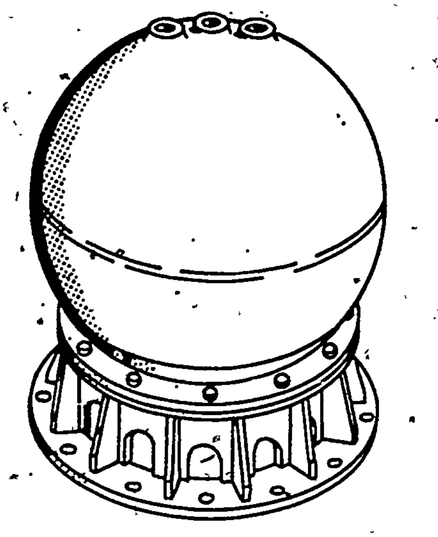

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Figure 4-8.—Air flask.

c. Advance buffer pressure.
d. Operating solenoids and control valves.
4. Bridle tension system differences.
a. Operating solenoids and control valves.
b. Air charging and blowdown valves.
c. Electrical circuit.
5. Lubrication system differences.
a. Location of nozzles.
b. Metering injectors.
c. Operating solenoid and control valve.
d. Location of supply tank and pump motor set.
6. Control system, C-13.
a. The control console has no handcrank, and is divided into four panels.
b. The deck edge panel controls retraction, and has additional lights and switches.
c. The auxiliary deck edge light panel incorporates a "fire" light.
d. The retraction control panel allows for control at one panel, and has retract engine suspend switch.
e. The water brake panel has a suspend switch and a suspend light.

CREW ORGANIZATION

The catapult crews are assigned the responsibility of operating and maintaining the catapult machinery. In addition, they operate and maintain the bridle arrester machinery, deck cooling panels, jet blast deflectors, and machinery associated with each catapult. They are also responsible for hooking the holdback release units to the aircraft and the bridles or pendants to the shuttle and to the aircraft. The knowledge they have and the teamwork and organization displayed in the performance of their assigned tasks contribute in a large measure to the attack capabilities of the carrier.

It is also a responsibility of the catapult crew to think about their duties, perform their assigned tasks willingly and to the best of their ability, and increase their knowledge (both operation and maintenance) of the catapult.

The catapult crew consists of:

1. Catapult Officer. All catapult operations are made under the direct supervision of a commissioned officer trained for this work. This officer must have an intimate knowledge of the catapult and all applicable Naval Air Systems Command technical publications pertaining to his particular catapults. He need not be a naval aviator.

The catapult officer is responsible for the proper inspection of the catapult and for the observance of all safety precautions. Before each day's operation, he insures that the catapult is inspected in accordance with 3-M preoperational inspections as described on applicable Maintenance Requirements Cards (MRC's). He designates the catapult pressure or constant steam valve (CSV) setting to be used during launching operations, supervises aircraft catapult spotting, and gives the signal for firing the catapult. Also, he has authority to delay a launching if some adverse condition arises, even after the signals to fire have been exchanged, by initiating suspend and the emergency HANG FIRE procedures.

The catapult officer must insure that catapult logs and records are maintained on each catapult. These logs and records must contain all data regarding launchings, overhaul, and repairs to the catapult as requird by current directives. The catapult officer makes a special report to the Naval Air Systems Command in the event any unusual condition arises in the operation of his catapults.

The assistant catapult and arresting gear officer acts as the catapult officer in the absence of

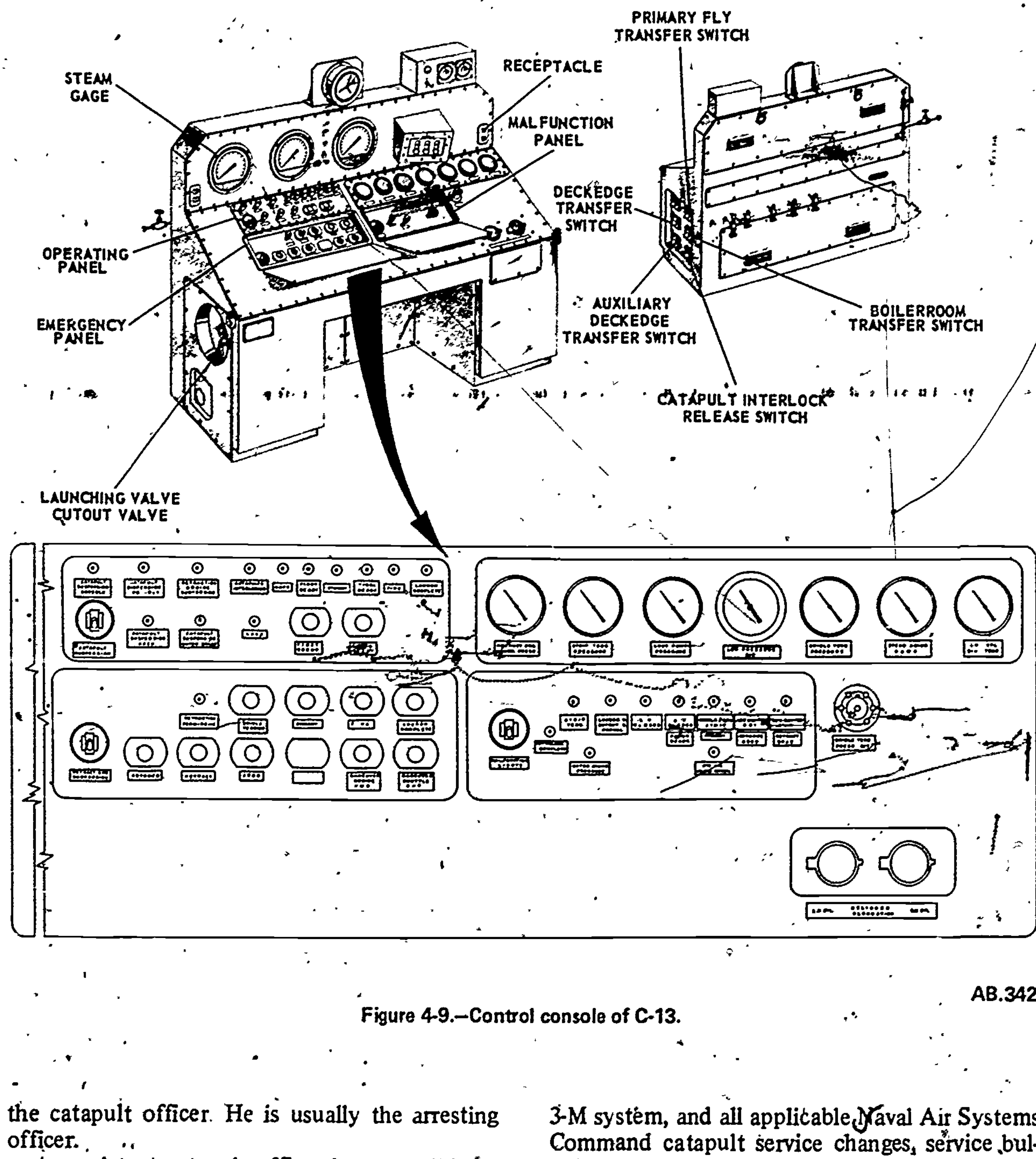

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Figure 4-9.—Control console of C-13.

the catapult officer. He is usually the arresting officer.

An assistant catapult officer is responsible to the catapult and arresting gear officer for the waist catapults on ships with four catapults.

Maintenance is accomplished under supervision of the catapult and arresting gear maintenance officer. He must have complete knowledge of the catapult, the catapult manual, the 3-M system, and all applicable Naval Air Systems Command catapult service changes, service bulletins, and repair procedures. However, the catapult officer is held responsible for proper inspections, test, repairs, and preventive maintenance procedures of the catapult.

2. Catapult Chief. Under the catapult officer, the catapult chief is responsible for proper operation, maintenance, cleanliness, and security

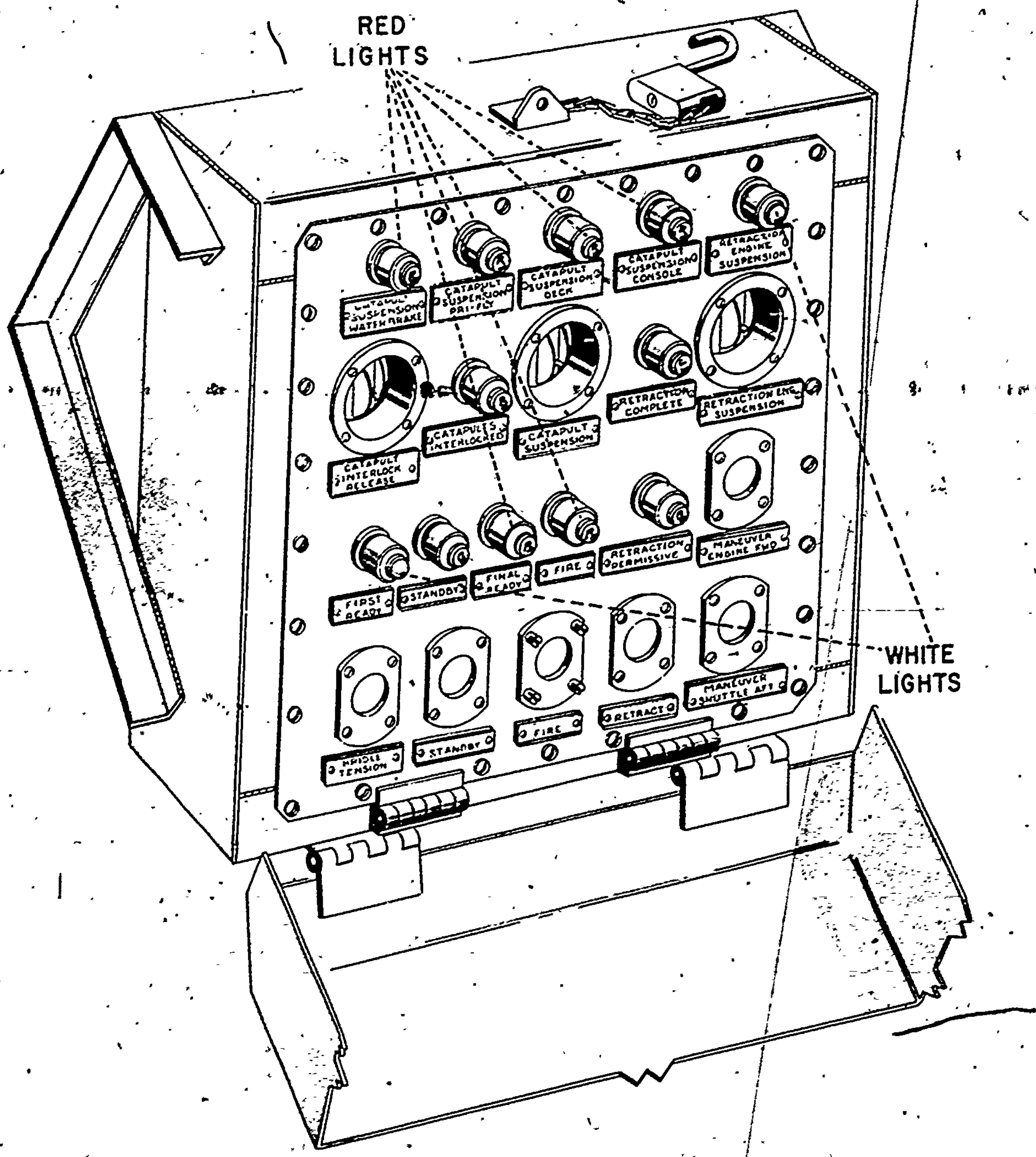

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Figure 4-10.—Deck edge control panel.

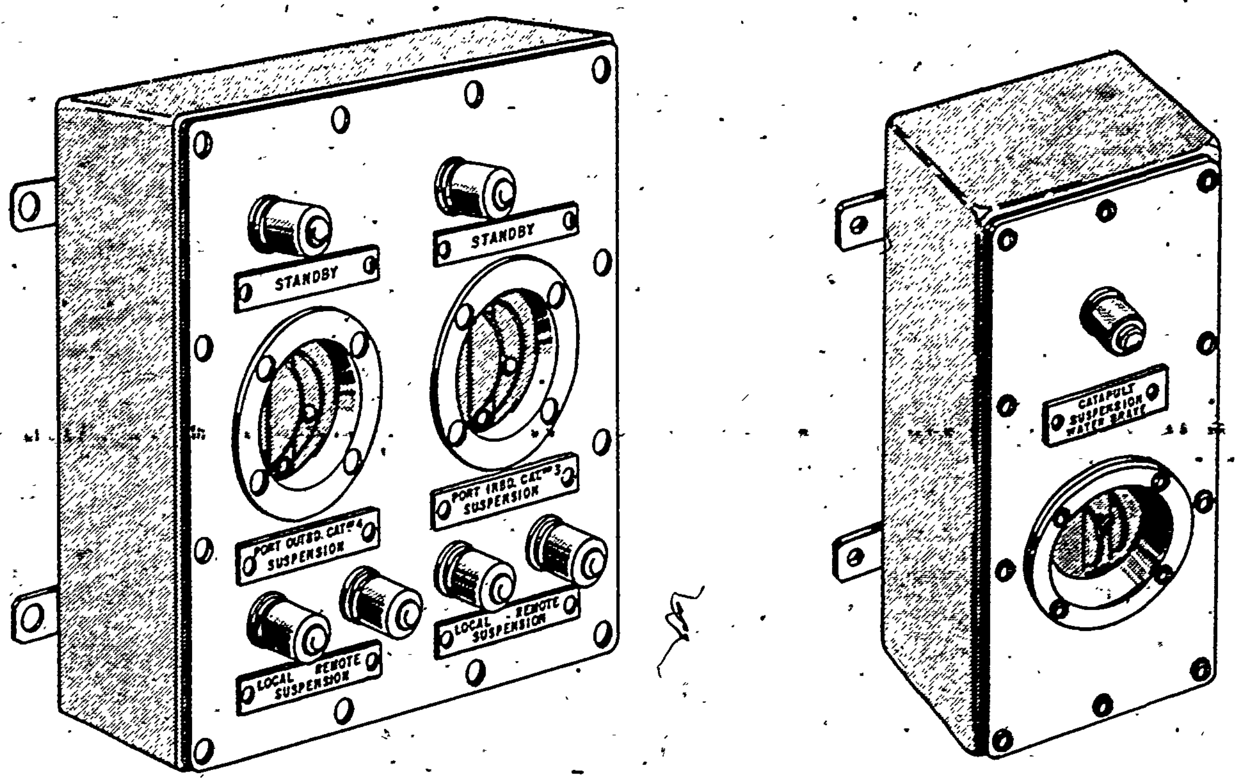

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Figure 4-11.—Auxiliary control and light panels.

of the catapults assigned to him. Some of the catapult chief's duties are:

a. Insure that all catapult personnel under his jurisdiction are thoroughly familiar with applicable instructions.

b. Supervise operation of the catapults during launching operations.

c. Direct preparation of the catapults for launching by insuring that the proper 3-M preoperational inspections are performed in accordance with the applicable MRC's and reported to the catapult officer prior to each day's operation.

d. Insure that all changes and bulletins are complied with.

e. Insure that only authorized personnel are permitted in the catapult spaces.

f. Insure that safety precautions set forth in pertinent instructions are rigidly adhered to at all times.

g. Report any malfunction or any unusual circumstances involving the catapults immediately to the catapult officer. No major part of the catapult machinery may be disassembled for repairs without first obtaining authorization from the catapult officer or higher authority.

h. Direct and supervise all repairs pertaining to his assigned catapults.

i. Insure that the training program is carried out.

j. Plan, schedule, and control the accomplishment of the Planned Maintenance System.

k. Perform such other duties as may be assigned.

The catapult chief reports to the catapult officer and the assistant catapult officer, all other personnel assigned to his catapults report to the chief via their supervising petty officers.

The catapult chief needs more than technical skill. He must assume responsibility, not only for his own work but also for that of the ABE's who serve under him. He is the master technician, leader, supervisor, inspector, and instructor. The catapult chief must train a first class petty officer to take over for him in his absence.

3. Catapult Captain. The catapult captain is directly responsible for proper operation, maintenance, cleanliness, and security of his assigned catapult. His duties and responsibilities include the following:

a. Insure that all personnel operating any part of the catapult machinery are thoroughly trained and qualified to perform such duties.

b. Perform the preoperational inspection and inform the catapult chief of the operational status of the catapult.

c. Insure that all stations are "manned and ready" for and during flight operations and reporting same to the catapult chief or officer.

d. Insure that all personnel in his crew are familiar with damage control instructions.

e. Insure that all instructions and safety precautions are posted and that personnel are familiar with such instructions.

f. Insure that no one operates any station without proper authorization.

g. Insure that catapult changes and bulletins are complied with.

h. Maintain daily maintenance and shot logs.

i. Insure that all unauthorized personnel stand clear of catapult spaces both during flight operations and nonoperating periods.

j. Observe safety precautions at all times.

k. Adhere to all operating instructions as outlined in directives from higher authority.

l. Perform such other duties as may be assigned.

The catapult captain is responsible for each man in his crew. He may never disassemble any portion of the catapult without first obtaining permission from the catapult chief.

The catapult chief may assume the duties of the catapult officer only upon the specific authorization of the air officer. The catapult chief reports to the catapult officer and the personnel assigned to a catapult captain's respective catapult crew report to him.

4. Deck Edge Operator. The deck edge operator, although assigned under the catapult captain, is directly responsible to the catapult officer during launching operations. This operator must carry out the orders and signals of the catapult officer under all circumstances. He must be thoroughly familiar with all catapult signals (both verbal and visual), the sequence of operation, and the resulting mechanical actions associated with the deck edge control station, including the proper use of communications between all other stations directly concerned with firing the catapult. He must be thoroughly familiar with the emergency hang fire procedures.

5. Console Operator. The catapult console operator, under the catapult captain, is responsible for proper operation, maintenance, cleanliness, and security of the console panel and associated mechanisms. He should also be thoroughly familiar with the sequence of operations resulting from his console movements. In addition, he should be familiar with the operations of the deck edge operator and the retract engine operator. He is normally assigned the following duties and responsibilities:

a. Be thoroughly familiar with the operation of the console and its component parts.

b. Insure that only qualified personnel operate the console.

c. Insure immediate manning of the console at the sounding of FLIGHT QUARTERS.

d. Remain on his station unless directed otherwise by the catapult captain or higher authority.

e. Keep unauthorized personnel out of the console room at all times.

f. Observe safety precautions at all times.

g. Carry out existing damage control instructions.

h. Adhere to catapult operating instructions as outlined from higher authority.

i. Insure that proper Sound-powered phone procedures are utilized at all times.

j. Be thoroughly familiar with the emergency hang fire procedures.

The console operator must never deviate from the designated launching pressures as prescribed by the catapult officer.

6. Water Brake Operator. Under the catapult captain, the water brake operator is responsible for proper operation, maintenance, cleanliness, and security of the water brake equipment assigned to him. He also has the responsibility of suspending the catapult due to a malfunction of the water brakes. This is accomplished by throwing his suspend switch on C-13 catapults, and by calling for a suspend over the sound-powered phone system when operating C-7/11 catapults.

7. Retraction Engine Operator. The retraction engine operator, under the catapult captain, is responsible for proper operation, maintenance, cleanliness, and security of his assigned retracting engine. He must be thoroughly familiar with the sequence of operations and the mechanics associated with the retract control panel. His duties and responsibilities are outlined in the following list:

a. Insure immediate manning of the retracting engine when FLIGHT QUARTERS is sounded.

b. Insure that proper sound-powered phone procedures are used at all times.

c. Inform the deck edge operator of any malfunctions immediately in order that the catapult officer and/or catapult captain may be notified.

d. Keep the engineroom clear of unauthorized personnel at all times.

e. Allow only qualified personnel to operate machinery.

f. Supervise the training of assistant retracting engine operators.

g. Observe safety precautions at all times.

h. Insure that all personnel working with the retracting engine are aware of existing damage control instructions.

i. Adhere to operating instructions as outlined in directives from higher authority.

j. Perform such other duties as may be assigned.

The retraction engine operator reports to

a. Catapult officer.

b. Catapult chief petty officer.

c. Catapult captain.

All personnel assigned to his engineroom report to the engineroom operator.

8. Chronograph Operator. This man is also supervised by the catapult captain. He is responsible for proper operation, maintenance, cleanliness, and security of the chronograph machine, component parts, and chronograph compartment. During catapult operations, his job is to operate the chronograph machine and convert readings to ascertain shuttle end speeds, and report end speeds to the main control console.

9. Recorder. The recorder is responsible to the console petty officer and the catapult captain for maintaining the catapult logs in an up-to-date status. He records data such as the following for each launch: catapult shot number; date and time; aircraft type; CSV setting, weight, and side number; wind over the deck; steam pressure before and after launch; cylinder elongation; end speed; launch valve clock timer indicators; and such other information as the catapult officer or other authority may cause to be kept.

10. Topside Petty Officer. Under the catapult captain, the topside petty officer is responsible for proper holdback and bridle/pendant hookup during launching operations, safety of all personnel in the hookup crew, and for maintaining a usage log for launching accessories (bridles, bars, pendants, holdbacks, etc). He is responsible for the inspection, lubrication and functional testing of:

a. Jet blast deflectors.

b. Launching accessories.

c. All topside gear.

The following personnel report to the topside petty officer: holdback man/crew, bridle hookup man/crew, bridle arrester crew, and jet blast deflector operator.

11. Holdback Crew. The holdback crew, under the topside petty officer, is responsible for proper holdback and hookup procedures. In addition, it is responsible for maintenance, cleanliness, and security of the holdback assemblies and tension bars.

12. Bridle Hookup Crew. This crew is responsible for proper bridle hookup, and main-

tenance, cleanliness, and security of bridles, pendants and bridle stowage compartments. They are supervised in the performance of their duties by the topside petty officer and the catapult captain.

13. Bridle Arrester Operator. The bridle arrester/nose tow operator, under the catapult captain, is directly responsible to the catapult officer during launching operations. This operator carries out orders of the topside safety petty officer and aircraft spotter, as applicable, and is responsible for the bridle arrester and nose tow equipment, including operation, maintenance, cleanliness, and lubrication.

14. Jet Blast Deflector Operator. The jet blast deflector operator, under the topside petty officer and catapult captain, is responsible for safe and proper operation of his assigned blast deflector. He is also charged with maintenance, cleanliness, and security of his deflector and its associated equipment.

15. Catapult Center Deck Operator. The center deck operator, under the catapult captain, is responsible to the catapult officer during launching operations for relaying the correct steam pressure settings (CSV setting) from the catapult officer to the console operator, and for monitoring the settings with a steam pressure gage located in the center deck control station. He is responsible for maintenance, cleanliness, and security of the center deck control station.

16. Catapult Bow Safety Man. The bow safety man, under the topside petty officer and the catapult captain, is responsible for insuring that personnel and equipment are clear of the catwalks and flight deck area at the forward end of the catapults. He is equipped with sound-powered phones for voice communications with the deck edge operator. He also controls the bow safety lights (red or green) during night operations to indicate to the catapult officer and deck edge operator a safe or unsafe deck.

MAINTENANCE PROCEDURES

The instructions contained in this section are limited to maintenance procedures that are to be performed by personnel who operate and maintain this equipment. It should be borne in mind that of the material that follows, such as tolerances, pressures, inspection requirements, etc., some are subject to change based on accumulated operational and maintenance data.

When actually performing the procedures discussed, use of the applicable Maintenance Requirements Cards is mandatory, however, they should be considered the minimum rather than the maximum amount of maintenance to be performed.

It is essential that all maintenance personnel be thoroughly familiar with and knowledgeable of the operational functioning of the catapult. This intimate understanding of the machinery enables the trained observer to detect any abnormal operation and correct a potential cause of trouble before a breakdown occurs. Visual inspections are not enough, because the majority of catapult components are hidden from view.

The following notes apply to general maintenance throughout the entire catapult:

1. Keep the entire catapult as clean as possible. Wipe down daily to remove excess grease, oil, and dirt. Remove rust, and paint as often as necessary. Do not paint threads or finished surfaces. If these surfaces are painted in error, use paint remover to remove the paint.

2. Check for loose or damaged bolts, screws, and nuts. Tighten or replace as necessary. Grease replacement fasteners to retard rusting. High-pressure joints are likely to leak if unequal bolt tension exists; therefore, all bolts must be torqued equally if sealing ability is to be maintained. Replacement bolts must be equal to or greater in strength than the original bolt. Use proper tools at all times.

3. Check frequently for hydraulic and pneumatic leaks. These can occur at any time.

4. Inspect, clean, and oil all machined surfaces regularly. The moist salt air to which the catapult machinery is exposed induces a strong corrosive effect on steel. Grease the extended portion of piston rods when it is anticipated that the catapult will be inactive for a week or longer. This prevents rust and preserves the finish. Wipe off excess grease when the catapult is reactivated.

5. Be constantly alert for unusual sounds or action of the machinery. Report any unusual condition to the catapult officer for immediate investigation.

6. Each day, during periods when the catapult is inactive, run all pumps and actuate all retraction engine valves if possible.

7. Check condition and amount of spare tools, tension bars, and bridles/pendants on hand against allowance lists. Requisition anticipated needs on a monthly basis.

8. Whenever components are cleaned with an alkaline material, be sure that the residue is completely removed before reassembly. This is necessary to prevent formation of soapy products in lubrication systems and close tolerance components. Use a jet of wet steam from a suitable nozzle for this purpose whenever possible. In all other instances, remove alkaline residues by repeated flushing and brushing with a mineral spirit solvent. Pay particular attention to crevices, holes, and cavities where such residue may accumulate. After parts have dried, look for surface film or powder indicative of incomplete removal of alkaline material. Any such indication will require recleaning with wet steam or solvent.

9. Finished surfaces of machined or plated parts should not be buffed, abraded with wire brushes or abrasive cloth, or polished with any polishing compound for the purpose of removing discoloration or restoring smoothness. Exercise caution in handling and storing these parts to avoid scratching and indentation, since fatigue failures may begin at sections weakened by such local dimensional reduction.

10. Do not blast any piston skirts or ring grooves with any but the finest vapor blast grit or fine soft grit. Do not use any form of scraper to clean ring grooves, since any scratch or root fillet will weaken glands and increase the possibility of ring seizure.

The following definitions apply to terms used to describe the kinds of damage for which parts should be inspected during routine inspection and troubleshooting:

1. Abrasion. Wearing away of a surface by friction, either by motion while in contact with another part or by mechanical cleaning or resurfacing with abrasive cloth or lapping compound.

2. Binding. Stopping or impeding motion between two surfaces due to foreign matter, unequal expansion, or unequal wear between surfaces.

3. Burr. A sharp projection of metal from an edge, usually the result of drilling, boring, countersinking, etc., but may also be caused by excessive wear of one or both surfaces adjacent to the burred edge.

4. Concentricity. Having a common center; usually refers to the closeness of tolerance between the common center of two or more circles (bore and OD bore, bolt and circle diameters, etc.).

5. Corrosion. Deterioration of a surface, usually caused by oxidation of metal.

6. Deformation. Deforming of a component due to overstressing or repeated usage.

7. Elongation. An increase in length due to stretching, heating, hammering, etc.

8. Erosion. Pitting or eating away of metal due to action of steam, chemicals, water, or atmosphere.

9. Fretting. Scuffing or deterioration of a metal surface caused by vibration or chattering against another part. A fretted steel surface may appear dull, scuffed, or corroded, depending on the length of time subjected to the action, dissimilarity and kind of contacting metal, and presence or absence of moisture.

10. Misalinement. Parts not in correct related positions as specified on manufacturing drawings.

11. Pitting. Small, deep cavities with sharp edges. May be caused in hardened steel surfaces by high impacts, or in any smooth steel parts by oxidation.

12. Scoring. Deep grooves in a surface caused by abrasion when fine, hard particles are forced between moving surfaces, as in a bearing and journal, or by galling when a moving part is not supplied with lubricant.

13. Security. Tightness, snug fit between related parts.

14. Shearing. Cutting, caused by force applied perpendicular to major axis of a component.

15. Warping. Bending or twisting out of shape in an irregular manner.

LAUNCHING ENGINE SYSTEM

The launching engine and its associated components are disassembled in the following order:

1. Trough covers.

2. Strip tensioner.
3. Sealing strip.
4. Expansion indicator.
5. Cylinder covers.
6. Water brake cylinders.
7. Shuttle.
8. Pistons.
9. Cylinder elongation indicator.
10. Launching engine cylinders.

It is not necessary to remove the transition section, thrust unit, and thrust unit support unless a crack or other defect is noted in one of these units.

All components upstream of the thrust unit, including the flow control valve, are under the cognizance of Naval Ship Systems Command.

The trough, deck plates, supporting structure, and piping (except where otherwise specified) also come under NavShipSysCom, and matters pertaining to these components should be referred directly thereto.

Past experience has shown that salt atmosphere, steam leakage, and high ambient temperatures cause rapid rusting of screws and bolts used in the launching engine components. This condition can seriously impede replacement or repair of a catapult component. Therefore, a schedule is set up to remove trough covers and deck plates every 6 months (preferably just prior to deployment) and replace bolts, screws, and nuts as necessary. Grease all replacement fasteners with a suitable high temperature lubricant to retard rusting.

Inspection and Removal of Pistons and Spears

Repairs to the piston assembly may be made as a result of inspection or a malfunction. Minor repairs are those which may be observed and repaired without removal of the piston assembly from the catapult. Due to the basic function of the pistons in the operation of the catapult, it may be necessary to make major repairs as well as minor repairs in order to keep the catapult in operation.

Piston assemblies must be supplied, installed, and stocked in matched pairs, and the two assemblies of each pair must weigh within 10 pounds of each other. The scale weight in pounds and ounces is stamped on the side of the barrel in black letters at least 2 inches high.

The spear, piston, guide, and barrel must be inspected as noted below. This inspection may be accomplished without removing the piston from the engine cylinder.

SPEAR.—The spears are inspected as follows:

1. Withdraw the spears past the lateral openings (cutoff sections) of the 9-foot forward cylinders to a point where the forward edges of the water deflector rings are immediately inside the solid walled section at the aft end of the 9-foot cylinders.

2. Examine the circumference of the water deflector rings for signs of scraping against the cylinder walls. If any evidence of scraping is found, investigate for water deflector ring flaring and/or piston guide wear.

3. If no evidence of scraping is found, use feeler gages to determine the clearance dimension at the FORWARD EXTREMITY (bottom side) of the water deflector ring. If clearance between the deflector ring and cylinder wall is reduced to 0.031 inch or less, due to flaring of the deflector ring, the spear must be rotated 90 degrees at the earliest possible opportunity. However, with daily inspection of the deflector ring, operations may continue until the clearance is reduced to 0.010 inch, after which operations must cease until the spear is rotated or replaced.

4. It should be noted that reduction of clearance between the deflector ring and cylinder wall is not always due to flare of the deflector ring. With either the reinforced type spear or the new contour type spear, reduction of clearance to below 0.031 inch has been found to be caused by GUIDE wear.

5. If a spear has been rotated three times due to flare of the deflector ring, it must be removed and replaced. If possible, the spear should be salvaged for further use.

PISTON GUIDE.—The piston guide is inspected as follows:

1. Move the piston assemblies into the 9-foot forward power cylinders until a position is reached where the piston guides begin to enter the aft end of the lateral openings (cutout sections).

2. Using feeler gages, determine piston guide wear by measuring water deflector ring clearance at AFT EXTREMITY with lower portion of the cylinder. If this clearance is 0.047 inch or less, replace guides at earliest opportunity. In no case is the guide to be used if the clearance is 0.031 inch or less.

STEAM PISTONS.–Measure the piston diameter at two places by using the method described below:

1. Tow piston assemblies AFT into the intermediate power cylinders until a position is reached where the spears will be clear of the solid walled section at the aft end of the 9-foot forward cylinders.

2. Measure the ID of each 9-foot forward cylinder at two places, approximately 1 o'clock and 11 o'clock on each side of the cylinder's centerline; at a point 13 inches forward of the 9-foot cylinder flange joints. Record these measurements.

3. Tow piston assemblies forward until bottomed in the water brakes; then measure with feeler gages the dimension between the cylinder wall and outside diameter of the piston. Measurements are taken at both top and bottom of the piston at the 1 o'clock and 11 o'clock positions. Record these measurements.

4. Add together the top and bottom feeler gage dimensions for the 1 o'clock position; then subtract this total from the ID dimension of the cylinder taken at the 1 o'clock position. The difference gives the OD of the piston at this particular point. Add together the top and bottom dimensions for the 11 o'clock position; then find the OD of the piston at this particular point. Record all measurements.

5. If wear on the piston, at the points described above, has reduced the OD to 17.781 inches or less, replace the piston at the earliest possible opportunity. If piston OD is 17.750 inches or less, the piston must be replaced immediately. (Check these tolerances against current applicable technical publications, as they are subject to change.)

Whenever a piston (fig. 4-12) has to be replaced, it is recommended that a scribemark or series of punchmarks be put on the "leading edge" of each new piston at points three thirty-seconds inch from the OD at the bottom of the piston, and one thirty-seconds from the OD at the top of the piston. These marks can facilitate piston inspection if they are used as a guide for determining maximum wear on a piston. If a piston is worn up to or beyond these marks, it should be removed at the earliest opportunity. Piston wear not reaching these marks is considered within acceptable wear limits.

Runaway Shot Inspections

Immediately after a runaway shot (end speed over 185 knots) certain components of the catapult must be inspected for damage. The determining factor on the type of inspection that has to be made is the shuttle end speed.

If the end speed recorded is between 186 knots and 250 knots (or as specified in the current technical publication) the following inspection must be performed.

NOTE: Blow down the steam in the steam receiver to zero pressure and keep the blowdown valve open prior to entering the water brake reservoir.

1. Examine the shuttle ramp pin for bending and replace if deformation exceeds 0.010 inch, or if elongation, shearing, or cracks exist.

2. Enter the water brake tank, reservoir and inspect the entire screened area for loose or broken pieces. Inspect all visible portions of the launching pistons, 9-foot cylinder sections, and adjacent components.

If an end speed between 250 knots and 275 knots is recorded, perform the following inspections in addition to those listed above:

1. Inspect piston guides. Tighten any loose piston guide bolts and secure with lockwire.

2. Check clearance between the spear deflector ring and cylinder walls at various stations around the circumference for radial flaring. Check condition of spear.

3. Check shuttle connector and strip-guide attaching bolts to see that they are in place and not sheared. Look for evidence of deformation of fasteners and elongation of holes, and cracked welds.

4. Inspect visible portions of launching pistons for cracks, paying particular attention to the upper forward edge aft of the cylinder cover seal stud boss.

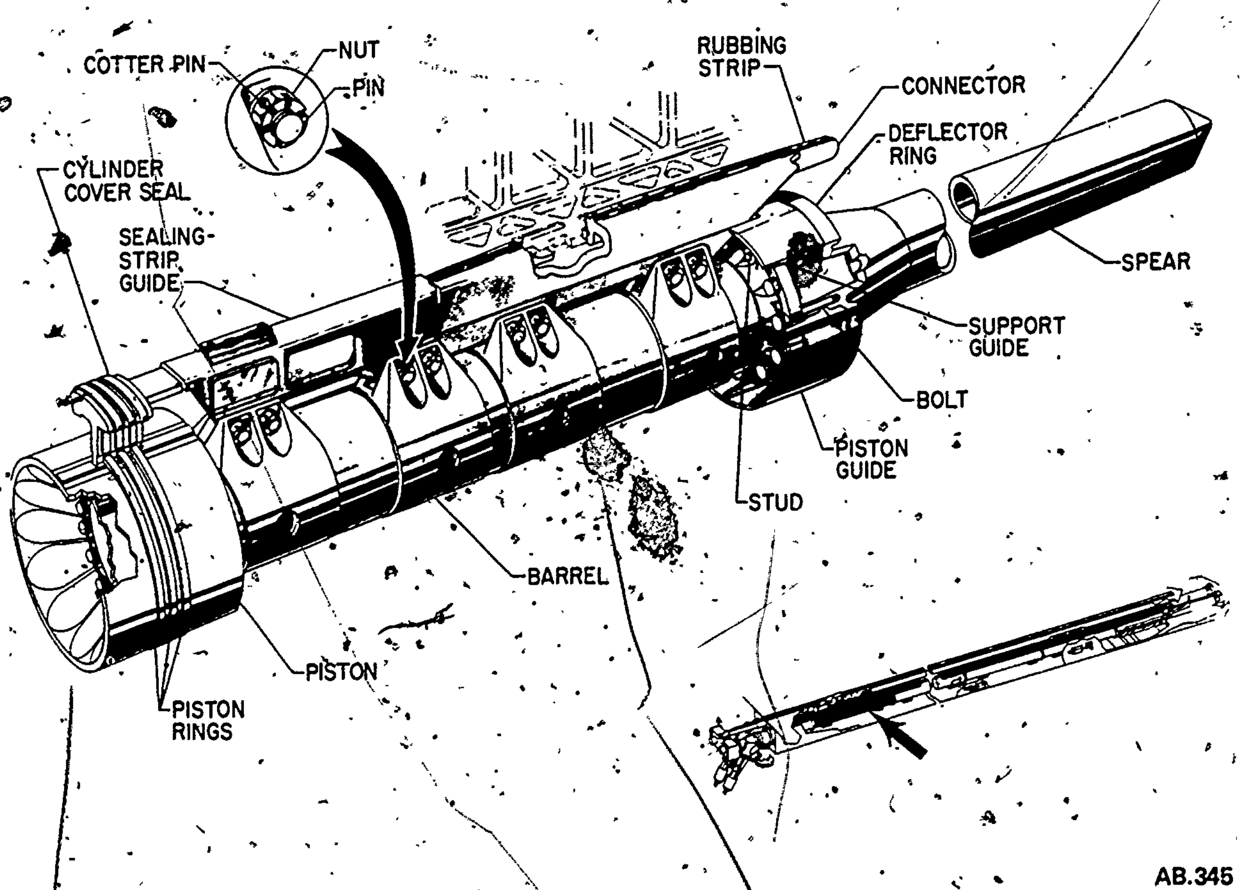


Figure 4-12.—Launching piston assembly.

5. Check the water supply hose and tighten any loose hose fittings. Check piston barrel lug.

6. Check the clearance between the annulus ring and jet ring. Replace any loose jet ring screws.

7. Inspect the cylinder cover seal assemblies.

If the components mentioned above are found to be free from defects and clearances are satisfactory, observe the retraction. If the retraction is normal, catapult launching operations may be continued.

If the runaway shot caused a shuttle end speed of 275 to 300 knots, do the following:

1. Perform steps 1 through 7 as above.

2. Pay particular attention to pitting of spears, deformation of brackets, and other signs of strain. Take spear measurements at various stations and check for correctness.

3. Inspect all visible portions of the shuttle.

4. Check choke ring measurements.

5. Look for clearances developing between stools and bearing plates of the forward power cylinder sections.

6. Remove any loose jet ring screws and check for "necking down." If necking down is evident on loose screws, check all others in the vicinity by removing and measuring. (See fig. 4-13.) Replace all loose screws; torque all replacement screws to 245-255 ft-lb.

7. Check concentricity of annulus ring and choke ring.

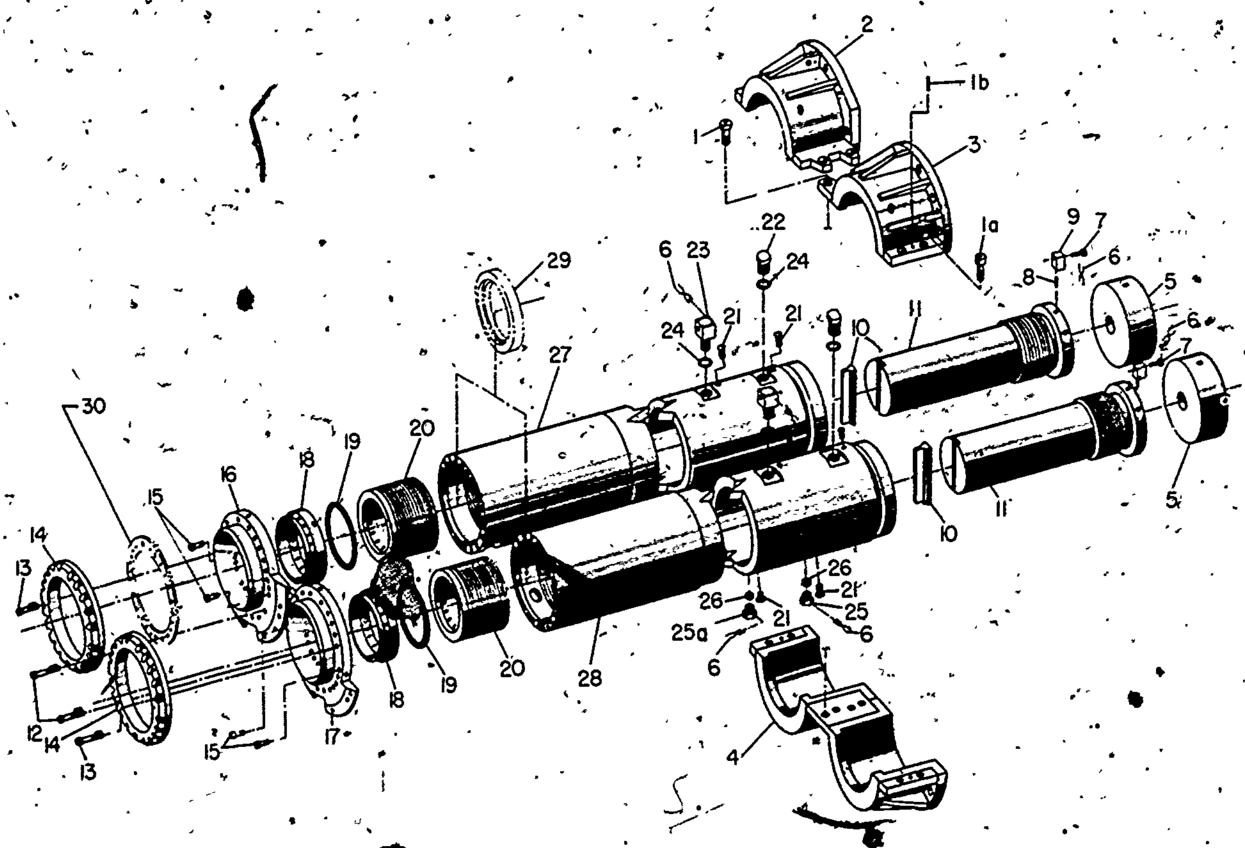
8. Check visible portion of the bronze piston guide, paying particular attention to the shoulders of boltholes where deformation or fractures may be evident.

9. Check and tighten any loose spear securing screws.

10. Check for cracks in the web of the forward power cylinder section slot at the forward end above the water-brake cylinder.

11. Check tightness of all visible bearing pads, blocks, and strips on the connector and guide.

12. Perform tow test of the shuttle and piston assembly, using a dynamometer Measure



1. Screw.
1a. Screw.
1b. Dowel pin.
2. Left clamp.
3. Right clamp.
4. Support.
5. Chock.
6. Lockwire.
7. Bolt.
8. Pin.
9. Body.
10. Vane.
11. End plug.
12. Self-locking screw.
13. Self-locking screw.
14. Striker ring.
15. Screw.
16. Jet ring.
17. Jet ring.
18. Annulus ring.
19. O-ring.
20. Choke ring.
21. Screw.
22. Plug.
23. Body.
24. O-ring.
25. Plug.
26. Gasket.
27. Cylinder.
28. Cylinder.
29. Choke-ring-seat (Ref)-for repair only.
30. Shim.

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Figure 4-13.—Water brake assembly, exploded view.

the average force required to pull at a constant velocity. It should not exceed normal towing force for the catapult, which is 1,500 pounds.

13. Repair any defects noted above prior to any further operations.

14. Inspect the cylinder cover seals for cracks.

If there is a runaway shot in which the shuttle end speed is in excess of 300 knots, do all of the above and, in addition, lift the track covers at the water brakes and inspect the launching shuttle. Look for bowing of the frame, loose or deformed rollers, looseness of roller shafts, and cracking or deformation of members and driving lugs.

Whenever replacing a choke ring, always check the choke ring NAEC part number. Some choke rings can be used only with a water brake spear having a certain NAEC part number.

PISTON REMOVAL.—Due to normal wear or to a malfunction of the catapult, it may be deemed necessary to remove and replace the piston assemblies. This job can be accomplished while at sea. If you are the senior ABE in a steam catapult crew, the responsibility for this repair procedure falls on your shoulders. The applicable manual of overhaul and maintenance instructions for the type catapult installed aboard your ship will have a step-by-step procedure to follow in removal of these components. Some of the important steps are:

1. Secure all preheating and blowdown receivers and the hydraulic system, and close the main steam valve.

2. Move the shuttle approximately 50 feet aft of the water brake cylinders.

3. Remove the trough covers and deck plates.

4. Place the tension tool over the end of the strip tensioner rod and tighten the bolt on the tool to compress the tensioner spring and release tension on the sealing strip.

5 Disconnect the sealing strip from the strip tensioner guide (fig. 4-14 (A)).

6. Disconnect and remove any structural piping supports which would interfere with lifting the 9-foot cylinders.

7. Remove the retaining bar and two retaining guides from between the forward ends of the 9-foot cylinders (fig. 4-14 (B)).

8. Disconnect the two forward cylinder covers on each cylinder and remove the forward cover from each side. Removal of the forward covers from the 9-foot sections requires breaking the butt joints and pulling covers forward about 6 inches followed by movement of the covers in an inboard and downward direction prior to lifting (fig. 4-14 (C)).

NOTE. After the forward cylinder covers are removed, remove the sealing strip guide and inspect it for signs of wear and corrosion.

9. Disconnect the lubrication lines leading to the second cylinder cover aft on each row of cylinders and remove the covers by pushing them forward and lifting at the same time disengaging the sealing strip. Removal of these covers provides freedom of movement when the sealing strip is shifted to one side.

10. Remove the bolts securing the water brake splash plates to the 9-foot cylinder sections. The bottom plate may not be removable prior to lifting the cylinders. In this case secure the bottom plate to the 9-foot cylinder with safety wire or light line. Care must be taken to mark the forward end of the bottom splash plate to insure proper reinstallation.

11. If necessary, remove the upper and lower track support bars to expedite removal of the 9-foot cylinders. This is not always necessary.

12. Remove the bolts that secure the water brake clamps to the buttress plate and lift the water brake clamps, loosen but do not remove the supports to the buttress plate to allow for removal of the chock. Screw an eyebolt into the chock and lift the chock away from the cylinder.

13. Blow down the cable equalizers on the retracting engine and run out adjusting and locking nut on the equalizers to throw maximum slack in the towing cables. Keep count of the number of turns made on each adjusting nut so that upon reassembly it will be easy to return the cable equalizer to its original adjustment.

14. Now bring the piston-shuttle assembly forward to allow removal of the shuttle, taking precaution to prevent the shuttle from dropping. Lift the shuttle from the pistons and remove it with a suitable hoist (fig. 4-14 (D)).

15. Move the piston assembly aft until the tip of the spear clears the 9-foot section.

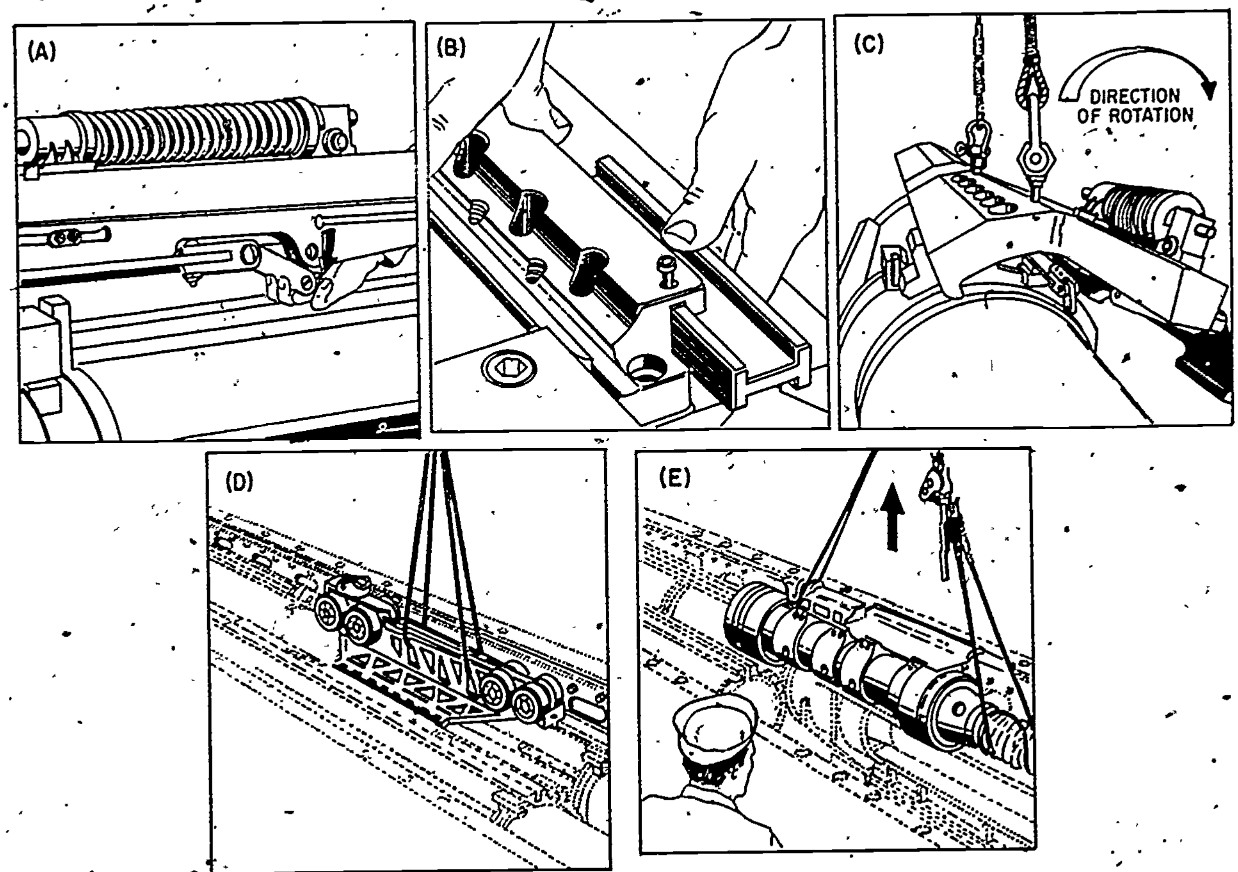

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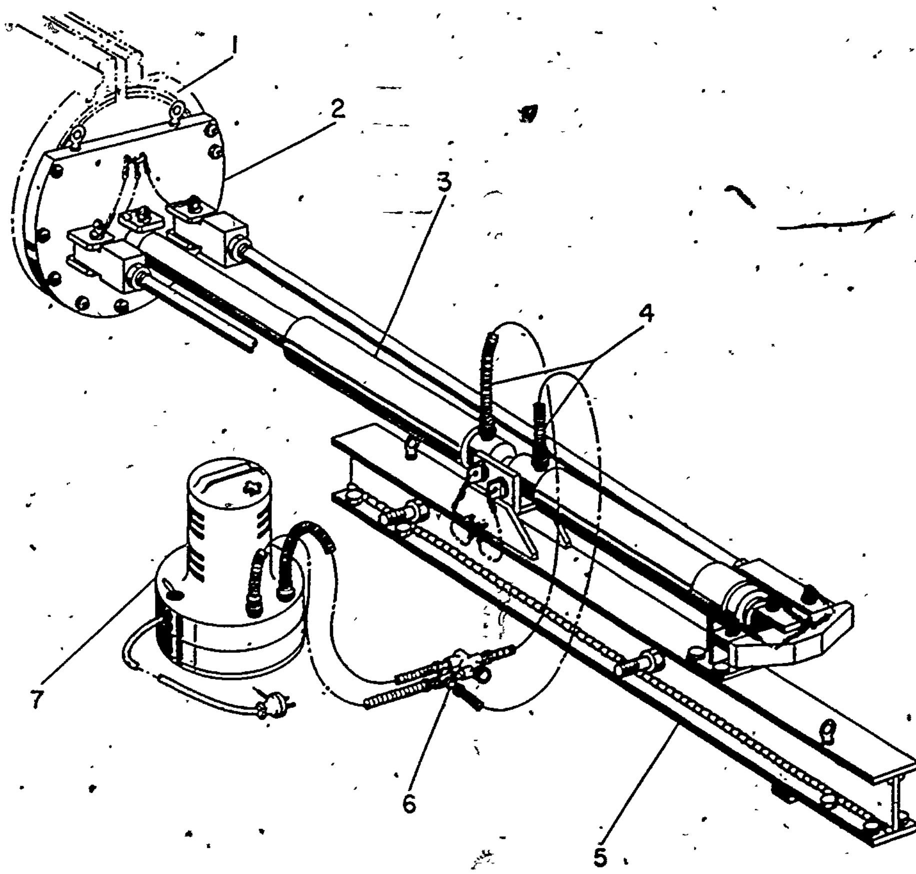
Figure 4-14.—Piston removal.

CAUTION: The sealing strip must be anchored with a chain fall before moving the pistons aft.

16. After removing the studs, nuts, spacers, and clamps from both 9-foot power cylinders, move the 9-foot power cylinders forward approximately 2 inches onto the water brake cylinders. This can be accomplished by means of a cylinder jack (fig. 4-15), a hydraulic jack, or by a chainfall rigged on deck.

17. Pull the forward part of the sealing strip and cables to the side opposite the cylinder to be removed. This will result in ample clearance to remove a 9-foot forward power cylinder section and water brake assembly. Handle the sealing strip with care. If it is necessary to roll up the strip, the inside diameter must not be less than 16 feet. Do not twist or kink the sealing strip, as this may cause permanent deformation.

18. Rig for removal of the water brake and 9-foot forward power cylinder section. Be sure that the hoist or crane can safely handle the 11,000-pound assembly. A hydraulic jack should be installed under the water brake to assist in breaking it loose. Remove the cylinder section and place it on the deck.



1. Cylinder.
2. End flange.
3. Ram.
4. Hose.
5. Base.
6. Hose and valve assembly.
7. Pump.

AB.347

Figure 4-15.—Cylinder jack.

19. Remove the piston by pulling it forward with a chainfall. As it is being removed, place a loop around the spear, after first protecting its finely machined surface with rags or packing. As the piston barrel is exposed, place another loop on the after end of the assembly between the piston barrel and the strip guide. The rigging should be capable of handling an approximately 2,000-pound assembly. This rigging should be secured to the crash crane. Provide adequate blocking under the assembly as it is being removed to prevent a down drop. After the piston is removed, place it on the deck (fig. 4-14 (E)).

20. After removal of the piston the same procedure is to be followed if the other cylinder and piston are to be removed. Reassembly is the reverse of the steps outlined above. When reassembling, grease is applied liberally to the chocks and brackets. Also apply grease to all bolts and screws to retard rusting.

LUBRICATION SYSTEM

The lubrication system control valve is the connection between the lubrication system and the control system. It is a three-way valve, actuated pneumatically when the lubrication solenoid valve is energized. The solenoid valve is energized automatically at the FINAL READY and RETRACT catapult conditions, or manually when the LUBRICATION pushbutton on the control console is depressed for approximately 10 seconds. This admits 150-psi air pressure into the control valve and permits the hydraulic pressure to reach the metering injector pistons which send a pressurized shot of lubricant through the injector nozzles, located in the cylinder covers, into the launch cylinders.

Manual lubrication is required prior to maneuvering for other than a short distance such as during bridle tensioning.

Troubleshooting the Lubrication System

If the lubrication system as a whole is inoperative, the probable cause is an empty lubricant supply tank, loss of 150-psi air supply, or an electrical malfunction; fill the tank or check the electrical components and connections.

The lubrication tank, when full, holds approximately 220 gallons. It is located at the midpoint of the power cylinders to provide equal distribution of the lubricant.

If there are leaky hose fittings or inoperative injector nozzles, it is permissible to plug lines temporarily; however, these should be repaired as soon as operations permit.

Inspect the lubrication system, using the Lubrication System Periodic Inspection Chart found in the applicable maintenance requirement cards.

During operations, keep the lubrication pump running.

STEAM SYSTEM

Steam for operation of the catapult is supplied from the ship's main propulsion boilers. The steam piping and joints are installed in accordance with applicable sections of Naval Ship Systems Command Manual. In addition to supplying steam to drive the pistons, the steam system is used to preheat the launching cylinders before firing the catapult. Preheating is accomplished by admitting steam into the finned tubing which runs the entire length of the catapult trough, or if shuttle and pistons are forward at the water brake, by admitting steam directly into the launching engine cylinders through the steam bypass valve. The flow control valve controls the flow of steam from the ship's boilers to the steam receivers. The steam receivers store the steam near the catapult for use during launching operations.

One of the most important lubrication points, during the time the catapult is being preheated or is cooling off to ambient temperature, is the power cylinder foot pads which are located in the bottom of the catapult trough and provide a bearing surface for the power cylinders during expansion or contraction. Lubrication of the foot pads is to be accomplished in accordance with current maintenance requirements cards. To insure the foot pads are actually taking grease, twenty complete grease gun strokes are required per fitting. It is recommended that the foot pads be greased prior to warming up the power cylinders, prior to cooling the cylinders to ambient temperature, or anytime salt water has entered the trough.

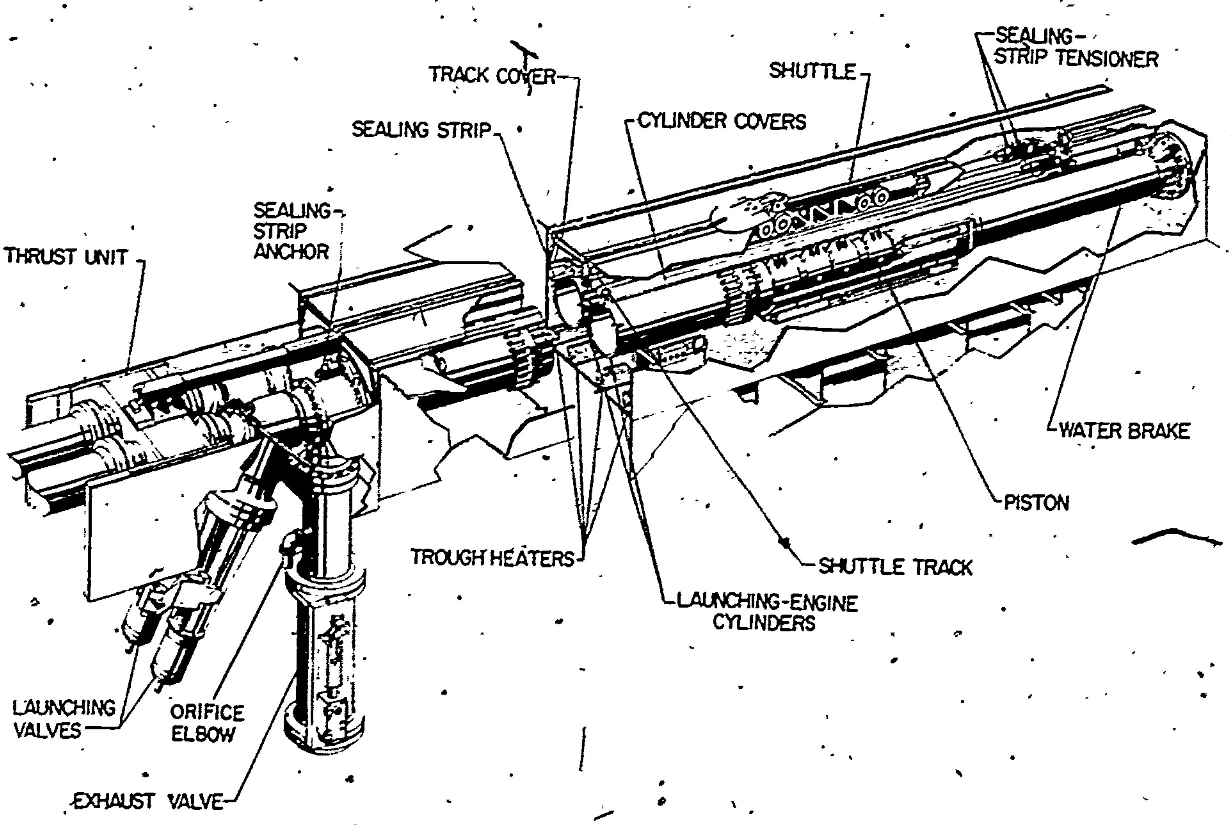
Whenever the power cylinders are lifted, all foot pad fittings should be cleaned, inspected, and pumped full of grease to insure that the fittings and lines are free of obstructions.

Whenever the launching cylinders are cooled to ambient temperature, visually inspect the bolts securing the exhaust tee and the first power cylinder.

Launching Valve

The launching valve assemblies admit steam into the power cylinders to drive the power pistons and to launch the aircraft. They are located between the exhaust tees and the transition unit, and are essentially a set of hydraulically operated globe type valves. The launching valves consist of a steam valve section, a lantern section where a trunnion connects both launch valves together, and a hydraulic-operating cylinder section. (See fig. 4-16.)

Located on top of each launching valve is a removable blank flange. These flanges are used to bleed air from the system prior to hydrostatic



AB.349

Figure 4-16.—Launching engine.

testing of steam receivers and are accessible when the portable cover is removed. The launching valves are operated hydraulically through the action of solenoid valves. The solenoids are energized and deenergized by the electrical control system, admitting or releasing the 2,500-psi hydraulic fluid from the retraction engine accumulator to the launching valve operating cylinders by way of the launching valve control valve. Each launching valve operating cylinder is equipped with a jacket through which the fluid from the temperature control system flows to maintain the cylinders at a constant temperature during operation. The launching valves and exhaust valve are hydraulically and electrically interlocked to prevent opening of the exhaust valve while the launching valves are open. A connecting shaft (fig. 4-17) between the launching valves insures simultaneous opening and closing of the valves.

The slotted metering rod, in conjunction with the primary orifice, controls the rate of opening of the launching valves and provides consistent operation of the catapult for aircraft of different weights. The metering rod is located in the operating cylinder. The primary orifice is located in the piping between the launching valve control valve and port B of the operating cylinder.

Variations in launching valve stroking rates may seriously affect catapult performance. The launching valve stroke timer provides a means of

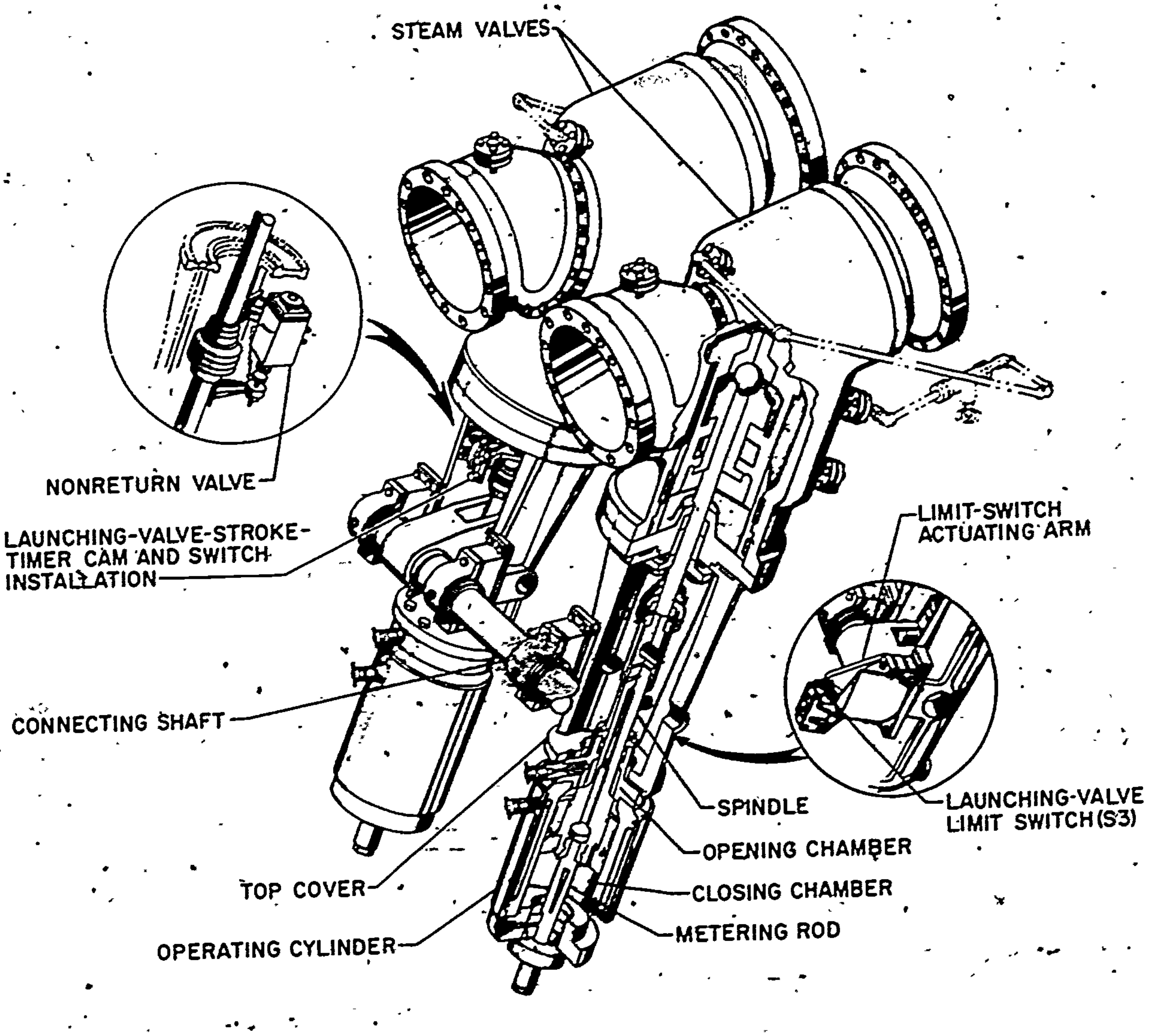


Figure 4-17.—Launching valve assembly.

detecting deviations in the launching valve stroke. The timer measures the length of time it takes the steam valve piston to move through two predetermined distances during the launching stroke. A cam mounted on one of the valves (fig. 4-17) actuates three switches which start and stop two clocks located on the control console (fig. 4-9). The time it takes the steam valve piston to move three-fourths of an inch is indicated on one of the clocks; the time it takes to move 3 inches is indicated on the other clock. Deviations in the launching valve stroke can be detected by comparing the timer readings with previously established timer readings.

Minor repairs consist of replacing defective packing rings, tightening fasteners, and correcting alinement of limit switch and valve components. Be sure hydraulic lines are completely depressurized before disconnecting them.

Replacement of worn or defective parts of the launching valve operating cylinder may be accomplished without disassembly of the steam valve. Relative location of the components of the operating cylinder is shown in figure 4-17.

The nonreturn valve (fig. 4-17) is installed on the launching valve lantern. It prevents the exhaust valve from opening before the launching valves are completely closed.

Minor repairs to the nonreturn valve consist of replacing O-rings and scraper caps, stopping leakage, and making minor adjustments. Be sure the valve is completely depressurized before disassembly. Replace all O-rings and lockwire when reassembling. Reassemble carefully, keeping O-rings properly located. Locate adjustable striker very carefully to provide for proper operation.

Adjust the striker on its bracket to allow the exhaust valve to open when the launching valves have completely closed, but not sooner. After adjustment, secure the striker in position with the locknut. There is no lubrication required for the nonreturn valve.

Lubrication of the launching valves is as follows. Keep the oil cups on the launching valve operating cylinder full of lube oil. As required, lubricate the fittings on the trunnion assembly. Foot pad grease is used as the lubricant. Clean and lubricate all spindles, shafts, and sliding surfaces daily with lube oil.

The steam valves are essentially the same in the launching valves and the exhaust valve. Note the location of the steam valves in figure 4-17. The main difference between the launching and exhaust valve steam valves is that the preheat piping (15, fig. 4-18) is found only on the launch valves.

Exhaust Valve

There are two types of exhaust valves. One is the lantern type and the other is the butterfly type. Each one is hydraulically operated and opens to release steam from the launching-engine cylinders after the launch is completed. When the steam pressure is removed from the cylinders the launching-engine pistons may be returned to battery position.

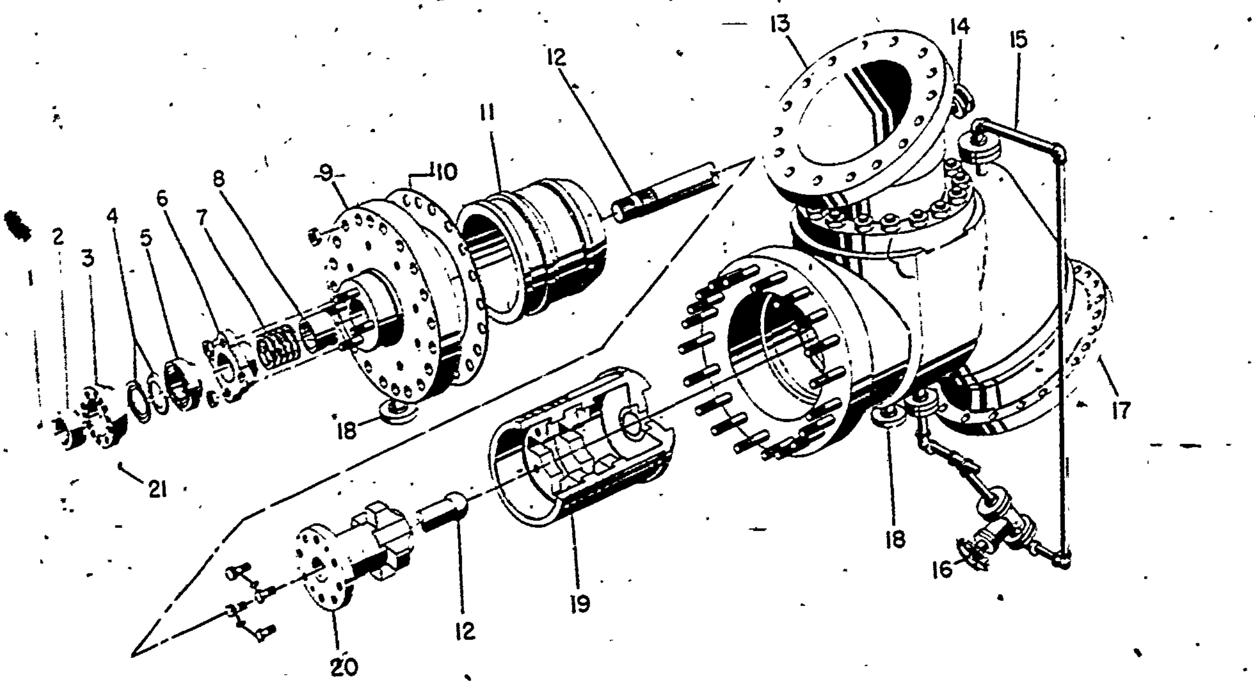
The lantern type exhaust valve (figure 4-19) used on the C-13 type catapults of aircraft carriers CVA-63 and -64 consists of a steam valve and an operating cylinder. The operating cylinder opens and closes the steam valve. When hydraulic fluid from the exhaust-valve control valve enters the operating-cylinder opening chamber, it moves the spindle to open the steam valve. An orifice in the lower cover controls the rate of escape of fluid from the operating cylinder. This stops the moving parts from slamming open and possibly being damaged. During the closing stroke, the fluid enters the closing chamber and acts on the spindle to close the steam valve. Limit switch S4 is mounted on the lantern of the exhaust valve, and when the exhaust valve is closed, the limit switch is depressed by the upper coupling of the piston rod. When the exhaust valve opens, the upper coupling moves to the exhaust position and the limit switch is released.

Construction and operation of the launching and exhaust steam valves are sufficiently alike to permit a discussion of both with reference to only one illustration (fig. 4-18). For a view of the exhaust valve operating cylinder refer to figure 4-19.

Minor repairs to the exhaust valve consist of replacing defective packing, tightening fasteners, and correcting alinement of the limit switch and components. Be sure hydraulic lines are completely depressurized before disconnecting them.

Replacement of worn or defective parts of the exhaust valve operating cylinder may be accomplished without disassembly of the steam valve. All parts, except the orifice (fig. 4-19) and operating cylinder are similar to parts of the launching valve operating cylinders. Parts are accessible by removing the lower cover or by removing the operating cylinder from the lantern.

The limit switch is adjusted as follows. When the exhaust valve is fully closed, the switch must be bearing against the upper coupling (fig. 4-19), with the roller depressed eleven thirty-seconds inch from free position. In this position, the



1. Setscrew.
2. Piston rod nut.
3. Upper coupling.
4. Washer.
5. Locknut.
6. Gland.
7. Packing.
8. Spacer.
9. Flange cover.
10. Gasket.
11. Piston chamber.
12. Piston rod.
13. Steam inlet flange.
14. Removable blank flange.
15. Preheat piping.
16. Globe valve.
17. Steam outlet flange.
18. Drain flange.
19. Piston and insert.
20. Locking bushing.
21. Setscrew.

AB.351

Figure 4-18.—Steam valve breakdown.

switch must indicate on the control console that the valve is closed. Also, shim the limit switch when necessary to bring the roller of the switch to the horizontal centerline of the upper coupling.

If the cause of a malfunction is not evident from inspection of the exhaust valve, inspect the control valve, solenoid valves, and electrical system to determine the cause of trouble.

The only lubrication necessary on the exhaust valve operating cylinder is to keep the oil cup full of oil.

The butterfly type exhaust valve is used on the C-13 catapults aboard all other carriers (fig. 4-20).

The butterfly-type exhaust valve consists principally of a valve body, a disk, and a hydraulic actuator. The hydraulic actuator opens and closes the valve. When hydraulic fluid from the exhaust-valve hydraulic-lock valve enters the opening port, the piston moves to open the butterfly valve. Fluid entering the closing chamber through the closing port acts on the piston to close the valve. Limit switch S4 is mounted on the side of the exhaust valve. When the exhaust valve is closed the limit switch is actuated by a cam attached to the crank, and when the exhaust valve opens, the cam rotates to the exhaust position and the limit switch is released.

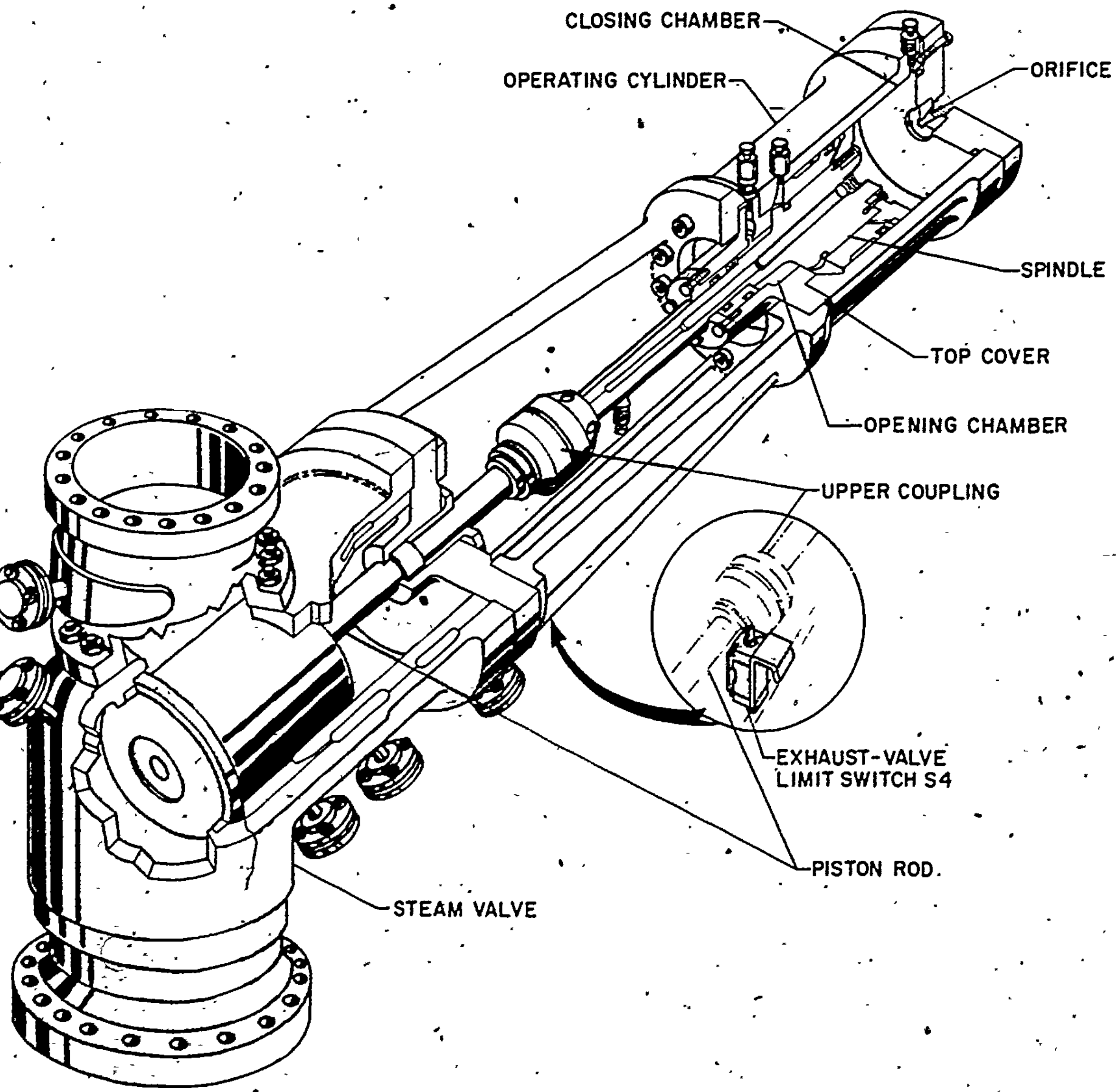


Figure 4-19.—Lantern type exhaust valve (CVA-63 and -64).

Exhaust Valve Control Valve

The exhaust valve control valve (fig. 4-21) is used with the lantern type exhaust valves installed aboard aircraft carriers CVA-63 and CVA-64. The control valve opens and closes the exhaust valve by controlling the flow of fluid into the exhaust valve operating cylinder. When hydraulic fluid from the hydraulic lock valve enters the control valve at port B, the piston of

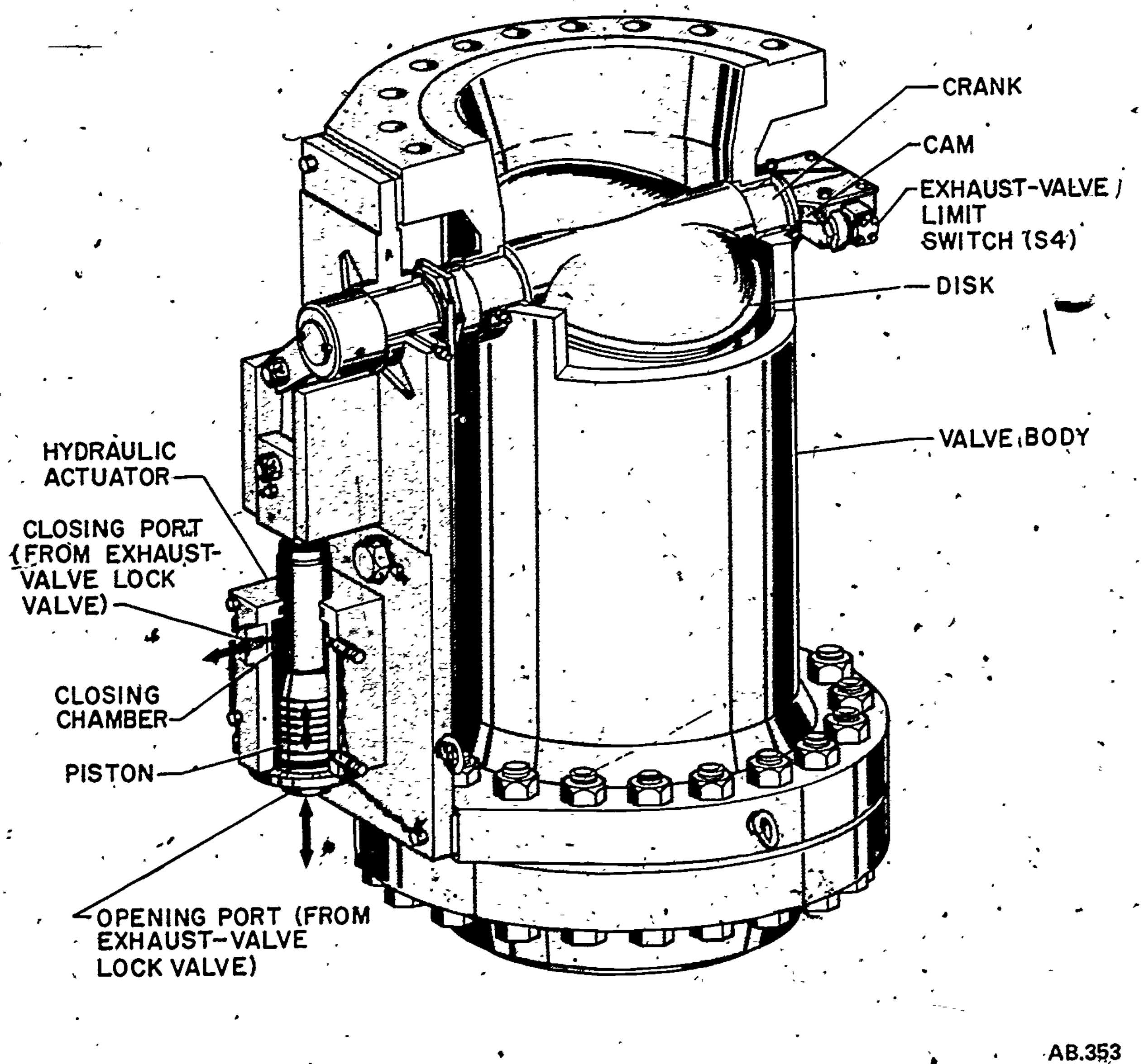
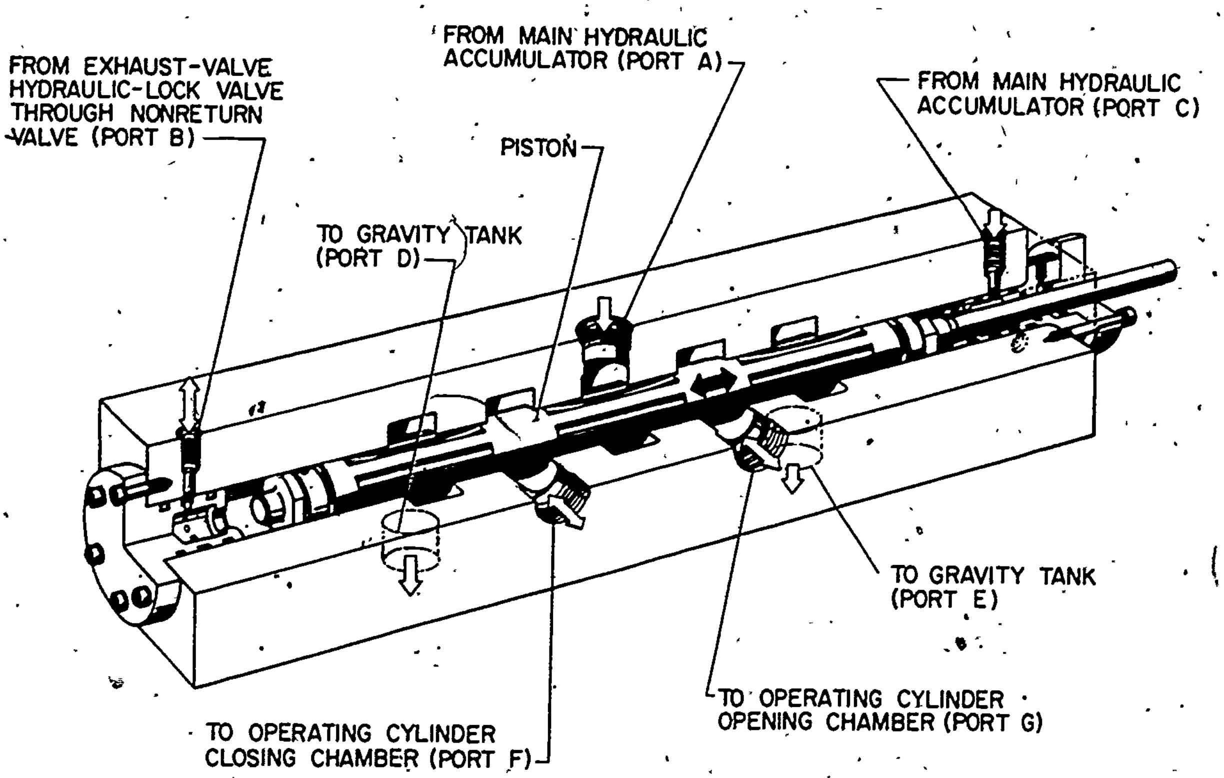


Figure 4-20.—Butterfly type exhaust valve.

the control valve shifts. The shifted piston allows hydraulic fluid from the main hydraulic accumulator to flow through the control valve, through port A to port G, to the opening port of the operating cylinder, and causes the exhaust valve to open. When the pressurized fluid at port B of the control valve returns through the hydraulic lock valve to the gravity tank, the piston of the control valve will shift. This allows hydraulic fluid from the main hydraulic accumulator to flow through the control valve, through port A to port F, to the closing port of the operating cylinder, and causes the exhaust valve to close.



AB.325

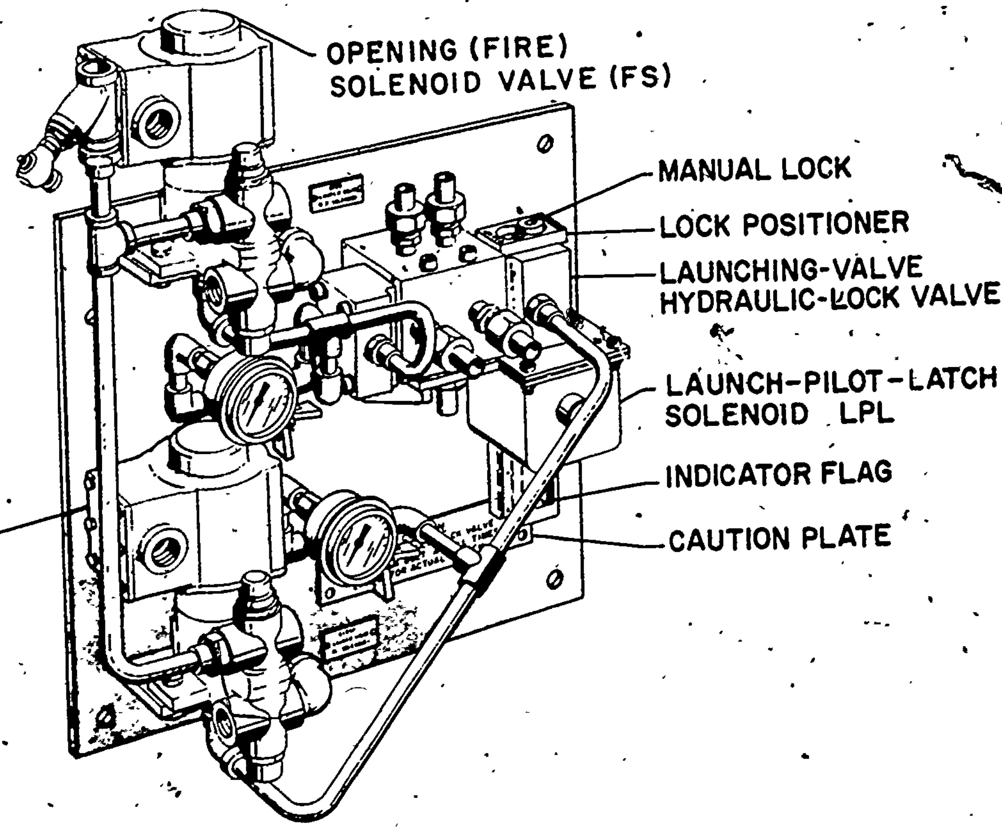
Figure 4-21.—Exhaust valve control valve (CVA-63 and -64).

Hydraulic-Lock-Valve Panels

There are two hydraulic-lock-valve panels, one for the launching valves and one for the exhaust valve. The principal difference between the two panels is the manual lock, launch pilot latch, and the indicator flag on the launching-valve hydraulic-lock-valve panel. (See figures 4-22 and 4-23.)

The launching-valve hydraulic-lock-valve panel (figure 4-22) consists essentially of two solenoid-operated air valves, a hydraulic-lock-valve solenoid, a lock, a caution plate, and a hydraulic-lock valve. The panel and piping connections essentially complete the assembly. There is no external linkage and the operation is highly reliable. The launching-valve hydraulic-lock valve (figure 4-24) prevents the launching valves from closing before launching is complete. When the launch-pilot-latch solenoid is energized, a plunger is released from the hole in the hydraulic lock valve, allowing air pressure to shift the piston of the lock valve when the opening (fire) solenoid is energized. Hydraulic fluid flows from port A through the lock valve to port B. The fluid flows through the normally open launching-valve cutout valve, then enters the launching-valve control valve causing the piston of the control valve to shift. The hydraulic fluid also passes back into port D of the lock valve, and pressure on this side holds the piston in this shifted position until the closing solenoid valve is energized.

When the piston is in the position shown in figure 4-24, pressure acting on the larger surface of the lock valve piston through port A locks the



AB.326

Figure 4-22.—Launching-valve hydraulic-lock-valve panel.

valve in this position to keep the launching valve closed. The valve is also locked in this position when the launch-pilot-latch solenoid is deenergized and the plunger has returned into the body of the lock valve. The position of the plunger is indicated by a flag located below the solenoid. (See figure 4-22.) The flag shows red when the plunger is down and the solenoid is energized, and shows white when the plunger is up and the solenoid is deenergized. The valve also has a manual lock which can be screwed into the valve to lock the piston. A lock positioner determines the position of the manual lock. The manual lock is only placed in the locked position as a safety measure to insure that the launching valves remain closed when the catapult is secured or during certain maintenance procedures. During catapult operations, the manual lock is in the unlocked position.

The exhaust-valve hydraulic-lock-valve panels (figure 4-23) installed aboard CVA-63 and -64 are slightly different from the lock-valve panels installed aboard CVA(N)-65 and CVA-66. The two panels differ in the type of lock valve installed on the panel and the piping connections to the lock valve. The exhaust-valve hydraulic-lock valve aboard CVA-63 and -64 has four ports; the exhaust-valve hydraulic-lock valve aboard CVA(N)-65 and CVA-66 has five ports.

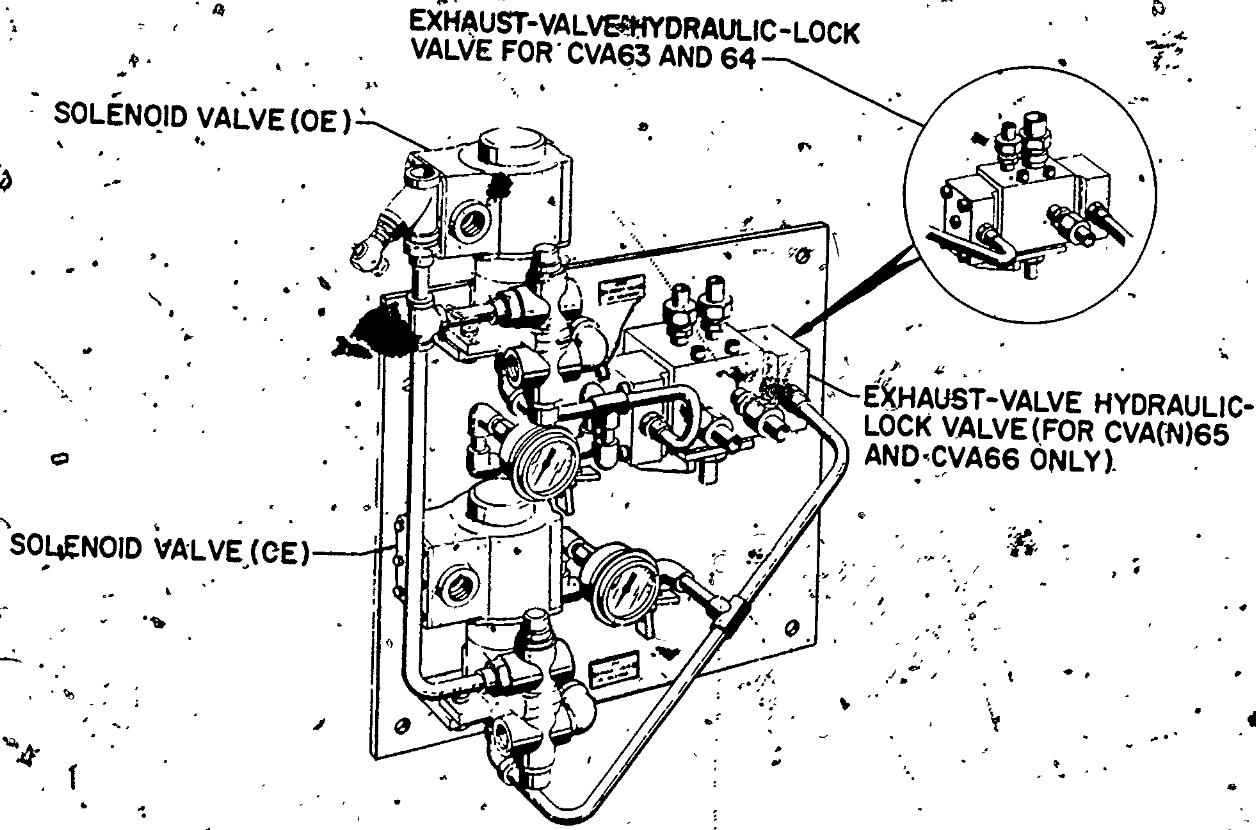


Figure 4-23.—Exhaust-valve hydraulic-lock-valve panel. AB.327

The exhaust-valve hydraulic-lock valve used aboard CVA-63 and -64 holds the exhaust valve open during the retraction cycle of the catapult and keeps the exhaust valve closed during the launching cycle. When the opening solenoid (OE in fig. 4-23) is energized, air pressure admitted to the opening side of the hydraulic-lock-valve assembly shifts the piston and allows hydraulic fluid under pressure from the main hydraulic accumulator to pass through the valve to the nonreturn valve. The fluid passes through the nonreturn valve to the exhaust-valve control valve and causes the piston in the exhaust-valve control valve to shift and allow fluid under pressure from the main hydraulic accumulator to pass through the exhaust-valve control valve to the opening chamber of the exhaust valve, thus opening the exhaust valve.

When the closing solenoid (CE) is energized, air pressure admitted to the close side of the hydraulic-lock valve assembly shifts the piston to release the pressure from the exhaust-valve control valve and the nonreturn valve, allowing the fluid to return to the gravity tank. Then, the piston of the exhaust-valve control valve shifts and shuts off the pressure to the opening chamber of the exhaust valve; this allows hydraulic pressure from the main hydraulic accumulator to pass through the control valve to the closing chamber of the exhaust valve, causing the exhaust valve to close. Hydraulic pressure working on the large surface of the

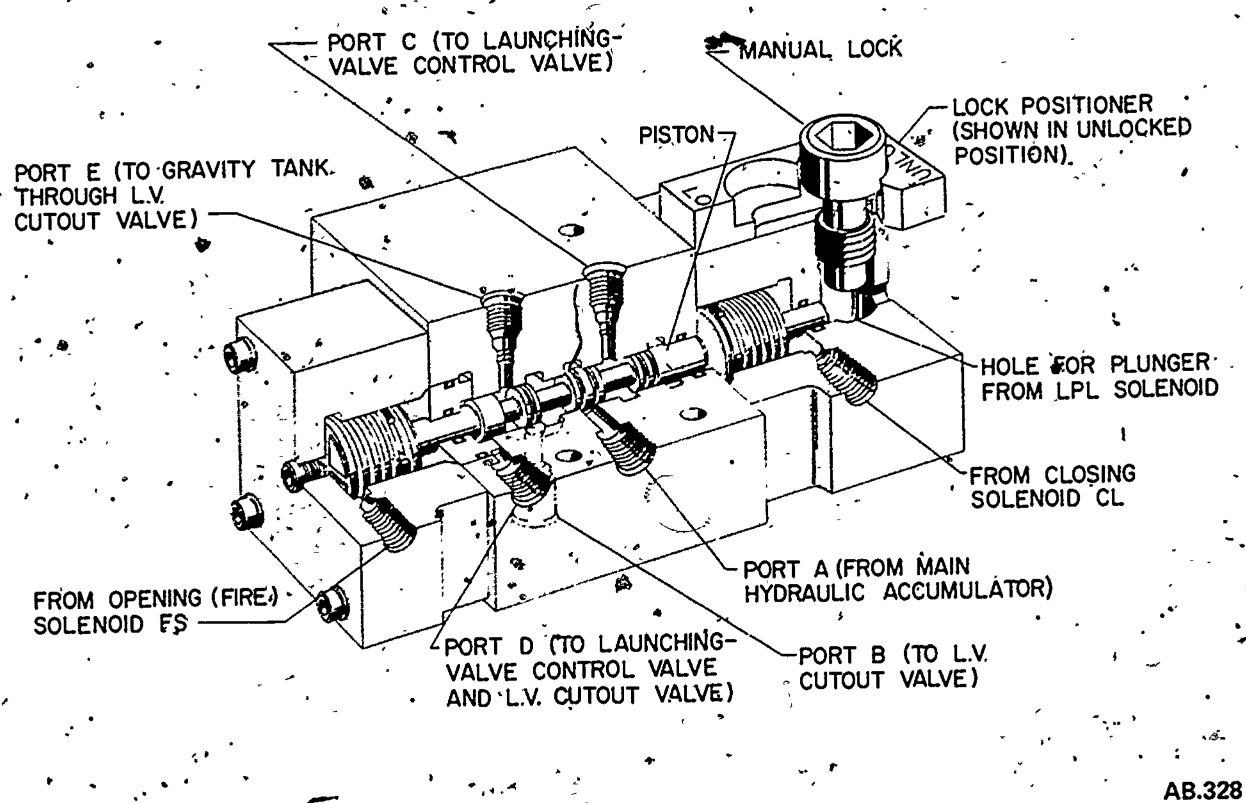


Figure 4-24.—Launching valve hydraulic-lock valve.

hydraulic-lock valve piston locks the valve in the close position, keeping the exhaust valve closed.

The exhaust-valve hydraulic-lock valve (figure 4-23), opens and closes the butterfly type exhaust valve by controlling the flow of hydraulic fluid into the exhaust-valve actuator. (See fig. 4-20.) When the opening solenoid (OE) is energized, air pressure enters the open side of the hydraulic-lock valve and shifts the pistons to allow hydraulic fluid from the main hydraulic accumulator to flow through the lock valve to the nonreturn valve. The fluid passes through the nonreturn valve to the opening port of the exhaust valve actuator and causes the exhaust valve to open. Hydraulic pressure acting on the lock valve piston locks the lock valve in the open position until the closing solenoid (CE) is energized. When the closing solenoid is energized, air pressure entering the close side of the hydraulic lock valve shifts the piston and allows fluid from the main hydraulic accumulator to flow through the lock valve to the closing port of the exhaust valve actuator, closing the exhaust valve. Hydraulic pressure acting on the large surface of the lock valve piston locks the valve in the close position to keep the exhaust valve closed.

Minor repairs consist of tightening hydraulic and electrical connections. Panel bolts must be kept tight at all times, since rigidity is required to assure smooth operation of the hydraulic-lock valve without binding or chattering. Very little trouble should be experienced with the assembly since there are no external moving parts.

Normally, no parts replacement is required except at overhaul. If leakage or malfunction occurs, fittings or O-rings should be replaced as required. Apply a thin coating of grease to securing bolts to retard rusting; and keep the caution plate clean at all times. Before installing or replacing O-rings, apply a light coating of grease to O-rings located on the pistons in each air cylinder of the hydraulic-lock valve assembly.

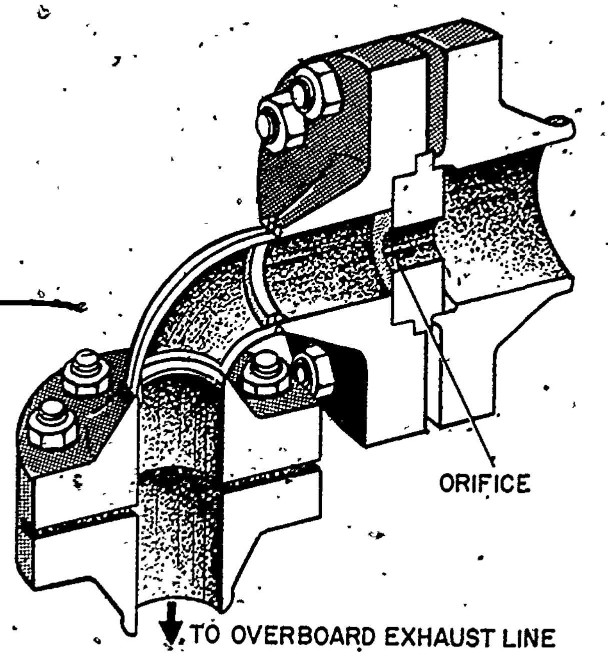
No adjustment is required after the initial or overhaul alinement of the two solenoid valves, the hydraulic-lock valve spool, and the assembly panel; and no lubrication is required for the hydraulic-lock valve panel assembly.

Pressure Breaking Orifice Elbow

The pressure breaking orifice elbow assembly (fig. 4-25) is a safety feature incorporated into the exhaust valve system to prevent steam pressure buildup behind the launching pistons with the launching pistons in the battery position and the exhaust valve closed.

The orifice elbow assembly is located on the exhaust manifold between the exhaust tee and the exhaust valve. (Refer to figure 4-16 for location of the orifice elbow.) The pressure breaking orifice elbow permits steam that may leak through the closed launching valves to escape by bypassing the exhaust valve, thus preventing a buildup of pressure in the power cylinders behind the launching pistons. A buildup of pressure behind the pistons could cause premature breaking of the holdback tension bar, possibly resulting in injury to personnel working around the aircraft, or to loss of the aircraft.

The pressure breaking orifice elbow assembly consists of elbow piping flanged to the exhaust valve manifold with a 0.750 orifice in the piping.



AB.67
Figure 4-25.—Pressure breaking orifice elbow assembly.

RETRACTION SYSTEMS (LINEAR AND ROTARY)

The function of both the linear and rotary retraction engines is to hydraulically control the movement of the grab and to maneuver the shuttle forward and aft when slow movement is required. Normally, the engines will be located directly below the flight deck in close proximity to the launching engine so that excessive cable reeving and hydraulic lines and piping are not required. The basic description of the newer rotary retraction system has been discussed previously in this chapter; and due to the limited number of these units in the fleet, only the linear retraction system is discussed in detail.

Maintenance procedures and inspections for both the rotary and linear systems are to be accomplished by use of the current Maintenance Requirements Cards, as directed by the weekly schedule of preventive maintenance.

Most of the common problems that will arise with the retraction engines will have to do with air or hydraulic fluid leaks. Whenever there is a leak, the remaining pressure must be blown down and the torque value of the retaining bolts checked and, if necessary, corrected. If this does not correct the problem, the leaking component and/or packing must be replaced. When there is chattering or binding, it may be due to misalined parts, binding of the packing, or worn parts. Some of the malfunctions that may occur, along with their probable causes and corrections are shown in table 4-2 for the linear retraction engine and table 4-3 for the rotary engine.

Linear Retraction Engine

Essentially, this system consists of the retraction engine cylinder and piston, the main hydraulic accumulator, air flasks, the grab, the cables which couple the grab to the retraction engine, the crosshead, sheaves, cable equalizers, associated valves, and electrical controls and piping. The general arrangement of the retracting engine is shown in figure 4-26.

The retraction engine cylinder and piston convert the hydraulic pressure into motion of the crosshead to cause advancement or retraction. The components are so designed that, when operating in either direction, the retraction engine piston starts slowly, travels at maximum speed through the greater portion of the stroke, and comes to a gradual stop. The flow of hydraulic fluid to and from the retraction engine cylinder is controlled by three solenoid-operated three-way valves, one solenoid-operated fourway valve, one hydraulically operated blocking valve, and three hydraulically operated three-way valves.

The function of the retraction system is to retract and position the shuttle and piston assemblies to battery position after each aircraft has been launched. Grab advancement is accomplished by forcing 2,500-psi hydraulic fluid into the advance end of the retraction engine cylinder by operation of the retraction engine advance three-way control valve and solenoid valve. Power is transmitted to the crosshead and thence through the cable system to advance the grab to the forward end of the track, causing automatic engagement of the grab with the shuttle. The advance stroke buffer slows and stops the forward motion of the grab, crosshead, and retraction engine piston at the end of the advance stroke. After the grab has engaged with the shuttle, 2,500-psi hydraulic fluid is admitted to the retraction end of the retraction engine cylinder. The motion of the crosshead is then reversed and the grab brings the shuttle and piston assemblies to battery position. The retract buffer slows and stops the motion of the shuttle and piston assemblies, grab, crosshead, and piston in the retraction engine cylinder at the end of the stroke.

Linear Retraction Drive System

The drive system (fig. 4-27) consists of a grab, two advance cables, two retrieving cables, an advance cable equalizer, a retrieving cable equalizer, a crosshead, and various sheaves. The drive system operates in conjunction with the retraction engine and hydraulic system to advance the grab to the shuttle after launching and retract the grab and shuttle to battery position.

Grab

When driven by the retraction engine, the grab advances the length of the shuttle track, automatically engages with the shuttle, withdraws the shuttle to battery position, and secures it until the catapult is fired. Figure 4-28 is a drawing of the grab.

The grab is a spring-loaded latch, mounted on a wheel frame and installed within the shuttle track behind the shuttle. The two retrieving cables are fastened to the aft end of the grab, and the two advance cables to the forward end. After a launching, the grab is pulled forward the length of the shuttle track by the drive system, and automatically latches to the shuttle with a positive-locking device. Diagram A of figure 4-29 shows the grab in the unlocked position, approaching the shuttle. When the grab latch (5) comes in contact with the shuttle clevis pin (6), the latch rotates and the latch cam follower (8) moves out of the cam detent (7) in the lock block (9) and continues upward until it reaches the top surface of the lock block. The spring-loaded lock block then moves under the cam follower, trapping the latch and locking the grab to the shuttle clevis pin, as shown in diagram B. The grab will not release the shuttle until both have been returned to battery position and the grab unlocking mechanism is actuated by the bridle tensioner. When the bridle-tensioner piston rod moves forward, the bridle-tensioner buffer cap (11) pushes the grab pushrod (1) inward until the buffer cap contacts the grab block (2). When the pushrod is pushed inward, the lock block (9) is pulled from under the latch cam follower and the latch is free to rotate and

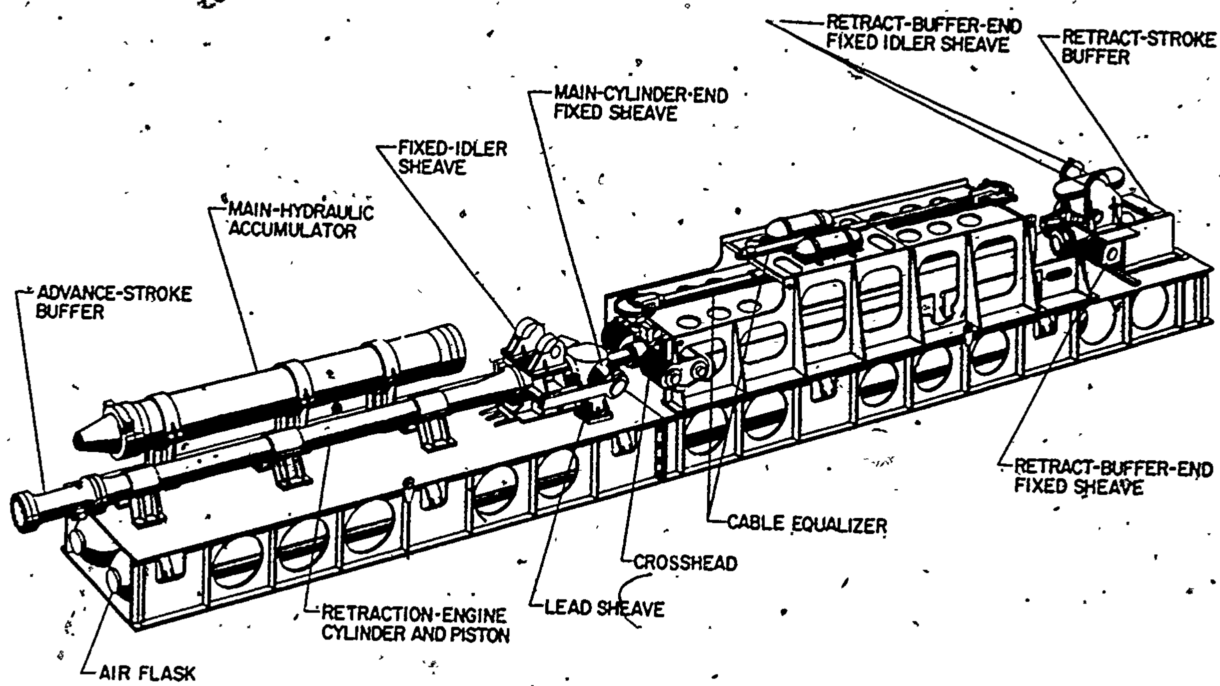


Figure 4-26.—Linear retraction engine. AB.184

release the shuttle, as shown in diagram C. When the shuttle and bridle tensioner move away from the grab, the grab remains in the unlocked position, as shown in diagram A. During no-load tests the grab and shuttle must be unlatched. The grab is manually released from the shuttle, as shown in diagram D. A manual-release disengaging lever (12) is placed over the manual-release arm (3), which is accessible through the track slot. The disengaging lever is then lifted up and pushed forward. This motion pulls the lock block from under the latch cam follower and frees the latch so that the grab and shuttle can be separated.

WARNING: The manual-release disengaging lever must be removed from the grab during normal operations.

Cable Equalizers

The advance and retract cable equalizers (fig. 4-30) operate hydraulically to keep the retraction-engine cables tight. Hydraulic fluid under pressure flows directly into the cable equalizer, keeping tension on both sets of cables. When one set of cables is loaded, the other set becomes slack. Slack is taken out of the retraction-engine cables by motion of the equalizers. A check valve in the supply piping to each cable equalizer allows rapid flow of fluid to the equalizer when the cables become slack, and prevents any return flow in this piping. When cable load is applied to the equalizer piston, fluid flows back to the reservoir through the vent piping. When one cable equalizer is work-

Table 4-2.—Malfunctions, linear retraction engine

Trouble	Probable cause	Correction
Catapult will not retract or advance.	Wiring to applicable pushbutton is open.	Repair as necessary.
	Transfer switch on EMERGENCY making the deck edge panel inoperative.	Turn transfer switch to NORMAL after determining that deck edge panel is not damaged.
	No hydraulic pressure.	Start main hydraulic pump.
	Hydraulic leakage or closed valve.	Repair leak or open valve.
	Broken or bound cable.	Repair reeving as necessary.
	One or more solenoid valves inoperative.	Repair or replace solenoid valve. Check electrical connections to solenoid.
	Defective relay.	Repair or replace relay.
	Retract or advance three-way valve inoperative.	Check for internal binding of piston.
	Retract or advance buffer limit switch not actuated.	Realine limit switch for correct tripping action. Check limit switch and replace if faulty.
	Bridle tensioner full in limit switch not actuated.	Check tension on limit switch control cable. Replace limit switch if faulty.
No bridle tension.	Bridle tensioner piston fully extended.	Reposition aircraft or dead load and retension.
	Wiring to pushbutton open, pushbutton defective, or transfer switch on EMERGENCY, making the deck edge panel inoperative.	Repair as necessary.
	Solenoid valve inoperative.	Repair or replace solenoid valve.
	Bridle tensioner piston binding.	Inspect and repair cause of binding.
	Hydraulic leakage in bridle tensioner piping.	Repair leakage as necessary.

Table 4-3.—Malfunctions, rotary retraction engine

Trouble	Probable cause	Correction
External fluid leakage.	Faulty seals, O-rings, or packing.	Replace faulty parts.
	Cracked welds.	Repair welds.
Excessive noise.	Air in hydraulic system.	Bleed air from system.
	Bearing wear.	Replace bearing(s).
Binding or excessive vibration of drum.	Lack of lubrication.	Lubricate shafts.
	Burrs or scoring of drum grooves.	Hone out as necessary, lubricate grooves and cable.
	Loose cable clamps.	Secure cable clamps.
Uneven or erratic operation of cable tensioners.	Air trapped in cylinders.	Bleed-off air from hydraulic fluid.
	Accumulator not pressurized properly.	Adjust pressure setting.
Traverse carriage misalined.	Worn slippers, or slippers improperly shimmed.	Replace or shim slippers to alinement.
Faulty electrical system.	Loose connections.	Secure connections.
	Faulty components.	Replace as required.

NOTE: Electrical system repair work should be handled by a qualified Electrician's Mate.

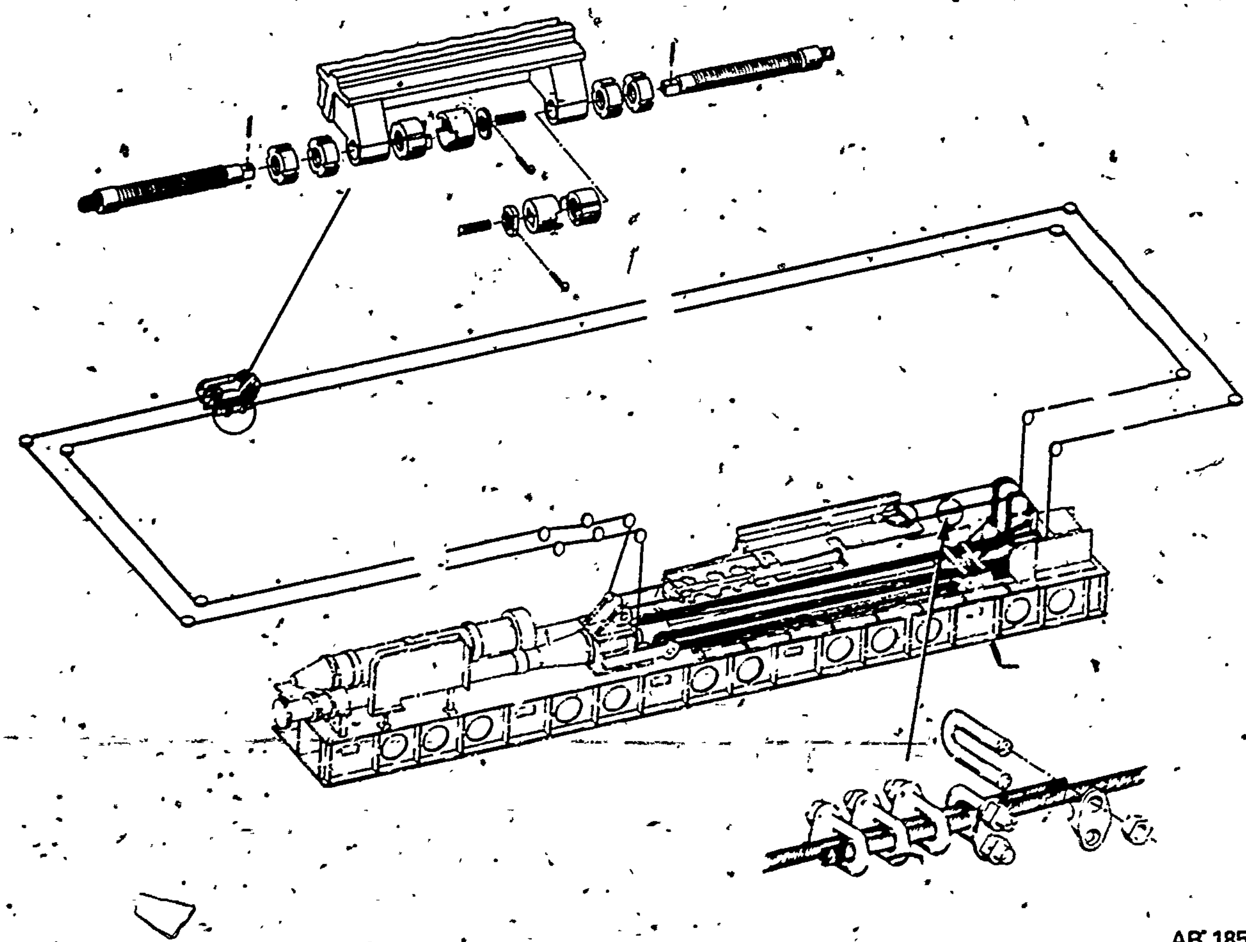


Figure 4-27.—Linear retraction engine drive system.

ing, the adjusting nut on the opposite equalizer is bottomed and acts as cable anchor.

The cable equalizers are also used to adjust the position of the grab to obtain ideal battery position of 16 inches, ± 1 inch, measured from the after end of the grab to the after end of the catapult track.

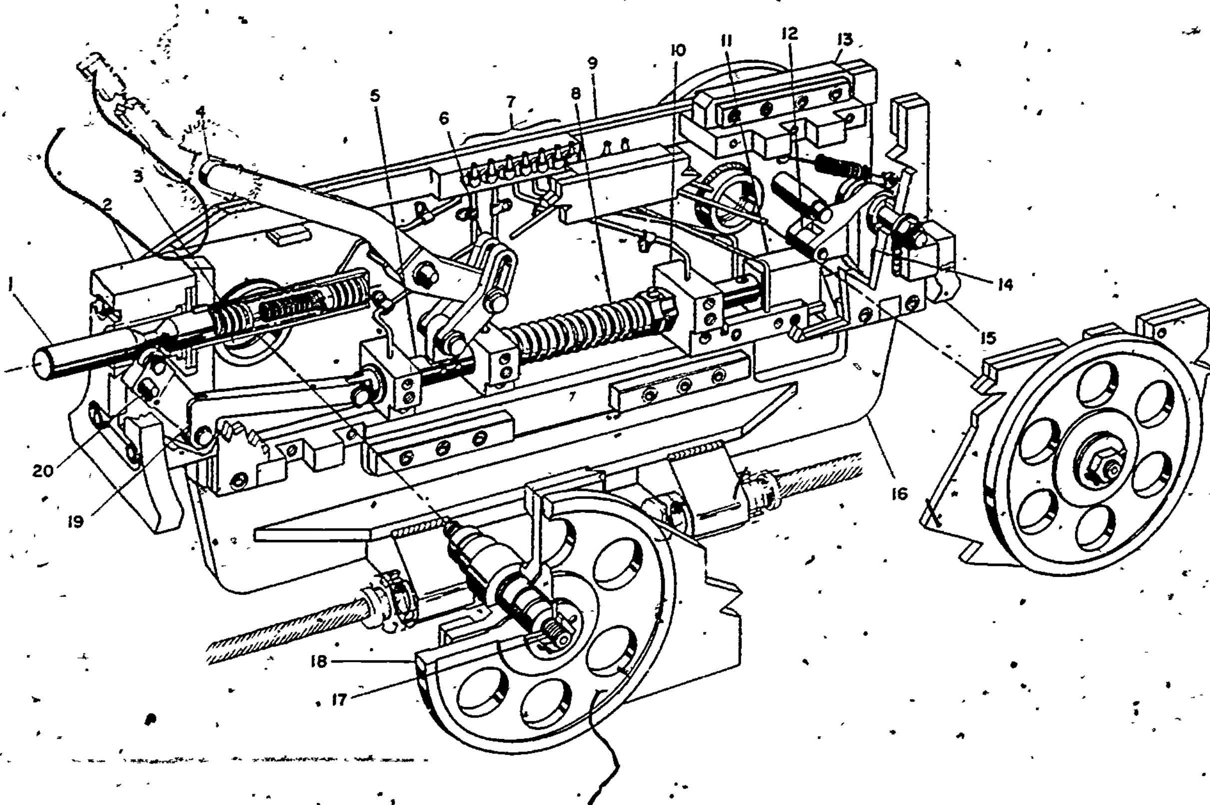
Maintenance and adjustment of the cable equalizers is performed in accordance with the applicable maintenance requirements card. The most frequent maintenance encountered with cable equalizers is replacement of packing, and making routine adjustments to maintain ideal battery position.

Cables and Lead Sheaves

The cable system, as shown in figure 4-27, transmits energy from the retraction engine to the grab. The cables are reeved around the sheaves in the retraction system to obtain a reeve ratio of 16 to 1. The cables are made of 9/16-inch diameter wire rope. There are four cables, two for advance and two for retract.

NOTE: When replacing cables always replace both advance or retract cables at the same time.

Each cable is equipped on one end with a swaged cable fitting which is attached to the grab. The cables are connected at the opposite



1. Pushrod.
2. Block.
3. Spring.
4. Manual-release arm.
5. Slide shaft.
6. Link.
7. Lubrication fitting.
8. Spring.
9. Plate.
10. Support.
11. Block.
12. Cam follower.
13. Upper tie bracket.
14. Latch.
15. Buffer plate.
16. Bracket.
17. Shaft.
18. Wheel assembly.
19. Link.
20. Lever.

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Figure 4-28.—Grab.

end at the retract engine by reeving one cable around the cable equalizer sheave and overlapping the other cable. They are then held together by means of cable clamps. (See insert, figure 4-27.)

New cables will stretch with use, and if, after operation of the retraction engine, the cables have stretched in excess of the amount that can be compensated by adjustment of the cable equalizer, the cable clamps must be removed, repositioned, and new cable clamps installed to clamp the ends of the two cables together.

Sheaves guide and support the cables between the shuttle track and the retraction engine. Numerous lead sheaves are used to guide the cables from the grab to the retraction engine and

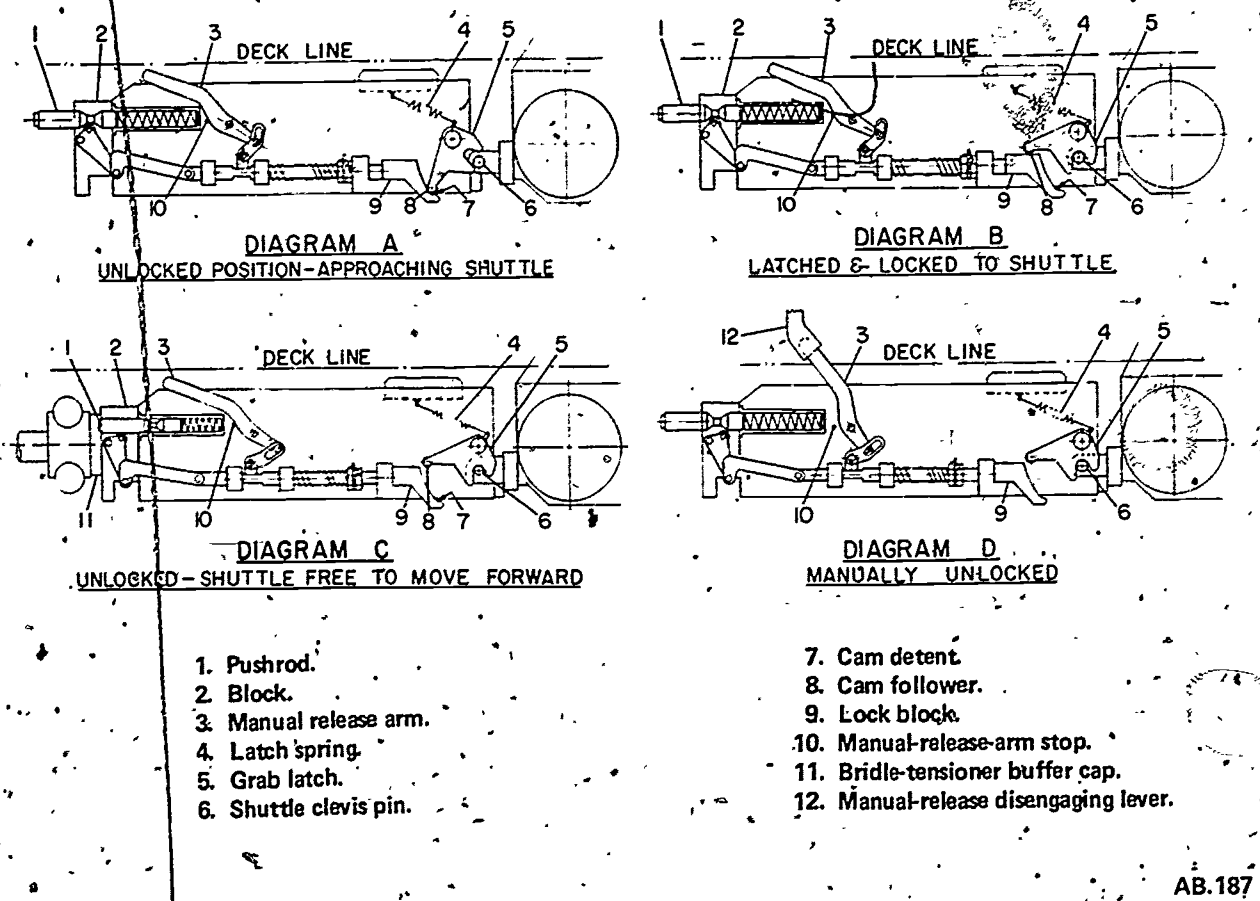

Figure 4-29.—Grab operation sequence.

change the cable direction as required by the ship's installation.

Two fixed idler sheaves are mounted on the cylinder extension and two on the retract buffer end of the retraction engine. These sheaves lead the cables to the cable equalizers.

The two fixed lead sheaves mounted near the cylinder extension on the retraction engine turn the retrieving cable 90 degrees as it enters the retraction engine.

BRIDLE TENSIONING SYSTEM

The bridle tensioning system consists of the bridle tensioner (fig. 4-31), a bridle tensioner control valve which is actuated by a solenoid operated air valve, a pressure regulator, a pressure set regulator valve, a relief valve, a surge accumulator, two bridle tensioner limit switches, and associated valves and piping. Associated with the bridle tensioning system is the hold-back installation which provides a means for securing the aircraft during bridle tensioning. During hookup, the aircraft is spotted in position, attached to the shuttle spreader by a bridle or pendant, and the aircraft holdback assembly is attached to the aircraft. The bridle tensioner is then activated to apply force against the grab and move the shuttle forward to tension the bridle. A relief valve is installed in the piping system to prevent excessive hydraulic pressures from causing premature release of the aircraft from the holdback.

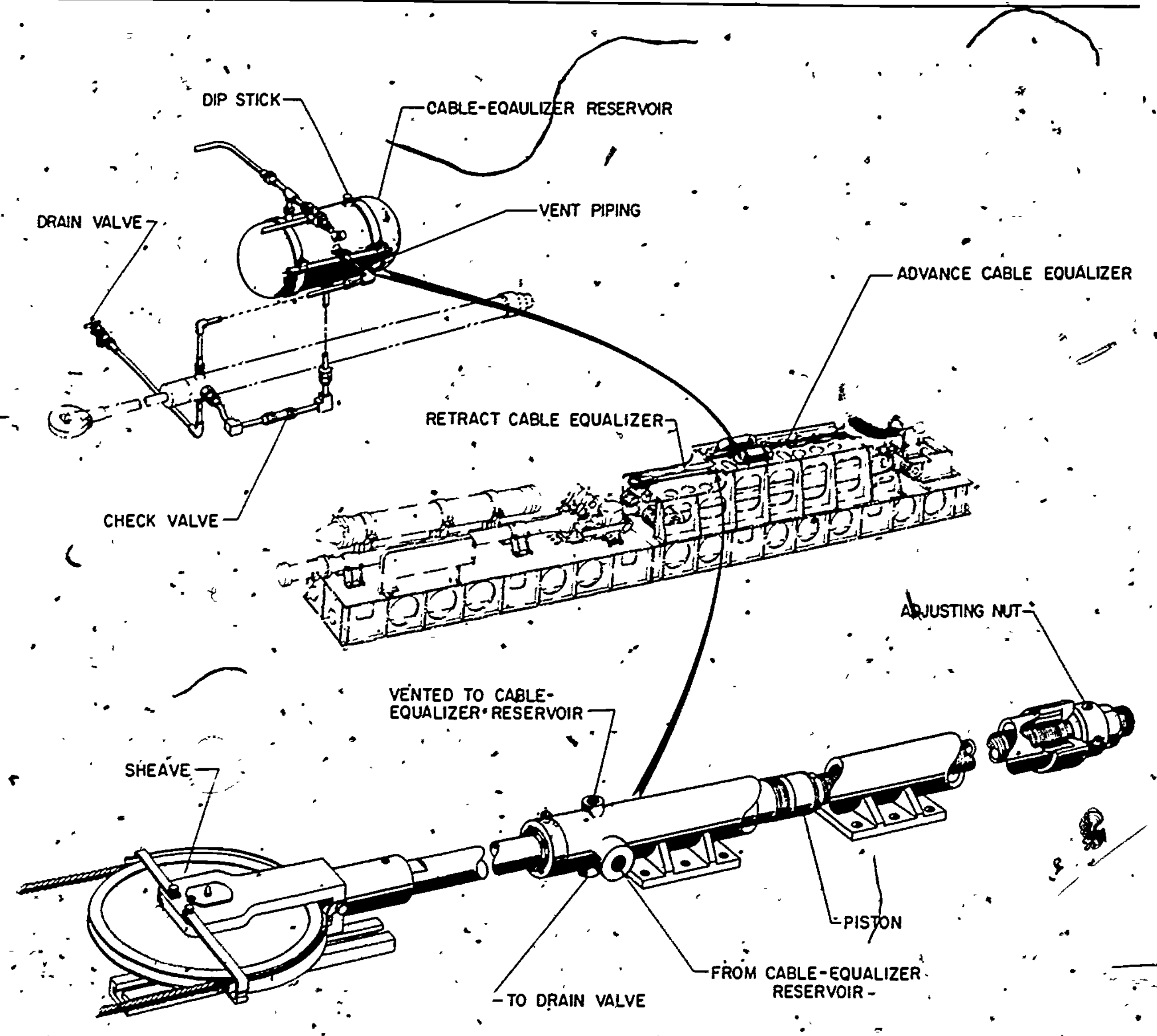

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Figure 4-30.—Cable equalizers.

Bridle Tensioner

The bridle tensioner (fig. 4-32) is located at the aft end of the catapult. It consists of a two-way hydraulically operated piston, a piston rod fitted with a ram support and buffer cap, a cylinder, a cylinder support which mounts on the thrust unit, and a saddle which fastens to the track cover. The advance chamber is connected by piping to the bridle tensioner control valve; the retraction chamber is connected by piping to a reducing valve. Hydraulic fluid for both lines is supplied from the retraction engine accumulator, but is reduced by a reducing valve to the

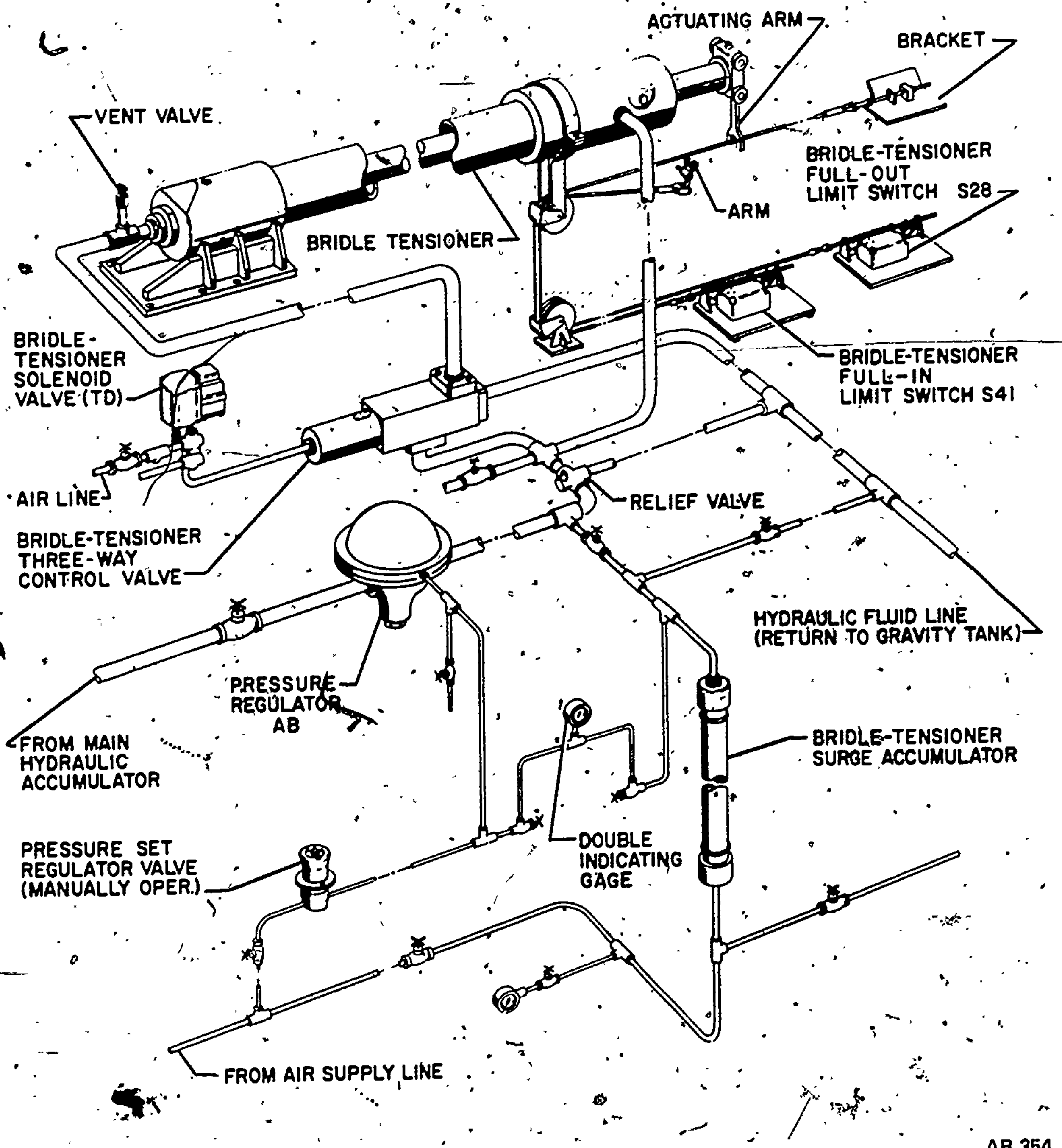
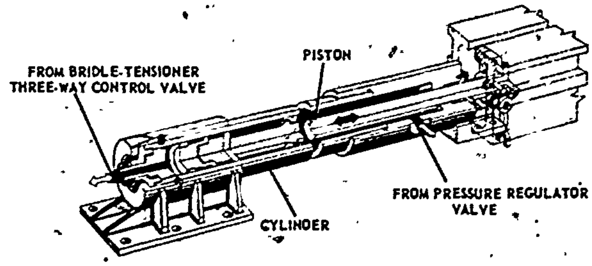


Figure 4-31.—Bridle tensioning system.

pressure required to produce the desired horizontal force against the grab. An accumulator is provided between the reducing valve and the bridle tensioner control valve to protect the reducing valve and maintain constant pressure in the system. There is a constant supply of hydraulic pressure to the forward end of the bridle tensioner when the system is charged. During bridle tensioning, pressurized fluid enters the after end of the bridle tensioner. An unbalanced force is set up due to the difference in surface area on the two sides of the piston and the piston is driven forward. The buffer cap on the piston rod hits the aft end of the grab, forcing the grab and shuttle forward. The rollers on the ram support ride along the shuttle track, keeping the piston rod properly alined. After the catapult is fired, the control valve shifts, venting the pressure in the bridle tensioner advance chamber back to gravity and causing the bridle tensioner piston to return to its battery position.

There are two limit switches in the bridle tension system, FULL OUT and FULL IN. The bridle tensioner FULL OUT limit switch prevents the catapult from firing unless there is bridle tension. Bridle tension cannot be insured if the bridle tensioner piston rod is fully extended. When the bridle tensioner piston rod is nearly FULL OUT, an actuating arm moves a cable which actuates a limit switch, deenergizing the STANDBY relay and preventing STANDBY condition from being completed. The bridle tensioner piston rod must then be retracted, the aircraft respotted, and bridle tension reapplied. The bridle tensioner FULL IN limit switch prevents damage to the grab and bridle tensioner by insuring that the bridle tensioner piston rod is FULL IN before retracting the grab, shuttle, and pistons. When the bridle tensioner piston rod is fully retracted, the actuating arm moves a cable which actuates a limit switch and allows the retraction operation to be completed.



AB.192
Figure 4-32.—Bridle tensioner (typical).

Holdback Cleat Installation

The holdback cleat (fig. 4-33) provides a means of holding the aircraft in place during bridle tensioning. It is installed in the deck directly behind the bridle tensioner. Cutouts along the entire length of the cleat permit attachment of different length aircraft. A link coupled to a holdback unit attached to the aircraft, is inserted into the appropriate cutout. When the catapult is fired a tension bar or ring in the holdback unit breaks, releasing the aircraft.

Electrical System

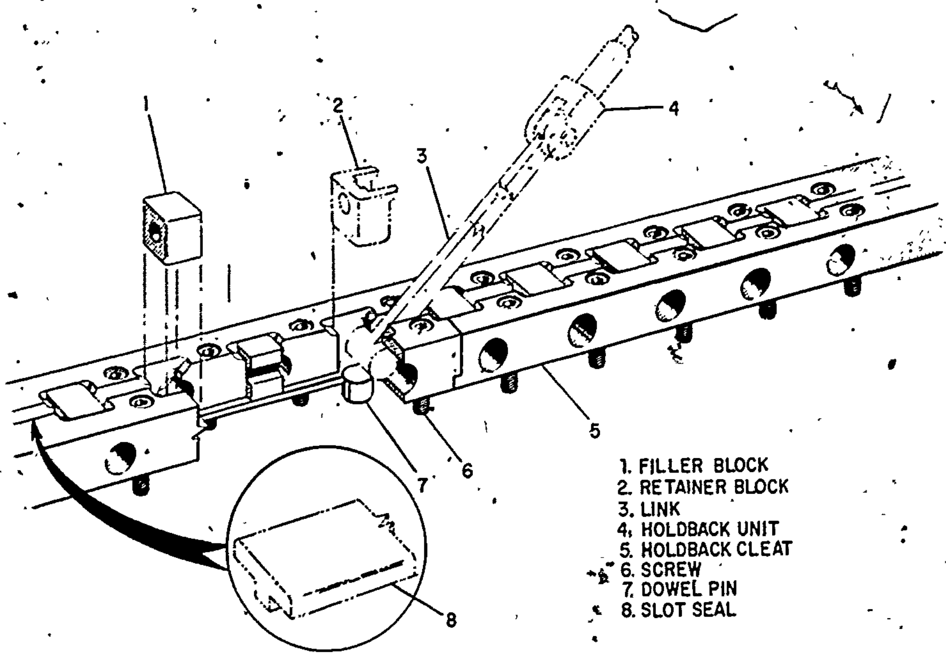
The electrical system of the C-13 catapult includes control components such as lights, pushbuttons, limit switches, toggle switches, panels and associated fuses, wiring and junction boxes, relays, solenoid valves, pump-motor sets, and special indicator systems (cylinder elongation indicator and velocity indicator). All panels, solenoid valves, and relays (except two individually housed 440-volt relays for the main hydraulic pump and motor set) use a conventional 115-volt, single-phase, 60-cycle a-c supply.

When troubleshooting the 115-volt, 60-cycle electrical system of the Type C, Mark 13 catapult, considerable assistance can be obtained in tracing a specific circuit by using the applicable wiring drawing. Overall functional operation can best be understood by studying the electrical schematic diagrams, which show in simplified form the interrelationship of the components of the electrical system throughout the cycle of operation. While conducting the control system test procedure, observe where deviations occur from anticipated results; then use these indicators as a clue in locating the cause of malfunction.

WARNING: Always observe extreme care to prevent electrical shock while troubleshooting. When replacing a component, open the main supply switch and hang a warning sign on it to prevent inadvertent closing of the switch by other personnel.

The following miscellaneous notes apply to electrical troubleshooting throughout the catapult:

1. If after replacement of an apparently defective light, switch, or other component the component continues to malfunction, check for a loose or disconnected wire at the component,



1. Filler block.
2. Retainer block.
3. Link.
4. Holdback unit.
5. Holdback cleat.
6. Screw.
7. Dowel pin.
8. Slot seal.

AB.93

Figure 4-33.—Cleat installation.

or the other end of the wire at the terminal strip or junction box.

2. Repeated blowout of the circuit breaker or fuse indicates overload or short circuit. Be sure an overload coil of the correct value is used in the circuit breaker, and a fuse of the correct value is used in the fuse box.

3. In case a defect is suspected in a relay or solenoid valve, check for the following:

a. Visible signs of coil overheating due to overload.

b. Visible broken wire in coil winding.

c. Loose wire connection.

d. Damage due to steam, water, or oil having leaked into the component.

4. If lines are open or shorted in the trough or conduit, check for defective lines. Investigate areas along the run of the line, cable, or conduit where welding or drilling has been done recently.

5. If insulation appears to be breaking down on a particular line, replace the line as soon as possible—do not wait for a short circuit. If lines break down repeatedly, investigate the cause. It may be dampness, high ambient temperature, or an object cutting through the insulation. If possible, move the conduit or trough to a new location. Be sure all terminal tubes and packing are secure and watertight.

6. Replace or repair switch and relay contacts which spark during operation. Sparking is a potentially dangerous condition and should be corrected at once.

Troubleshooting Electrical System

NOTE: Troubleshooting and maintenance of electrical systems will be accomplished by an EM designated as the catapult electrician. The senior ABE should know the electrical system to enable him to assist the catapult electrician in finding an electrical problem, thus expediting return of the catapult to the up status.

In troubleshooting the launching, lubrication, and steam systems, proceed as follows:

1. Be sure the main power switch is ON and that SUSPEND switches have not been placed in the SUSPEND position.
2. Check for malfunctions by means of lights on the malfunction panel of the control console.
3. Check the following by pushbutton, if pertinent:
   a. Manual LAUNCH COMPLETE on emergency panel of control console.
   b. LUBE on control console.
4. Check whether the transfer switch has been turned to the EMERGENCY position, thus deactivating a control panel.
5. Investigate the possibility that the trouble is nonelectrical (stuck valve, low hydraulic or pneumatic pressure, or similar cause). Check thoroughly the component or components which the symptoms indicate may be defective.
6. Check supply voltages with a voltmeter.
7. Where possible, observe mechanical actuation of a suspect limit switch. Be sure the switch is securely bolted in its proper position.
8. If launching engine components appear normal, investigate other components in the circuit such as relays and pushbuttons.
9. Check for an open or shorted line between components. Check applicable junction box and terminal strip connections.

In troubleshooting the retraction and bridle tensioning control system, proceed as follows.

1. Be sure the RETRACTION ENGINE SUSPENSION switch has not been operated.
2. Check for malfunctions by means of lights on auxiliary panel. If the catapult will not advance, check visually whether the advance buffer is out. If the buffer is out, depress the MANUAL ADVANCE pushbutton on the control console.
3. Check whether a transfer switch has been turned to EMERGENCY, causing a control panel to be deactivated.
4. Check sheaves, cable, hydraulic pressure supply, and other nonelectrical components which may be causing the malfunction. Check thoroughly any symptoms in a component which indicate that it may be defective.
5. Check supply voltages with a voltmeter.
6. Observe mechanical actuation of the limit switches. Be sure that each switch is securely bolted in its proper position.
7. If retraction and tensioning engine components appear normal, investigate other components such as relays and pushbuttons in the same circuit.
8. Check for open or shorted lines between components. Check applicable junction box and terminal strip connections.

During a sequence of operations, certain malfunctions may occur which will remove the catapult from operation. As a senior ABE you should be able to recognize when a malfunction does occur and where the trouble lies, and immediately initiate the proper steps that must be taken.

A malfunction of any of the electrical components in the system, or disconnection of any electrical wire, may result in failure of the catapult to launch when the FIRE button is pressed. Binding of mechanical parts, or hydraulic blockage, may also cause a hangfire. Proper discharge of operational and maintenance duties is the best guarantee against hangfire and its resultant danger to personnel and equipment.

If the catapult does not fire within 10 seconds after the fire pushbutton has been depressed, a hangfire exists and the following procedures must be followed to remove the aircraft from the catapult. (NOTE. The procedures to remove an aircraft from the catapult after a hangfire has been declared by the launching officer are changed and updated periodically, and the actual procedures to be used for individual ships and catapults are found in the applicable handbook of operating instructions (NavAir 51-15 (Series), Section 111).) The hangfire procedures discussed below are the procedures for the C-13 and C-13-1 catapults installed aboard CVA-63 through CVA-66.

1. Procedures in case of a hangfire during day flight operations (conventional bridle/pendant hookup).

a. If the catapult does not fire within 10 seconds after the fire button is pressed, a hangfire exists and the aircraft must be removed from the catapult. In this case, the catapult suspend signal is given.

WARNING: Personnel will not go under the aircraft until the throttle back signal has been given. Under normal conditions the aircraft will stay at military power until the bridle/pendant has been disengaged from the aircraft. If the bridle/pendant cannot be disengaged using the procedures below because the shuttle cannot be moved forward or aft, other procedures discussed later in this chapter must be used.

b. The catapult officer signals hangfire to the deck edge operator by pointing the index finger of one hand to the palm of his other hand.

c. The catapult officer follows the hangfire signal with the untension aircraft signal by pointing one hand in the direction opposite to launching.

d. The deck edge operator observing these signals shall immediately actuate the suspend switch and phone the console operator to close the emergency cutout valve.

NOTE: When the deck edge control panel operator observes the signal from the catapult officer that a hangfire exists, he relays it to the console operator via sound-powered phone. During the verbal communication between the deck edge control panel operator and the console operator the word "HANGFIRE" will NOT be used. The deck edge operator will say, "CLOSE THE EMERGENCY CUTOUT VALVE," and will repeat it to insure there is no missunderstanding.

e. The console operator shall remove the cotter pin, unscrew the stop screw, and rotate the handle of the launching-valve cutout valve to the emergency position. He shall then push the maneuver shuttle aft pushbutton S39 on the emergency panel and hold it for 15 seconds to release bridle tension.

WARNING: The launching-valve cutout valve handle SHALL NOT be rotated from the emergency position until steps f through j have been accomplished.

f. If the hangfire was caused by an electrical failure, the console operator, after rotating the launching-valve cutout valve to the emergency position, shall call the retraction engine operator to inform him of a power failure. The retraction engine operator shall depress the manual override pushbutton on the maneuver shuttle aft valve to manually maneuver the shuttle aft.

g. The catapult crew shall remove the bridle or pendant from the aircraft and shuttle

h. The catapult officer shall then give the throttleback signal to the pilot.

i. The aircraft is then removed from the catapult by the catapult spotter (director).

j. After the aircraft is removed from the catapult, the steam pressure in the receiver shall be reduced to no-load pressure.

k. The launching-valve cutout valve shall be returned to normal position with the stop screw properly installed. The control system shall be operated through the entire operating cycle to determine and eliminate the cause of the hangfire. Two no-load shots shall be fired prior to resuming normal launching operations.

2. When using conventional bridle/pendant hookup, the procedures to be taken in case of a hangfire during night flight operations are the same as those used for day operations except for the signals used. During night operations, the catapult officer gives the signal for hangfire by holding a red wand over his head in the horizontal position.

3. The procedures to be followed in case of a hangfire during nose gear launching day operations are:

a. Follow the steps above for hangfire procedures for conventional bridle/pendant day operations through step f.

b. The launch bar is disengaged from the shuttle and the shuttle is maneuvered forward.

NOTE: Each catapult crew shall be provided with a suitable tool to manually raise the launch bar (which is under spring load) while maneuvering the shuttle forward. The tool insures against hand injuries when handling the launch bar.

c. The catapult officer shall then give the pilot the signal to throttle back.

d. The catapult officer then turns the aircraft over to the catapult spotter (director).

e. The director signals the nose gear launch operator to move the aircraft aft.

f. The nose gear launch operator presses the buffer aft pushbutton, causing the aircraft to move aft.

g. With the buffer and the aircraft in the aft position, the director signals the pilot to hold brakes.

h. The nose gear launch operator, observing the hold brakes signal, presses the buffer forward pushbutton to slack off the trail bar. The catapult crew disconnects the trail bar.

i. With the trail bar removed the director removes the aircraft from the catapult.

j. With the aircraft removed, the console operator can now reduce the steam receiver pressure to no-load pressure.

k. The launching-valve cutout valve shall be returned to the normal position, and the control system shall be operated through the entire cycle to determine and eliminate the cause of the hangfire. Two no-loads shall be fired prior to resuming normal launching operations.

4. The procedures to be taken in case of a hangfire at night during nose gear launching operations are the same as for day launching operations except for the signals used. Signals used during day and night flight operations aboard carriers can be found in Section III of the applicable catapult handbook of operating instructions, NavAir 51-15 (Series).

5. The following procedures shall be used during a suspend or hangfire situation using conventional bridle/pendant hookup when, due to failure of the grab to latch onto the shuttle, the shuttle cannot be maneuvered aft following tensioning.

WARNING: The catapult officer shall not signal the pilot to throttle back until he has positively determined that the bridle/pendant is no longer attached to the aircraft, or, when operating with nose tow launch, the catapult shuttle is forward of the launch bar, except for the following emergency conditions. If the bridle/pendant cannot be removed or the launch bar cannot be raised without sending personnel under the aircraft, the catapult officer shall positively determine that the catapult is in a safe condition, then step in front of the aircraft wing and give the throttle back signal to the pilot.

a. Attempt to remove the bridle/pendant by pressing the bridle arrester return pushbutton.

b. If the lanyard tension is insufficient to pull the bridle/pendant from the aircraft hooks, the catapult officer shall signal the pilot to throttle back, and the catapult crew will attempt to remove the bridle by shaking the bridle or pulling on the lanyards.

c. If the bridle/pendant cannot be removed as described above, the shuttle must be towed aft utilizing a cable assembly provided with a hook on one end and an eye on the other. (The cable must be of sufficient length to clear the widest aircraft landing gear.) The hook is anchored to an aircraft tiedown that has been marked for quick identification, and the cable is stretched across the deck in front of the shuttle spreader, with the eye end of the cable attached to a tractor.

6. Listed below are the procedures to follow when using the nose gear launch system and the launch bar fails to raise automatically after the shuttle has been maneuvered aft, or if the shuttle cannot be maneuvered aft.

a. Failure of the launch bar to raise automatically after the shuttle has been moved aft constitutes an emergency situation that requires personnel to go under the aircraft and manually raise the launch bar. The aircraft must be throttled back before personnel are allowed to go under it.

b. If the shuttle cannot be maneuvered aft after the untension signal, the nose gear launch deck edge operator shall press the buffer aft pushbutton to pull the aircraft and shuttle aft approximately 8 to 10 inches. This may not be possible with the aircraft turning up at military power, an emergency condition then exists that requires the aircraft to be throttled back to idle. After the aircraft is throttled back, the nose gear launch deck edge operator again pushes the buffer aft pushbutton, holding it until the shuttle and aircraft are pulled aft. When the buffer is fully aft, the pushbutton is released and the aircraft will move forward under its idle thrust. After the aircraft moves forward and the launch bar raises, move the catapult shuttle forward of the launch bar.

PERIODIC INSPECTIONS

Prior to conducting any 3-M prelaunch inspection or maintenance on catapult equipment (water brake, retraction engine space, etc.) where injury could occur due to inadvertent or careless operation, insure that the following safety requirements have been accomplished in the order indicated below:

1. Topside, control console, and retraction safety watches on stations.

2. Reduce steam pressure in the receivers to atmospheric. OPEN blowdown valve FULLY.

When conducting a postlaunch inspection, do the following:

1. Disconnect the grab from the shuttle and move it fully aft.

2. Secure the main steam supply to the steam receivers.

3. Reduce steam pressure in the receivers to atmospheric. OPEN blowdown valve FULLY.

4. Insure that the exhaust valve is in a fully OPEN position and that the catapult is in a safe condition by placing all the suspend switches in a SUSPEND position.

5. Suspend retraction engine and maintain retraction engine hydraulic pressure at 2,500 psi during water brake inspection.

6. Station a "safety man" at each of the following stations to prevent unauthorized operation of catapult controls and to keep all unauthorized personnel out of danger areas: control console, deck edge panel, retraction engine, and water brakes. These "safety men" must be qualified catapult crewmen, properly instructed in the safety procedures and hazards involved in catapult maintenance. They man sound-powered phones and maintain communications with all stations to insure proper coordination.

WARNING: Strict compliance with these safety requirements is mandatory. Only an extreme emergency will justify any deviation. In any event, if an inspection of the water brake tank area is required, the catapult is deactivated to preclude any possibility of injury to the inspecting personnel due to inadvertent movement of the machinery.

7. Open the retraction engine accumulator blowdown valve and reduce the hydraulic pressure in the main accumulator to ZERO psi. (Do not blow off air pressure in the main accumulator.)

8. Upon completion of water brake inspection, charge the retraction engine accumulator and shut the receiver blowdown valve and charge the receiver to applicable holding pressure.

Lubrication of the catapult is a great aid in the inspection of the catapult and its components. Almost all of the components of the catapult must be lubricated daily, or if they have oil cups, these must be checked daily because they must be kept full at all times. Make sure that the personnel making these checks are aware of the importance of their task. Many lives and countless millions of dollars have been saved because a hazardous condition or an imminent failure of a component has been observed by an alert person going about a routine task.

CHAPTER 5

CATAPULT DECK GEAR AND ACCESSORIES

This chapter deals with the deck gear and accessories that work hand in hand with catapults covered previously. This equipment includes the bridle arresters, blast deflectors, holdback and release units, flight deck cooling system, launching bridles and pendants, and the nose gear launch (NGL) equipment. Some types of each of the above equipments, the inspections that must be made, and some of the malfunctions that may arise are also covered.

As a senior ABE, it is your responsibility to make sure that all personnel are familiar with the operation of various types of deck gear and accessories, and also that safety precautions are established and followed.

Safety is not, in itself, accidental. Safety is the result of trained personnel knowing their jobs and doing those jobs to the very best of their ability. Attention to every detail, concern for every function, and awareness of the possibility of malfunction helps to nullify the probability of accidents due to improper operating procedures. Mechanical failure cannot be completely eliminated, but trained personnel can make sure a failure is a rarity.

BRIDLE ARRESTERS

The bridle arrester is designed for ease of operation; however, because of its association with the catapult, which requires a considerable expenditure of energy to produce high-speed, short-run launchings, there is a potential danger in its operation. (Hereafter, "bridle" means "bridle/pendant.")

The bridle arrester is used to halt the bridle and absorb the bridle energy after separation from the aircraft, thereby preventing bridle loss overboard. The bridle is brought to a safe and smooth stop on the deck without striking or damaging the aircraft or any of its external stores. After the bridle has been brought safely to rest, the arrester performs the additional function of returning the bridle to its approximate starting point.

TYPES

One type of bridle arrester in use today, but only aboard the U.S.S. Lexington, CVT-16 and U.S.S. Intrepid, CVS-11, is the Mark 1 Mod 0 (All American). This arrester was designed for use with steam catapults, but as aircraft increased in size and weight, the size and weight of the launching bridles and pendants increased accordingly, as well as the end speeds of the aircraft being launched, thus a better type of bridle arrester was needed. This brought about the design and manufacture of the Mark 2 and Mark 4 bridle arresters. These arresters were designed and manufactured by Van Zelm Associates, Inc., Baltimore, Maryland, and are commonly referred to as Van Zelm bridle arresters.

The bridle arresters currently in use aboard carriers in the fleet are the Mark 2 Mod 0, Mark 2 Mod 2, Mark 4 Mod 1, and the Mark 4 Mod 2. The Mark 2 Mod 2 and Mark 4 Mod 1 were designed for use with bow catapult installations, and the Mark 2 Mod 0 and Mark 4 Mod 2 were designed for use with waist catapult installations.

Both the Mark 2 and Mark 4 bridle arresters are discussed in detail in the ABE 3 & 2, Rate Training Manual. Coverage of the operation and maintenance of the Mark 2 is included in this chapter. Figure 5-1 shows the general arrangement of the Van Zelm bridle arrester.

PRINCIPLES OF OPERATION

The following paragraphs explain the mechanical, hydraulic, and electrical functions in the operating cycle.

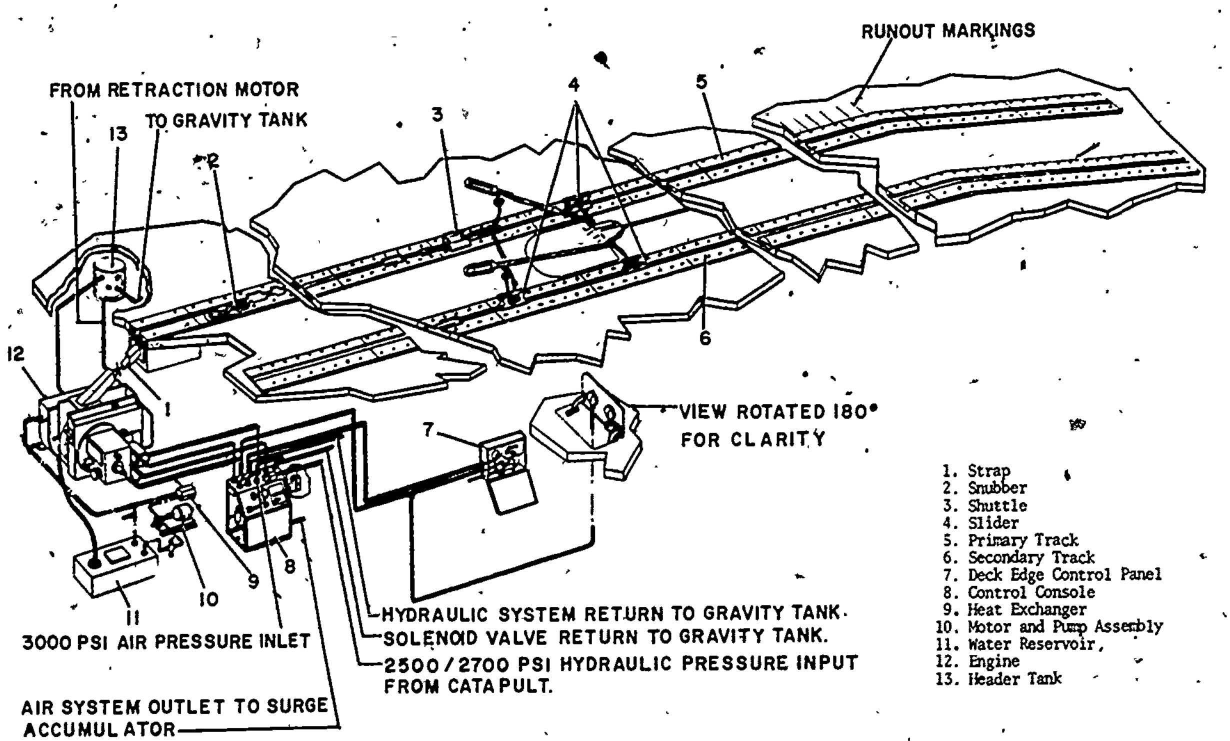


Figure 5-1.—General arrangement of a bridle arrester.

Tension

After the bridle or pendant is tensioned on the catapult, the arrester return pushbutton is depressed. (See fig. 5-2.) Fluid from the catapult retraction engine accumulator is directed to the cam reset clutch cylinder, releasing the clutch and allowing spring tension to set the brake cams. The limit switch closes, lighting the green CAM RESET light on the deck edge panel. Simultaneously, fluid is directed to the retract clutch cylinder and the pilot section of the retract three-way valve. The retract clutch engages and the three-way valve strokes, directing fluid to the hydraulic motor. The strap rewinds slowly, removing slack from the lanyards. The return pushbutton is released. The cam reset clutch engages; the three-way valve strokes, cutting off fluid flow to the hydraulic motor; and the retract clutch disengages. The arrester is tensioned and ready for the launch.

Braking (Secondary)

See figure 5-3. During the catapult power stroke, the strap unwinds, rotating the drum, brake dish, brake cams, and return cam. At 90 feet (110 feet for C-13-1 catapult) of power stroke, the secondary cam opens the secondary brake valve, directing low hydraulic pressure (90 psi) to the brake cylinders. This brake force puts a drag load on the strap, preventing unwrapping at the drum due to centrifugal force. The check valve in the primary brake line at the engine restricts the secondary pressure from backing up through the primary brake valve, which is open to gravity. The cam-reset limit switch opens, the CAM RESET indicator light goes out, and the CAM NOT RESET lights comes on.

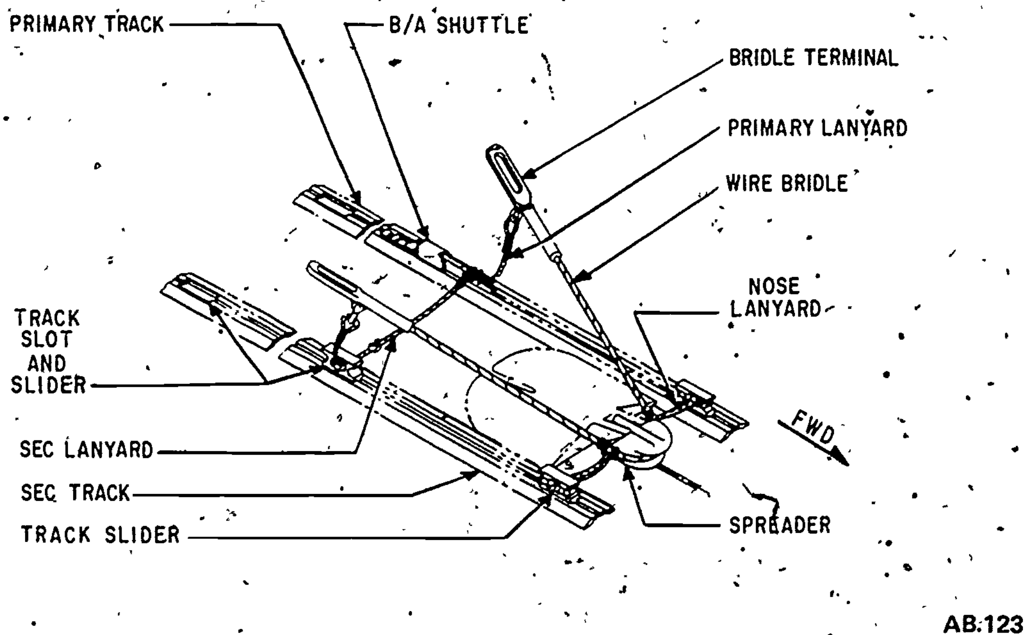


Figure 5-2.—Typical bridle hookup on Van Zelm bridle arrester.

Braking (Primary)

The primary cam opens the primary brake valve, directing the main braking pressure to the brake after power stroke travel as follows:

For C7 and C13 catapults . . . . 235 feet
For C11-1 catapults . . . . 195 feet

This pressure is prevented from backing up into the secondary system by the double check valves in the secondary line at the engine. After the bridle separates from the aircraft catapult hooks, it is smoothly arrested within 35 to 45 feet. Longer runouts are permissible on ships with longer runout areas.

Braking (Third Brake System)

Near the end of the required runout, the third brake cam (attached to the secondary cam) opens the third brake valve and directs hydraulic pressure (750 psi) to the brake cylinders. This pressure is applied after 288 feet of runout on class 59 and above aircraft carriers, and 241 feet on class 43 and below carriers.

Retraction

Hydraulic and electrical functions during the retract phase are the same as explained in the paragraph on tension.

Retract speed is controlled through the cam-operated deceleration valve. At the start of the return phase, the deceleration valve is wide open. During the return stroke the return cam rotates, closing the deceleration valve, gradually building up a back pressure in the hydraulic motor discharge line to retard the motor's rotation. Near the end of the return stroke, flow through the main spool of the deceleration valve is completely shut off. However, a small flow through the bypass section of the valve affords a slow return speed in the battery area. Prior to engaging the snubber (approximately 1 ft), the full aft limit switch opens, deenergizing a relay and lighting the FULL AFT POSITION blue light.

Low Energy Operation

Bridle arrestments during low-speed launches of aircraft would result in extremely short brake

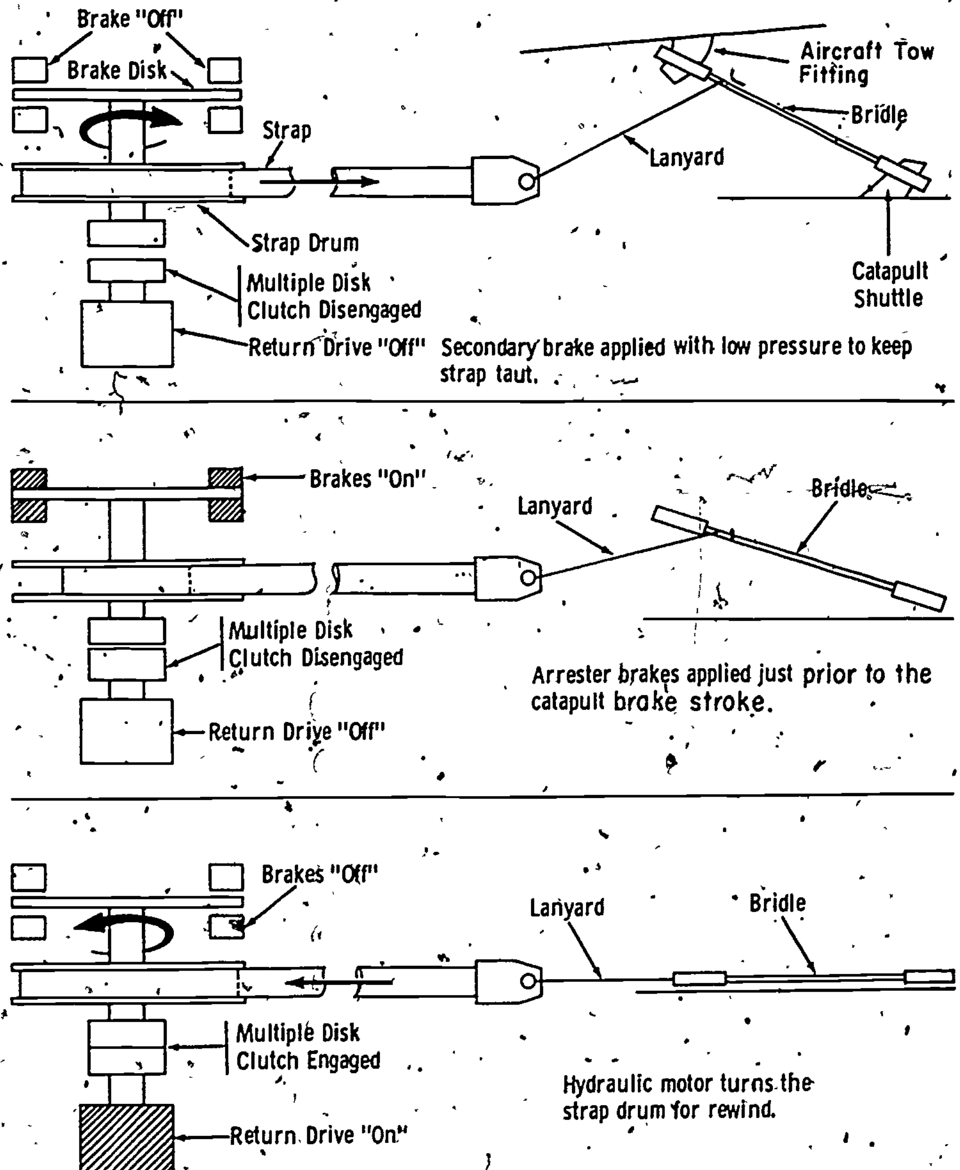


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Figure 5-3.—Operation sequence of Mark 2 bridle arrester.

runs with the full brake system effective. Therefore, when launching aircraft at low catapult end speeds (70 to 100 knots), provision is made to shut off half the brake system. Operational events remain the same except the brake pressure is applied to two instead of four brake pucks. This is accomplished by closing the LOW-ENERGY valve located under the engine.

Brake Cooling

See figure 5-4. When the bridle arrester power switch is turned on, the electric-motor-driven pump delivers fresh water to the cooling tubes mounted in the top and bottom sections of the brake enclosure. A continuous spray is emitted through holes in the cooling tube onto the brake disk. The expended water is returned to the 35-gallon fresh water tank. A separate salt water heat exchanger maintains an approximately constant temperature of the fresh water.

Emergency Operation

In the event the deck edge control station is damaged, it is possible to operate the bridle arrester from the main console below deck. This is accomplished by shifting the selector lever located on the main console from the deck edge to the console position, and the bridle arrester transfer switch from NORMAL to EMERGENCY. All phases of operation are the same as previously explained except that the primary brake pressure is adjusted, using the regulator on the main console, and retract is accomplished by using the pushbutton on the main console.

OPERATING INSTRUCTIONS

Prior to each day's operation, complete the PMS preoperational MRC. Insure that there are sufficient bridles and/or pendants available to satisfy the scheduled launch.

To hook up the aircraft:

1. Pull the arrester shuttle forward to the aft end of the deck tensioner cover. This position will yield sufficient lanyard slack to permit hookup of all types of aircraft.
2. Attach the bridle or pendant to the shuttle and sliders as shown in figure 5-2.

To tension the bridle arrester:

1. After the aircraft is tensioned on the catapult, and at the signal of the petty officer in charge of hookup, the bridle arrester deck edge operator depresses and holds the return pushbutton until all the lanyard slack is removed.

WARNING: Make sure the area is clear of personnel prior to giving the tension signal.

2. After the pushbutton is released, the shuttle will snap forward a very short distance and the trailing lanyards will relax. This is normal.

CAUTION: Do not launch with the return pushbutton depressed. This will result in late brake application with attendant loss of strap, possible damage to the retractor motor, and possible premature bridle/pendant release.

Setting Primary Brake Pressure

The catapult officer must determine the proper primary pressure depending on the type aircraft being launched and the catapult end speed. He will find this pressure in the tables furnished in the Catapult Deck Gear and Accessories Bulletin pertaining to the operation of the Mark 2 bridle arrester.

CAUTION: Excessive brake pressure will result in short brake runs and probable aircraft damage.

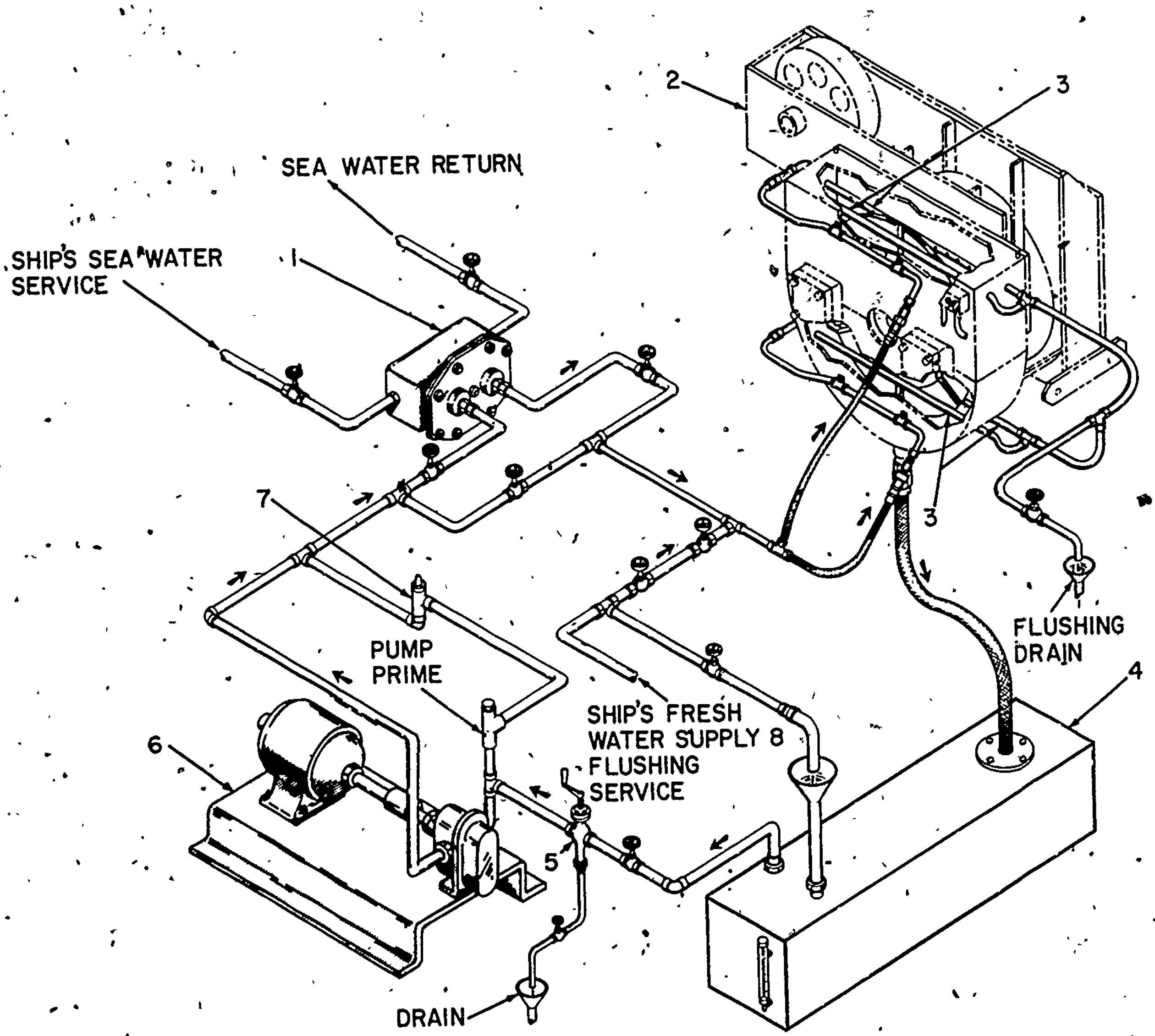
The bridle arrester operator sets the pressure at directed by the catapult officer.

NOTE: Minor deviations to the primary brake pressure settings are permissible to attain a minimum of 35 feet of total runout when using lighter weight bridles, or to complete the arrestment of heavier weight bridles in the space available on vessels in the CVA-43 class and below. However, any deviation in excess of 100 psi necessitates a thorough inspection of the equipment.

Ready for Launch

The arrester operator checks the pressure setting and the CAM RESET indication (green light on).

The operator signals the catapult officer that the arrester is ready for launch.



1. Cooler.
2. Engine.
3. Spray tubes.
4. Reservoir.
5. Drain valve.
6. Pump-motor set.
7. Relief valve.

AB.361

Figure 5-4.—Cooling system.

Retract (Bow Catapults)

After the arrestment is complete, the bow safety man notes the runout and positions the shuttle spreader cover.

The signal, CLEAR TO RETRACT, is given by the bow safety man.

The petty officer in charge of hookup, signals the arrester operator to retract the bridle.

WARNING: Make sure the track is clear before retracting.

The arrester operator depresses the RETURN pushbutton and holds it until the hookup petty officer gives the signal to stop.

NOTE: Stop the arrester shuttle at the aft end of the deck tensioner cover.

As soon as the bridle clears the catapult shuttle, the bow safety man removes the shuttle spreader cover and returns to the catwalk.

Retract (Waist Catapults)

Due to the physical arrangement of waist catapults, a different retract procedure is required, as follows:

1. After the arrestment is complete, note the brake run.
2. Retract the catapult shuttle.
3. Retract the bridle.

CAUTION: Prior to launching an aircraft from the opposite catapult (waist), make sure the bridle is clear on the other catapult. If not, the aircraft may be damaged by rolling over the bridle.

Low Energy Operation

Bridle arrestments during low-end-speed launches, and when operating with lightweight bridles/pendants, would result in extremely short brake runs if the full brake system were in operation. Therefore, for operation at low catapult end speeds, a remotely controlled high-low energy brake valve is installed on the bridle arrester engine, in the line that supplies hydraulic fluid to one set of the brake pucks. During normal operation, the valve is controlled by a toggle switch located at the deck edge control panel; during emergency operations, it is controlled by a toggle switch located on the main control console. Indicator lights are provided at each location to show the position of the valve. A red light indicates the valve is closed and in the low-energy position, a green light indicates the valve is open and in the high-energy position.

During operations, the high-low energy valve is normally in the open (high-energy) position. If use of the low-energy system is required, the procedure is as follows:

1. After retraction of the bridle arrester is completed, the bridle arrester operator closes the low energy valve.

CAUTION: If the LOW-ENERGY valve is closed prior to retraction, brake pressure will be trapped in one set of the brake cylinders and retract cannot be accomplished.

2. Prior to giving the READY TO LAUNCH signal, the arrester operator must inform the catapult officer of the valve status.
3. All other operational procedures are the same as for high-energy operation.

MAINTENANCE

Maintenance instructions for the bridle arrester delineated in this section are limited to general procedures that can be used as a basis for supervision by the senior ABE who is charged with the maintenance and operation of this equipment.

A maintenance program, to be effective, must encompass the following objectives:

1. Safe condition of the equipment before use.
2. Efficient operation to insure safety of personnel and maximum service life of the equipment.
3. Minimum downtime by adoption of correct and efficient repair procedures.
4. Thorough familiarization with the equipment to enable maintenance personnel to recognize abnormal operations or indications of malfunctioning.

Maintenance personnel should bring to the attention of the officer in charge all cases of malfunction, wear, looseness, leakage, damage, or any other irregular conditions pertaining to the equipment. They should also know the physical location of all operating parts, electrical supply lines, valves, switches, fuse boxes, tools, and spare parts.

Some of the general maintenance procedures and considerations are:

1. Keep equipment as clean as possible. Using a clean cloth, wipe down daily to remove excess grease, dirt, and oil. Remove rust and paint as often as necessary. Do not paint threads or finished surfaces.

NOTE: If threads or finished surfaces are painted in error, remove the paint by applying paint remover.

2. Check for loose or damaged bolts, nuts, screws, and lockwire. Tighten or replace as

necessary. Use correct tools of proper size at all times. Replacement bolts must be equal to or greater in strength than the original bolt, and all replacement parts should be greased to retard rusting.

3. Check frequently for hydraulic leaks. These are most likely to occur at joints, couplings, or around packings.

4. Inspect, clean, and oil all machined surfaces regularly.

5. Grease exposed surfaces of engine components when it is anticipated the equipment will be inactive for one week or longer. Wipe off excess grease when the equipment is reactivated.

6. Maintain a constant alert for any unusual sound or action of the equipment. Report any unusual condition to the catapult officer for investigation.

7. Check condition and quantity of spare parts against allowance list. Requisition anticipated needs as required.

8. Whenever components are cleaned with an alkaline solution, make sure that the residue is completely removed before reassembly. This is necessary to prevent formation of soapy products in the lubrication system and between close tolerance components. Use a jet of wet steam from a suitable nozzle for this purpose whenever possible. In all other instances, remove alkaline residue by repeated flushing and vigorous brushing with a mineral spirit solvent. Pay particular attention to crevices, holes, and cavities where such residue may accumulate. After parts have dried, look for surface film or powder indicative of incomplete removal of alkaline material. Any such indication necessitates recleaning with wet steam or solvent.

9. Finished surfaces of machined or plated parts should not be buffed or abraded with either wire brushes or abrasive cloth, or polished with any polishing compound for the purpose of removing discoloration or restoring smoothness. Exercise caution in handling or storing these parts in order to avoid scratching and/or denting; fatigue failures may begin at sections weakened by such local dimensional reduction.

Periodic inspection schedules should be considered as minimum preventive maintenance requirements and be performed in accordance with the MRC's provided each ship. These cards are located in each work center.

During launching operations, the following checks must be made:

1. Water level.
2. Secondary cam slippage.
3. Secondary brake pressure.
4. Fluid leaks.
5. Condition of bridles, lanyards, and shackles.

To clear the recovery area after the last launch on No. 3 catapult, the bridle arrester shuttle must be removed. To do so, proceed as follows:

1. Retract the arrester shuttle to the slotted section of the primary track.
2. Lift the shuttle out of the track and stow it in the catwalk.
3. Remove all sliders.

In the event the deck edge control station suffers a casualty, the bridle arrester control may be transferred below deck to the main console. To do so, proceed as follows:

1. Rotate the bridle arrester transfer switch (TSR) to the EMERGENCY position.
2. Shift the selector lever on the main console to the CONSOLE position.
3. Tension and retract are now accomplished by using the RETURN pushbutton on the main console.
4. Adjustment of the primary pressure is accomplished by adjusting the regulator (primary) on the main console.
5. All commands between the deck and the arrester control station (main console) must be delivered via sound-powered telephones.

NOTE: When bridle arrester operations are controlled below deck at the main control console, LOW-ENERGY operations are accomplished by closing the LOW-ENERGY valve, using the toggle switch on the main control console. In the event of electrical failure in the high-low energy valve system, the valve can be manually operated by use of the handle provided with each valve. Place the handle onto the spindle on top of the valve, depress the handle and spindle, and then turn the valve to the desired position, either open or closed.

Securing After Operations

Before this equipment is secured, reliability of its operation for subsequent use must be assured. The PMS postoperational MRC must be completed, all malfunctions must be corrected, and all needed repairs or adjustments made.

This equipment does not require continuous monitoring by personnel during the secured period.

The following procedure is used to secure the equipment for short shutdown periods:

1. Retract the shuttle to the FULL AFT position.
2. Reduce the primary pressure to ZERO.
3. Turn the electrical power OFF.
4. Close the main fluid supply valve.
5. Close and lock the deck edge console.

The following procedure is used to secure the equipment for extended shutdown periods.

1. Retract the shuttle to the FULL AFT position.
2. Close the main fluid supply valve.
3. Reduce all fluid and air pressures to ZERO.
4. Drain, clean, flush, and refill the water tank.
5. Flush the coolant discharge lines by using the flushing valve.
6. Turn the electrical power OFF.
7. Close and lock the deck edge console.

All personnel involved with launching operations must become thoroughly familiar with the following precautions:

1. Clear the deck of all unnecessary personnel when firing no-loads with bridles, and station a watch to insure continued compliance.
2. Avoid congestion at the deck edge control station.
3. Do not anticipate commands.
4. Execute readiness signals in deliberate and precise fashions.
5. Make sure all deck hardware is in good condition.
6. Check all fastners for security.
7. Do not depress the return button at the start of or during a launch.
8. Make sure the arrester is tensioned before launching.
9. The green CAM RESET light must be on prior to launching.
10. Do not cross the tracks while the bridle is retracting.
11. Avoid standing in the bight of the bridle at any time.
12. On waist catapults, make sure the bridle is clear on the opposite catapult before launching.
13. On waist catapults, remove the bridle arrester shuttle and slider from the number 3 catapult prior to recovery operations.
14. Make sure the primary pressure is set prior to the launch.

All personnel stationed below decks must become familiar with the following precautions:

1. All personnel stand clear of the arrester engine while it is operating.
2. Make sure the brake system is thoroughly vented and wedges are removed.
3. Make periodic checks of the water level and secondary brake pressure during operations.
4. Check for cam slippage during extended launching periods.
5. Change the position of the LOW-ENERGY valve only when directed by the catapult deck edge operator. ACKNOWLEDGE all changes.
6. Report all equipment discrepancies, such as fluid leaks, loose components, unusual noises, etc., without delay.
7. Do not permit grease or oil to get on the brake disk or pucks.
8. Use only fresh water in the cooling system reservoir.

Prior to the first launch of the day's operation, all preoperational checks on the bridle arrester must be completed and so indicated on the weekly PMS schedule located in each work center.

~~There is~~ also an operation check to be made of the bridle arrester. During no-load firing:

1. Use an inverted A-4 bridle.
2. Set the primary brake pressure in accordance with the applicable catapult deck gear and accessories service bulletin.
3. Fire two shots at catapult end speeds of 110 to 120 knots.
4. Check for average brake runs of 35 to 45 feet.

At the completion of each day's operation the following checks must be made:

1. Check the strap for wear, kinks, and nicks.
2. Inspect the shuttle for damage, excessive wear to shoes, pins, springs, and cover.
3. Inspect the snubber for security.
4. Inspect the bridle impact area for loose track, holddown screws, and damage. Pull the track slot gage through the impact area.

5. Check the engine for loose bolts, nuts, and fluid leaks.
6. Main supply valve CLOSED.
7. Valve in the pilot line to the three-way valve CLOSED.
8. Reduce the primary pressure to Zero the deck edge).

Replacing the Brake Pucks

The 4-inch brake pucks are replaced between 600 and 700 shots regardless of the amount of wear. To replace the brake pucks the following steps are taken. (See figs. 5-5 and 5-6.)

1. Remove the brake and disk lower cover by disconnecting the water hoses and removing the attaching thumbscrews.
2. Open the vent valves.
3. Using a pry (fig. 5-6 (A)), move the brake piston back against the cylinder cap, then remove the brake puck as in (B) of the figure.
4. Install the new brake puck.

CAUTION: Insure that grease or hydraulic fluid does not get on the brake puck or disk while installing new pucks, and also that the brake cylinders are vented of all air prior to operating the equipment.

5. Close the vent valves and pressurize the system.
6. Reinstall the brake and disk lower cover and the water hoses.

JET BLAST DEFLECTORS

There are various types of jet blast deflectors (JBD's) in use. For identification of the different configurations, a model number has been assigned to the various JBD's used in the fleet and those planned for future installation in the fleet. The model number for JBD's consists of a Mark and Mod number, such as Mark 1 Mod 0, Mark 1 Mod 1, Mark 3 Mod 0, Mark 3 Mod 1, etc. The most common type of JBD in use is the multipaneled, water-cooled type. Until recently, the power source for JBD operation was separate from the catapult system. Although some of the existing JBD installations still have a separate power source, recent service changes have (or will in the near future) modified most of the configurations to utilize the main hydraulic system of the catapult. The configurations utilizing a power source other than the catapult's main hydraulic system can be operated by either an electric motor or a separate hydraulic system.

The Mark 3 Mod 0 and Mark 3 Mod 1 JBD's are of the multipaneled, water-cooled type. The difference between the Mark 3 Mod 0 and the Mark 3 Mod 1 is the power source—the Mod 0 has a separate hydraulic system, and the Mod 1 utilizes the catapult's main hydraulic system.

This chapter deals only with the Mark 3 Mod 1 installed aboard the carriers CVT-16, CVA-34, and CVA-43. The Mark 6 Mod 1 installed aboard the carriers CVA-42, CVA-59, CVA-61 through CVA-66 is covered in ABE 3 & 2, NavTra 10302-C. A listing of JBD's by model number and applicable NAVAIR handbooks for each model can be found in JBD service bulletin No. 1, revision B.

DESCRIPTION AND OPERATION

This section contains a detailed physical description of the JBD panels and a detailed functional description of the mechanical linkage and the operating systems, including the hydraulic and the water systems.

All JBD panels are of unit construction. The panel structure consists of a network of cross-stiffeners welded to an extruded aluminum panel. On all water cooled panels of JBD's 1, 2, and 3, the extruded sections are mitered to provide an intake, internal flow, and outlet for circulating water. The water enters and leaves the panel through transition pieces that are welded to the panel.

The mechanical linkage is hydraulically actuated to raise and lower a deflector panel. (See fig. 5-7.) Each panel has a hydraulic cylinder, clevis, and driving arm. The small JBD 1 outboard panel has two lower and two upper actuating arms, whereas all other panels have four each. The driving arm and lower actuating arms are welded to a trunnion shaft which turns in four trunnion bearings.

Raising and Lowering Panels

To raise a panel, hydraulic pressure is applied to the hydraulic cylinder whose piston actuates

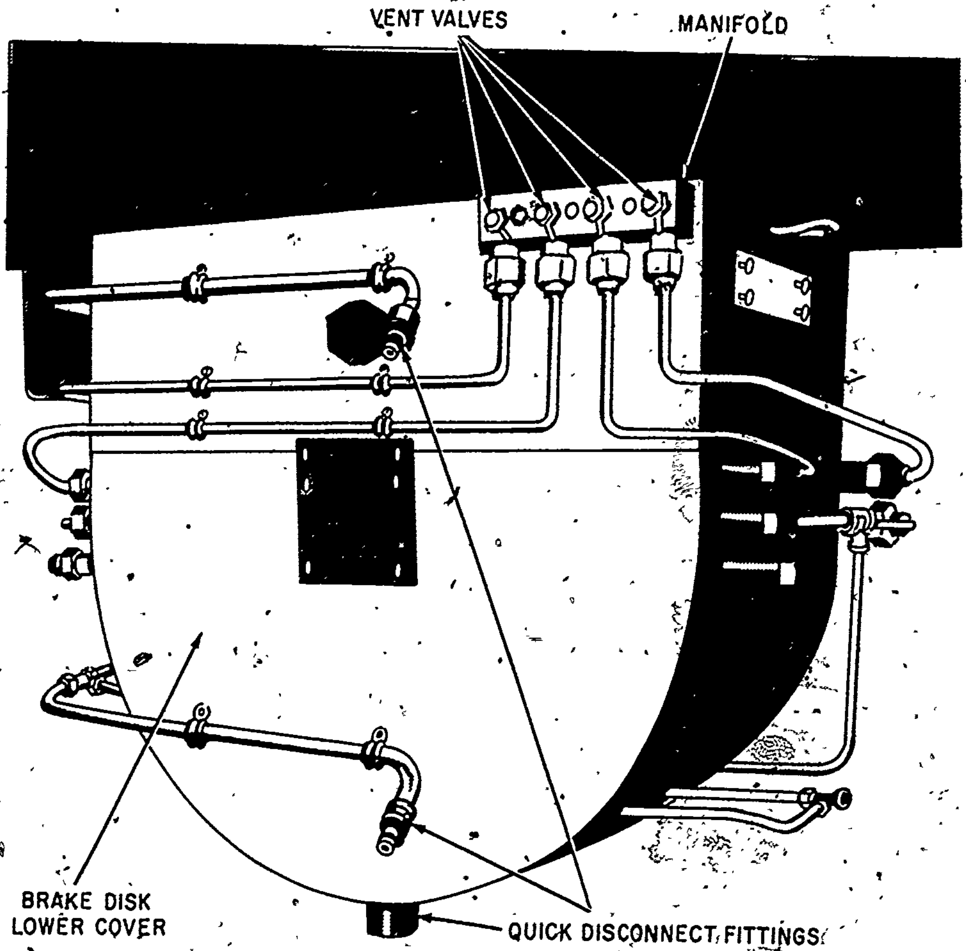


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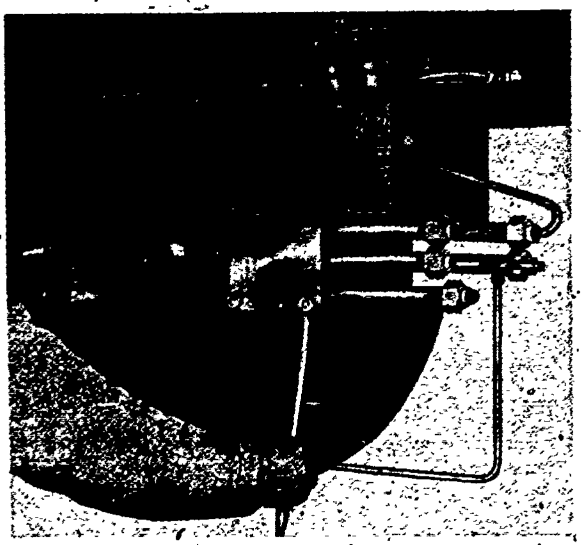
Figure 5-5.—Bridle arrester engine, brake side.

the driving arm which turns the trunnion shaft. As a result, the lower and upper actuating arms are extended, as shown in the lower portion of figure 5-7, to raise the panel through a 60-degree angle (55 degrees for all inboard and outboard panels on CVA-34 and CVT-16, and only the JBD 3 inboard and outboard panels on CVA-43). The actuating arms travel slightly beyond an inline position, thereby locking the panel in an overcenter position. The lower arms contact positive stops in this position.

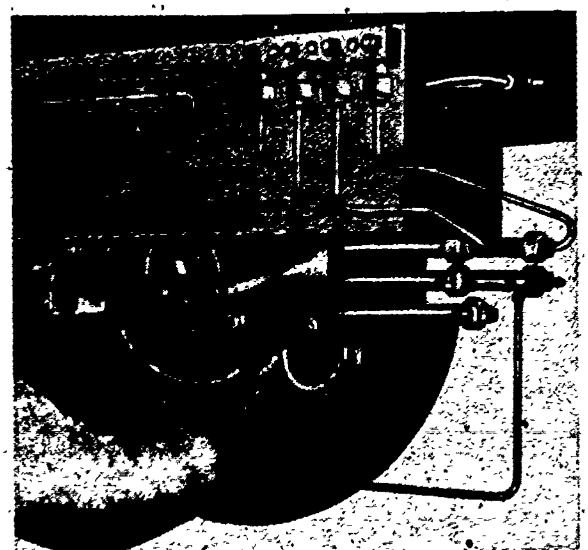
To lower a panel, hydraulic pressure is applied to the opposite end of the hydraulic cylinder. This reverses the direction of motion of the piston and the mechanical linkage, and causes the panel to lower to its normal position flush with the deck.

For maintenance purposes, auxiliary supports should be fabricated to hold the panel in the raised position.

A chain fall is required in order to release the arms and links from the mechanical stop posi-



(A)



(B)

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Figure 5-6.—Removal of brake puck.

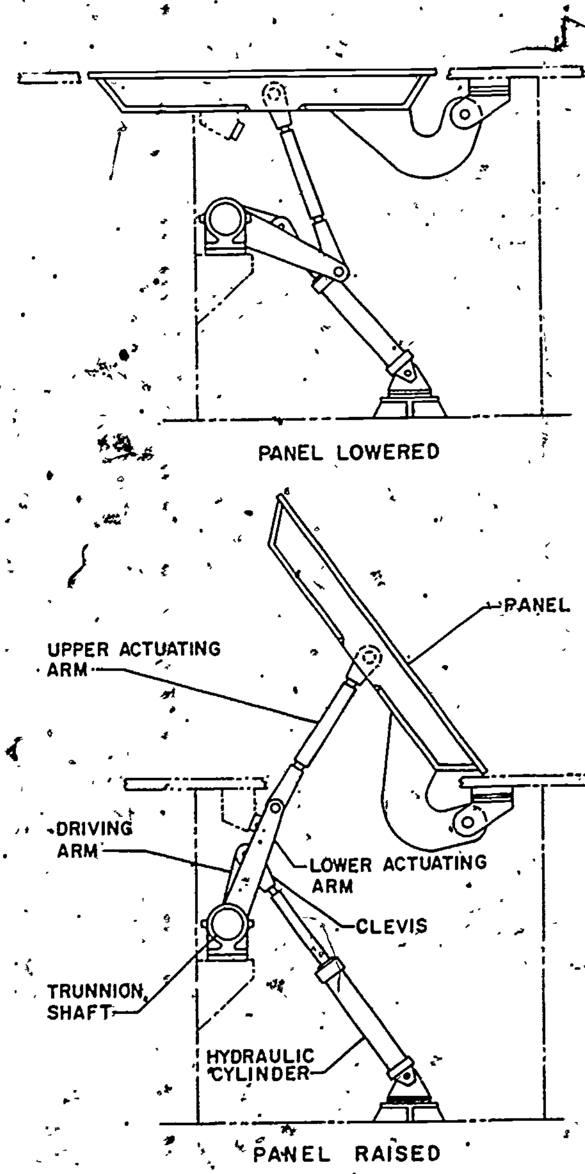

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Figure 5-7.—Mechanical linkage.

tion when lowering the panel by manual means (fig. 5-8).

Hydraulic System

Each jet blast deflector has a hydraulic system which is an extension of the associated catapult hydraulic system. In the following paragraphs, a basic JBD hydraulic system is described in detail.

Figure 5-9 (C) shows several components of the catapult hydraulic system, and those items of the JBD system that lead to the 4-way valve. This valve, which has three possible settings, is shown in the NEUTRAL position. Pressurized fluid from the catapult pumps is applied through

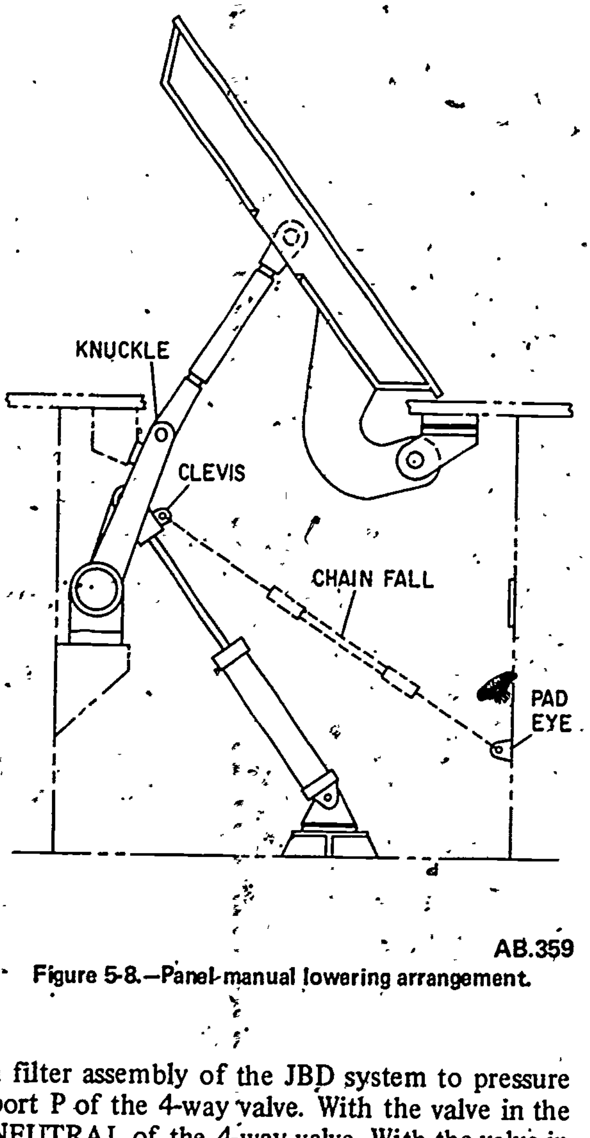


Figure 5-8.—Panel-manual lowering arrangement.

a filter assembly of the JBD system to pressure port P of the 4-way valve. With the valve in the NEUTRAL of the 4-way valve. With the valve in the NEUTRAL position, the fluid path terminates at the valve. The return line from port T of the valve goes to the catapult gravity tank. The filter assembly is equipped with a bypass valve which can be positioned manually to bypass the filter element in the event that it becomes clogged.

Figure 5-9 (A) shows the 4-way valve in the UP position and the resultant fluid flow to and from the hydraulic cylinder. Fluid passes through the valve from port P to port A, and through an orifice which limits the rate of flow. The fluid is applied to port A of the cylinder by way of an isolation valve. Fluid pressure forces the piston forward and raises the JBD panel. Fluid ahead of the piston flows from port B of the cylinder to port B of the 4-way valve and returns through the valve by way of port T to the gravity tank. The rate of ascent is controlled by the size of the orifice in the orifice union. As the panel approaches its upper limit, the rate of ascent is slowed by hydraulic cushioning brought about by hydraulic cylinder design. This cushioning is necessary to prevent damage to the mechanical linkage as the lower actuating arms contact the positive stops in the over-center position.

Figure 5-9 (B) shows the 4-way valve in the DOWN position and the reversal of fluid flow in the cylinder lines. Fluid now passes through the valve from port P to port B and is applied to port B of the cylinder. The piston is forced back and the JBD panel is lowered. Fluid leaves port A of the cylinder and passes through the orifice and the 4-way valve, by way of ports A and T, to the catapult gravity tank. The rate of descent of the panel is determined by the size of the orifice in the orifice union. As the panel approaches the deck, its descent is slowed to prevent it from slamming into the deck; this is accomplished through the design of the hydraulic cylinder.

Piping diagrams of JBD hydraulic systems are shown in figure 5-10. Those in (A) of the figure have identical hydraulic systems. Note that the system in figure 5-10 (A) is similar to the basic system just described in figure 5-9, but has additional 4-way valves and cylinders to operate the two additional JBD panels. The diagram in (B) of figure 5-10 also shows three 4-way valves, but their orientation is different from those shown in (A). Note that the UP and DOWN positions are reversed and that the A and B lines are likewise reversed at the valve. These are physical differences that permit the UP position to be in the forward direction at all control stations on these two vessels. Functionally, there is no difference since the flow is still from port P to port A to raise the panel, and from port P to port B to lower the panel. Thus, the 4-way valves on CVA-43 are oriented to permit raising and lowering with the control valve handle in the same position relative to the JBD operator.

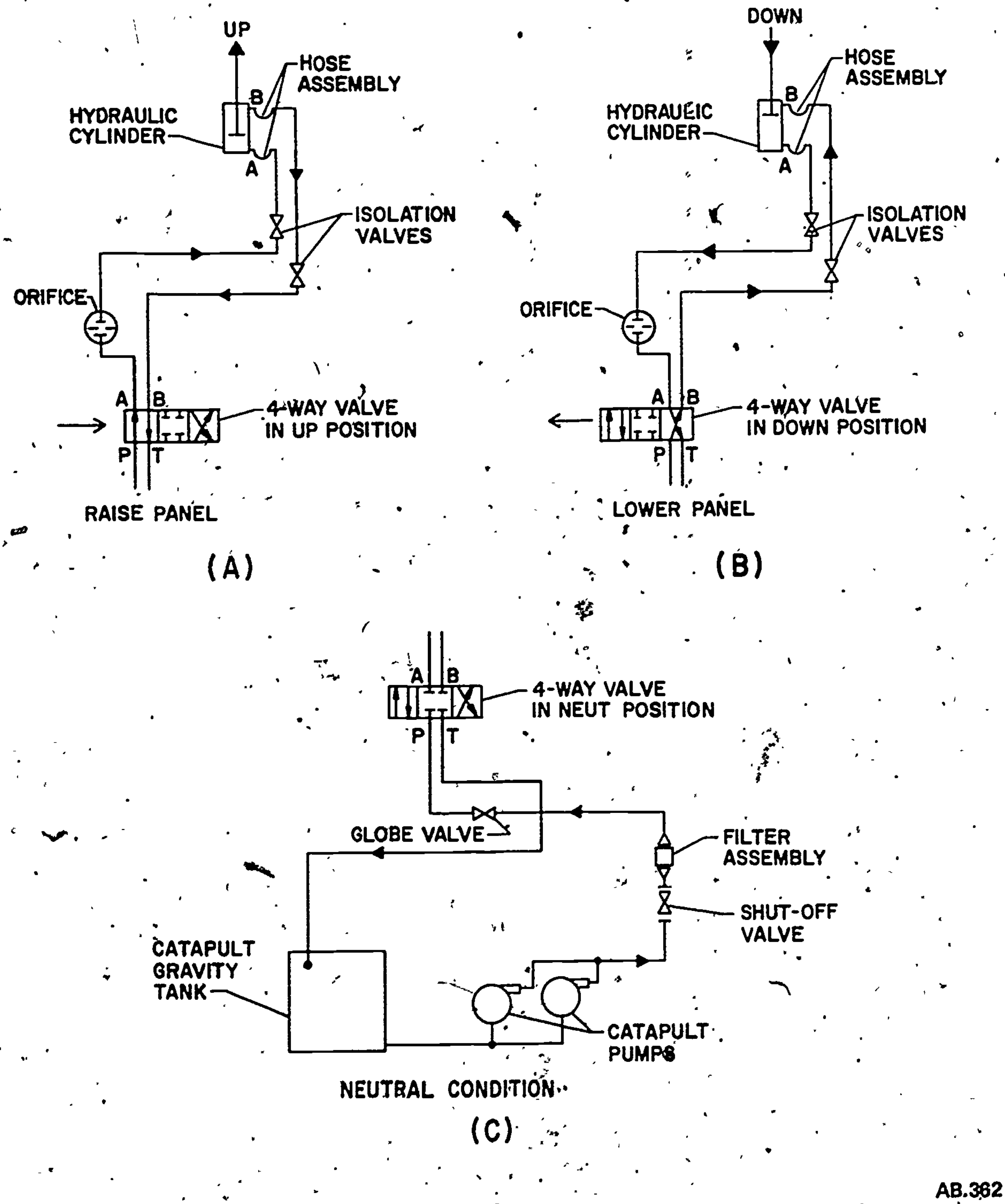
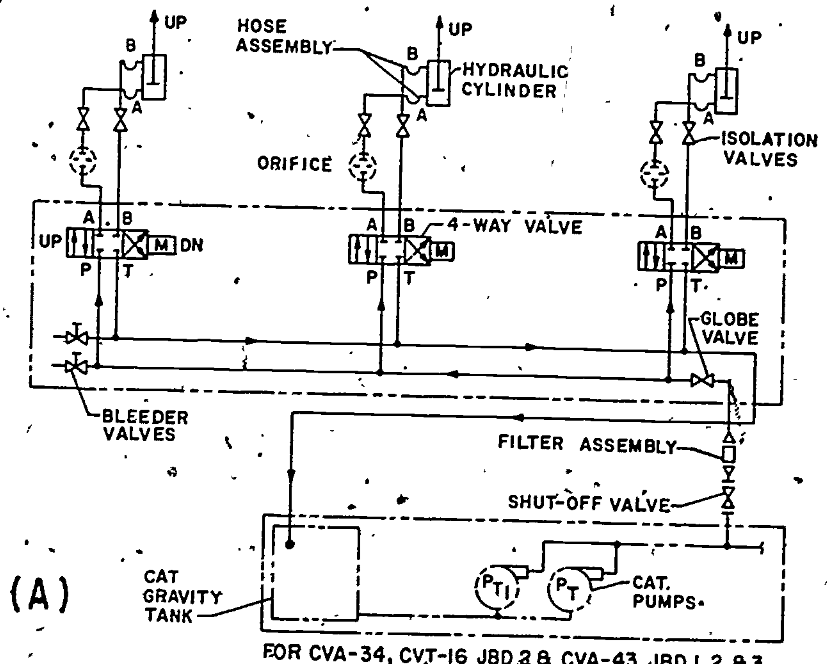


Figure 5-9.—Basic hydraulic schematic diagram.



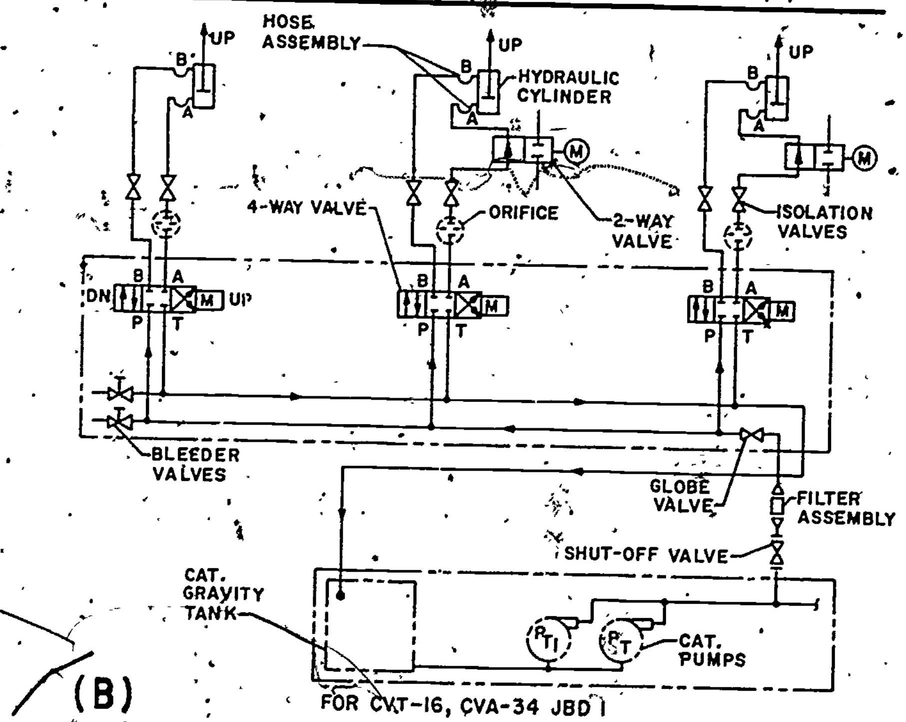


Figure 5-10.—System hydraulic schematic diagram.

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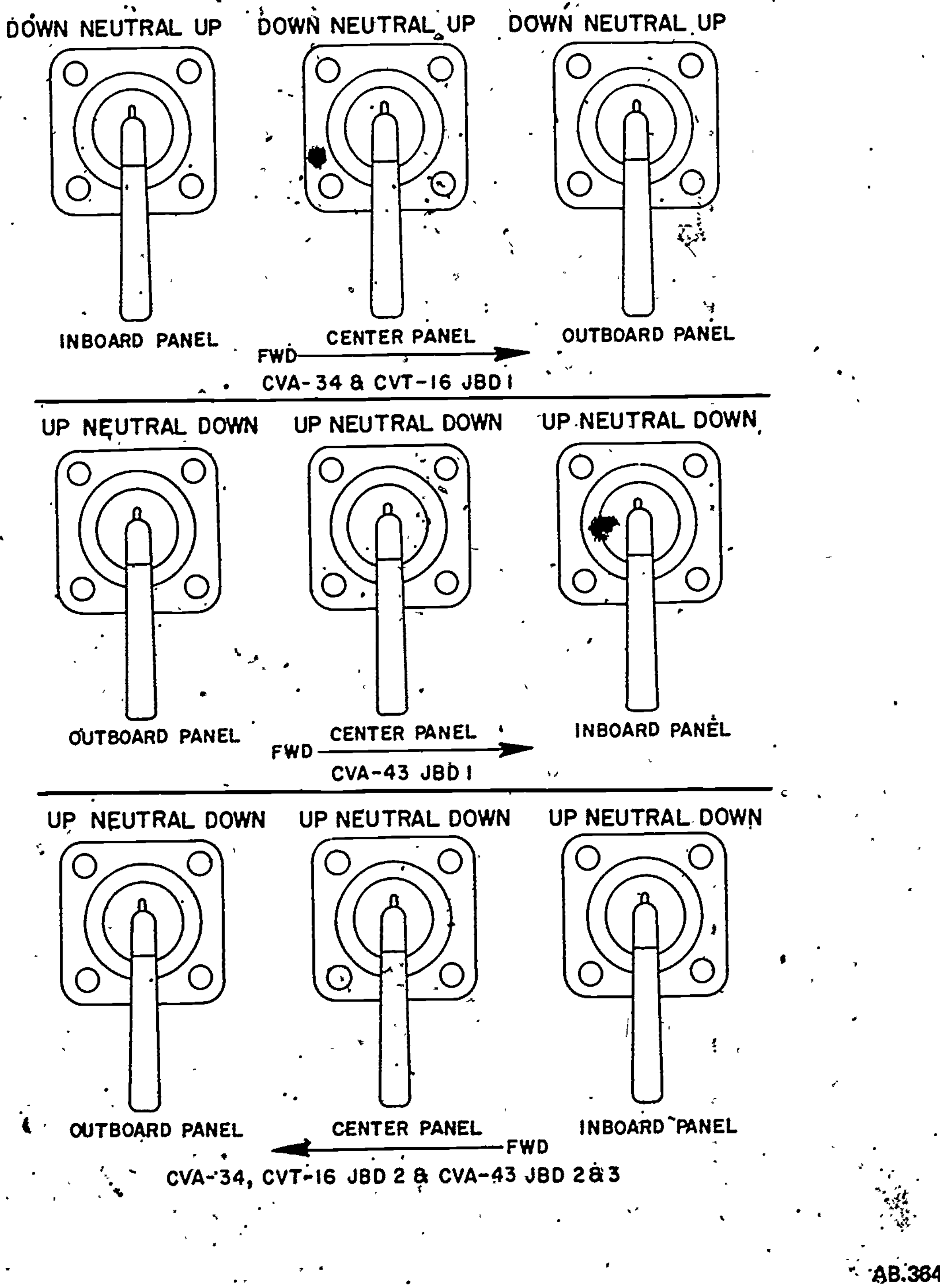


Figure 5-11.—JBD operating controls.

Each JBD catapult hydraulic system ties into its associated catapult hydraulic system.

The operating controls for all JBD's are located at the deck edge control stations. Each JBD panel is separately controlled by means of a 4-way, 3-position valve. These valves are grouped together as shown in figure 5-11. The valves are arranged so that the outboard control and UP position are forward, except for JBD 1 on CVA-43 where they are aft.

CAUTION: During launching operations, be sure the tail of the aircraft is clear of the panel's travel arc before raising the panel.

Should a leak occur in the JBD portion of the hydraulic system, this portion can be isolated from the catapult system by closing the shutoff valve on the high pressure side of the JBD filter assembly.

In the event of failure of the catapult hydraulic system or the JBD portion of the system, the JBD panels can be lowered manually. If the 4-way valve is operative, select the DOWN position. Attach a chain fall to the clevis and to a pad eye on the bulkhead as shown in figure 5-8, and then pull the actuating arms past dead center with the chain fall. The chain fall only breaks the knuckle. It has no control over panel lowering; the panel's own weight will lower it to the deck.

If the 4-way valve cannot be moved to the DOWN position, or if fluid cannot flow through the 4-way valve, close the isolation valves to the affected hydraulic cylinder and bleed fluid at the cylinder by using the cylinder's vent valve or by disconnecting the cylinder's hydraulic hose. After venting the cylinder, proceed with the chain fall as described above.

WARNING: To avoid injury to personnel preparing to lower the panel manually, the panel must be held in the up position by supports until actual lowering is commenced.

JBD Cooling System

The center panels of all JBD's, as well as the inboard panel of JBD 1 and 2 on CVT-16, are provided with a circulating water system to remove heat that is generated by the jet exhaust. The panel inlet and outlet water lines are flexible hoses which interface with piping from individual salt water cooling stations. These cooling stations supply water from the ship's firemain to the respective JBD panels. These stations are equipped with a pressure regulator and hytrol valve to regulate and control the water to the panels. A pilot valve is located at each JBD deck edge control station to control cooling water to that JBD's water cooled panel.

CAUTION: All water-cooled panels can be damaged by excessive heat from jet engine exhaust if cooling water is not flowing into the panel under full pressure of 40 psi. Water leaving the panels is forced through a small orifice, which retains a solid head of water in the panels.

JBD 1 on CVA-34 and CVT-16 is equipped with an electrical interlock. This prevents raising the center and outboard panels while the bomb elevator, immediately aft of these panels, is in the down position. This is accomplished by limit switches which are tied into a motor-operated-bomb-elevator-interlock valve. The electrical system is under the cognizance of the Naval Sea Systems Command.

MAINTENANCE

Maintenance procedures for JBD's are covered in ABE 3 & 2, NavTra 10302-C. All maintenance on the JBD's is performed in accordance with applicable Maintenance Requirements Cards.

SAFETY PRECAUTIONS

As mentioned at the beginning of this chapter, safety is a prime concern of the senior ABE. Safety is the result of trained personnel knowing and performing their duties well with attention to detail, concern for every function, and awareness of the possibility of malfunction. Safety precautions must be observed by all operating, maintenance, and deck personnel, and any other persons located in the area of related catapult equipment. Copies of safety precautions are normally posted in conspicuous locations to enable all personnel to become thoroughly familiar with them.

FLIGHT DECK COOLING SYSTEM

Flight deck cooling panels are installed on all operating carriers. They are for the protection of the flight deck from the high temperature exhaust gases of jet aircraft that are launched in after-burner and/or in a nose-high attitude.

The panel is mounted flush with the deck in a location between the catapult track and the jet blast deflector. It is made of aluminum or steel channel welded together so that sea water is circulated evenly through the panel to carry away the heat. Cooling water is supplied to the panels from the ship's firemain.

The sea water supply to each cooling panel passes through a cutout valve (1, fig. 5-12), a reducing valve (2), and a remotely operated spring-loaded hytrol valve (6). A bypass with a manually operated throttling valve (3) is fitted around the reducing valve (2). A relief valve (4) and a test gage (5) are fitted in a reducing valve discharge line. Remote operation of the hytrol valve (6) is from a point near the catapult console. For remote operation, a manually controlled pilot valve (7) is used. When the pilot valve is turned to the ON position, water at firemain pressure enters under the hytrol valve diaphragm, opening the valve and allowing water to enter the cooling panel. When the pilot valve is turned to the OFF position, the water is drained from under the diaphragm, closing the valve. After the hytrol has closed, the pilot valve is turned to the NEUTRAL position.

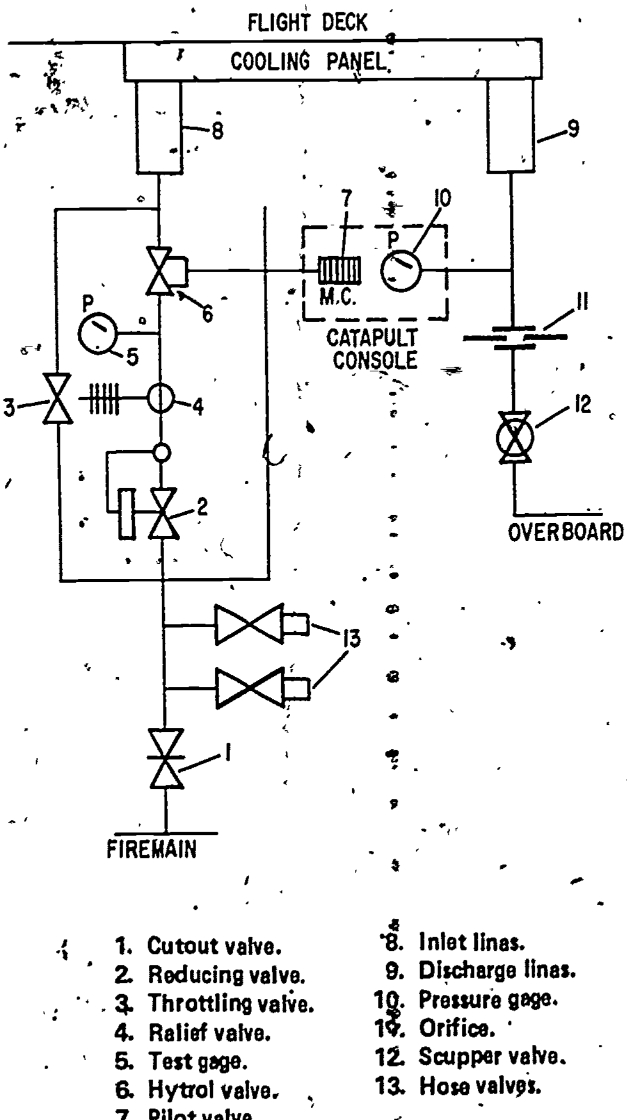
When the reducing valve is inoperative, it is necessary to throttle the supply to the cooling panels by using the manually operated throttling valve. When this valve is used, the cooling water no longer passes through the hytrol valve, and the remote control system is not in effect.

Downstream of the hytrol valve, the line branches into two lines (8) to enter the cooling panel. Two discharge lines (9) from the panel combine into one discharge line. This line contains a pressure gage connection and an orifice.

The pressure gage (10) is mounted near the catapult console. The orifice (11) is installed to hold a back pressure on the panel as an aid in the control of the water flow through the panel. The discharge line from the panel discharges overboard near the ship's waterline through a remote control scupper valve (12) installed in the discharge line near the shell of the ship. The scupper valve's controls are located on the deck above for convenience of operation.

NOTE: The supply of cooling water should be checked before and during operation of jet aircraft by observing the pressure gage at the catapult console.

The catapult personnel should check for proper operation and cleanliness of the flight deck cooling system. At times it may be necessary to make adjustments or minor repairs to the system. When making repairs or adjustments to any of the valves, refer to the manufacturer's instruction book for the proper procedures.



1. Cutout valve.
2. Reducing valve.
3. Throttling valve.
4. Relief valve.
5. Test gage.
6. Hytrol valve.
7. Pilot valve.
8. Inlet lines.
9. Discharge lines.
10. Pressure gage.
11. Orifice.
12. Scupper valve.
13. Hose valves.

AB.207

Figure 5-12.—Typical piping schematic for deck cooling panel.

In an emergency, cooling water may be supplied to the panel through two 2 1/2-inch hose valves (13). Firehose may be used from a nearby fireplug.

CAUTION: To prevent a pressure buildup in the panel when operating aircraft from the catapult without the use of the panel, insure that the scupper valve is open to provide a vent.

LAUNCHING BRIDLES AND PENDANTS

An ideal situation when launching aircraft from the flight deck of a carrier would be for all aircraft to have nose gear launch capability. This is not the case, however, and many aircraft utilize a bridle or a pendant as a means of transmitting the force of the catapult shuttle to the aircraft.

As a senior ABE assigned to a catapult crew, it is your responsibility to insure that the bridle/pendant hookup procedures for each individual type aircraft are strictly adhered to.

One of the greatest hazards in catapulting aircraft is premature bridle/pendant shedding. As an ABE, you must always be alert and aware of the importance of proper hookup of an aircraft. Some of the factors that may occur singly or in combination to cause premature bridle/pendant shedding are:

1. Mispositioning on the aircraft's catapult hook by the hookup crew.
2. Mispositioning caused by relative motion between the terminal and the aircraft's catapult hook after catapult tension has been applied.
3. Bridle mispositioning because of bridle twist.
4. Tension bar mispositioning.
5. Aircraft brakes being applied during tensioning.

Tests of aircraft hooks indicate that, to some extent, all hooks are subject to bridle mispositioning. Therefore, continuous emphasis in proper bridle hookup and rigorous inspection after aircraft tensioning are considered the only practical solutions to the mispositioning problem.

When catapulting aircraft, always refer to the applicable catapult deck gear and accessories service bulletin. The bulletin includes such information as the type bridle or pendant to be used and any added precautions that must be taken with a certain type aircraft.

A maintenance requirements card is provided for all launching accessories and gives such information as inspection and replacement criteria, and stock number and length of lanyards used with each bridle or pendant.

HOLDBACK AND RELEASE UNITS

The holdback and release units provide a means of holding an aircraft in position on the catapult until the catapult is fired. A holdback and release unit is provided for each type of aircraft being launched. Each unit is designed for a particular type aircraft and cannot be used with another type. Holdback units are made up of either chain links, cable, or metal straps. All holdback units are equipped with a deck cleat link at one end and a tension bar retainer assembly at the opposite end. The deck cleat link is fitted into a slot (designated for that particular type aircraft) in the holdback deck cleat that is located in the flight deck immediately aft of the catapult track and forward of the deck cooling panel. The tension bar retainer end of the holdback unit is connected to the aircraft tension bar fitting by means of a tension bar that is also designed and manufactured for a particular aircraft. The tension bars are designed for a particular holdback unit, and color coded to prevent using the wrong bar. Each tension bar is designed to break at a predetermined strain. The breaking point at which the tension bar is designed to break is stamped on one end of the bar.

For instructions in the proper use of aircraft holdback units, refer to the applicable catapult deck gear and accessories service bulletins. Maintenance Requirements Cards are also provided for each unit.

NOSE GEAR LAUNCH SYSTEM

There are two types of nose gear launch equipment, the Mark 1 and the Mark 2. The Mark 1 is the more widely used at the present time. The Mark 2 (flush deck type) is installed aboard the U.S.S. Nimitz, CVAN-68, and will be installed on all new constructions. The Mark 1 being the more prominent of the two nose gear launch units, is chosen for discussion in this chapter.

Some of the advantages of the nose gear launch (NGL) equipment over the conventional bridle/pendant hookups are better and faster alinement of aircraft on the catapult, and elimination of the chance of bridle shedding and the need for a bridle arrester. (See fig. 5-13.)

The Mark 1 NGL equipment is designed to assist in launching aircraft by attaching the nosewheel strut to the towing mechanism of the catapult. This means of launching aircraft permits positive and automatic engagement of aircraft to catapult, thereby eliminating the need for personnel in close proximity to the aircraft during engagement, thus enhancing the safety factor. Also, this means of launching aircraft provides smooth and rapid operation.

The Mark 1 NGL equipment is suitable for use with existing steam-operated catapult systems and features minimum maintenance requirements. It can be quickly and easily interchanged with conventional launching systems supplied as original equipment. The major components of the Mark 1 equipment are the launching hardware assembly (deck ramp), control system (control panels, transfer switch, valve box assembly), approach ramps, shuttle spreader, and ramp.

All personnel involved in the operation, maintenance and overhaul of nose gear launch equipment are responsible for attaining a thorough knowledge of its operation and upkeep. This may be accomplished by careful study of applicable technical manuals, engineering drawings, service changes and bulletins, and through gaining actual experience by undergoing intensive drills, to become acquainted with both the physical and functional aspects of the equipment.

The catapult officer is charged with the responsibility for overall operations. He supervises, with the assistance of the senior ABE, the training of personnel and ascertains that training is conducted in a manner that results in complete familiarization with equipment operation and maintenance. He insures readiness of the equipment by assuming responsibility for conducting frequent tests and inspections of launching hardware, controls, and their associated components. He supervises repair and maintenance functions. In addition to assuring that the equipment is maintained in operating condition, he is responsible for detailed procedures such as routine inspections, lubrications, and adjustments.

All vessels which operate NGL equipment keep a log in which is recorded all data regarding equipment operation, repairs, and overhaul. This log need not be submitted to Naval Air Systems Command Headquarters, but is maintained as a record from which information may be supplied when requested. Any unusual conditions observed during equipment operation, maintenance, or overhaul may, at the discretion of the catapult officer, be made the subject of a special report to Naval Air Systems Command.

On carriers with NGL equipment installed, the deck configuration in the catapult area is such that it is a routine matter to make the change from conventional bridle or pendant launching to nose wheel launching.

When installing NGL equipment on steam catapults, it is necessary to remove the conventional ramp, ramp pin, spreader pin and spreader. After the bridle/pendant components are removed, reinstall the NGL shuttle ramp and spreader. The shuttle ramp and spreader are installed as a unit.

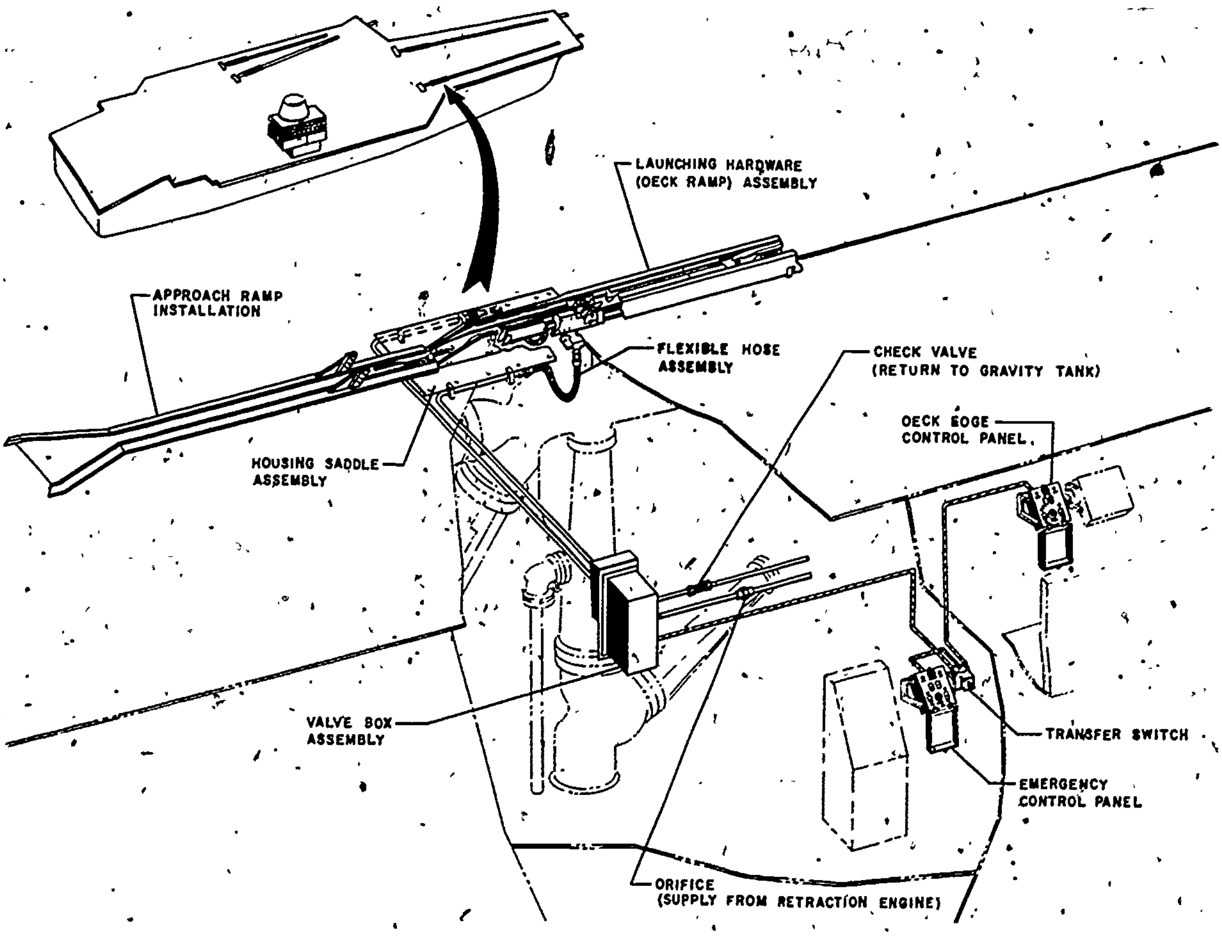
Retraction of the shuttle into the deck ramp with the conventional spreader and/or launch ramp will damage the NGL equipment; thus, prior to installation of the deck ramp, the catapult shuttle must be checked to ascertain if the correct spreader and ramp combination have been installed.

NOTE. Conditions may exist where the shuttle has been replaced during an overhaul and not adapted to receive the components for NGL operations; therefore, upon installation of the shuttle spreader and ramp for NGL operations, a check of the shuttle blade must be made for proper pin bore diameter.

The deck ramp should be installed utilizing the special lifting tool (fig. 5-14). This tool is designed for carrying, installing, or removing the ramp assembly.

Procedures for installation of the deck ramp are: (See fig. 5-15.)

1. Prepare the deck to receive the deck ramp by first removing the deck flushing cover



AB.375

Figure 5-13.—Nose gear launch, general arrangement.

Rotate the saddle locks counterclockwise (with special tool) and remove the deck flushing cover.

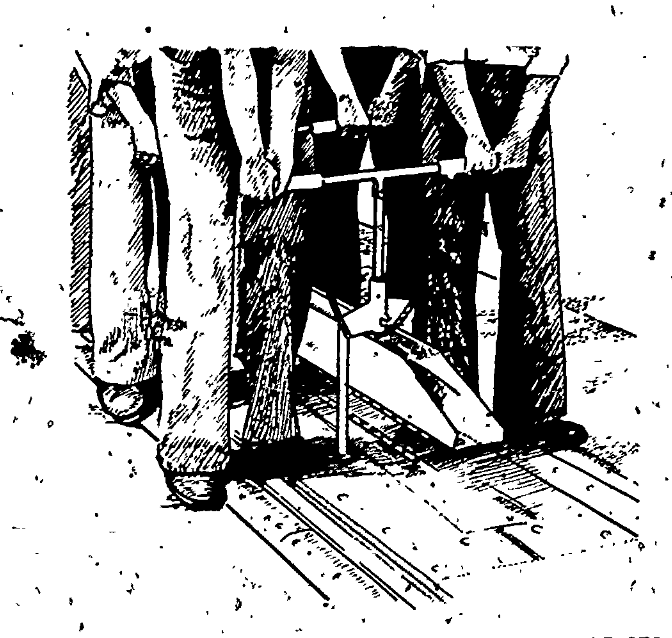
2. Remove the deck ramp from the stowage box with lifting tools installed. Move the deck ramp into position over the housing saddle. Wipe clean the mating surfaces of the housing saddle and the hydraulic manifold. Insure that all moving parts are free of dirt and foreign matter.

3. Lubricate the housing saddle teeth and forward deck locking pins on the deck ramp as required by the lubrication chart.

4. Remove the dust caps from the deck ramp hydraulic manifold and the dust plugs from the exposed quick-disconnect fittings. Place the dust plugs into the dust caps before installing the deck ramp into the deck. Connect the quick-disconnect fittings to the hydraulic manifold in the deck ramp.

NOTE. The starboard coupling connects to ports of the forward (head) end of the cylinders. The port coupling connects to ports of the aft (rod) end of the cylinders.

5. Vent the cylinders, then lower the deck ramp to the deck position by releasing the locking pin on the lifting tools, insuring that the forward locks on the side plates engage the holes in the deck. Pull the chains (attached to the handle) to release the stops, rotate the handle



AB.376

Figure 5-14.—Manually carrying the deck ramp.

assembly in a clockwise direction until the tool disengages. Remove the lifting tools and return them to stowage box.

6. Place the pry bar end of the bar assembly (special wrench) into the rectangular hole in the aft end of the housing saddle and pry the deck ramp forward (approximately 1 1/4 inches) until the manifold teeth engage the teeth of the housing saddle assembly. At times it may prove difficult or impossible to slide the deck ramp into full forward engagement with the housing saddle due to thermal distortion of the latter. As an interim measure, loosen the 12 saddle housing holddown bolts (working from the center out) sufficiently to allow full ramp engagement. Retighten the bolts, but do not slug.

7. Check to make sure the hydraulic manifold teeth have meshed with the housing saddle teeth and the forward lockpins (on the forward side plates) are in their mating holes.

8. Close the hinge fittings.

9. Using the special wrench, rotate the housing saddle lock 180 degrees clockwise to lock the hinge fittings.

For one of the following reasons, difficulty may be experienced in making up the quick-disconnect fittings:

1. Improper deck ramp handling techniques have resulted in damage to the quick-disconnect fittings. To avoid this damage, insure that the dust caps and dust plugs are installed when the flexible lines are uncoupled.

NOTE: If damage has occurred and it is not expedient to immediately renew quick-disconnect couplings, aircraft hookup and launch may be accomplished by taxiing into the penetrated buffer at a DEAD SLOW speed (to avoid overloading the tension bar on engagement). If the buffer is not already penetrated, keep the forward vents open while the aircraft engages and penetrates the buffer.

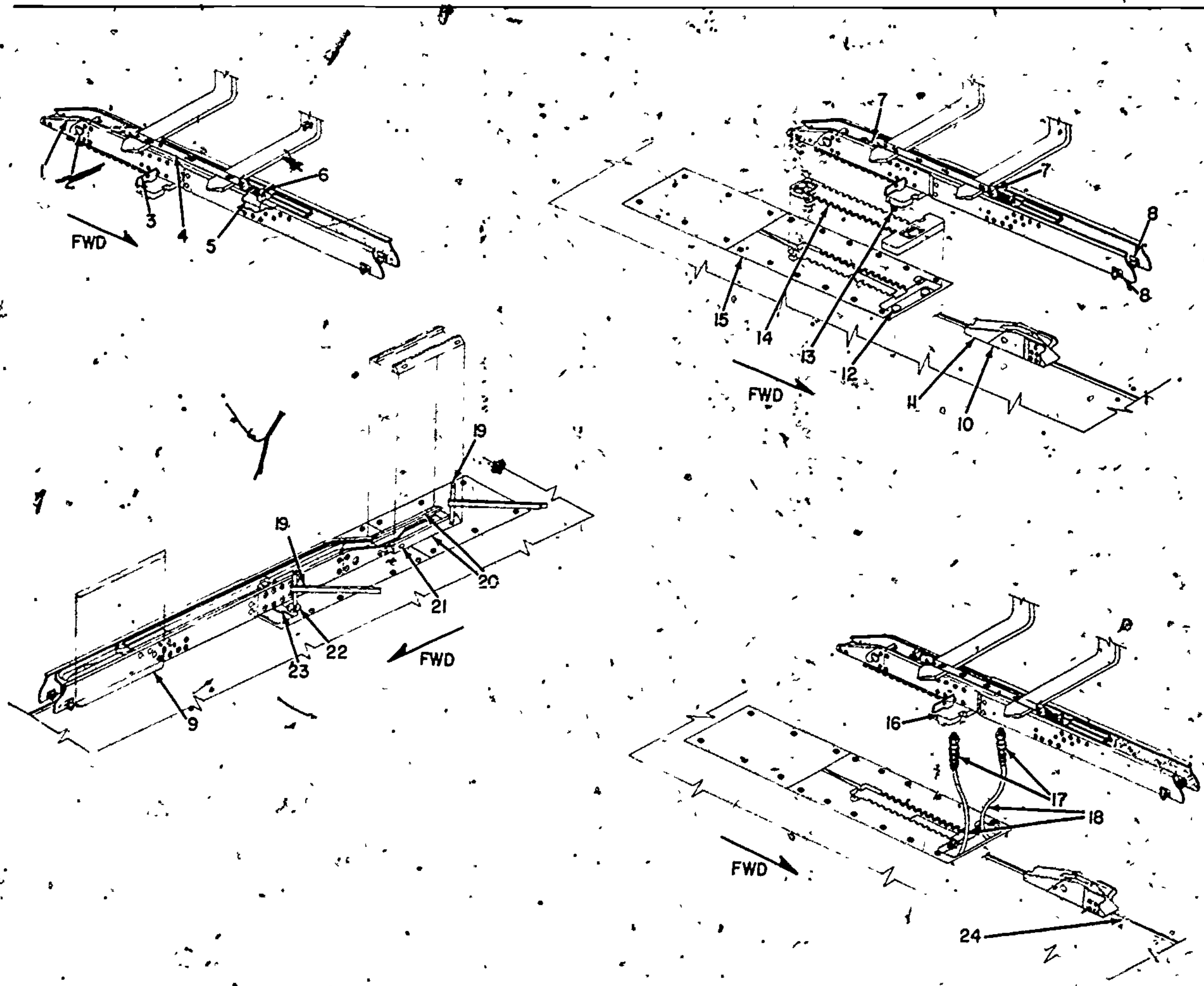
2. Ambient temperature increase during stowage resulted in pressure buildup within the buffer cylinders. To relieve this pressure, vent the buffer cylinders by opening the bleed plugs.

NOTE: Venting will only be accomplished when it has been determined that pressure buildup is the reason for preventing hookup of the quick disconnect fittings. Arbitrary venting prior to installation of the deck ramp will introduce air into the hydraulic system and must be avoided. Repeated cycling of the buffer cylinders will eliminate small amounts of entrapped air by gradually working it back to the gravity tank.

3. Setting the deck ramp assembly in direct contact with the deck, without the dust caps being installed on the hydraulic manifold, resulted in fluid contamination. Foreign matter adhered to the quick-disconnect coupling and, on the next hookup, was introduced into the hydraulic system. Strict adherence to reason one noted above should eliminate introduction of foreign matter from this cause.

4. Damage to and/or contamination of the cylinder surfaces occurred because they were left exposed for long periods of time. To eliminate this potential damage during periods when the nose gear launch equipment is in a standby condition (inactive for long periods of time), or when the nose gear launch deck ramp assembly is removed from the catapult, stow with the buffer penetrated.

NOTE: The buffer must be fully penetrated by actuating the BUFFER FORWARD pushbutton on the control panel.



1. Deck ramp structure.
2. Hoisting pin.
3. Hinge fitting.
4. Strap.
5. Yoke.
6. Thumbscrew fitting.
7. Pouch.
8. Forward deck lockpins.
9. Deck anchors.
10. Spreader.
11. Shuttle ramp.
12. Dust plugs.
13. Dust caps.
14. Deck flushing cover.
15. Housing saddle.
16. Hydraulic manifold.
17. Quick disconnect fittings.
18. Flexible hose.
19. Special wrench.
20. Front section guide track.
21. Camlocks.
22. Housing saddle lock.
23. Hinge fitting.
24. Catapult track slot.

AB.377

Figure 5-15.—Installation of launching hardware.

PRELAUNCH PREPARATION

The following preparations should be made prior to each launch or launch cycle.

1. Determine the type, or types of aircraft to be launched.
2. Obtain applicable aircraft launching bulletin for each type aircraft included in the launch cycle. (This bulletin contains information pertinent to aircraft launching weight, wind-over-deck, airspeed, pressure setting, buffer setting, and the required launching accessories.)
3. Before moving the buffers from the stowed (penetrated) position, wipe the slider area of the housing manifold, clean to remove all grit and foreign matter, paying particular attention to the area adjacent to the upper slot. Relubricate the housing before cycling the slider, as required by the prelaunch functional check.
4. Check the forward deck locks for firm seating.
5. Check the lock securing the launching hardware to the housing saddle. If loose, tighten with the special wrench.
6. Check the housing saddle mounting bolts. Tighten any loose bolts.
7. Make sure that the hydraulic system is charged with no leakage from the piping.
8. Clear the deck of all obstacles in the aircraft approach area, the guide track and launching hardware track, and the deck area forward of the launching hardware.
9. Check the launching bulletin for any additional prelaunch preparation.

PRELAUNCH FUNCTIONAL CHECK

The following 3-M preoperational checks should be made to insure that the launch equipment is in readiness for operation:

1. Check the transfer switch, and all pushbuttons and switches on the deck edge and emergency control panels to make certain they are operative.
2. Cycle the slider forward.
3. Cycle the slider aft.
4. Locate the slider in the BUFFER AFT position.
5. Cycle the valve setting to the DECREASE and INCREASE limits.
6. Set the BUFFER SETTING in accordance with the applicable aircraft launching bulletin before the launch or trail bar contacts the nose gear deck ramp. If not otherwise indicated, set the buffer metering valve dial to 8.5.

NOTE: To avert the possibility of premature tension bar failure, do not actuate BUFFER FWD or BUFFER AFT pushbuttons during the aircraft buffer stroke.

7. Check the launching bulletin for additional prelaunch functional checks.

OPERATION

The following terms are defined herein for purpose of clarity:

Aircraft Positioning. Taxiing the aircraft to the entrance of the approach ramp with launch bar raised.

Aircraft Engagement. Engagement of the aircraft trail bar with the buffer slider of the launching hardware assembly (deck ramp). The launch bar must be lowered and the aircraft taxied forward into the equipment to accomplish engagement.

Aircraft Hookup. Engagement of the launch bar with the shuttle spreader, and tensioning. (Trail bar has engaged slider.)

Launch Bar. A T-shaped bar located on the forward section of the nosewheel strut which engages the shuttle spreader.

Trail Bar. A T-shaped bar (on the aft side of the nosewheel) which engages the buffer slider.

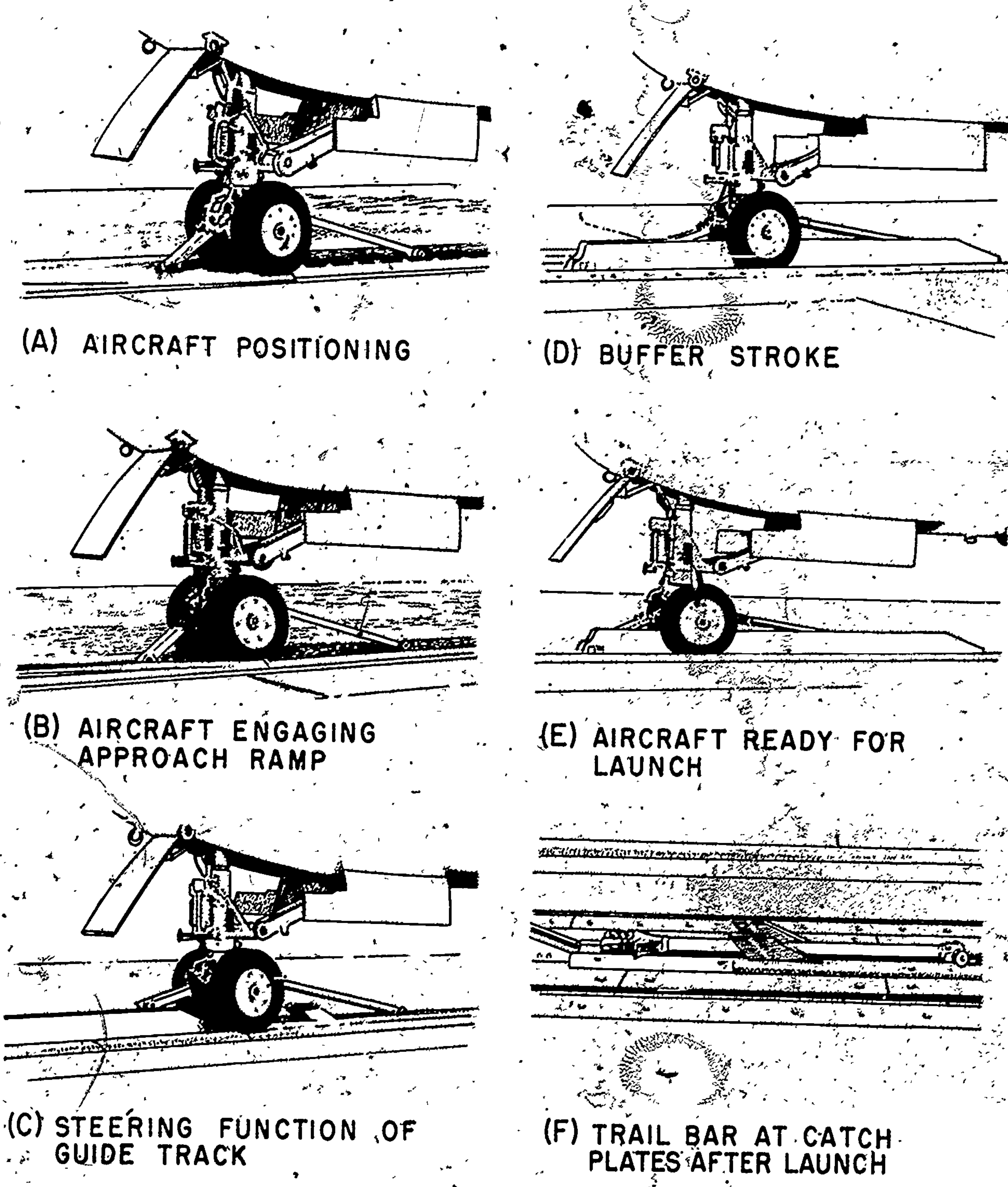
Launching Hardware Assembly (Deck Ramp). That portion of the nose gear launch equipment which retains the aircraft for launch: hereinafter referred to as deck ramp.

Buffer Stroke. Engagement of the trail bar with the buffer slider and stroking thereof to slow and to stop the aircraft within the 18-inch buffering distance.

The cycle of operation consists basically of three phases—aircraft positioning, aircraft engagement, and aircraft hookup.

Aircraft Positioning

The aircraft to be launched, with nose gear accessories installed, is taxied to the mouth of the approach ramp (fig. 5-16 (A)), where the



AB.378

Figure 5-16.—Nose gear launch operation.

launch bar is lowered from taxi (raised) position to the deck.

Aircraft Engagement

The aircraft is steered into the aft section of the approach ramp (fig. 5-16 (B)), where the steering function is taken over by the launch bar which engages the track built into the approach ramp and deck ramp (fig. 5-16 (C)). The aircraft continues forward until the trail bar engages the buffer slider, causing deceleration of the aircraft. During deceleration of the aircraft, the launch bar rides in grooves constructed within the deck ramp (fig. 5-16 (D)). When the aircraft stops, the launch bar drops into position to receive the shuttle spreader (fig. 5-16 (E)).

Aircraft Hookup

The bridle tension pushbutton on the catapult deck edge control panel (or the catapult emergency control panel) is depressed, causing the shuttle spreader to move forward, engaging the launch bar and tensioning the gear. Procedures for a normal catapult launch cycle are followed. As launch pressure builds up, the trail bar load increases until the tension bar fails and the aircraft starts its catapult run. As the trail bar separates from the aircraft, it recoils toward the deck in the aft direction, engages the vertical catchplates on the approach ramp, and comes to rest below the level of the ramp. (See fig. 5-16 (F)). The trail bar must be retrieved from this ramp position prior to the next launching.

LUBRICATION

Check to determine if the applicable MRC daily lubrication procedures of the deck track key slots and slider have been completed.

INSPECTION

Before commencing launching operation, make a final inspection of critical points.

1. Forward deck locks.
2. Launching - hardware - to - housing - saddle security.
3. Housing saddle mounting bolts.
4. Hydraulic system
5. Buffer setting in accordance with aircraft launching bulletin.
6. Obstacle clearance.

MONTHLY EXERCISE

To insure functional adequacy of the equipment during prolonged periods of inactivity, the following monthly exercise procedure is outlined:

1. Remove the bridle/pendant launch components and install nose gear launch hardware in accordance with the handbook for the nose gear launch equipment. Record the time required for the changeover.
2. Insure that the hydraulic system is charged, and that there is no leakage.
3. From the deck edge control panel:
   a. Actuate the slider forward and aft 10 complete cycles.
   b. Cycle the buffer setting dial from 0 to 8 1/2, through two complete cycles.
   c. Retract the catapult shuttle into the nose gear launch deck ramp.

WARNING. Insure that the nose gear launch shuttle ramp and spreader have replaced the conventional ramp and spreader before retracting the shuttle into the nose gear launch deck ramp.

4. From the emergency control panel, repeat steps 3a and 3b noted above.
5. Problems encountered with the equipment must be recorded for eventual reporting to:
   a. Type Commander.
   b. NAVAIRSYSCOM (Attn: applicable code).
   c. Naval Air Engineering Laboratory (SI) (Attn: applicable code).
   d. NAVSEASYSCOM.

MALFUNCTIONS

When a malfunction occurs, the catapult officer and his assistants should be able to recognize where the trouble lies and should immediately initiate the proper repair procedures. Proper discharge of operational and maintenance checks will greatly reduce malfunction occurrence and resultant danger to personnel and equipment.

Some of the causes of malfunctions are described in the following paragraphs, and the procedures for correcting them are listed.

1. Electrical Components. Burnt out speed reducer, switch, relay, solenoid, or other electrical component. Remedy this malfunction by replacing inoperative components.

2. Electrical System. Disconnected, broken, or shorted electrical wires will cause malfunction of the electrical system. Repair any such wires if practical; otherwise replace them.

3. Hydraulic Components. Ruptured or blocked hydraulic lines can cause a malfunction. Any ruptured line should be replaced immediately; blocked lines should be air cleaned.

4. During Aircraft Hookup. Possible causes for the launch bar failing to seat in the spreader are tow bar or spreader misalinement. Remedy by tightening loose connections or replacing misalined part.

5. Trail bar failing to engage the slider. Check trail-bar-to-release-element connections. Tighten any loose connections and check the slider slots and the slider mounting cutout (in the deck ramp manifold) for damage. Damage to the slider or the slider housing necessitates removal and replacement of the launching hardware.

CHAPTER 6

SHIPBOARD ARRESTING AND BARRICADE GEAR

The recovery equipment discussed in this chapter is the Mark (MK) 7 type arresting gear. It is recommended that chapter 5 of ABE 3 & 2, NavTra 10302-C, be studied in conjunction with this chapter.

TYPES OF ARRESTING GEAR ENGINES

MARK 7 MOD 1

The Mk 7 Mod 1 is the smaller of the three Mk 7 type arresting engines discussed in this chapter. This equipment is installed aboard all carriers in commission that were built prior to the U.S.S. Forrestal, CVA-59, with the exception of the U.S.S. Coral Sea, CVA-43, and U.S.S. Midway, CVA-41, which are equipped with the Mk 7 Mod 2 and Mk 7 Mod 3, respectively.

The Mk 7 Mod 1 is designed to absorb theoretical maximum energy of 29,300,000 foot-pounds at peak fluid pressure and maximum cable runout. This is equivalent to stopping a 50,000-pound aircraft at an engaging speed of 105 knots (110 knots if the equipment is equipped with sheave dampers) in a distance of 228 feet.

Each carrier in the fleet is equipped with five arresting engines (four pendant and one barricade), with the exception of the U.S.S. Intrepid which has a total of six engines (five pendant and one barricade), and the U.S.S. Midway which does not have an endless reeved barricade engine for emergency use. The Midway has a complement of four arresting engines, all single reeved, with only three connected to a deck pendant at any one time during flight operations. The fourth engine, engine number 3A, is a standby or alternate to engine number 3. It has been structurally altered, as has number 3 engine, to function as either a pendant or a barricade engine. When either is rigged as a pendant engine the other is a standby for use as a barricade.

Table 6-1 lists all the leading particulars of the Mk 7 Mod 1, Mod 2, and Mod 3 recovery equipment. This table can be used to compare the Mk 7 Mod 1 with the Mod 2 and Mod 3 which are discussed later in this chapter.

MARK 7 MOD 2

As carrier-based aircraft became heavier and faster, an arresting gear engine was needed that would provide a greater capacity to absorb the increased amount of kinetic energy built up by the force of the forward motion of an aircraft during an arrestment. This need led to development of the Mk 7 Mod 2, and later the Mk 7 Mod 3, arresting engines.

The Mk 7 Mod 2 is installed aboard the U.S.S. Coral Sea, CVA-43, and all carriers built after the Coral Sea except U.S.S. John F. Kennedy, CVA-67, and U.S.S. C.W. Nimitz, CVAN-68.

The Mk 7 Mod 2 is designed to recover a 50,000-pound aircraft at an engaging speed of 120 knots in a distance of 310 feet.

MARK 7 MOD 3

The Mk 7 Mod 3 has the capability of recovering a 50,000-pound aircraft at an engaging speed of 130 knots in a distance of 340 feet. Mk 7 Mod 3 arresting engines are installed aboard the U.S.S. John F. Kennedy, CVA-67, U.S.S. C. W. Nimitz, CVAN-68, and U.S.S. Midway, CVA-41.

OPERATING PRINCIPLES

MARK 7 MODS 1, 2, AND 3

The operating principles of the different modifications of the Mk 7 type arresting gear are basically the same. The primary differences are their sizes and capabilities, as can be seen in table 6-1.

Table 6-1.—Leading particulars of Mk 7 recovery equipment

	Mod 1	Mod 2	Mod 3
MAXIMUM ENERGY ABSORPTION:			
Service stroke	29,300,000 lb-ft	38,373,000 lb-ft	47,500,000 lb-ft
ENGINE DRIVE SYSTEM CABLES:			
Diameter	1-3/8 in.*	1-3/8 in.*	1 3/8 in.*
Breaking strength			
Deck pendant (6 x 30 flattened strand)	188,000 lb	188,000 lb	188,000 lb
Purchase cable (6 x 25 round strand)	175,000 lb	175,000 lb	175,000 lb
Reeving ratio	18 to 1	18 to 1	18 to 1
ARRESTING ENGINE:			
Length	41 ft	50 ft	50 ft
Weight	32 tons	37 tons	43 tons
Engine fluid	Ethylene glycol	Ethylene glycol	Ethylene glycol
Engine fluid capacity (without cooler)	250 gal	320 gal	380 gal
Engine fluid capacity (with cooler)	430 gal	500 gal	560 gal
Ram diameter	20.00 in.	18.495 in.	20.000 in.
Effective ram area	314.16 sq. in.	268.8 sq. in.	314.16 sq. in.
Length of maximum stroke	133.875 in.	186.00 in.	192 in.
Length of service stroke	118.000 in.	171.00 in.	183 in.
Crosshead battery position (distance from stop)	1 to 7 in.	1 to 7 in.	1 to 6 in.
Accumulator operating medium	Ethylene glycolair	Ethylene glycolair	Ethylene glycolair
Maximum pressure	650 psi	650 psi	650 psi
Initial working pressure	400 psi	400 psi	400 psi
Type of coolant	Sea water	Sea water	Sea water
Length of runout	228 ft	310 ft	340 ft

* 1 3/8-inch diameter purchase cable is being replaced by 1 7/16-inch cable upon depletion of 1 3/8-inch cable in stock.

The Mk 7 Mod 2 differs from the Mk 7 Mod 1 and Mk 7 Mod 3 in that the Mod 2 operates on the hydraulic (volume) displacement principle. This means that the Mk 7 Mod 2 has the packing installed in the mouth of the engine cylinder, and not on the end of the ram. The Mk 7 Mods 1 and 3 operate on the positive displacement principle and have the packing installed on the end of the ram. Figure 6-1 shows a fluid flow diagram of the Mk 7 Mod 2 arresting engine during an engagement. Notice the volume displacement of the fluid as the ram moves into the cylinder. Figure 6-2 shows a fluid flow diagram of the Mk 7 Mod 3 arresting engine during an engagement. Notice the total displacement of the fluid as the ram moves into the cylinder. The Mod 1 fluid flow is the same as the Mod 3 except that the Mod 1 is not equipped with cable anchor dampers.

The function of the arresting engine is to absorb and dispel the energies developed when a landing aircraft is arrested. As shown in the diagrams in figures 6-1 and 6-2, the fluid is forced out of the cylinder by the ram, through the constant runout (CRO) valve, to the accumulator. A smooth controlled arrestment of

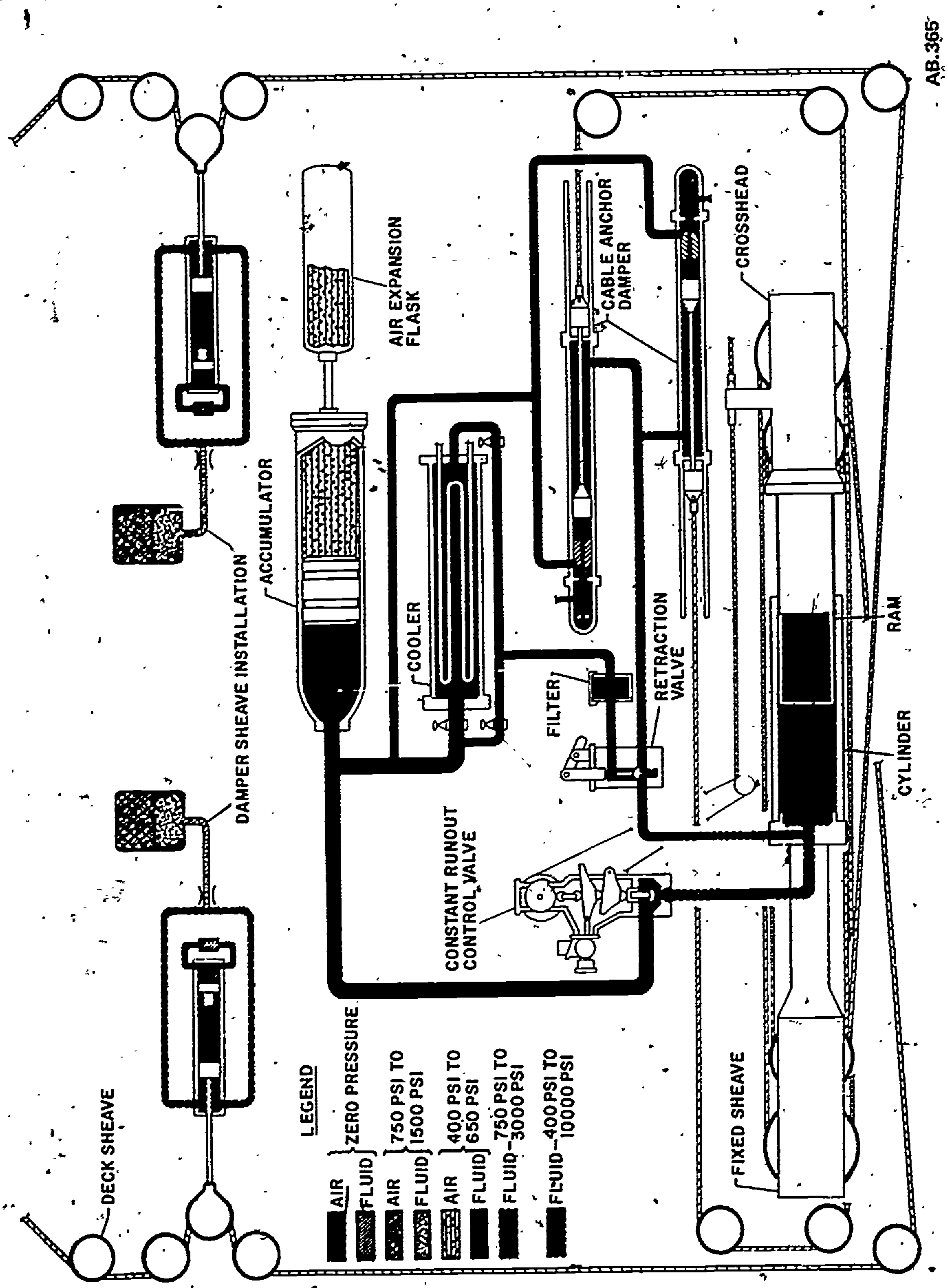


Figure 6-1.—Mk 7 Mod 2 fluid flow diagram during arrestment.

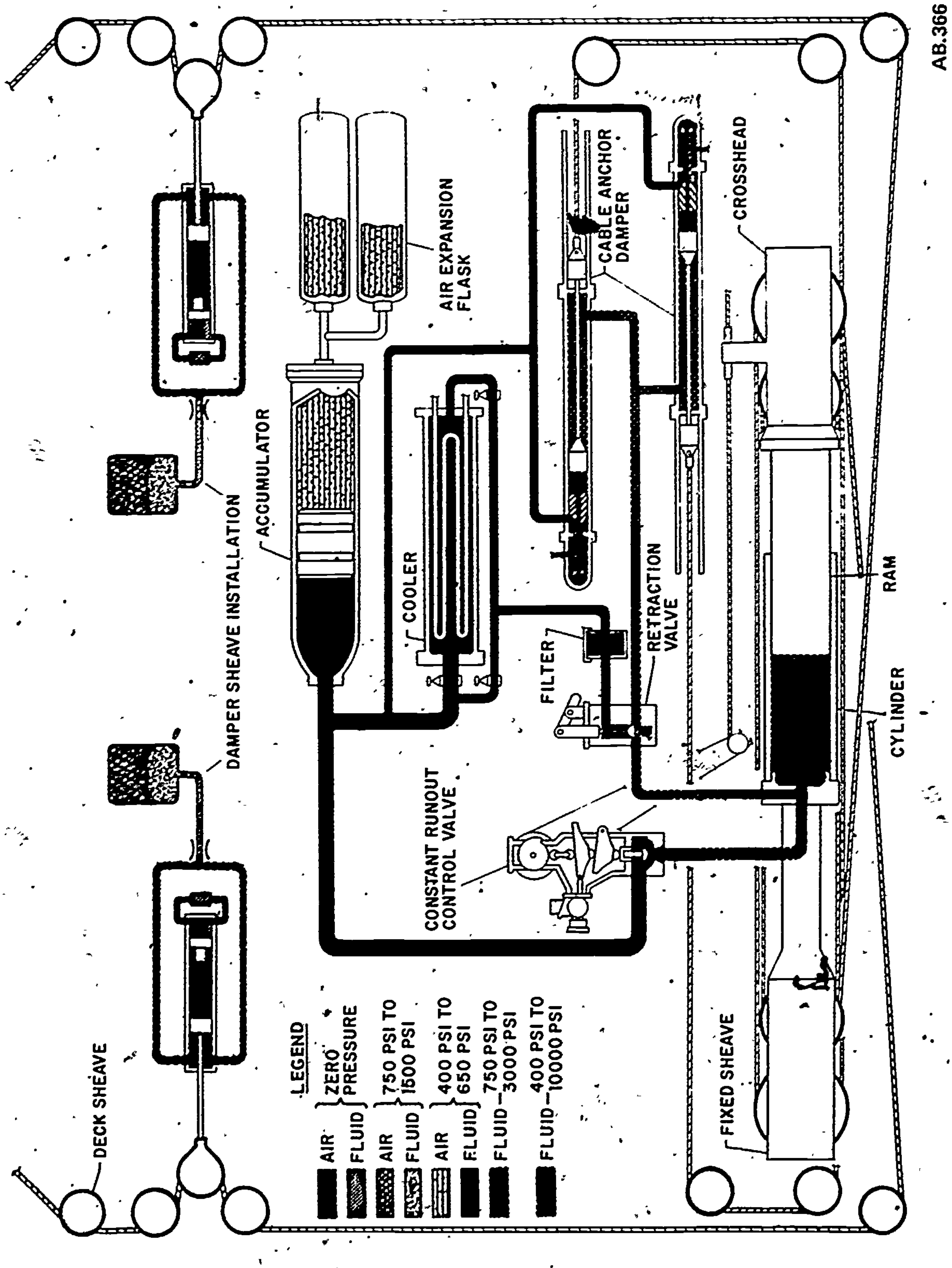


Figure 6-2.—Mk 7 Mod 3 fluid flow diagram during arrestment.

the landing aircraft is accomplished by the fluid being metered as it passes through the CRO valve.

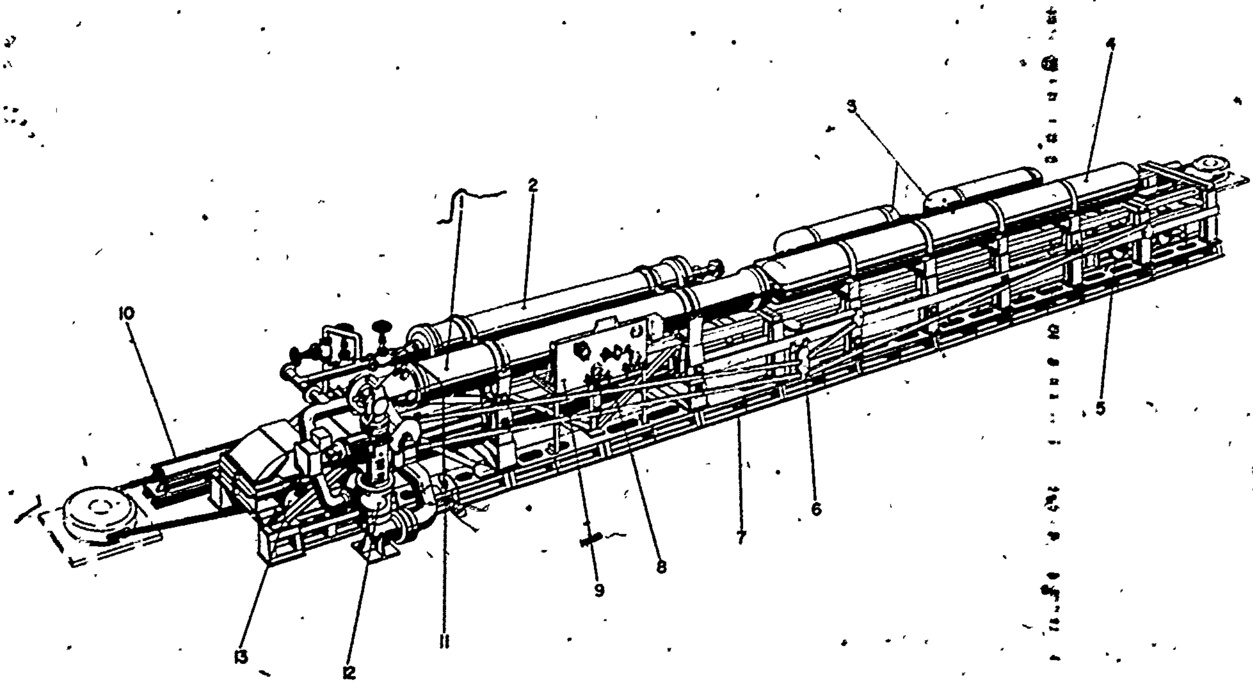
MAIN PARTS

Constant Runout Valve

The Mk 7 constant runout valve is installed on the fixed end of the arresting engine as illustrated in figure 6-3. The CRO valve system is comprised of four major parts—arresting valve, aircraft weight selector, drive system, and control system.

The arresting valve is the heart of the equipment. It is the main valve which controls the flow of fluid from the cylinder of the arresting engine to the accumulator. The remainder of the equipment is used either to adjust the initial opening of this valve for aircraft of different weight, or to activate the valve during the arresting stroke. The retracting valve is used to return the fluid from the accumulator to the cylinder and is operated independently of the control valve.

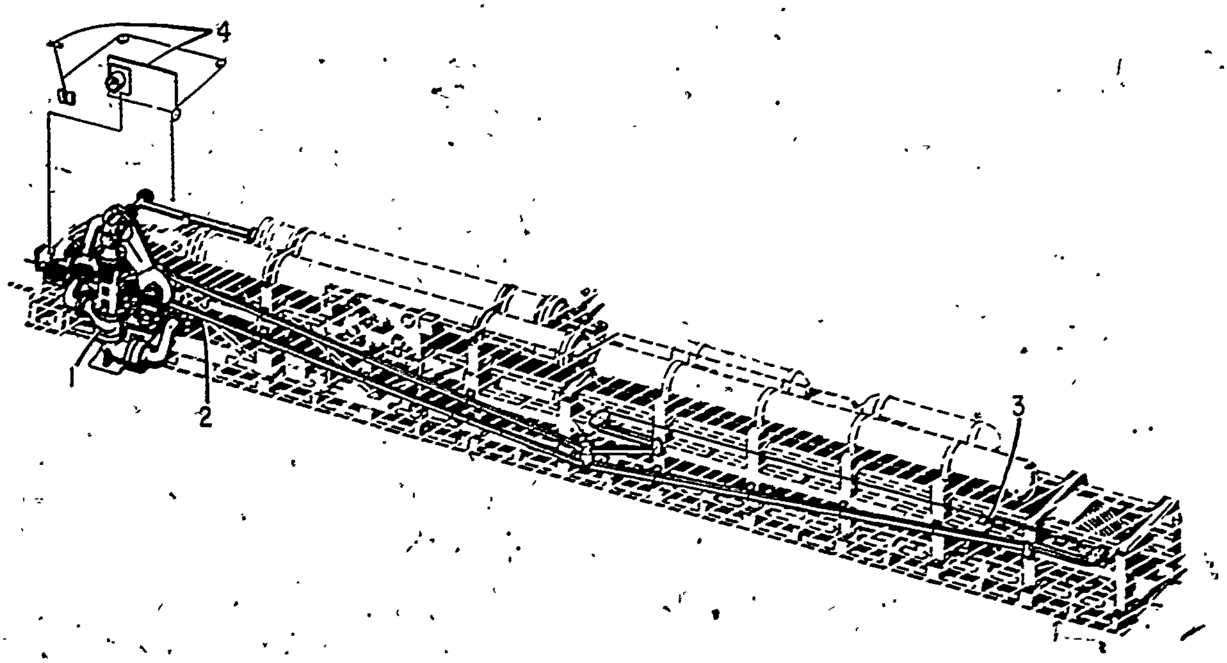
When a landing aircraft engages a deck pendant, or barricade, it withdraws purchase cable from the arresting engine. This action causes the crosshead to move toward the fixed sheave end of the engine. In addition to displacing fluid from the cylinder, this movement of the crosshead activates the drive system (2, fig. 6-4), causing rotary motion of the cam in the cam and plunger assembly. To keep the drive system and cam always in battery position, the adjustable anchor (3, fig. 6-4) is used.



1. Accumulator.
2. Fluid cooler.
3. Auxiliary air flask.
4. Air expansion accumulator.
5. Crosshead.
6. Control valve drive system.
7. Engine structure.
8. Cylinder and ram assembly.
9. Control panel.
10. Cable anchor damper.
11. Fluid replenishing system.
12. Control valve.
13. Fixed sheave.

AB.379

Figure 6-3.—Mk 7 Mod 2 arresting engine.



1. Control valve.
2. Drive system.
3. Adjustable anchor.
4. Control system.

AB.84

Figure 6-4.—General arrangement of the Mk 7 CRO valve system.

It is necessary to have a smaller valve opening to arrest heavier aircraft, and a larger valve opening to arrest lighter aircraft. The aircraft weight selector (fig. 6-5) makes it possible to adjust the valve for aircraft of different weight by varying the valve opening.

The size of the initial valve opening is adjusted while the arresting engine is in battery position. The lead screw receivers rotary motion from the motor unit or handwheel and converts it into linear motion. This linear motion positions the upper lever and drives the local and remote indicators.

In each of the two levers (upper and lower), the distance between the fulcrum and roller is constant. On the upper lever, the distance between the fulcrum and the point of application of force from the cam is variable, its greatest length being twice that of the lower lever. The lever arm ratio of each lever, therefore, is variable between 1:1 and 2:1.

When the upper lever is fully extended, the ratio of each lever is 1:1. In this setting the initial opening of the control valve upon engagement of an aircraft is maximum. The levers are in a 1:1 ratio in figure 6-5. The resulting rotation of the cam, caused by the crosshead moving inward, forces the plunger downward. A plunger movement of 1 inch, acting through the upper lever, would move the lower lever 1 inch, the lower lever, in turn, would move the valve sleeve and stem 1 inch.

The cam is of the disk plate type with the desired contour machined on its periphery. As the cam rotates, it forces the plunger down. The plunger is fitted with rollers, top and bottom.

The bottom roller on the plunger acts against the top flat bearing surface of the upper lever. The pivot end of the upper lever has a bushed hole which mates with the clevis end of the lead screw yoke. The upper lever is connected to the clevis end of the yoke by a pin. This pin extends beyond the sides of the yoke and acts as a shaft and has a bushed roller mounted on each extended end. The rollers ride inside the guide attached to the housing. The block end of the

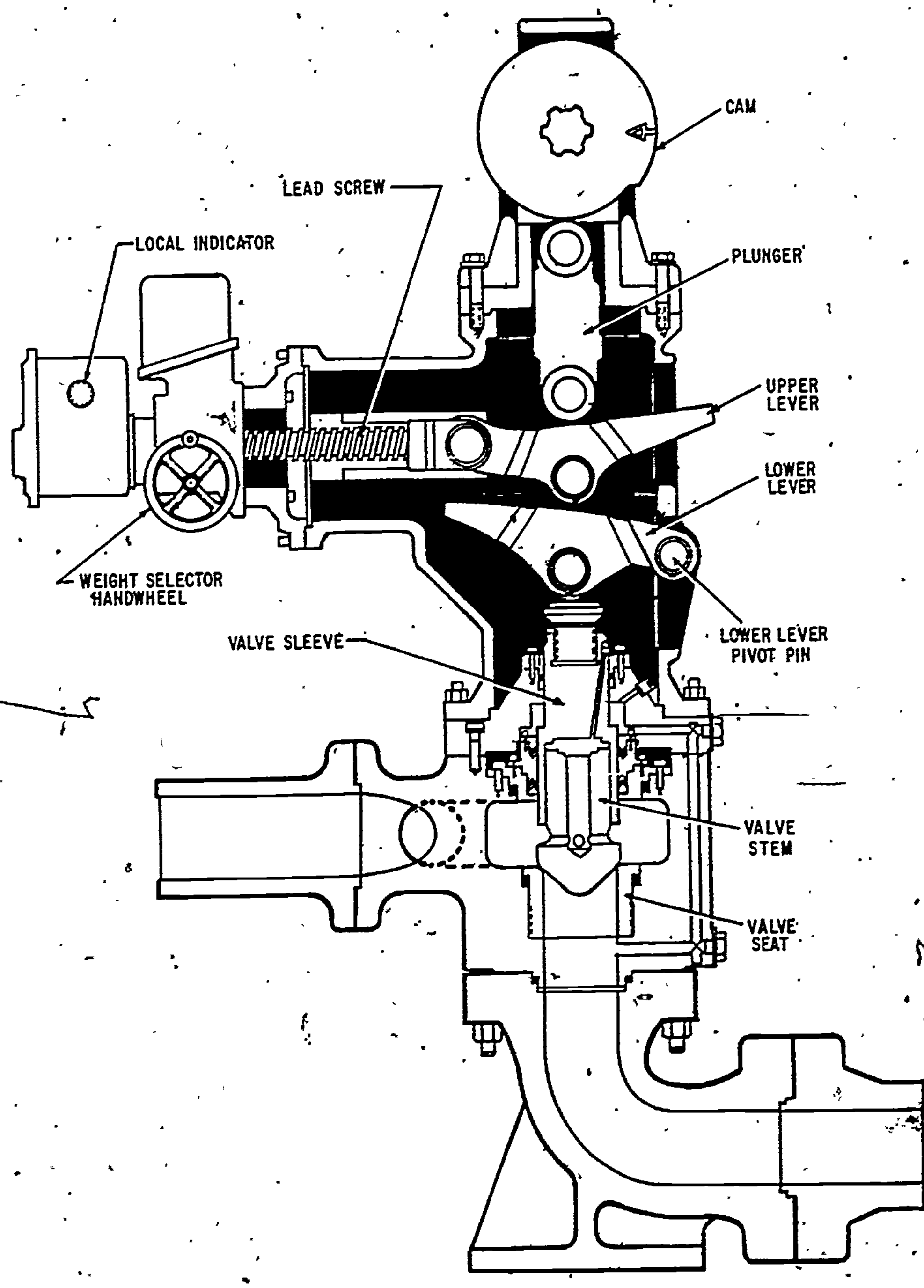


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Figure 6-5.–Sectional view of the Mk 7 Mod 3 CRO valve.

yoke is connected to the lead screw by means of two dowel pins. This connection provides the means by which the lead screw adjusts (moves) the upper lever.

The bottom of the upper lever is fitted with a roller which bears against the flat surface of the lower lever. One end of the lower lever has a bushed hole to receive a pivot pin. The pivot pin passes through the lever and through two mounting holes in the stanchion.

The bottom of the lower lever is fitted with a roller which bears on the stem screw on top of the valve sleeve. The vertical position of the roller on the lower lever determines the vertical distance that the valve sleeve may move. Thus, it controls the size of the initial opening of the control valve.

The levers are mounted in such a way that, as the upper lever is withdrawn, the lever arm ratio of both levers is increased by an equal amount. When the upper lever is fully withdrawn, the ratio of each lever is 2:1, and the ratio through the lever system (upper and lower levers) is 4:1. In this case the initial control valve opening is minimum. A plunger movement of 1 inch, acting through the upper lever, would move the lower lever 1/2-inch; the lower lever, in turn, would move the valve sleeve and stem 1/4-inch.

A critical point to consider is the position of the levers when the valve stem is seated by cam action at the termination of each arrestment stroke. The levers are so mounted and adjusted that the bearing surfaces of the levers are level when the valve is seated. When the bearing surfaces are level, the distance across the lever system is the same regardless of the ratio setting. Because of this, the point of closing of the valve is independent of the aircraft weight selector. It is a function of the cam only; therefore it is constant.

As the engine is retracted, the upper lever rises a distance equal to the movement of the plunger. If the ratio is 1:1, the valve sleeve rises the same distance. In this case the initial valve opening is maximum. If the ratio is 4:1, however, the valve sleeve rises only one-fourth the distance that the plunger moves. In this case the initial valve opening is minimum.

The lever setting may be adjusted to any setting within the two extremes previously discussed; the particular setting used is dependent upon the weight of the aircraft to be arrested. The setting is made with the engine in battery position prior to landing the aircraft.

Adjustment of the setting determines the position of the valve sleeve, and therefore determines the amount the valve will be able to open at the beginning of the arrestment stroke. It also determines the rate of closure during the stroke, so that the valve will always seat at the same runout.

The valve stem sleeve allows a relatively unloaded and cushioned opening at the beginning of the stroke.

The lever system, if set for a heavy aircraft, reduces the allowable valve stem opening and thus increases the resistance of the valve to the flow of fluid. The energy of the aircraft is dissipated in forcing fluid through the restricted valve opening.

Electrical System

The function of the electrical system is to provide, control, and safeguard the distribution of electrical energy to the lever change motor and the synchro indicators. The electrical circuits (fig. 6-6) are the control valve weight selector circuit and the indicator circuit.

Control Valve Weight Selector Circuit

This circuit provides control of the weight change motor. Contained in this circuit are a master switch, a motor controller, motor increase-decrease limit switches, two momentary contact pushbutton stations, a handwheel limit switch, and a terminal box.

With the handwheel pushed in to close the handwheel limit switch, the master switch is thrown to energize the circuit prior to landing operations and remains on until the arresting engine is secured. If a change in the weight is desired, it is normally accomplished from the pushbutton station near the control valve. If an increase in the weight is ordered, the button marked INCREASE is depressed and held depressed until the desired weight is reached as shown by the local weight indicator mounted on the control unit. When the INCREASE button is depressed, the electrical energy acts to rotate the

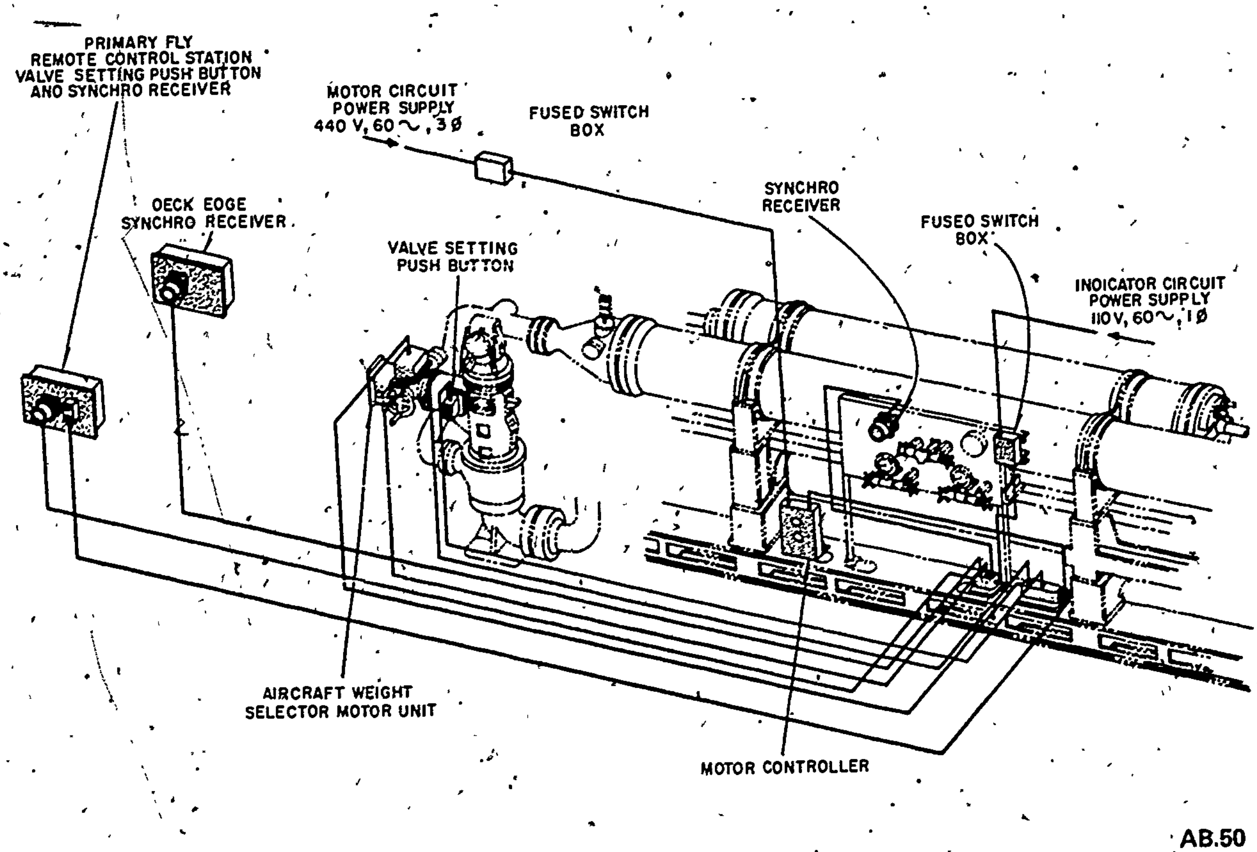


Figure 6-6.—Electrical circuits.

weight change motor in the correct direction as determined by the contractors. The motor may be stopped at any point by release of the pushbutton. If the limit is reached, the geared increase limit switch will open, due to the mechanical action of the levers against the gearing, and the motor will stop.

Operation is identical for a decrease of weight, with the direction of the motor being reversed by the action of the contactors. Action of overload relays, fuses, and the emergency run switch are conventional and need no detailed description. The master switch is thrown off after landing operations have been completed, to deenergize the complete circuit.

Pushbutton Stations

The function of the pushbutton stations is to select the proper contactor of the weight selector motor controller so as to rotate the shaft of the motor in the proper direction to increase or decrease the weight setting.

There are two pushbutton stations. One is mounted adjacent to the main control valve, another is remotely mounted in the primary fly control station. Each station has two pushbuttons—one for increase and one for decrease.

Weight Selector Indicator Circuit

The function of the indicator circuit is to energize the elements of the synchro system so that remote indication of the weight selector is obtained.

The indicator circuit includes the necessary wiring and fusing, and a master switch for the operation of one synchro transmitter and three synchro receivers located at the main control panel, primary fly, and at the deck edge control station.

When the indicator circuit master switch located on the main control panel is thrown on, the indicator circuit is energized. The synchro transmitter is mechanically connected to the local indicator of the weight control mechanism. This connection is made at one end of the rotor shaft of the transmitter. When the setting of the weight selector is changed, the rotor of the transmitter turns. This rotor movement is transmitted electrically to the remote synchro receivers whose rotors turn the same angular distance as the rotor of the transmitter. The receivers have an indicating dial on one end of their rotor shaft that shows the weight setting by the position of the rotors. If the system is properly zeroed, the receivers will indicate the same weight setting readings as the local indicator.

Retracting Valve

The retracting valve permits the controlled return of fluid, displaced by the engine ram, from the accumulator or fluid cooler to the cylinder. The general location of the retracting valve is shown in figure 6-7.

The retracting valve is a self-contained poppet-valve assembly composed principally of a housing, a plunger, an operating lever, a valve stem, and a valve seat.

The retracting valve operates as a check valve against the flow of fluid from the accumulator to the engine cylinder. Fluid at accumulator pressure enters the housing and bears on the stem in the direction which would open the valve; however, the pressure also bears against the base of the plunger, tending to close the valve. Since the area of the plunger end is greater than that of the stem, the differential in force keeps the valve closed.

When the engine is retracted to battery position, force is applied to the operating lever. This force, transmitted through the plunger to the stem, aids the accumulator pressure on the stem and overcomes the pressure on the plunger, thus opening the valve and permitting fluid flow.

The retracting valve effectively blocks fluid flow from the engine cylinder to the accumulator, except by way of the control valve, since the greater the engine cylinder pressure acting on a shoulder of the stem the tighter the seal.

Retracting Lever

There is a retracting lever for each arresting engine, located at the deck edge control station. The function of the retracting lever is to provide a remote means of opening the retracting valve in a location where the operator will have full visibility of recovery operations.

The retracting lever (fig. 6-8) is a T-shaped lever which pivots in a support bolted to the flight deck catwalk bulkhead.

When the retracting lever (1) is pulled down, it tensions the cable (3) leading to the retracting valve operating lever (5) and opens the valve. Release of the lever allows the spring-loaded operating lever to lower, thus closing the retracting valve (6). A shock absorber (7) is installed to cushion the closing of the valve and to eliminate chattering of the valve when it is opened.

Accumulator System

The accumulator system (fig. 6-9) consists of an accumulator cylinder with its floating piston, and two air expansion flasks mounted in saddles on top of the engine structure. The accumulator is the receiving chamber for the fluid that is displaced by the engine ram during an arrestment. As it receives fluid during an arrestment, air pressure on the air expansion flask side of the accumulator piston is increased from the initial 400 psi to 650 psi. The increased pressure is required in order to return the system to its "battery" position for the next arrestment. Fluid and air within the accumulator are separated by the floating V-ring packings fitted on the accumulator piston. The piston is also fitted with replaceable slippers which aid its motion within the accumulator cylinder.

At battery position, the 400 psi air pressure in the air expansion flasks holds the accumulator piston at the nozzle end of the accumulator. In this position the fluid level indicator registers the fluid level in the entire engine. The fluid level indicator registers three conditions:

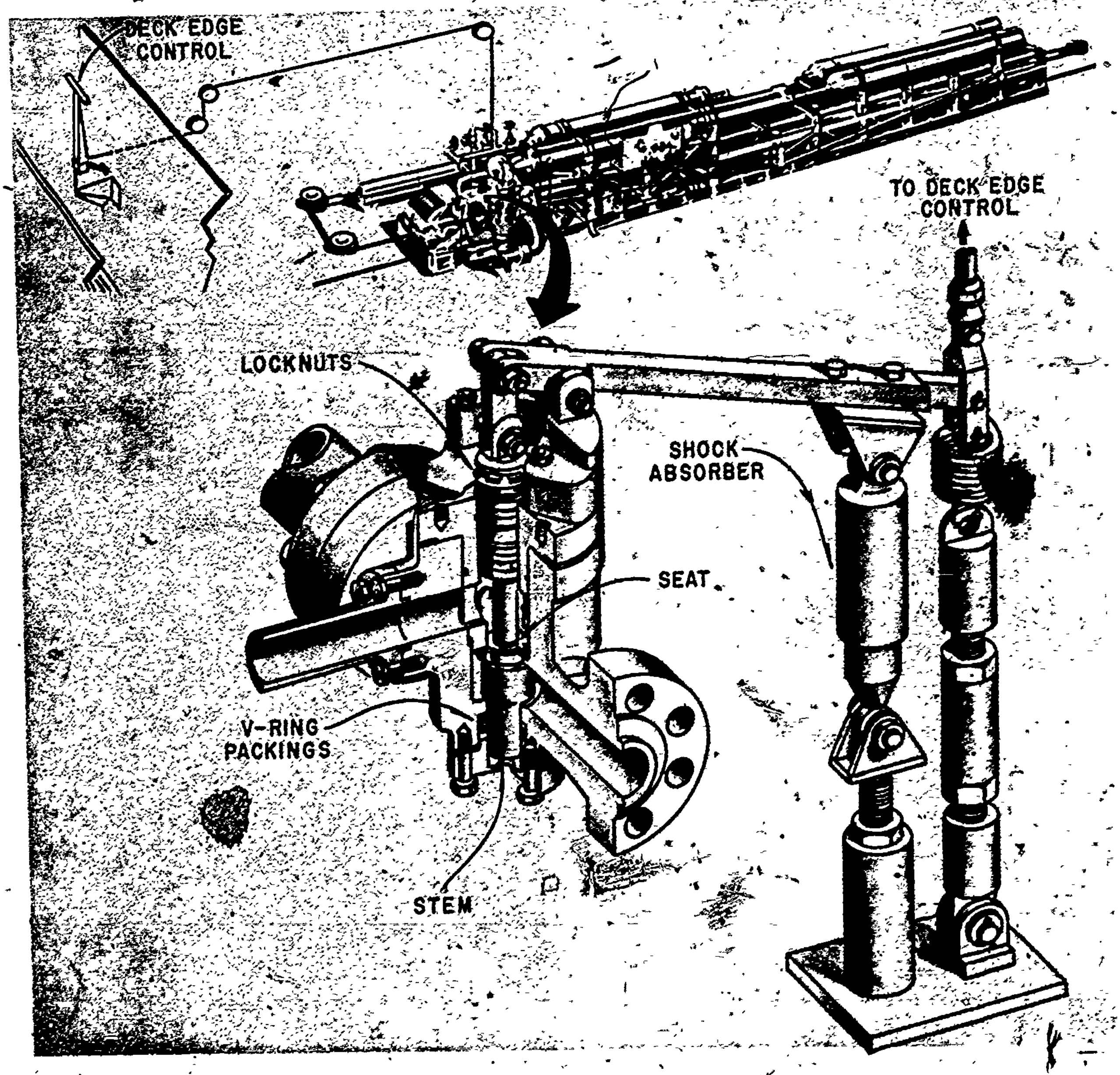
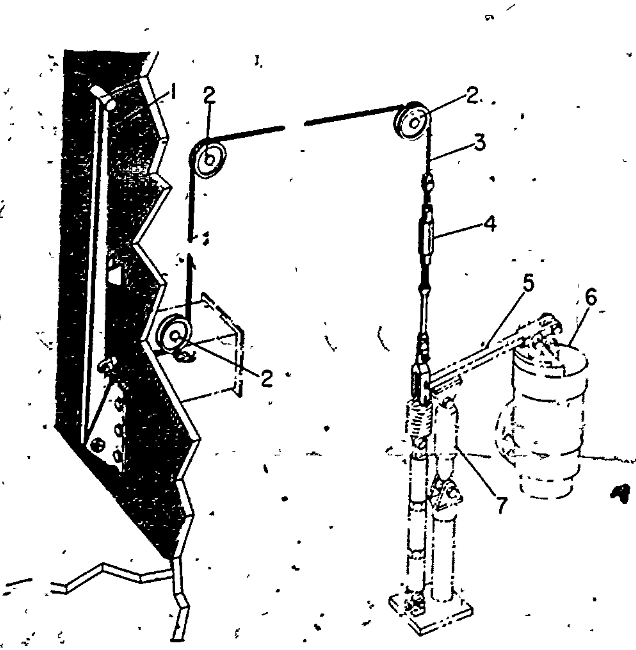


Figure 6-7.—General location of the retracting valve.

1. Battery—proper amount of fluid in the system.
2. Fill—insufficient fluid in the system.
3. Drain—excessive fluid in the system.

NOTE: The top of the fluid indicator rod must indicate "battery" when the arresting gear engine is in battery condition (ready for arrestment).

A safety head is installed at the air expansion flask end of the accumulator to provide a safeguard against excessive pressure buildup within the accumulator.



1. Retracting lever.
2. Sheave.
3. Cable.
4. Turnbuckle.
5. Lever (operating).
6. Retracting valve.
7. Shock absorber.

AB.89

Figure 6-8.—Retracting lever installation.

Fluid Cooler

The cooler unit lowers the temperature of the engine fluid by permitting the hot engine fluid to contact the cool exterior surface of a number of tubes containing cool, circulating salt water. Each cooler contains anodes, which aid in preventing corrosion in the cooler. (Fluid coolers are not installed on engines used only for barricade positions.) The fluid cooler (fig. 6-10) is mounted in saddles on top of the engine structure, adjacent to the accumulator. The main parts of the cooler are the body (6), the tubes (7), the two heads (3 and 10), the manifold (2), the baffle supports (8), and the facing plate (1).

The body assembly consists of a cylindrical steel shell with studs on each flanged end. These studs are used for securing the heads to each end of the cylinder. The body also has equally spaced holes on each end, extending from the rim of each flange to the interior surface of the body. These holes, normally closed by pipe plugs (11) or vent valves (5), provide a means of draining and venting the cooler.

The tube assembly through which the coolant flows and which acts as a cap for the container holding the engine fluid, is composed of a bronze tube head, copper tubes, brass baffles, gaskets, facing plates, and manifolds.

Auxiliary Air Flasks

The auxiliary air flasks provide a means of stowing ship's air at 3,000 psi. In the event of failure of the ship's air system, the air stowed in the auxiliary air flasks can be used to recharge the arresting engine.

The air flask is a cylindrical container with hemispherical ends. One end of the air flask is provided with a pipe tap for connecting an air line which is used for charging and venting.

Air can be supplied to the air unit of the arresting engine from the auxiliary air flasks by use of the valve mounted on the main control panel.

Main Control Panel

The function of the main control panel is to provide an easily accessible and centrally located control center from which the arresting engine may be adjusted or activated.

The main control panel (fig. 6-11) consists of a rectangular panel containing two air pressure gages, an engine fluid temperature indicator, a synchro receiver, a cable anchor damper battery position indicator light box (on Mod 2 and 3 engines), and three sets of air valves with associated piping.

The valves of the arresting engine air system are manually operated. Piping of the air system is so arranged that the accumulator may be charged either from ship's high-pressure air supply or from the auxiliary air flasks.

Cylinder and Ram Assemblies

The cylinder acts as a receiver for the ram and as a reservoir for the fluid to be displaced by the

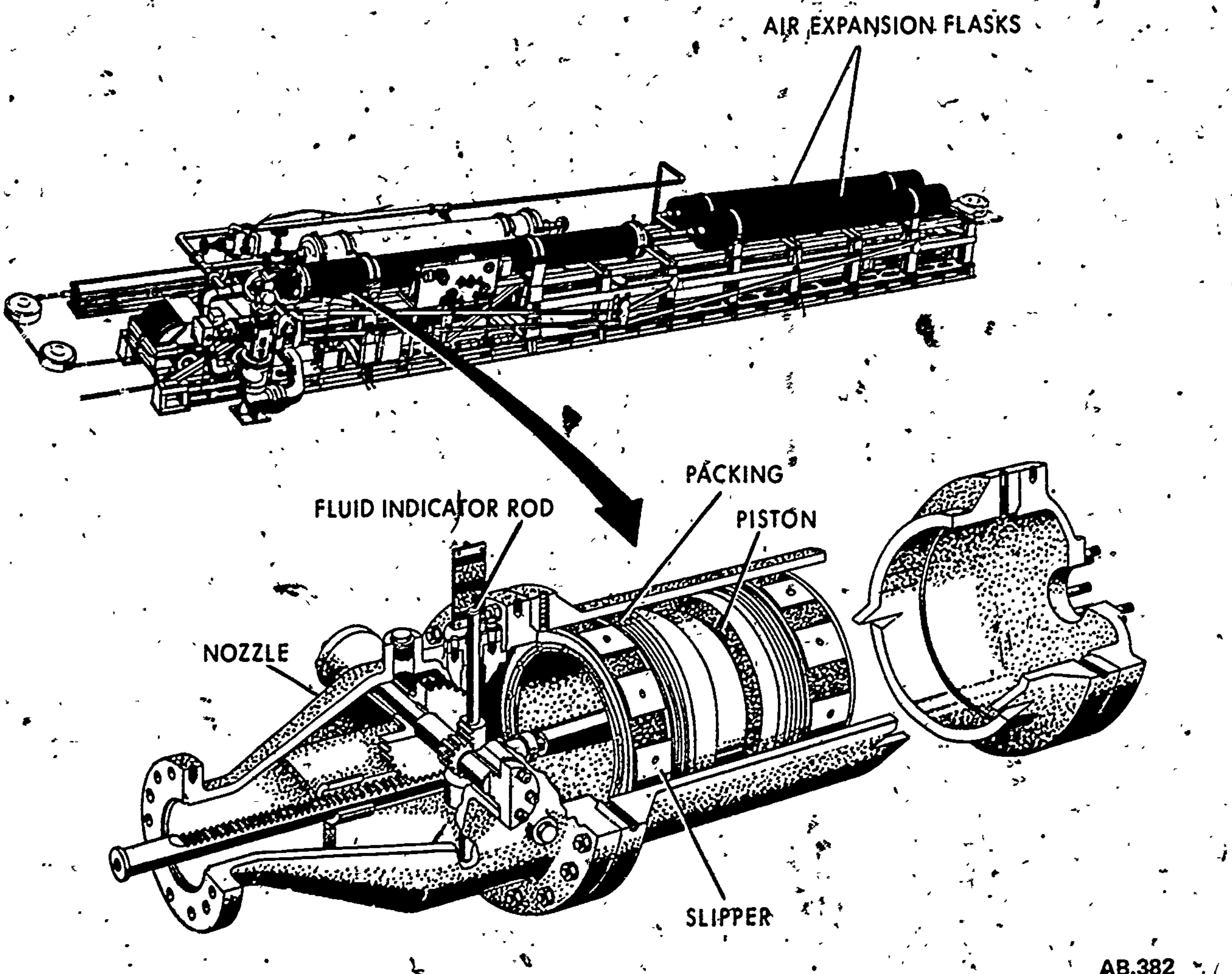
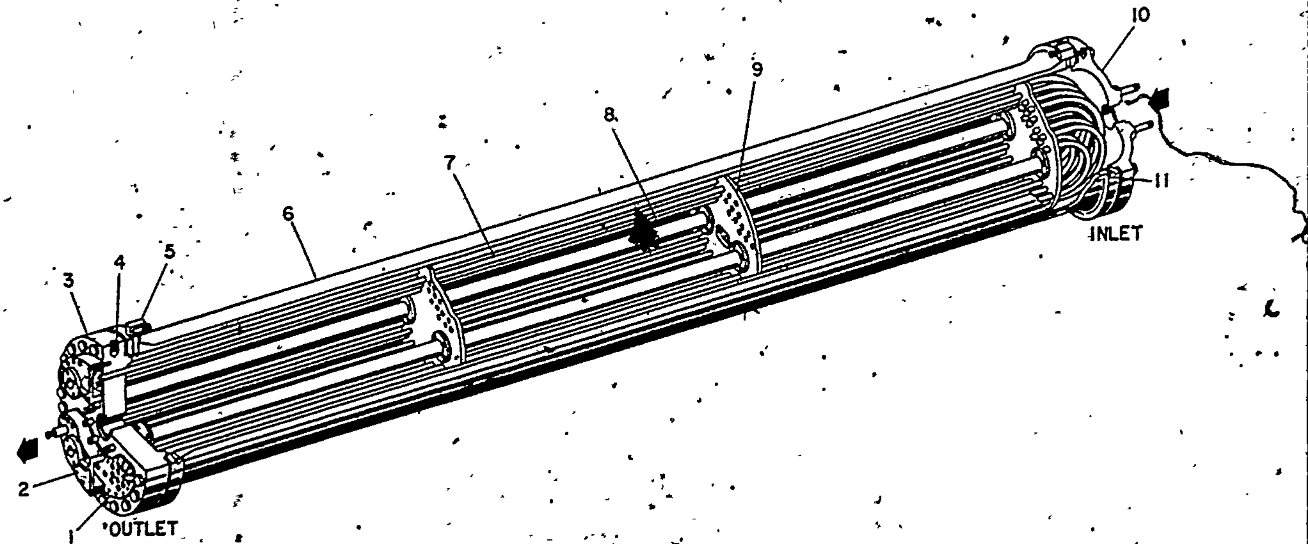


Figure 6-9.—The accumulator system.

ram. Figure 6-12 shows illustrations of the cylinder and ram assemblies of the Mods 1, 2, and 3 arresting engines.

The cylinder and ram assembly constitutes the actual engine of the arresting gear and is located within the engine structure between the movable crosshead and the cylinder outlet elbow on the Mod 2 and Mod 3 engines, and between the movable crosshead and the pressure valve body on the Mod 1.

The cylinder is a machined, forged steel, smooth-bore tube, open on both ends, and large enough to provide a working area for the ram and to house the fluid necessary for aircraft arrestments. It is supported within the engine structure by cylinder support saddles. On the Mod 2 and Mod 3 engines, one end of the cylinder is clamped and bolted with four cylinder clamps and Allen bolts to the cylinder outlet elbow (to the pressure valve body on the Mod 1). The other end receives the ram. The ram end of the Mod 2 engine cylinder is stepped and counterbored on the inside diameter to accommodate a slipper and cage assembly, a set of V-ring (chevron) packing, a retainer, and shims. A split wiper and wiper retainer are



1. Facing plate.
2. Manifold.
3. Tube head.
4. Lifting hole.
5. Vent valve.
6. Body.
7. Tubes.
8. Baffle support.
9. Baffle.
10. Head.
11. Plug.

AB.92

Figure 6-10.—Fluid cooler.

secured to the end of the cylinder to clean the ram as it moves into the cylinder. The Mod 1 and Mod 3 differ from the Mod 2 in that the packing is installed on the end of the ram instead of at the mouth of the cylinder as on the Mod 2.

The ram is a large hollow steel piston that is moved in and out of the cylinder by the crosshead. It is bored to reduce the weight, although it is not bored completely through. The inner end (the end that fits in the mouth of the cylinder) is solid and provides a working area between the ram and engine fluid during arrestments.

As previously mentioned, the inner end of the ram on the Mod 1 and Mod 3 contains a set of V-ring packing to provide a seal for the engine fluid between the cylinder wall and the ram, and on the Mod 1, a bronze liner on the ram serves as a bearing surface between the cylinder wall and the ram. The inner end of the ram on the Mod 2 and Mod 3 is stepped to accommodate a cage and slippers which provide a bearing surface for the ram as it slides in and out of the cylinder.

The outer (open) end of the hollow steel ram is clamped into a socket on the crosshead by a split flange which fits into an annular groove near the end of the ram.

Crosshead Assembly

By means of the crosshead and fixed sheaves, arrestment forces transmitted by the deck pendant and purchase cable are applied to the arresting engine.

The crosshead (fig. 6-13) consists of two groups of nine sheaves each. Due to the similarity of the crosshead and the fixed sheave assembly, only the crosshead is discussed in

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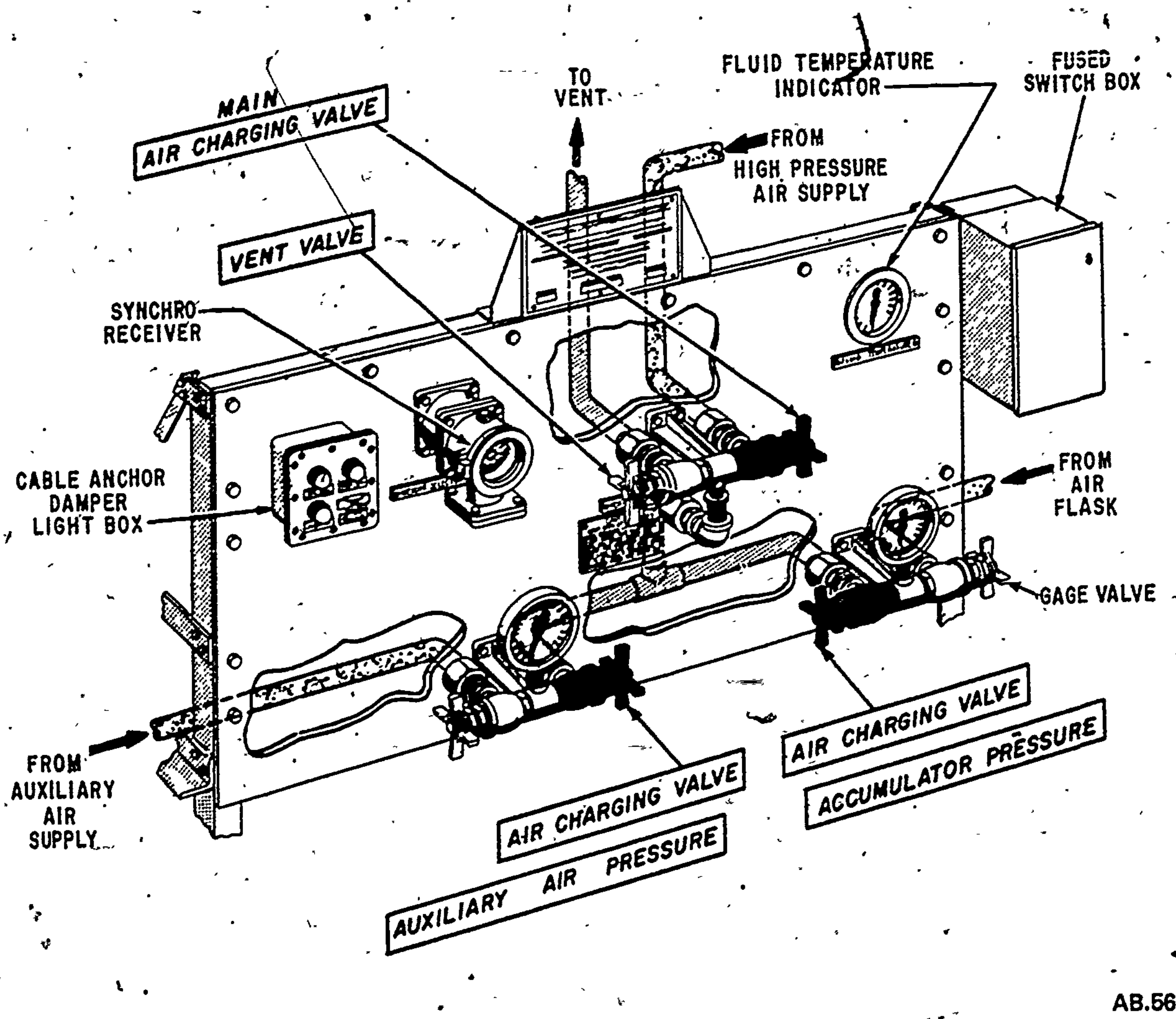

Figure 6-11.—Main control panel.

detail. The major difference between the two is that the crosshead is movable and has phenolic slippers as a bearing surface.

The sheaves are mounted on two shafts contained in three weldments. The outer sheaves are 33 inches in diameter, and the inner sheaves are 28 inches in diameter. This diameter differential is necessary for purchase cable clearance. The sheaves are separated by slotted spacers and rotate on roller bearings. A lubricator extension installation connects lubrication fittings to the ends of the shaft to provide the means of lubricating the sheaves, spacers, and roller bearings.

An automatic lubrication system has been designed to maintain lubrication between the high speed spacers and bearing pads on both the crosshead and the fixed sheave assemblies. This automatic lubrication system utilizes the high speed lubricators shown in figure 6-13. The system is operated by air pressure, and lubricant is delivered to the high-speed spacers on each engagement. In the event of a breakdown the system can be disconnected and the spacers

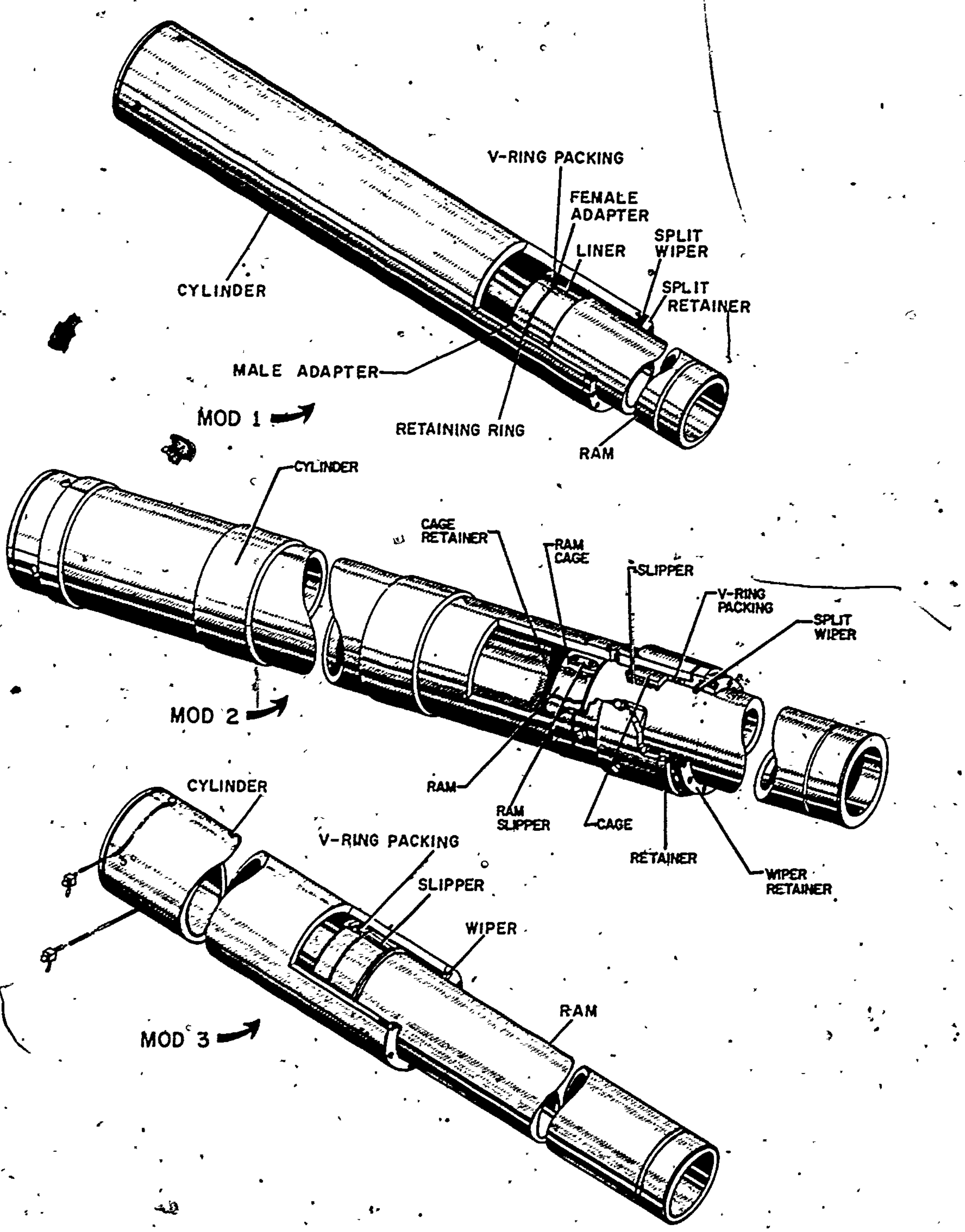

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Figure 6-12.—Cylinder and ram assemblies.

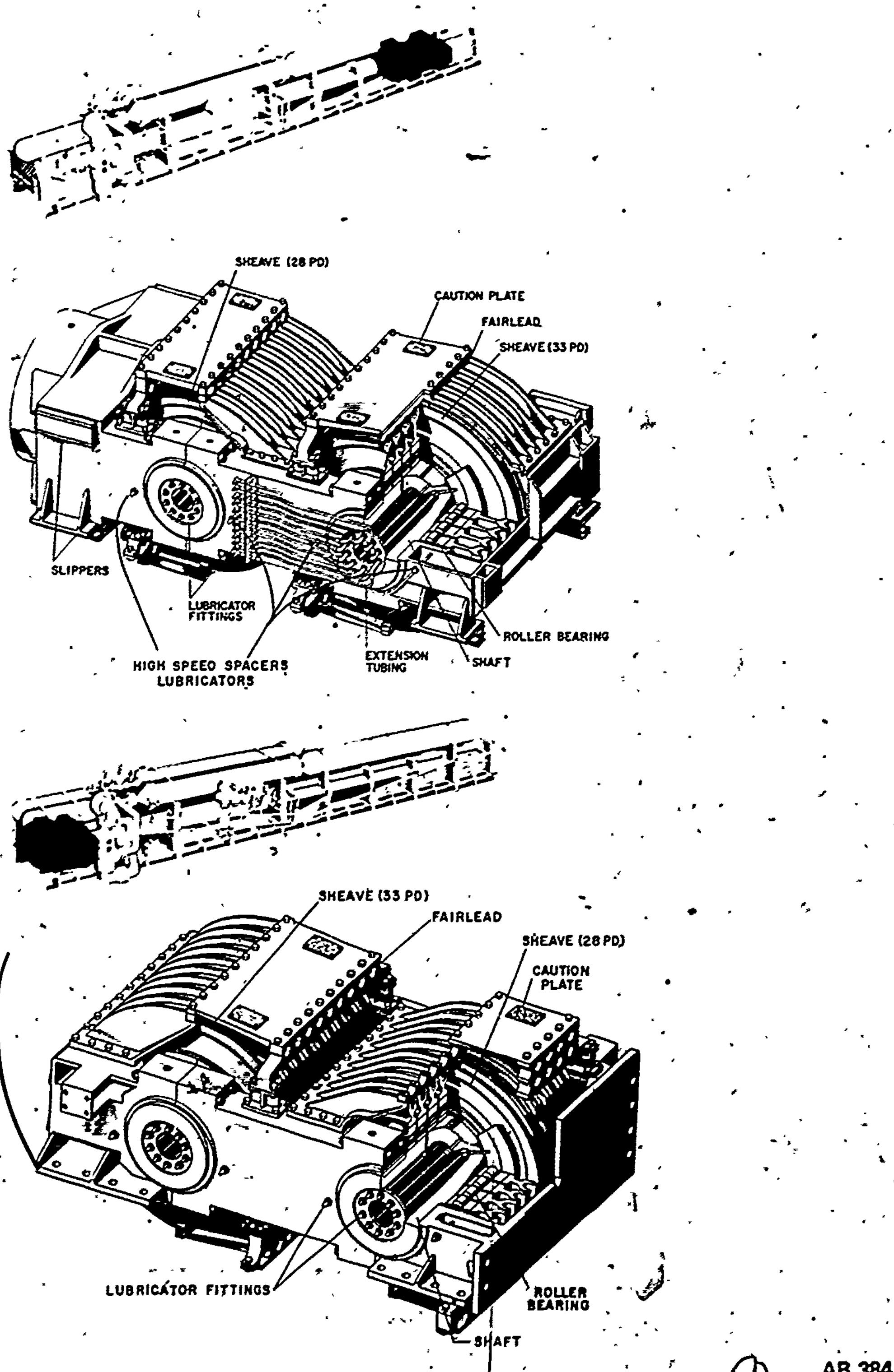


Figure 6-13.—Crosshead and fixed sheaves.

lubricated by hand at the lube fittings. This system is not used for barricade engines.

Stiffeners welded to the outer, center, and inner sections of the crosshead act to strengthen the assembly. Sheave guards are mounted at the top and bottom of the sheaves to provide protection for operating personnel and to prevent cables from jumping sheaves. Fairleads provide a guide for the purchase cable at the top and bottom of each sheave nest. Slippers mounted on each corner of the crosshead are held in place by brass retainer plates and dowel pins. There is a total of 16 slippers. These slippers support and level the crosshead, and provide a bearing surface when the crosshead is moving. The crosshead and fixed sheave assembly operate on the principle of a block and tackle, with a reeving ratio of 18:1. This means that the deck pendant topside moves 18 times as fast and 18 times as far as the crosshead on an arrested landing.

Cable Anchor Damper

The cable anchor damper installation consists of two identical cable anchor damper assemblies which are either deck mounted (fig. 6-14) or overhead mounted. Compartment configuration determines which units are installed.

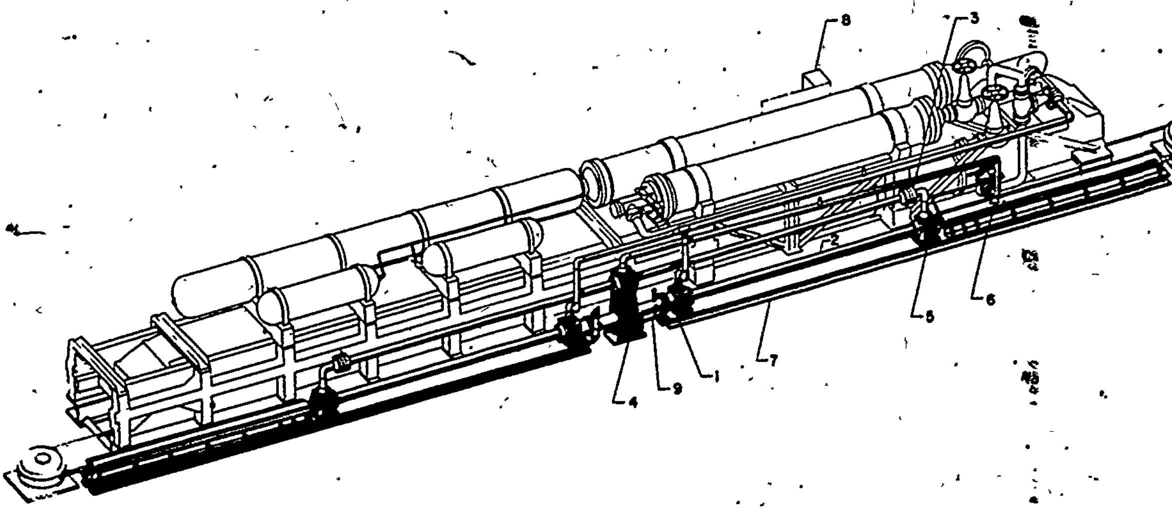
The purpose of the cable anchor damper is to eliminate excessive purchase cable slack between the crosshead and fixed sheave assembly at the beginning of the arrestment stroke. Through service use and experimental testing, it was found that when this slack was taken up by the landing aircraft, excessive cable vibrations occurred with the Mods 2 and 3 engines. The cable anchor damper removes this slack as it occurs, thereby eliminating vibration of the purchase cable. The cable anchor damper assembly is used with pendant engines only.

Each cable anchor damper assembly consists of a cylinder (2) which connects to an operating head (5) and a cushioning head (1). Piping connects engine cylinder fluid to the operating head through a manifold tee (4). Two lines branch from the manifold tee, one to each damper assembly operating head. Each of these lines contains a flow control valve (3). A cover (6) is placed over the operating piston rod and coupling assembly for safety of operation and protection against foreign matter. Each damper assembly is mounted on a base (7) before installation. A battery positioner (9), actuated by means of the retracting lever, is provided to insure the return of the damper assembly to battery position after an arrestment. A battery position indicator is provided to indicate when the cable anchor damper is in battery position, ready for aircraft engagement. The limit switch and cam actuator for the battery position indicator are located on the cable anchor damper assembly, and the indicator lights are located on the arresting engine control panel.

The end of the purchase cable is attached to the operating piston rod which is attached to the operating piston. When the force on the operating piston, due to engine cylinder pressure, is greater than the tensile force in the purchase cable, the piston moves away from its battery position. Movement of the operating piston into the cylinder removes the cable slack during the first portion of the arrestment. When the slack is taken up, the operating piston resists the return of the cable, thus keeping it taut and preventing excessive cable vibrations.

Upon engagement of the deck pendant by the aircraft, the engine crosshead is accelerated toward the fixed sheaves. This movement forces the ram into the arresting engine cylinder, increasing the fluid pressure in both the engine cylinder and the operating head of each cable anchor damper. (See fig. 6-15.)

Due to the acceleration rate of the engine crosshead, the tension in the purchase cable (2) between the engine sheaves and the cable anchor dampers decreases momentarily. The instant the tensile force in the cable becomes less than the force on the operating piston (4), fluid pressure moves the operating piston away from its battery position until all slack is removed and the cable tension is again greater than the fluid pressure force acting on the operating piston. The engine fluid has free flow through the flow control valves (1), to the operating end of each cable anchor damper. The flow control valves open as the operating pistons accelerate away from the flanges to allow equal fluid pressure to be exerted on the entire force area of each operating piston. When the tension of the purchase cable is transmitted to the cable anchor ends, the fluid pressure force on the operating



1. Cushioning head.
2. Hydraulic cylinder.
3. Flow control valve.
4. Manifold tee.
5. Operating head.
6. Cover.
7. Base.
8. Light box assembly.
9. Battery positioner.

AB.385

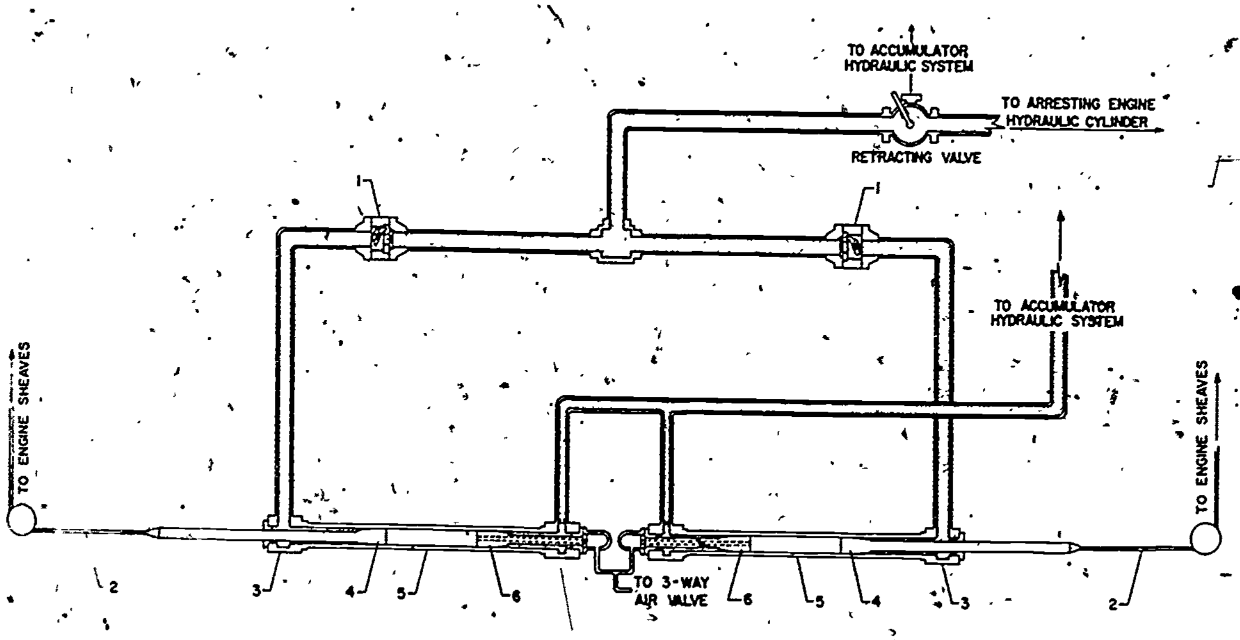
Figure 6-14.—Cable anchor damper installation, deck mounted.

pistons is overcome by this cable tension and the operating pistons are pulled back toward battery position. Resistance to their return is furnished by the engine fluid pressure and the controlled flow of fluid through the flow control valves back to the engine cylinder. A 2-inch buffer stroke between the operating pistons and flanges prevents a hard impact between the two as the pistons bottom against the flanges.

The sole function of the cushioning piston is to prevent the operating piston from slamming into the opposite end of the cable anchor damper assembly if the purchase cable should break or in the event of an extreme offcenter landing. In either situation, the operating piston accelerates away from its battery position and rams the cushioning piston.

The battery positioner (fig. 6-16) functions to return the cable anchor damper piston to its battery position during the retracting cycle of the arresting engine.

The battery positioner consists of a 3-way air valve (3) which is connected to the 100-psi air supply and to the air container mounted on the cushioning end of each damper assembly. An air strainer (4) is located in the supply line ahead of the 3-way valve. The 3-way air valve is mounted on a base plate (5), secured to the arresting engine retracting valve, and operated by means of a cam (1) mounted on the retracting valve actuating lever. When the actuating lever is moved to its retract position, the cam positions the 3-way air valve to admit 100-psi air to the air containers. From the air container, the 100-psi air passes through a hole in the cushioning piston rod and acts against the operating piston, moving it to its fully retracted position. As soon as the actuating lever is released, the air pressure is shut off and the air container is vented through an exhaust line (2) at the 3-way air valve. A line containing a liquid sight indicator (7) and a drain plug (6) is provided at each



1. Flow control valve.
2. Purchase cable.
3. Operating head.
4. Operating piston.
5. Cylinder.
6. Cushioning piston.

AB.386

Figure 6-15.—Cable anchor damper fluid flow, arrestment.

container. The fluid sight indicator permits detection of fluid leakage into the air container.

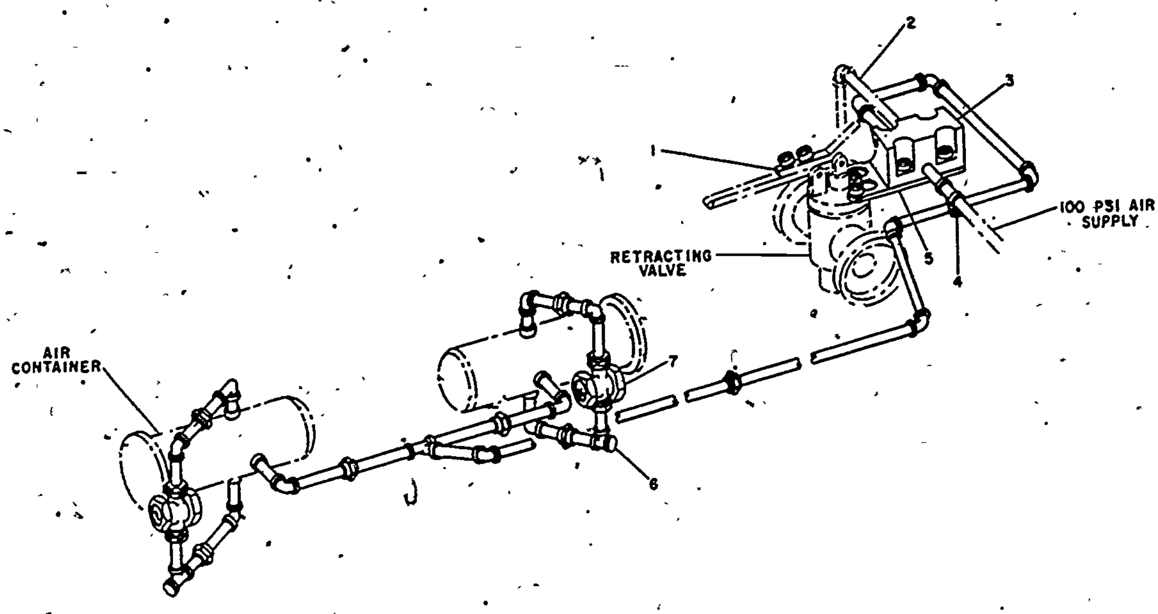
Sheave Damper

Due to the high engaging velocities of modern carrier-based aircraft, cable tension and vibration would be excessive unless eased by shock absorption in the sheave damper. The sheave damper reduces peak cable tension and lessens cable vibration.

A sheave damper assembly (fig. 6-17) is mounted to the ship's structure below each port and starboard retractable or fixed horizontal deck sheave. The port and starboard assemblies are identical; therefore, only one will be discussed.

DESCRIPTION.—Each sheave damper assembly consists of a movable crosshead assembly, damper cylinder assembly, damper piston, damper accumulator and fluid piping, buffer assembly, and a charging panel. The system is also equipped with a common fluid stowage tank that provides a stowage space for fluid in the sheave damper assembly while maintenance is being performed. The tank is capable of stowing all the fluid in one sheave damper installation.

The crosshead assembly consists of one roller bearing sheave mounted between a steel base plate and a side plate that are bolted together. A sheave shaft, mounted through the bottom of the base plate, is secured to the side plate by a cap and setscrew. A yoke is bolted between the side plate and the base plate and provides a



1. Cam.
2. Exhaust.
3. Three-way air valve.
4. Strainer.
5. Base plate.
6. Drain plug.
7. Sight indicator.

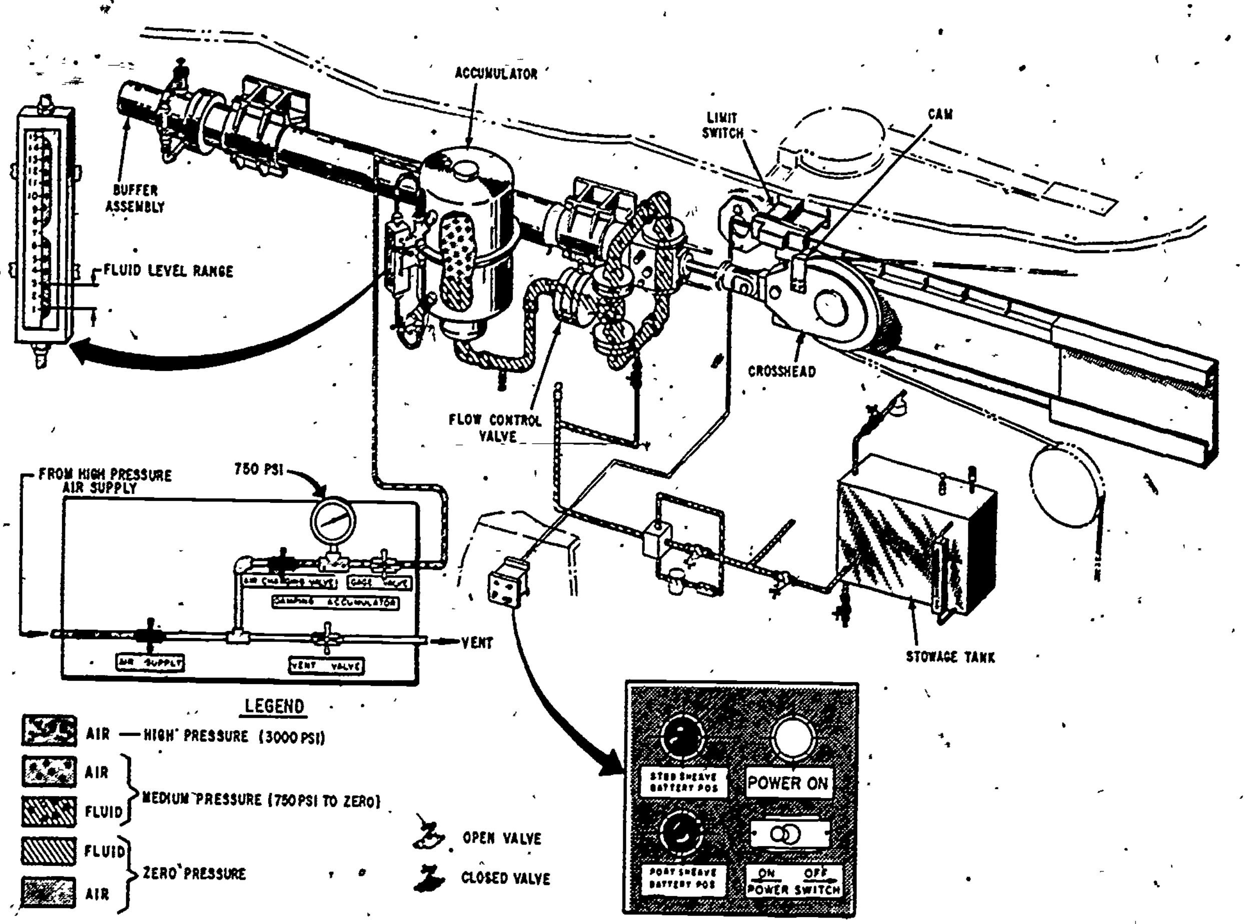
AB.387

Figure 6-16.—Battery positioner.

means of connecting the crosshead to a clevis that is screwed onto the end of a piston rod. The crosshead rides in a track mounted in a horizontal position on the bulkhead. Phenolic slippers, at all four corners of the base plate, provide a bearing surface between the crosshead and the track. Attached to the crosshead is a cam that actuates a limit switch when the crosshead is fully retracted and causes a green light to light at the deck edge control station. This indicates to the deck edge operator that the sheave damper is in its battery position.

The damper cylinder assembly is secured to the ship's structure by brackets which are welded to the bulkhead and bolted to the cylinder. A cylinder cap is screwed onto the crosshead end of the cylinder and held in place by setscrews. The cap provides a fluid passage between the cylinder and the fluid manifold piping leading to the damper accumulator. The damper piston rod extends through the cap at the crosshead end of the cylinder. The damper piston is secured onto the opposite end of the piston rod and held in place by a castle nut and cotter pin. When the damper piston is in its battery position, 3 1/2 inches of the piston rod extends from the cylinder at the crosshead end.

The fluid manifold is bolted to the top and bottom of the cylinder cap. A reducing tee connects the upper and lower manifold piping and serves to divert fluid flow from the accumulator equally into the upper and lower manifolds. A flow control valve is located between the reducing tee and the accumulator. The flow control valve has a flapper type (swing gate) orifice plate that allows free flow of fluid from



AB.61

Figure 6-17.—Sheave damper assembly.

the cylinder to the accumulator, and a restricted flow through an orifice in the center of the plate from the accumulator to the cylinder.

The accumulator acts as a fluid stowage tank, and has a high pressure air connection from the upper head to the charging panel. The charging panel has a charging valve and a gage valve with a gage mounted between them, a high pressure air supply valve, and a vent valve. The accumulator is charged to 750 psi and must have a reading of 2 (±1) inches of fluid on the fluid sight indicator when the sheave damper is in its battery position.

The end of the cylinder opposite the crosshead end has a flange threaded on it that mates with a flange on the buffer assembly. The two flanges are bolted together. The buffer assembly consists of a cylinder, buffer ram, spring, and a fluid sight indicator. The purpose of the buffer assembly is to buffer the damper piston when returning to its battery position.

PREOPERATION.—Before operating the sheave dampers, the hydraulic system must be filled and an air charge must be supplied.

Use the following procedure in filling the hydraulic system:

1. Block the arresting engine crosshead and pull out the deck pendant until the crosshead of each sheave damper is fully extended.

2. Fill the accumulator until it is approximately one-half full.

3. Pressurize the accumulator to 100 psi. This will retract the sheave damper crosshead.

4. Open all needle valves in the hydraulic system until the flow of fluid is free of air and foam.

5. Fill or drain fluid from the accumulator to obtain a fluid level gage reading of 3 inches maximum, 1 inch minimum.

6. Increase the damper accumulator pressure to 750 psi.

OPERATION.—An incoming aircraft engages the deck pendant, causing an increase of tension on the purchase cable. The purchase cable is reeved around the sheave damper crosshead in a manner that any increased tension experienced by the purchase cable will cause the crosshead to move away from its battery position. As the crosshead moves, the damper piston moves, forcing fluid from the cylinder, through the fluid manifold, flow control valve, and fluid piping into the accumulator. The resulting pressure buildup in the accumulator will be proportional to the purchase cable pull. Retraction of the sheave damper is automatic and occurs when accumulator pressure becomes greater than cable tension. Retraction normally occurs prior to full runout of the aircraft. The pressure buildup in the accumulator forces the fluid from the accumulator, through the fluid piping, the orifice in the flapper of the flow control valve, the reducing tee, and the fluid manifold to the damper cylinder, thereby forcing the damper piston back to its battery position. Just prior to the damper piston reaching its battery position, the end of the damper piston rod comes in contact with the buffer ram. The buffer assembly works on the liquid pressure control principle to buffer the damper piston. The spring only extends the buffer ram during arrestment.

As the sheave damper crosshead reaches its battery position, the battery position limit switch is engaged and lights the battery position indicator light at deck edge.

BARRICADE

Except for the reeve of the engine and the absence of a fluid cooler, the arresting engine used for the barricade is identical to the pendant engines used for normal arrested landings. The barricade engine is endless reeved instead of single reeved like the pendant engines, and because of the infrequent use of the barricade engine, a fluid cooler is not needed.

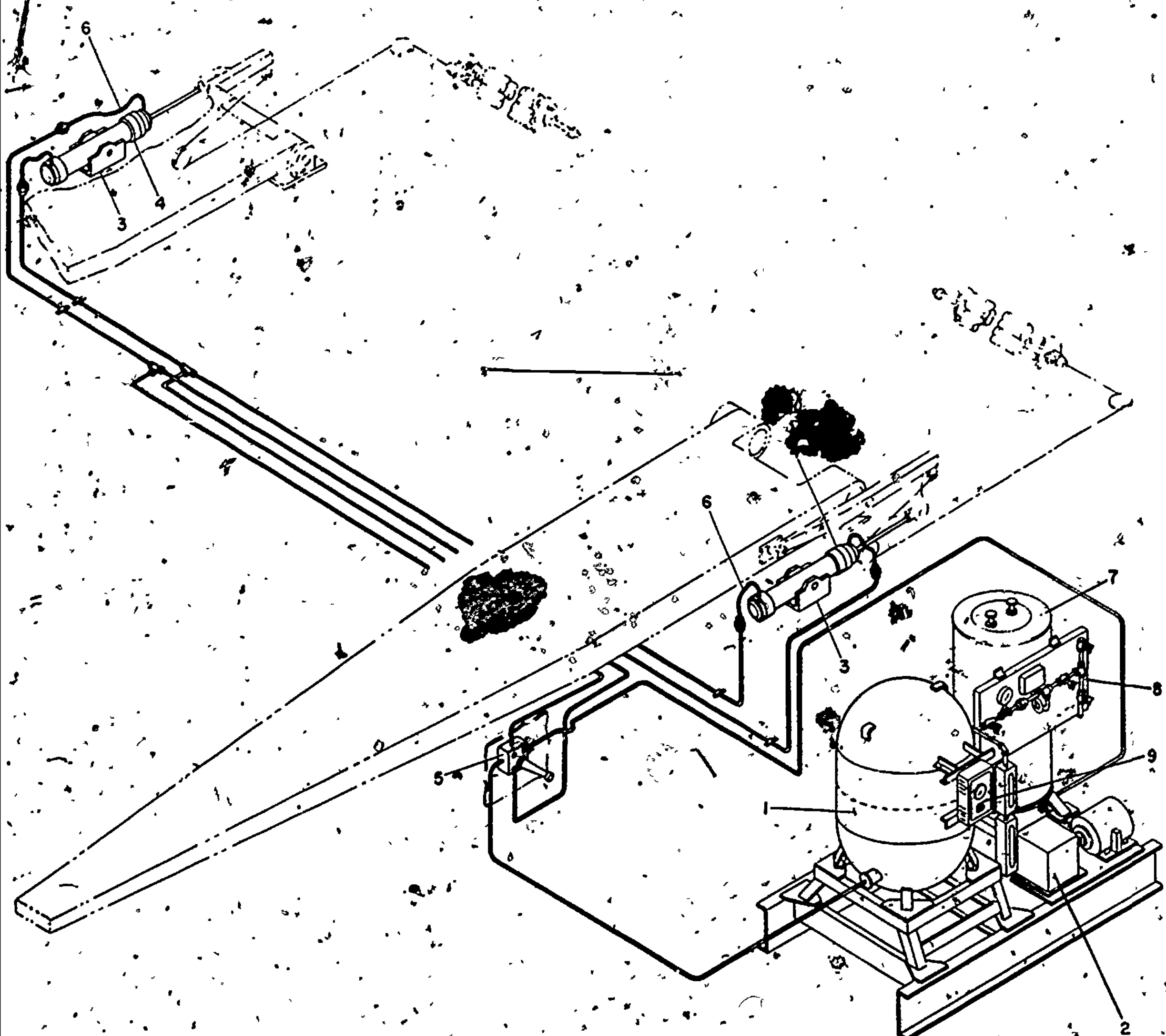
The actual barricade is a webbing assembly stretched across the flight deck and connected to two stanchions, one port and one starboard. The stanchions are hydraulically operated to raise the webbing assembly when an aircraft cannot make a normal arrested landing

The barricade stanchions house the winch assemblies which tension and support the upper loading straps of the barricade webbing assembly. The stanchions are provided with a pivot about which they are raised and lowered.

Included in the hydraulic barricade assembly is a power package located below decks, a hydraulic control valve operated at the deck edge control station, hydraulic piping and hose assemblies, and the hydraulic operating cylinders.

The power package (fig. 6-18) provides and maintains the fluid pressure required by the hydraulic cylinders to raise and lower the barricade stanchions. It consists of a base weldment, gravity tank assembly (7), control panel assembly (8), accumulator (1), motor controller (9), pump (2), electric motor, electrical system, and a piping system.

The gravity tank assembly has a capacity of approximately 100 gallons and is the fluid reservoir in the power package assembly. Displaced fluid from the cylinder assemblies is returned to the gravity tank and from there it is pumped back to the accumulator. The gravity tank is welded steel, closed at the top and bottom by flat plates. The top cover plate has an access hole which is covered by a cap plate and gasket held in place by bolts. Tapped bosses welded to the cap plate are for breather vents. A liquid level gage is connected to the side of the gravity tank. An indicator plate is attached to



1. Accumulator.
2. Pump.
3. Cylinder support.
4. Hydraulic cylinder.
5. Hydraulic control valve.
6. Flexible hose.
7. Gravity tank assembly.
8. Control panel assembly.
9. Motor controller.

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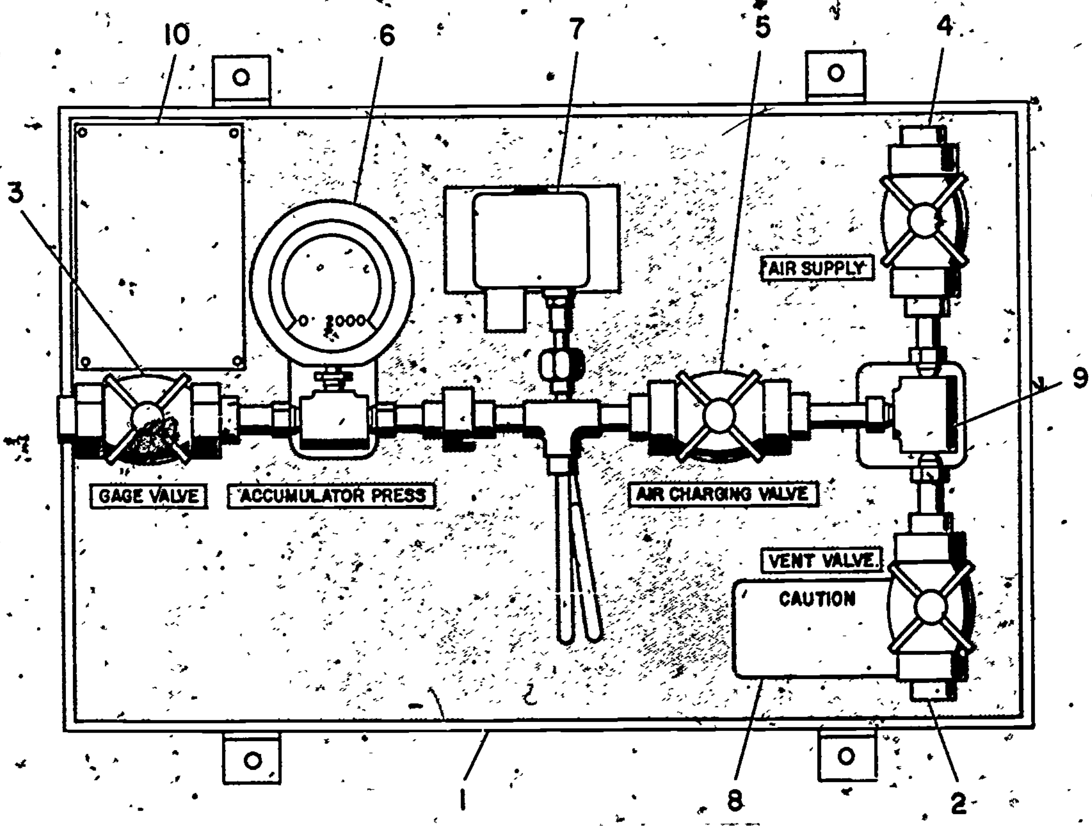
Figure 6-18.—Barricade hydraulic control installation.

he tank at the level gage to show the proper luid level.

The control panel assembly (fig. 6-19) is ttached to the gravity tank by four bolts.

The panel consists of the panel frame (1), two iping support brackets (9), accumulator pressure gage (6), pressure sensing switch (7), gage valve (3), air charging valve (5), vent valve (2), air supply valve (4), caution plate (8), and operating instruction plate (10). Necessary copper tubing and sil-braze fittings connect the panel to the accumulator assembly, to a ship's



1. Frame.
2. Vent valve.
3. Gage valve.
4. Air supply valve.
5. Air charging valve.
6. Accumulator pressure gage.
7. Pressure sensing switch.
8. Caution plate.
9. Bracket.
10. Instruction plate.

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Figure 6-19.—Control panel assembly.

exhaust line, and to the ship's high pressure air supply line. The accumulator pressure gage (6) is used to indicate pressures ranging from 0 to 2,000 psi in the accumulator.

The pressure sensing switch (7) is a piston type, contained in a splashproof housing. It is connected to the pressure line from the accumulator with a threaded adapter and a coil of tubing between the adapter and tee in the pressure line. The function of the pressure sensing switch is to maintain accumulator pressure between 1,250 psi and 1,500 psi. It does this by opening or closing to stop or start the pump motor. The pressure switch operates only when the motor controller switch is set at AUTOMATIC position. The caution plate (8) is located next to the vent valve (2). It cautions all concerned to keep the vent valve open at all times except when charging the accumulator, and contains instructions for closing the vent valve when charging the accumulator.

A gage valve (3) is furnished to maintain pressure in the accumulator when it is necessary to remove the pressure gage (6). The air charging valve (5) regulates the charging flow. The air supply valve (4) controls the flow intake of air to the control panel and accumulator. The operating instruction plate (10) contains basic operating instructions and a piping schematic.

The accumulator has a threaded boss welded to the top of the shell to provide for venting when hydrostatic testing. A liquid level sight glass gage is connected to two ports on the accumulator.

The motor controller regulates the starting and stopping of the pump motor in conjunction with the pressure sensing switch. The controller, operating magnetically, provides a switch control for OFF, AUTOMATIC, or RUN positions. The OFF position is used when the power package is secured. The AUTOMATIC position is used when the power package is to be operated, and the RUN position is used when it is necessary to bypass the pressure sensing switch. Protective features of the controller include pilot circuit and motor overload protection and undervoltage release. A white light is mounted on the controller to indicate when power is available. When the switch is in the OFF position, the circuits from the controller to the motor and pressure sensing switch remain open, or dead. In AUTOMATIC position, the motor starts when the contacts are closed in the pressure sensing switch, and the motor stops when the contacts open. The RUN position is spring returned, and the motor runs only as long as the switch is manually depressed.

In the piping system, manual valves are placed in the lines to provide for operating and standby conditions and for maintenance. Each valve is tagged with a nameplate giving its number and normal operating position (OPEN or CLOSED). Miscellaneous equipment includes a check valve, fluid strainer, hydraulic pressure relief valve, and an air safety head. The check valve between the accumulator and pump prevents fluid pressure from backing up to the pump. The fluid strainer in the line between the gravity tank and the pump removes foreign matter before it enters the pump. The hydraulic relief valve connected to the line between the check valve and pump provides for pressure relief. The hydraulic relief valve is adjusted to crack open at 1,600 psi (minimum) and open full at 1,750 psi. This line is equipped with a liquid sight indicator for visual checking of fluid flow which would indicate an open relief valve. The air safety head which ruptures at approximately 2,000 psi is connected to the air line between the accumulator and control panel. It acts as a safety to prevent charging the accumulator and related components above their design limits. Two breather vents at the top of the gravity tank provide for passage of air out of or into the tank as the liquid level rises or lowers. A screen in the breather vent removes any foreign matter from incoming air.

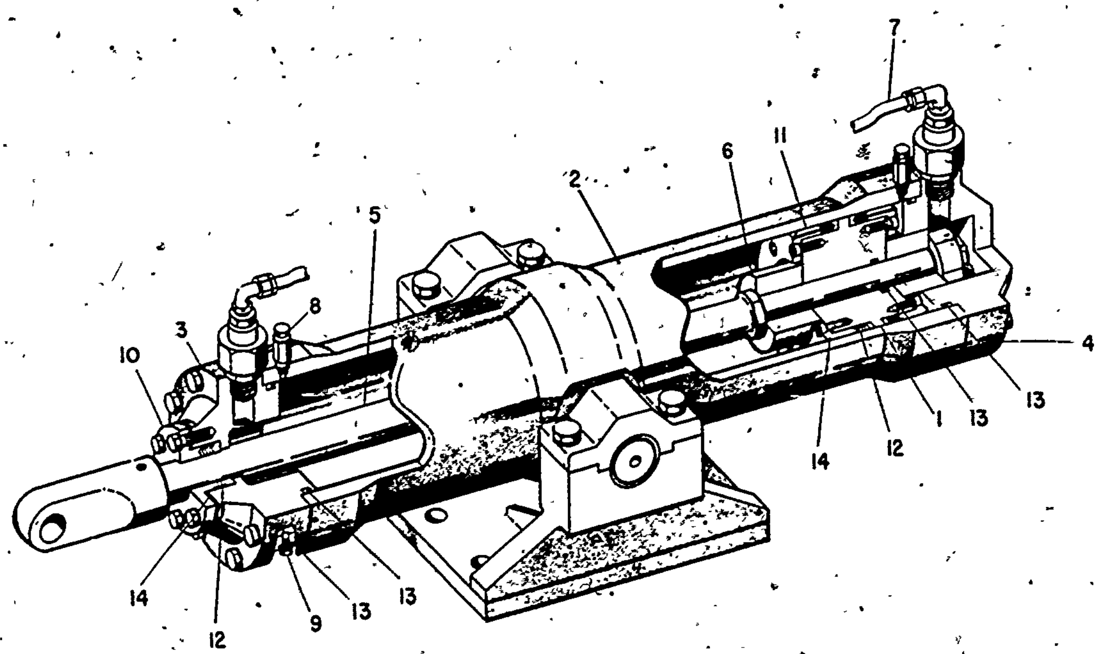
The hydraulic cylinder assembly (fig. 6-20) raises or lowers the barricade stanchion when hydraulic fluid under pressure is introduced into the cylinder on the proper side of the piston.

A front cap (3) and a rear cap (4) are each attached to the cylinder ends by bolts and washers and sealed by an O-ring (13) and backup rings. Contained in the cylinder (2) is a piston rod (5), two plungers (6), and a piston (1). The piston and plungers are held in position on the rod by a castellated nut secured by a cotter pin. The piston and piston rod are sealed by an O-ring (13) and backup rings. The piston is fitted with two packing followers, two sets of V-ring packings (12) (four rings each), and two piston glands (11) secured by bolts, each safety wired. Shims (14) are provided between the piston face and piston gland to obtain the proper packing float. The piston rod is sealed where it extends through the front cap (3) by a set of V-ring packings (12), a spacer, and the piston rod gland (10) secured by bolts and washers. Shims (14) are provided to obtain proper packing float. A terminal is attached to the end of the piston rod and is secured by a setscrew. The front and rear caps are each fitted with tailpiece, adapter, orifice plate, union nut, and an elbow for hose attachment; joints are sealed by O-rings and packing. A vent valve assembly (8), plug (9), and two O-rings are located at each end of the hydraulic cylinder to vent air or drain fluid.

Hydraulic Barricade Operation

During normal operations the system is put in READY condition:

1. Accumulator pressure at 1,500 psi.
2. Accumulator and gravity tank liquid at operating level.
3. Proper valves open or closed.



1. Piston.
2. Cylinder.
3. Front cap.
4. Rear cap.
5. Piston rod.
6. Plunger.
7. Hose.
8. Vent valve assembly.
9. Plug.
10. Piston rod gland.
11. Piston gland.
12. Packing.
13. O-ring.
14. Shim.

AB.390

Figure 6-20.—Hydraulic cylinder assembly.

4. Motor controller switch on AUTOMATIC.
5. Controls checked for proper operation,
6. Barricade tensioning pendants inspected for fraying.

After the holddown latch at the top of the stanchion is released and the deck edge control valve lever is placed in the UP position (No. 1), the stanchions will raise simultaneously. Raising operations may be stopped and stanchions held in any position by placing the deck edge control valve lever in midposition (No. 2).

To lower stanchions, the deck edge control valve lever is placed in the DOWN position (No. 3), and the stanchions will lower simultaneously. Lowering operations may be stopped and stanchions held in any position by placing the deck edge control valve lever in midposition (No. 2).

The deck edge control valve lever midposition (No. 2) is for standby position. It blocks all valve ports, and all passage of fluid is stopped when the valve is in this position. This position is used to stop stanchions during raising or lowering, and to hold the stanchions either up or down.

CAUTION: The control valve lever must never be held or left in any position between 1 and 2, or between 2 and 3, since this will allow fluid to drain from the accumulator to the gravity tank.

The gravity tank is not of sufficient size to contain the fluid if the stanchions are raised more than three times without the pump operating. Approximately 20 minutes is required for the pump to replenish fluid to the operating level in the accumulator if stanchions are cycled three times without the pump operating. The READY CONDITION for normal operation specifies 1,500 psi accumulator pressure; however, stanchions will raise and lower, taking a longer period of time, with a lower pressure, as is experienced if stanchions are cycled without the pump operating. Pressure at the start of the third cycle will be approximately 850 psi without the pump operating.

NOTE: If stanchions are cycled more than three times without the pump operating, air will enter the piping and cylinders and fluid will overflow the gravity tank. It will then be necessary to fill, vent, and charge the system as specified in the applicable operating manual.

During READY and SECURE conditions, the following checks are to be made:

1. During READY condition, at 1-hour intervals, checks of the accumulator pressure, accumulator and gravity tank liquid levels, controller switch for AUTOMATIC setting, and a check to ascertain that the pump is not operating when accumulator pressure is 1,500 psi or above.

2. During SECURE condition, daily checks of the accumulator pressure, accumulator and gravity tank liquid level, valves for position (open or closed), and controller switch for OFF setting.

The system must be operated weekly to raise and lower the stanchions, to vent air from both ends of hydraulic cylinders, and to check the operation of the system. It is not necessary to attach the barricade webbing during this exercise.

Webbing Assemblies

When the need for an emergency barricade rigging arises, it is too late for checking or insuring that the webbing assembly is properly assembled or properly stowed for ease of installation. To operate effectively, it is of prime importance that the barricade be correctly rigged, and that all of its component parts be of the latest specification and issue, and in optimum condition to accomplish a successful engagement and subsequent arrestment. Use of defective parts or improper rigging of a barricade could result in premature failure of barricade components, which would render the barricade useless and result in property damage and serious injury or death to the pilot and/or flight deck personnel.

The preassembled triple webbing should be stowed in a space (or area) where it will be protected from exposure to of the elements, and where it may be readily transported onto the flight deck for installation.

NOTE. The double webbing assembly MAY BE USED FOR E2/C2 AIRCRAFT ONLY. It is preassembled and stowed in a box at deck edge ready to be rigged.

Constant inspection and checks must be made to determine that the nylon webbings are free from signs of wear or deterioration and fraying. A barricade that has been used for two or more practice or training rigs, or that has been exposed to direct sunlight for 100 hours or more, will not be used for an actual aircraft engagement. Barricades will be covered with canvas if conditions require stowage of preassembled barricades or component parts on deck.

If a tractor is used to remove a barricade from the stowage location onto the flight deck, special care must be exercised to prevent any tearing or fraying of the webbing, extension loops, loading straps, etc, on deck hatches or other protrusions.

SHEAVES

There are four types of sheaves used in Mk 7 arresting gear. These are the horizontal deck sheave, the vertical through deck sheave, the fairlead sheave, and the retractable sheave. All these sheaves are designed to accommodate 1 3/8-inch diameter purchase cable and are made of forged aluminum alloy.

A typical sheave consists of a base and cover that retains the sheave assembly. Two lubricator fittings provide access for lubricating the sheave bearing and spacers. The sheave assembly consists of three races—an inner race, a bearing race, and an outer race. Mounted with each sheave is a two-piece concentric spacer. The inner spacer is made of steel and is the lubricant distributor. The outer spacer, made of phenolic, is bonded to the sheave and provides a bearing surface and is a lubricant retainer for the sheave. The horizontal and vertical sheaves are identical except for the lubrication arrangement.

NOTE: Mark 7 Arresting Gear Service Change #230, dated 30 September 1966, directs the replacement of all 24-inch pitch diameter sheaves with 28-inch pitch diameter sheaves. The larger pitch diameter sheave decreases purchase cable bending, thus improving cable reliability. Unless specifically directed, this service change does NOT include the anchor damper assembly sheaves. Fairlead tubing of 2 1/2-inch diameter is installed whenever necessary between fairlead sheaves. This is to protect the purchase cable and to prevent any dangerous whipping in the event of purchase cable breaking. The purpose of all fairlead sheaves is to change the direction of the purchase cable so that it can be led from the arresting engine to the flight deck.

Retractable Sheave

The function of a retractable sheave is to provide a means of lowering deck sheaves which would interfere with the passage of aircraft and deck equipment when in the raised operating position.

Each retractable sheave is operated by an electric motor unit controlled by a deck pushbutton station. In addition, an indicator light box is installed adjacent to the deck edge pushbutton station to show the position of the sheave—a green light when the sheave is fully raised, or a red light in all positions other than fully raised. The retractable sheaves may also be operated by means of handwheels in case of emergency. The handwheel is located below decks on the operating unit. To eliminate the chance of the retractable sheave being lowered inadvertently during landing operations, the handwheel is removed from the unit whenever it is not actually being used.

The retractable sheave operating unit is bolted to the bottom of the retractable sheave assembly. It is accessible for maintenance and manual operation from that compartment on the gallery deck which is directly below the retractable sheave.

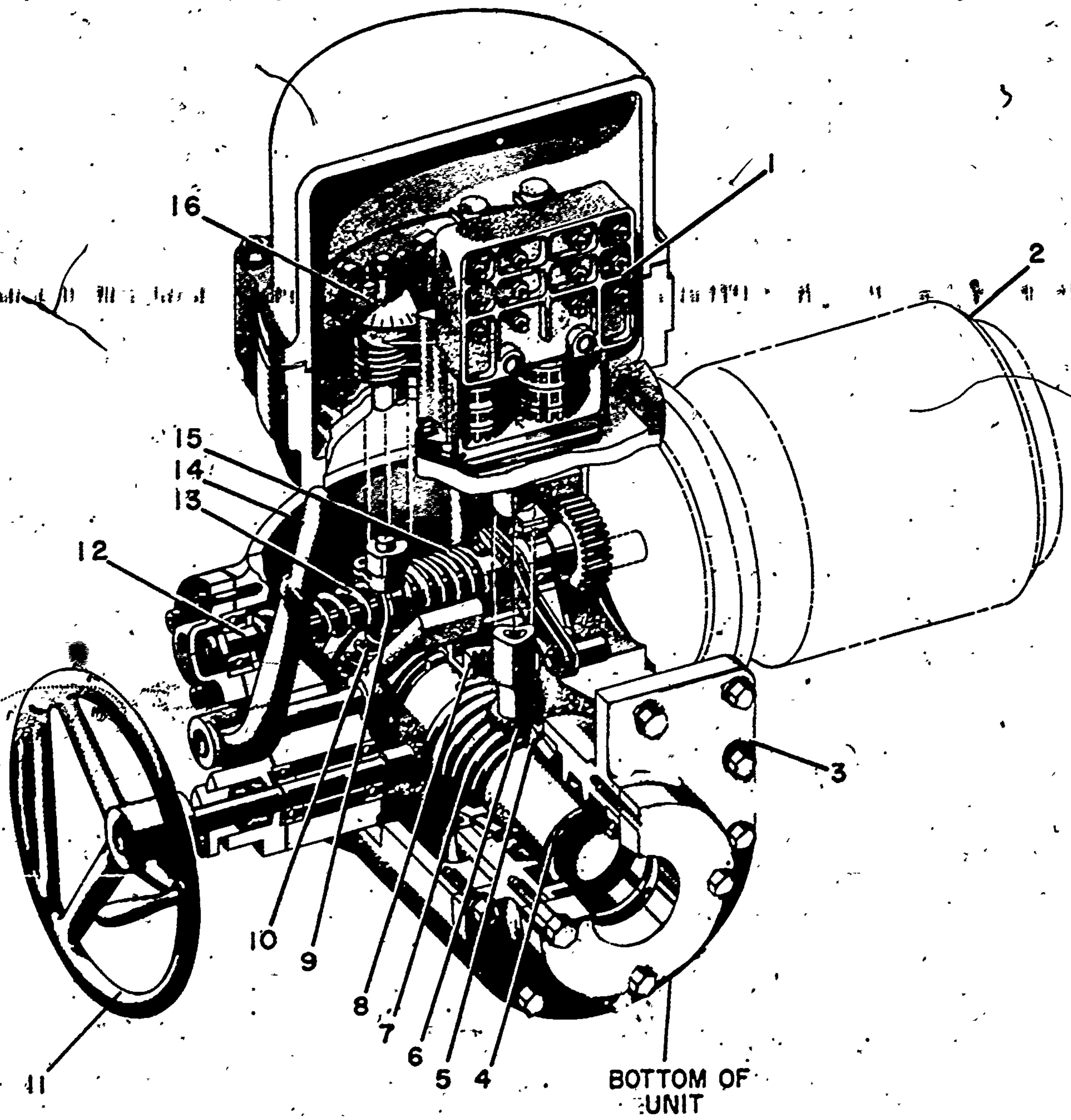
The retractable sheave operating unit (fig. 6-21) is a self-contained unit consisting of a high starting torque electric motor, a geared drive system, and limit switches.

The motor (2) is coupled to a wormshaft (12) which has a worm (15) splined to the shaft. The worm (15) engages the worm gear (10) which is free to rotate on the sleeve (4). There are two lugs on the back of the worm gear (10) which, after some free rotation, engage two lugs on the back of the clutch bevel gear (8). The free rotation is to prevent putting an immediate load on the electric motor (2). The clutch bevel gear (8) is splined to the sleeve (4), so that any rotation of the clutch bevel gear (8) rotates the sleeve (4).

The sleeve is directly keyed to the lead screw of the retractable sheave so that rotation of the sleeve raises or lowers the sheave. The amount of sleeve rotation while the sheave is rising is governed by the adjustable geared limit switch (1) which opens the motor circuit when the sheave is fully raised. An adjustable torque limit switch (16), actuated by the tripping plate washer (9), opens the motor circuit when the sheave is fully lowered and further provides overload protection for the unit. The worm is normally held in position with a heavy torque spring (13). If an obstruction under the sheave prevents the sheave from lowering, the sleeve cannot turn. Then the torque exerted by the worm exceeds the normal torque, causing the worm to slide along the wormshaft (12), pushing the tripping plate washer (9), and opening the torque switch. A handwheel (11) is provided for manual operation, and a declutch lever (14) is provided to change from motor to hand operation.

It is imperative that the deck edge operator knows whether the retractable sheave is in the raised position during landing operations. During night operations, visual sighting of the retractable sheave is impossible.

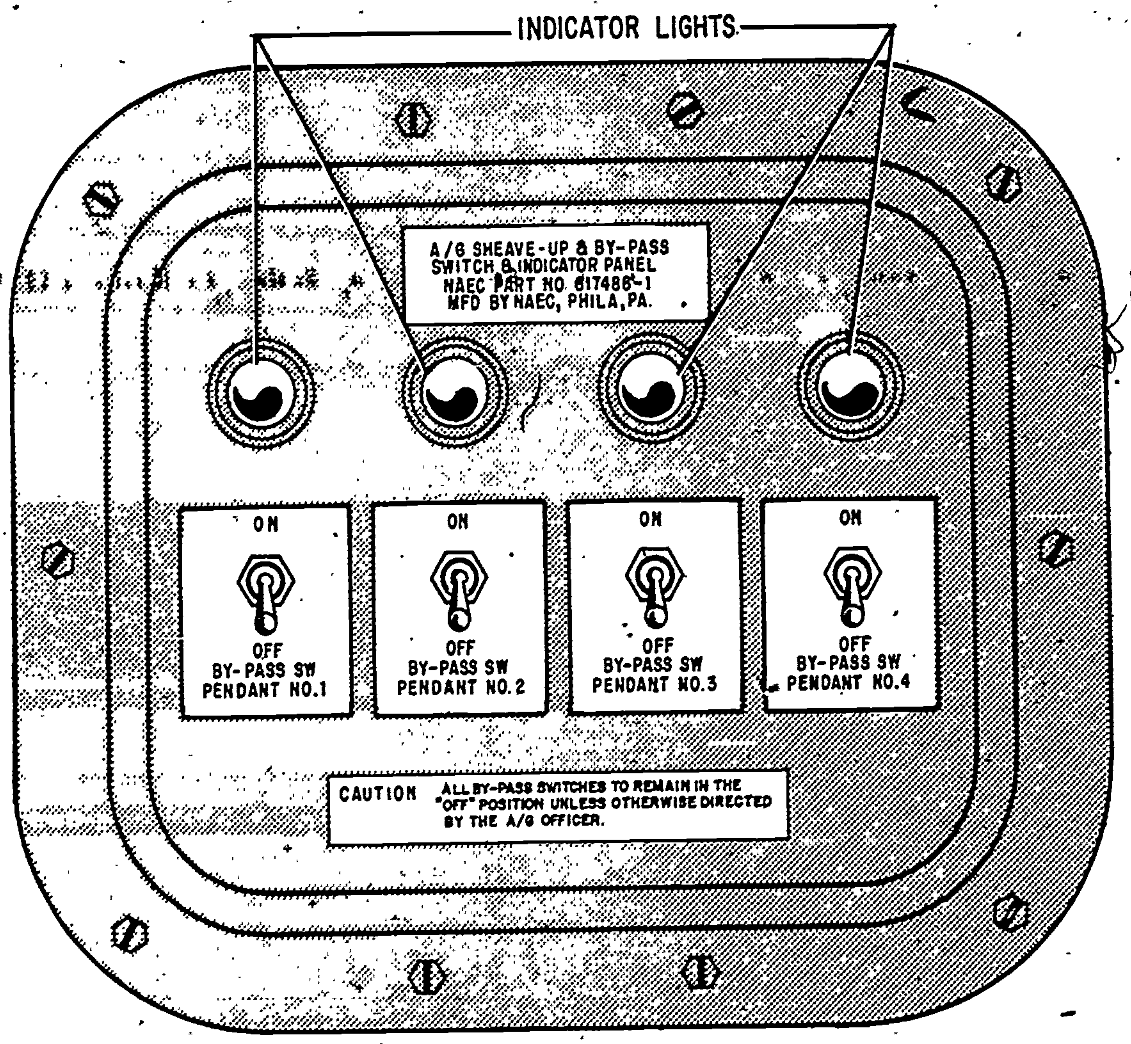
An arresting gear SHEAVE-UP and BY-PASS switch and indicator panel (fig. 6-22) is located aft of the arresting gear deck edge control station to indicate the retractable sheave status. The panel is wired into the clear/foul deck light and will prevent the arresting gear officer from giving a clear deck signal if one or more of the retractable sheaves is not in the fully-up position. Green lights indicate that all sheaves are



1. Geared limit switch.
2. Motor.
3. Housing.
4. Sleeve.
5. Lower bevel gear.
6. Pinion.
7. Clutch fork spring.
8. Clutch bevel gear.
9. Tripping plate washer.
10. Worm gear.
11. Handwheel.
12. Wormshaft.
13. Torque spring.
14. Declutch lever.
15. Worm.
16. Torque limit switch.

AB.391

Figure 6-21.—Retractable sheave operating unit.



AB.368

Figure 6-22.—SHEAVE-UP and BY-PASS switch and indicator panel.

up, a red light indicates a sheave is down and will prevent the clear deck signal from being given. A BY-PASS switch is provided for each pendant to enable recovery operations to be continued by removing the pendant from the engine with a down retractable sheave and placing the BY-PASS switch in the ON position.

The indicator lights can be readily checked by raising all sheaves to the fully-up position and then lowering one sheave at a time. As each sheave is lowered, the panel is checked for a RED light indication for the pendant served by the sheave that has been lowered. With the BY-PASS switch in the ON position, the panel is checked for an AMBER light. When the BY-PASS switch is in the ON position, capability to give a GREEN clear deck signal is restored.

Sequence of Operation

Energizing the motor to raise the retractable sheave, by pressing the RAISE pushbutton, causes the motor to rotate a helical gear keyed to its shaft. This transmits the motor force to another helical gear on the wormshaft. The wormshaft turns the worm and drives the worm gear on the sleeve. The worm gear rotates freely on the sleeve for part of the rotation, thus permitting the motor to gain speed before full loading. As the worm gear rotates, the lugs on its face engage the lugs on the face of the clutch bevel gear. Rotation of the clutch bevel gear, which is splined to the sleeve, rotates the sleeve which is directly connected to the screw of the retractable sheave, and thus, the sheave is raised. When the sleeve rotates, the limit bevel gear, keyed to the sleeve, rotates to turn the pinion of the geared limit switch. This is the only function of the limit bevel gear. When a predetermined point is reached by the rotor of the geared limit switch, the RAISE circuit is broken and the raising operation ceases. As the geared limit switch is actuated, the green lamp (sheave UP lamp) will light in the deck edge light box.

Energizing the motor to lower the retractable sheave by depressing the LOWER pushbutton causes the motor and the drive system to operate in the reverse direction. Again there is free rotation until the lugs on the worm gear make a complete revolution before striking the other side of the lugs on the clutch bevel gear. The sheave lowers until it is completely seated and opens the torque limit switch to break the motor circuit. If an obstruction prevents lowering of the sheave, the worm, still rotating due to the force of the motor, will not turn the worm gear but will be driven axially along the wormshaft until the torque limit switch is opened by the tripping plate washer. By adjusting the torque switch, the sheave can be made to seat with a predetermined force before the circuit is interrupted. The torque spring will absorb the remaining inertia of the system after the circuit is broken. During lowering and raising of the sheave, and until the RAISE geared limit switch is tripped, the red (sheave NOT UP) lamp will glow on the deck edge light box.

For manual operation, the hand wheel must be mounted on its shaft and secured to the shaft with a setscrew. The declutch lever must then be thrown in a counterclockwise direction. This movement will slide the clutch bevel gear along the splined section of the sleeve to engage a gear on the handcrank shaft. When the handcrank is turned, the sleeve will turn, rotating the sheave screw to raise or lower the sheave. The declutch lever will remain in the declutch position until operation under motor power is resumed, at which time the handwheel is disconnected automatically by the clutch trippers. There is no danger to an operator if he is turning the handwheel when the motor is started, because the handwheel is disengaged instantly without shock or jolt.

Listed below are instructions for the removal of parts necessary to gain access to the unit to be serviced or inspected:

1. Shut off the power.
2. Remove the limit switch cover.
3. Disconnect the power and control wires from the operating unit.
4. Remove entire operating unit from the mounting pad.
5. Remove the electric motor.
6. Remove the mounting screws and take out the geared limit switch.
7. Remove the pipe flange (end opposite mounting pad), and take out the gland thrust ring.
8. Remove the housing cover from the end opposite the mounting pad. Remove the gland follower and packing cover.
9. Remove the lubricant from the housing.
10. Loosen the setscrew in the declutch lever hub and remove the declutch lever.
11. Remove the three capscrews from the handwheel through the cap and pull out the entire handwheel pinion assembly.
12. Loosen the jamnut and setscrew in the clutch fork and remove declutch lever.
13. Remove the cotter pin and washer, withdraw the clutch tripper pin, and take out the clutch trippers and clutch tripper springs.
14. Remove the clutch fork trunnion retainer and clutch fork trunnion.
15. Draw the clutch fork out of position and remove from the housing.
16. Remove the external retaining ring on the wormshaft and pull the wormshaft gear.
17. Remove the wormshaft blind cap.

18. Remove the wormshaft assembly by pressing on the end from which the shaft gear has been removed.

19. Remove the drive assembly from the housing.

The assembly removed in step 18 can be further disassembled without further instructions, Bearings are a press fit.

NOTE. Adjustments on the geared limit switch are made only by a qualified electrician.

The following procedure is to be used for setting the torque limit switch:

1. Turn off the power.
2. Remove the limit switch cover from the housing.
3. Loosen the jamnut on the adjusting screw on the torque limit switch.
4. Move the adjusting screw in if a lighter seating of the sheave is desired. Move the screw out if a tighter seating is desired.
5. Turn on the power and lower the sheave by depressing the LOWER pushbutton, allowing the torque switch to function in stopping the motor.
6. Readjust as necessary. The final setting is obtained by means of this "trial and error" adjustment.
7. Install the limit switch cover on the housing.

Sheave Inspection

All sheaves on the arresting engine are subject to the following checks along with the sheaves in the fairlead system:

1. Visually inspect the sheaves for cable fairlead system misalinement. This is evidenced by the fact that one side of the sheave throat shows more wear than the other side. If this condition is found, the sheave should be replaced and the fairlead system alinement checked.
2. Examine the sheave grooves for cracks. The existence of cracks requires replacement of the sheaves. This does not include surface scratches.
3. According to the applicable MRC, check for groove condition of all engine and fairlead sheaves.
4. According to the applicable MRC, check for bearing and spacer condition on fairlead sheaves.

NOTE. If time permits, the inspections listed above may be accomplished at more frequent intervals; however, the times specified on the MRCs are the maximum between inspections and must not be exceeded.

The sheave groove gage is used to accurately determine the exact cable groove depth of all arresting gear sheaves. The sheave groove gage (fig. 6-23) consists of a depth indicator, indicator face, gage body, centering disc, screw, and tensioning spring. The indicator face is divided into seven equal sectors and has six equally calibrated steps, each 1/32 inch in depth. The steps begin at the BASIC position, which represents 1 1/4 inches normal sheave groove depth, and descends counterclockwise in 1/32-inch increments to the sixth step which indicates 3/16-inch total depth. To properly use the sheave groove gage, the following procedure should be utilized.

1. Pull up the depth indicator until the depth indicator shoulder is above the BASIC position
2. Insert the centering disc in the sheave groove and press the gage body firmly against the outside diameter of the sheave.

NOTE: The gage must be positioned carefully with the depth indicator and centering disk on a direct line with the axis of the sheave.

3. Hold the gage firmly in this position and depress the depth indicator until it bottoms in the sheave groove throat (indicator face can be read at this point when in an accessible position).
4. Release pressure on the gage body, being careful not to misaline centering disk and depth indicator.

CAUTION: False readings will result if the depth indicator binds in the centering disk while releasing pressure.

5. Remove the gage and read the indicator face.

NOTE: The total wear is the amount indicated on the sector of the indicator face even with the depth indicator shoulder. Should the depth indicator shoulder be located between two sector levels, read and record the greater of the two increments. Figure 6-24 shows groove

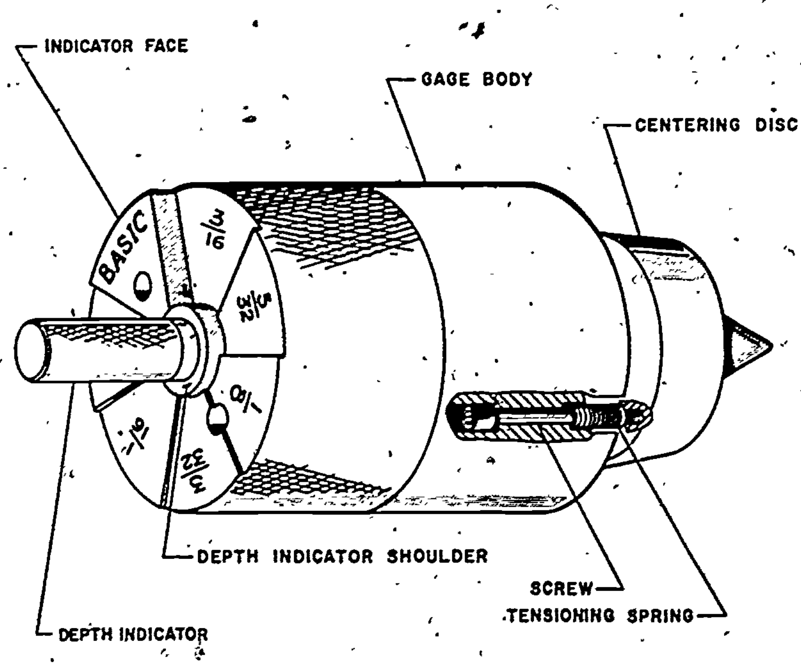


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Figure 6-23.—Sheave groove gage.

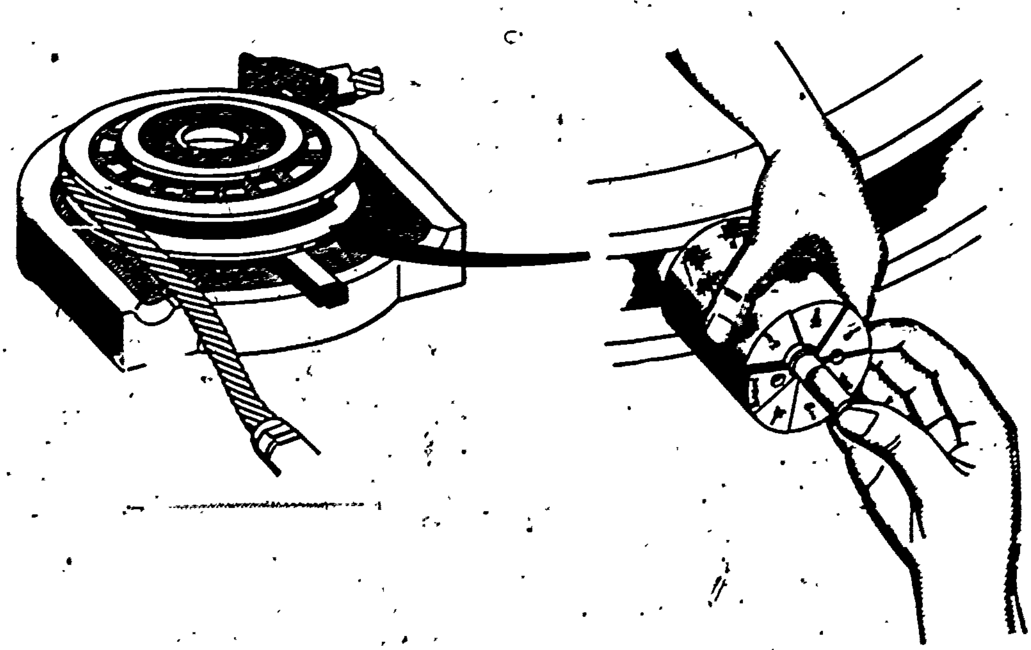

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Figure 6-24.—Using sheave groove gage.

depth readings being taken, with the sheave partially disassembled.

NOTE: All sheaves must be rotated and a depth gaging done at four points (spaced approximately 90° apart) on the sheave groove throat.

The retractable sheaves and any fairlead sheaves that do not have access openings will have to be partially disassembled to measure their groove wear.

When inspecting engine sheaves, using the sheave groove gage, obtain four cable groove depth readings for each sheave. Rotate each sheave and establish the groove depth reading approximately 90° apart. (See fig. 6-25.)

Record all groove depth readings taken and take appropriate action in accordance with the replacement criteria.

After all arresting gear sheaves have been properly inspected and gaged, charge the accumulator to 400 psi and tension the purchase cable by retracting the system.

MAINTENANCE PROCEDURES

In order to be effective, a maintenance program must attain the following objectives: Safe condition of the equipment before use, efficient operation to insure safety and maximum service life, discovery of trouble before it can cause damage to equipment, minimize down time by adoption of correct and efficient repair procedures, and familiarization with the equipment to recognize abnormal operation or indication of trouble.

Maintenance by the arresting gear crew must go beyond a wipedown and periodic lubrication. The arresting gear personnel must be instructed to bring to the attention of the officer in charge, any sign of malfunction, wear, looseness, leakage, damage, or any other irregular conditions in the arresting gear equipment. They should also learn the physical location of all operating parts, cable runs, air supply lines, valves, electrical supply lines, switches, fuse boxes, tools and spare parts.

Inspection of the engine should include visual, mechanical, and operational inspections. The following general notes apply to maintenance throughout the arresting gear equipment.

1. Mechanical inspection is performed while the engine is at rest. It consists of a security check, exercising the engine, and manipulating the controls. This inspection is a check for looseness, excessive play, improper operation of hidden parts, lack of lubrication, or any abnormal resistance to motion.

2. Operational inspection consists of running all operable systems through a full cycle of operation, checking for smoothness of operation, proper timing, and synchronization.

3. All maintenance performed on recovery equipment should be noted in the maintenance log for that particular unit.

4. Changes in critical measurements should be logged so they can be used to predict trends and avoid possible troubles.

5. Wipe down all arresting gear equipment daily to remove dirt and grime.

6. Remove rust and paint when necessary.

7. Do not paint threads or finished machined surfaces.

8. Check for loose or damaged bolts, nuts, and screws. Tighten or replace as required. Replacement bolts should be of equal or greater strength than the original.

9. All bolts should be tightened to the proper torque value.

10. Check for hydraulic and pneumatic leaks.

11. Be alert for any unusual sounds which may indicate malfunctioning equipment Report these conditions to the officer in charge

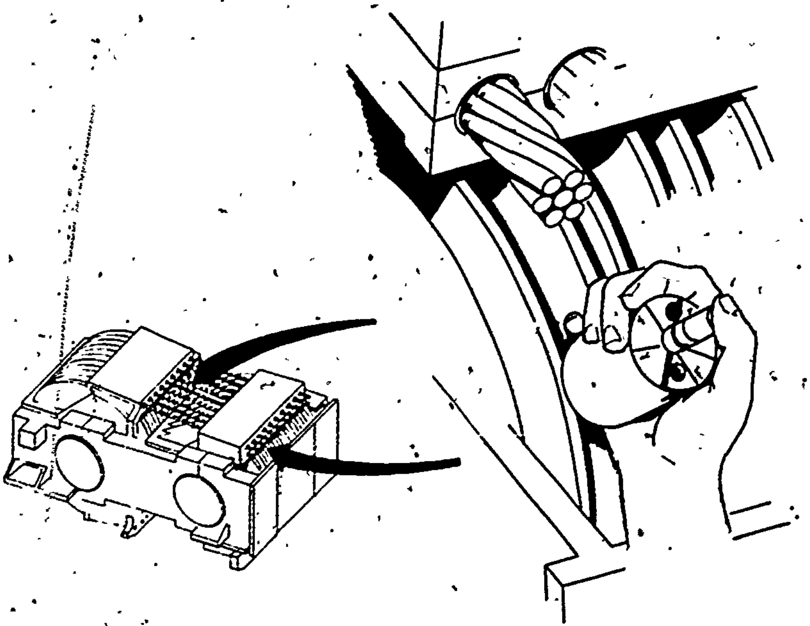
12. Check spares on hand against allowable spares list. Replenish spare parts monthly.

13. Maintenance personnel must establish and carefully maintain the Recovery Wire Rope History Chart, recording all wire rope data

14. The replacement of any O-ring, V-ring, or other pressure seal necessitates a high-pressure test of the equipment before resuming arresting operations. When making a pressure test of newly installed seals, it is necessary that the unit stand for a period of 1 hour before the seal can be accepted.

Once each year (or as modified by appropriate technical publications), drain the ethylene glycol from the system and replace with fresh fluid.

The maintenance procedures and inspections outlined in this chapter should be verified by



AB.394

Figure 6-25.—Gaging groove depth of engine sheaves.

checking them against the requirements contained in the latest applicable technical publications when actually performing the jobs discussed. Experience and later findings frequently result in modifications to procedures and changes in specifications.

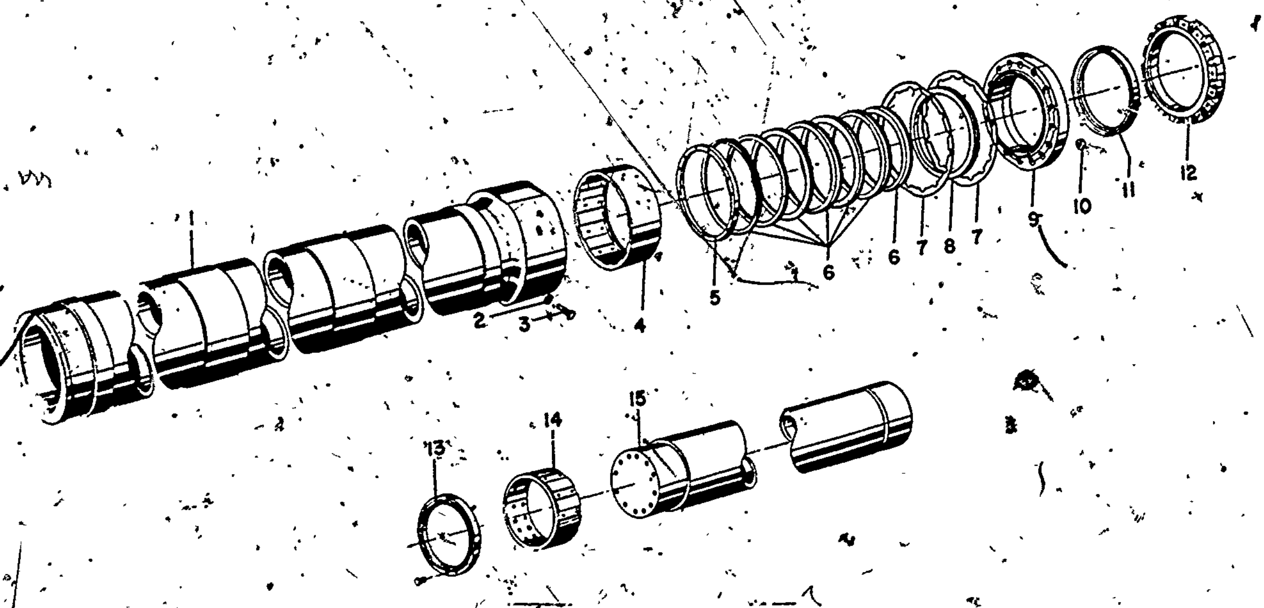
REPLACING CYLINDER AND RAM PACKING

In the Mk 7 Mod 2 arresting engine cylinder there are two sets of chevron packing. One set is in the mouth of the cylinder and is the seal between the cylinder and the ram. The other set of packing seals the cylinder from the fluid outlet elbow.

Whenever the packing at the mouth of the cylinder needs replacing (fig. 6-26), use the following procedures:

1. Blow down the accumulator and drain the hydraulic system.
2. Pull out the deck pendant until the crosshead is moved to half-stroke position. Block the crosshead in this position to provide working access.
3. Remove the screws and slide the retainer (12) and wiper (11) along the ram (15) to the crosshead end.
4. Remove nuts (10) and slide retainer (9), shims (7), and follower (8) along the ram to the crosshead. Remove the packing (6).
5. Install the ram fixture approximately midway between the cylinder and the crosshead. Adjust the fixture to receive the full weight of the ram when the crosshead and ram are separated.
6. Remove the bolts securing the ram two-block assembly to the ram and remove the ram two-block assembly.
7. Remove the screws securing the split ring retainer to the crosshead.
8. Separate the ram and the crosshead and remove the split ring from the ram.
9. Slide the parts removed from the cylinder off the ram. Discard the packing (6) and the shims (7).
10. Install new packing assembly on the ram.

NOTE: This procedure is necessary when repacking the cylinder because NON-SPLIT packing must be used in the mouth of the cylinder.



1. Cylinder.
2. Rubber seal.
3. Cylinder slipper cage retaining bolt.
4. Cylinder slipper cage.
5. Spacer.
6. Packing.
7. Shim.
8. Follower.
9. Packing retainer.
10. Nut.
11. Wiper ring.
12. Wiper retainer.
13. Ram slipper cage retainer.
14. Ram slipper cage.
15. Ram.

AB.395

Figure 6-26.—Cylinder and ram assembly.

11. Reinstall the follower (8), retainer (9), wiper (11), and retainer (12) on the end of the ram (15).

12. Reinstall the split ring retainer on the end of the ram, slide the ram and crosshead together, and secure the ram and crosshead with the securing screws.

13. Reinstall the two-block assembly.

14. Remove the ram fixture from the engine structure and slide the packing assembly and the follower along the ram into the proper position.

15. Slide the packing retainer into place next to the follower. Hand tighten and measure the distance between the face of the cylinder and the retainer in four places to make sure the packing is seated evenly. Add shims to fill the gap and also to give the proper packing float. Then install the packing retainer.

16. Secure the retainer with the nuts and tighten to the proper torque value.

17. Slide the wiper and the wiper retainer into place and secure.

18. Remove the block from the crosshead, refill the hydraulic system, and recharge the engine.

If it becomes necessary to remove the ram completely from the cylinder, the following method is used to replace the slippers on the ram and cylinder slipper cages and to replace the packing assembly in the mouth of the cylinder:

1. Blow down the accumulator and drain the hydraulic system.

2. Block open the retracting valve.

3. Pull out the purchase cable to get slack on the flight deck.

4. Block the purchase cable and cut off the topside terminals.

5. Butt braze approximately 350 feet of 1/2-inch-diameter cable to each side of the purchase cable on the flight deck.

6. Remove the crosshead stop from the engine frame.

7. Install the ram fixture to the engine and adjust it until it supports the weight of the ram.

8. Remove the screws and the slide wiper retainer and wiper along the ram.

9. Remove the nuts and slide the packing retainer and shims along the ram.

10. Remove the four bolts holding the cylinder slipper cage in place.

11. Pull the crosshead along the tracks until the inner slippers are at the end of the track. As the ram is withdrawn from the cylinder, the ram slipper cage will contact the cylinder slipper cage and pull it out of the cylinder along with the packing assembly.

When this is accomplished, the slippers can be replaced and the cylinder can be inspected. Using the reverse procedure, reinstall the components, replacing the packing assembly and shims at this time.

The packing between the fluid outlet elbow and the cylinder may be replaced using the following procedure:

1. With the crosshead in battery position, blow down the accumulator and drain the arresting engine.

2. Remove the two-block assembly from the ram.

3. Remove the fairlead mounted on the fixed sheave end of the cylinder.

4. Remove the vent valve bracket from the engine structure and the vent valve tubing.

5. Move the crosshead forward by pulling both ends of the purchase cable equally until the crosshead is within 23 inches (minimum) of the cylinder. Block the crosshead in this position.

6. Install two cylinder support assemblies as shown in figure 6-27. Adjust the roller assemblies of the cylinder supports firmly against the outside diameter of the cylinder by means of the adjusting bolts.

NOTE: Because of space limitations, it is necessary to remove the adjustment bracket and roller support on one side of the cylinder support in order to place the cylinder support assemblies in place.

7. Loosen both cylinder saddle caps that secure the cylinder to the saddle assemblies.

8. Remove the four cylinder clamps that secure the cylinder to the elbow assembly.

9. Turn in the jacking bolts on the cylinder supports evenly to take the load of the cylinder off the supporting saddles so that the cylinder may slide back freely during subsequent packing operation.

10. Place the jacking block assembly on the engine cylinder. Make certain that the fingers of the jacking blocks are firmly placed in the groove of the cylinder.

11. Jack the engine cylinder from the elbow assembly as follows:

a. Insert the plunger end of the ram and pump assembly (fig. 6-27) between the face of the elbow assembly and the takeup screw of the jacking block assembly. Pumps may be placed in any location suitable for operating the ram plunger.

b. Operate the pumps simultaneously to provide equal jacking action of the ram plungers. After the maximum stroke of the ram plunger (2 1/2 inches) has been reached, return the ram to the starting position by turning in the takeup screw. Repeat the jacking procedure until the fixed sheave end of the cylinder has been moved 18 inches from the elbow assembly.

12. Remove the jacking unit.

13. Remove the lockwire and bolts securing the packing retainer to the end of the elbow assembly. Remove the packing assembly from the end of the elbow assembly. Inspect all parts for damage.

14. Reinstall the assembly using new packing and shims, and safety wire the bolts.

15. Slide the engine cylinder back into position with the elbow assembly as follows:

a. Hold the ram and pump assemblies with one end of the ram plunger contacting the wiper retainer on the end of the cylinder. Contact should be made as close as possible to the outer

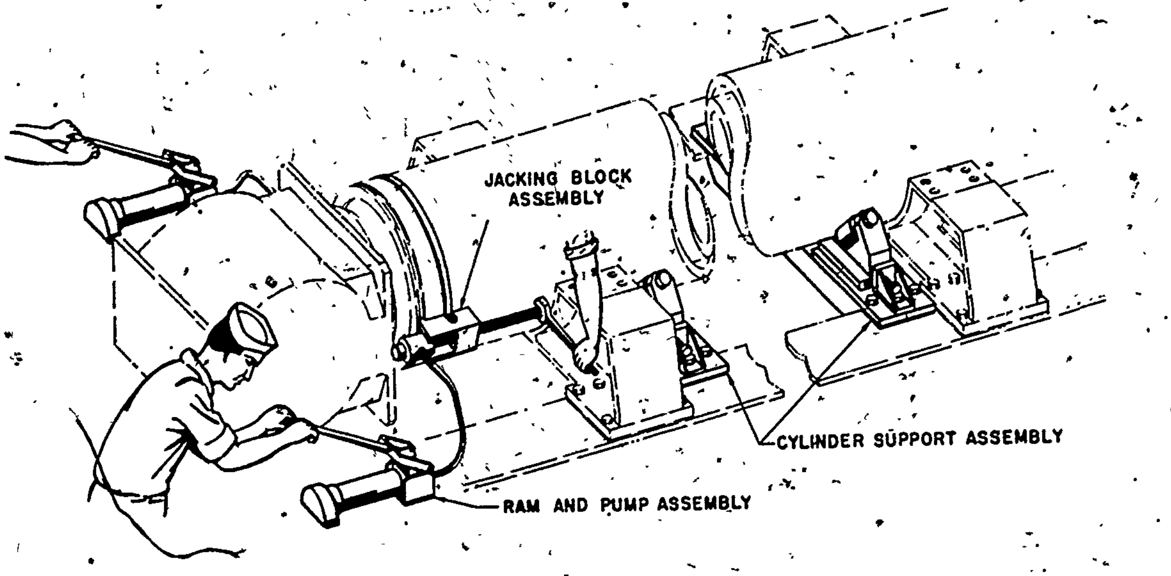


Figure 6-27.—Special equipment for moving the cylinder.

edge of the wiper retainer. The opposite end of the ram plunger should be against the crosshead.

b. Operate the pumps simultaneously to provide equal jacking action of the ram plungers. After the maximum stroke (2 1/2 inches) of the ram plunger has been reached, return the ram plungers to the retracted position. Repeat the jacking procedures using progressively longer extensions between the ram plungers and the wiper retainer until the cylinder has been pushed back into position against the elbow assembly.

NOTE: The above extensions can be made by ship's personnel, using any suitable materials at hand.

16. Remove the extensions and the ram and pump assemblies, then reinstall the cylinder clamps to secure the cylinder to the elbow assembly, and secure the bolts with the proper torque value.

17. Reinstall all components removed and tighten down the cylinder saddle caps that secure the cylinder to the saddle assemblies.

18. Fill and charge the system and return the crosshead to battery position.

INSPECTION AND SETTING OF CONSTANT RUNOUT VALVE

The heart of the arresting engine is the constant runout valve. Operation of the constant runout valve allows aircraft of differing weights and landing speeds to get the same amount of deck runout. Allowing all aircraft to get maximum runout makes it easier on the landing aircraft and the arresting engine.

Due to the importance of the constant runout valve, halfway measures of maintenance and inspection cannot be tolerated. The valve is closely inspected daily for proper operation and adjustment. Its failure to function could very well mean the loss of life.

The torque required to rotate the cam to the DWELL position shall be checked after approximately every 300 arrestments, or monthly, whichever occurs first, to determine if torque values are within the allowable limits. The allowable limits are:

Aircraft Weight Setting	Torque (Pound-Feet)
14,000	80-110
50,000	110-125

The procedure for checking and setting cam torque is:

1. Blow off engine accumulator pressure.

2. Using the motor unit, set the levers at the 14,000 pound weight position. Then disengage the motor unit by pulling out on the manual handwheel. (See fig. 6-28.)

3. Disconnect the roller chain at the master link and remove the chain from the cam sprocket. (See fig. 6-29.)

4. Unlock the key washer at the stem screw and loosen the spanner nut. (See fig. 6-30.)

5. Adjust the stem screw until the upper and lower levers are approximately parallel. Tighten the spanner nut. (See fig. 6-31.)

6. Using a torque wrench, rotate the cam to the DWELL position. Read torque on the indicator dial and record. Rotate the cam off the DWELL position. (See fig. 6-32.)

7. Set the levers to the 50,000 pound weight position and again rotate the cam to the DWELL position. Read torque on the indicator dial and record. Rotate the cam off the DWELL position.

8. Repeat torque readings at 14,000 and 50,000 weight settings at least three times, alternating from one to the other, to determine consistency of readings. Record all readings.

NOTE: If torque readings are inconsistent at either position, check component parts for wear, deformity, or damage. Replace worn or damaged components to insure consistent readings.

9. The cam torque chart (fig. 6-33) can be utilized as an aid in obtaining the desired cam torque values. (Use of this chart is intended as a guide only. Due to the variations in valves and torquing techniques, the exact positions of the guide lines are indeterminate.) Perform corrective functions, if necessary, as indicated in the cam torque chart under applicable situations and take new readings. (See fig. 6-34 for procedures to rotate the adjusting ring.).

NOTE: Each time the adjusting ring is rotated, be certain to retorque the cam housing bolts carefully to the required torque (240 pound-feet). Variation in torquing these bolts will cause corresponding variation in cam torque. Also, each time the stem screw is turned to accomplish cam torque adjustment, be certain to securely tighten the spanner nut.

CAUTION: When arresting heavy jet aircraft, cam torque value should be kept as close as possible to the 125 pound-feet limit of the 110-125 pound-feet torque range at the 50,000 pound weight setting to lessen the possibility of ram overtravel.

10. Make a final check for torque readings at the 14,000 and 50,000 pound weight positions.

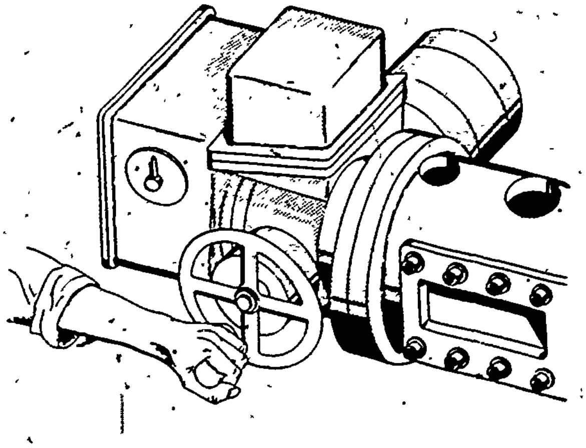


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Figure 6-28.—Decreasing weight settings.

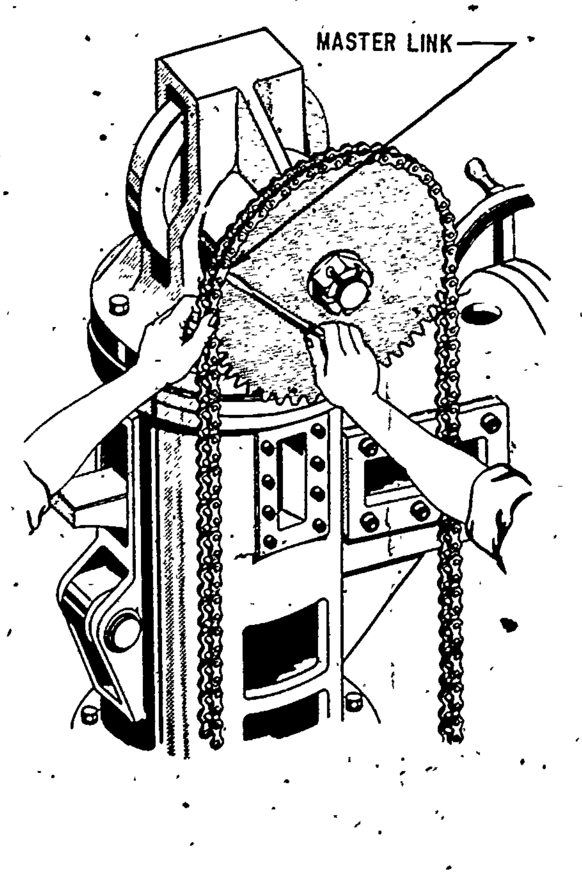

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Figure 6-29.—Removing master link.

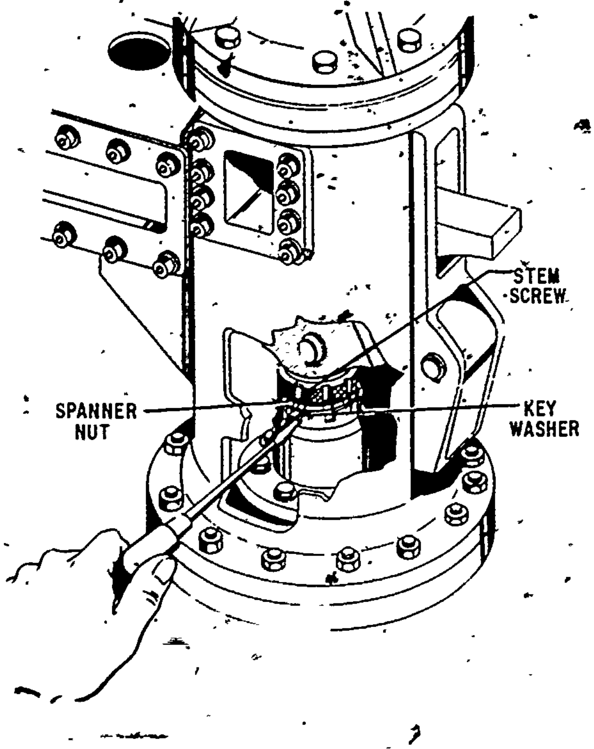

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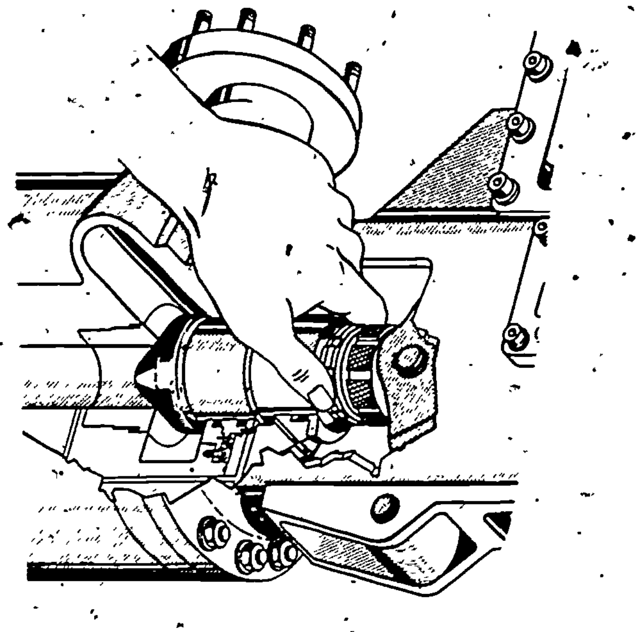
Figure 6-30.—Unlocking key washer.



AB.400
Figure 6-31.—Setting stem screw to adjust roller levers.

If all values are within the acceptable torque range, secure the key washer by folding a tab up into a slot in the spanner nut, and another down into a slot in the valve sleeve.

11. Rotate the cam until the BAT. POSIT. mark on the cam is alined with the zero index mark on the cam housing indicator plate. With the engine crosshead in battery position, reinstall the chain and master link, and attach the appropriate cable ends to the chain and to the adjustable anchor on the crosshead. Make sure the screw on the adjustable anchor is centered before attaching the cable ends to it. (See fig. 6-35.)

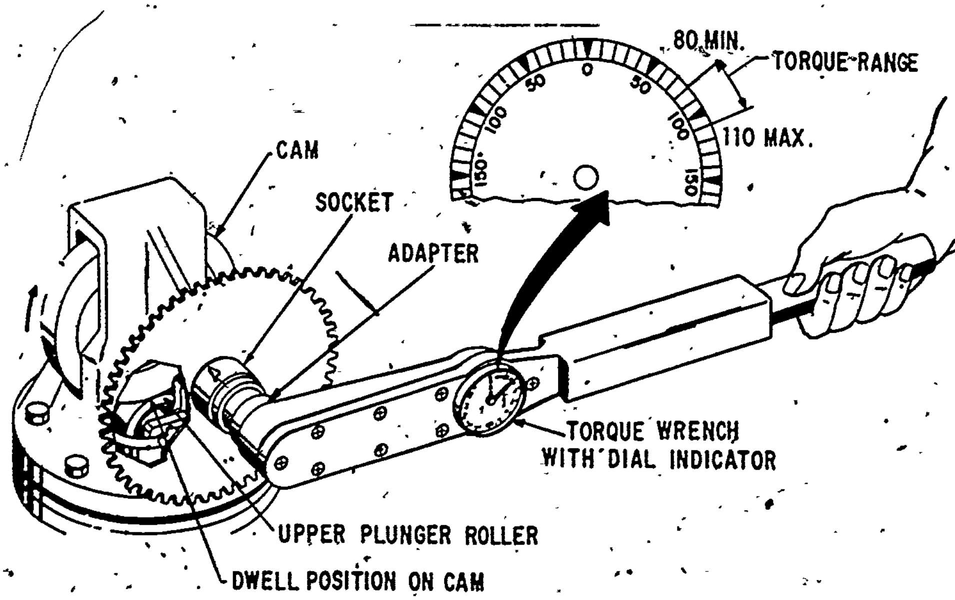
Recheck for coincidence of the index marks on the cam. If they are out of position, use the adjustable anchor to position them.

The drive system of the constant runout valve is tensioned by means of the turnbuckles to 400 pounds. This tension is checked daily prior to operations with the tension indicator shown in figure 6-36.

During operations, the problem of purchase cable stretch always presents itself. As the purchase cable stretches, the crosshead will move closer to the crosshead stop. As the crosshead moves in this direction, the drive system of the constant runout valve will over-rotate the cam, putting it out of position. The adjustable anchor is used to realine the battery index mark on the cam with the mark on the cam housing. (See fig. 6-37.)

If, due to continued stretch of the purchase cable, there are no more threads left on the screw of the adjustable anchor, the adjustable anchor screw must be repositioned to center, the cam drive chain removed, the cam manually repositioned to battery position, and the turnbuckles adjusted to retension the drive system.

The drive system is the critical part of the constant runout valve. Therefore, it is checked daily prior to operations for proper tension and for broken wires.



AB.401

Figure 6-32.—Checking cam torque.

The complete drive system is replaced if there are one or more broken wires in the drive system or if there is one cracked link in the chain of the drive system.

REPLACING SHEAVE DAMPER PACKING

Maintenance on the sheave dampers consists primarily of replacing worn packing when leakage occurs. (See fig. 6-38.) Sheave damper packing consists of O-ring and V-ring packing. O-ring packing is installed at all flanged connections, vent valves, and plugs, while V-ring packing is used as a seal between the buffer ram and gland, the damper piston rod and cylinder cap, and the damper piston and cylinder.

Fluid leakage at one of the flanged joints is an indication of either a bad O-ring or improper torque on bolts or nuts. The procedure to follow when leakage occurs where an O-ring is used as a seal is:

1. Blow down the accumulator pressure.
2. Check for proper torque on bolts and nuts.
3. Recharge the accumulator.

If leakage still exists, proceed as follows:

1. Blow down the accumulator.
2. Drain the system.
3. Remove and discard the old O-ring.
4. Clean the mating surfaces, with special care given to the O-ring grooves.
5. Lubricate and install the new O-ring.
6. Reassemble the joint and tighten to the applicable torque values.

NOTE: Improper use of the torque wrench will cause variations in the torque actually imposed on bolts and nuts. Turn the wrench slowly and smoothly to obtain the most accurate readings.

7. Refill the system with fluid.
8. Charge the accumulator to 750 psi and check again for proper seal against leakage.

When the flow control valve is disassembled to replace the seals, make sure the flapper in the flow control valve is installed properly when replaced. The valve housing must be installed so that the flapper will swing open and allow free flow of fluid from the cylinder to the accumulator.

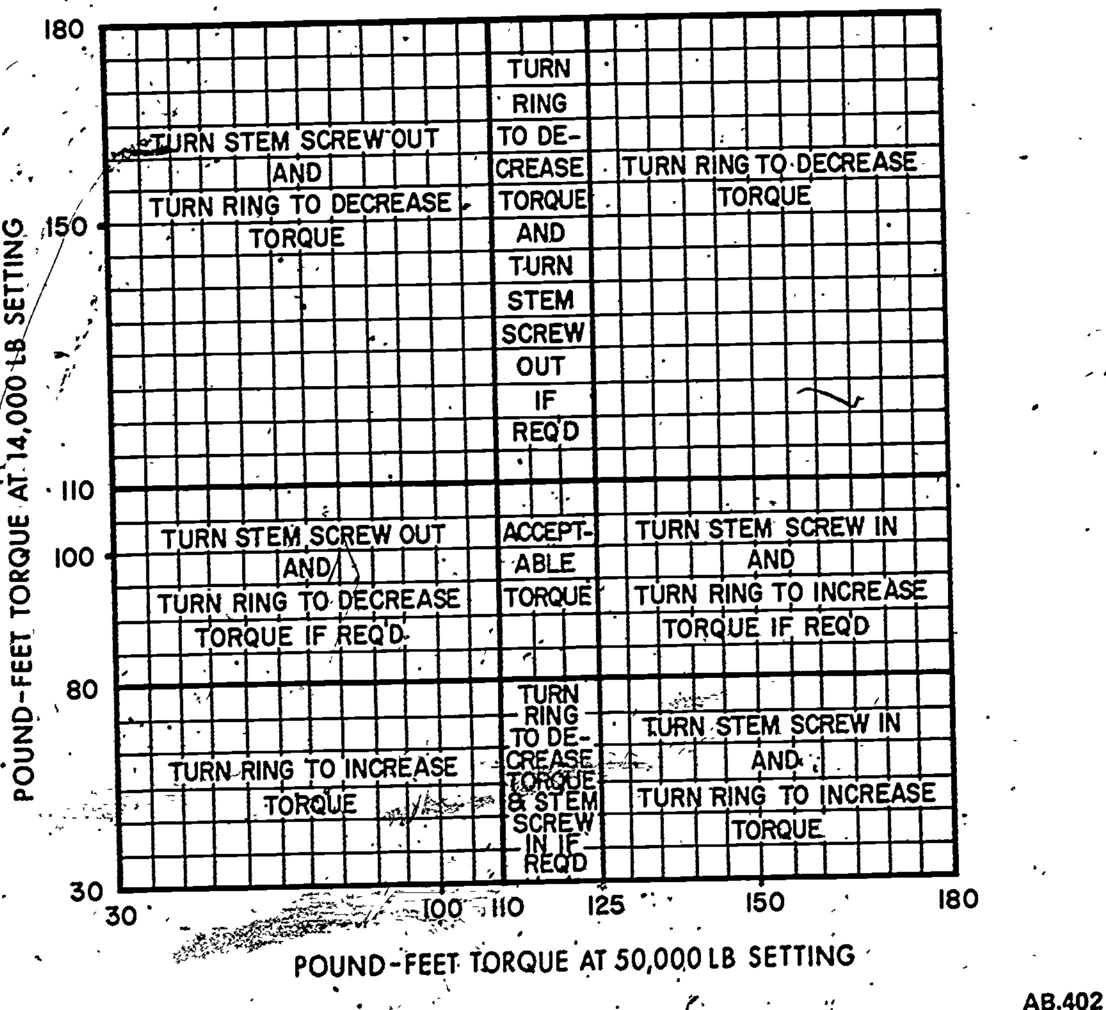


Figure 6-33.—Cam torque chart.

Fluid leakage that occurs between the damper piston rod and the gland, or between the gland and the cap assembly, indicates a failure of the V-ring packing.

Drain the system as necessary, then remove the bolts securing the gland and slide the gland back on the piston rod. Remove and discard the old packings. Retain the spacer and follower. Check the piston rod for possible scoring, burrs, or any irregularities which may have damaged the packing. Lubricate and install new packings, and reinstall shims to insure proper packing float.

Fluid leakage that occurs between the damper piston and the cylinder is due to faulty V-ring packing on the damper piston.

Leakage that occurs between the damper piston and the piston rod is caused by failure of the O-ring seal. One method of replacing the V-ring and the O-ring seals is to remove the cap assembly and remove the piston from the damper cylinder at the forward end. Since this

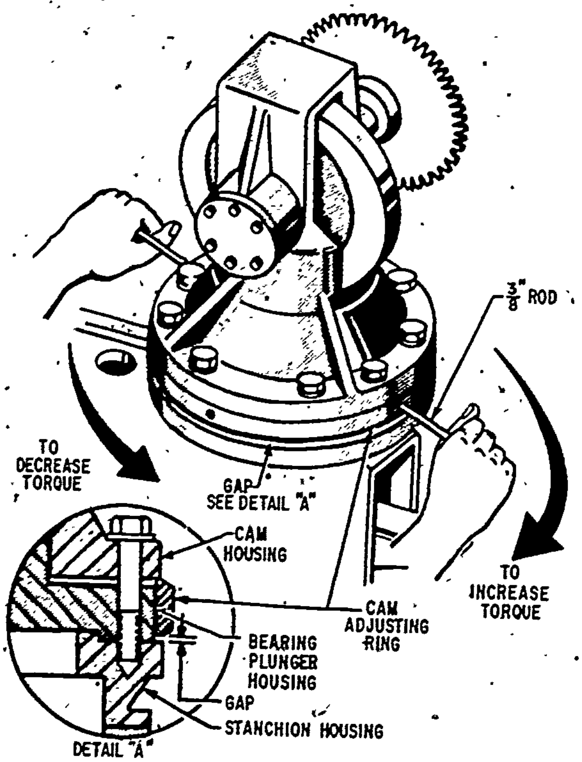


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Figure 6-34.—Rotation of adjusting ring.

procedure entails a lot of unnecessary labor, an alternate method of repacking the piston has been developed.

The alternate method consists of removing the buffer assembly and extending the piston clear of the cylinder to gain access for replacement of the packing seals, and is accomplished as follows:

1. Blow down the pressure on the arresting engine accumulator.

2. Blow down the sheave damper accumulator and drain the fluid.

3. Disconnect the sheave damper crosshead from the clevis by removing the clevis pin (fig. 6-39).

WARNING: Be absolutely certain that no tension exists in the cable system that would cause the sheave damper crosshead to move forward violently (away from the clevis end of the piston rod) when the crosshead is disconnected from the clevis.

4. Secure a length of rope to the sheave damper crosshead, as shown in the figure, and pull the crosshead 3 to 4 feet from the clevis end of the piston rod. This will provide room for installing the piston rod extension.

5. Loosen the setscrew on the clevis enough to allow removal of the clevis from the piston rod. Remove the clevis from the piston rod and the gland from the cylinder cap as shown in the figure.

6. Install the piston removal kit (piston rod extension, packing guide, and piston rod support), as shown in figure 6-40.

7. Disassemble the piston and replace the V-ring packing. The O-ring seal between the piston and piston rod must be replaced every time the V-ring packing on the piston is replaced.

8. Reinstall the sheave damper cylinder components in the reverse order of disassembly.

9. Fill the sheave damper system with fluid and charge the sheave damper and arresting engine accumulators to operating pressures.

10. Functionally check the assembly.

REPLACING ANCHOR DAMPER PACKING

Cable anchor damper installations are of two types, the deck mounted installation and the overhead mounted installation. Each installation consists mainly of two cable anchor damper assemblies, fluid piping to the engine accumulator and retracting valve, a battery positioner, and a battery position indicator. The cable anchor damper installation, used only with pendant engines, removes slack as it occurs between the engine sheaves and the anchored ends of the purchase cable at the beginning of an arrestment.

O-rings are used as seals between all flanges in the anchor damper assembly. These are the most common points of fluid leakage. The first step in correcting these leaks is to remove all pressure at the seal, after which the torque value of the securing bolts is checked. If the proper torque does not stop the leakage, the joint must be

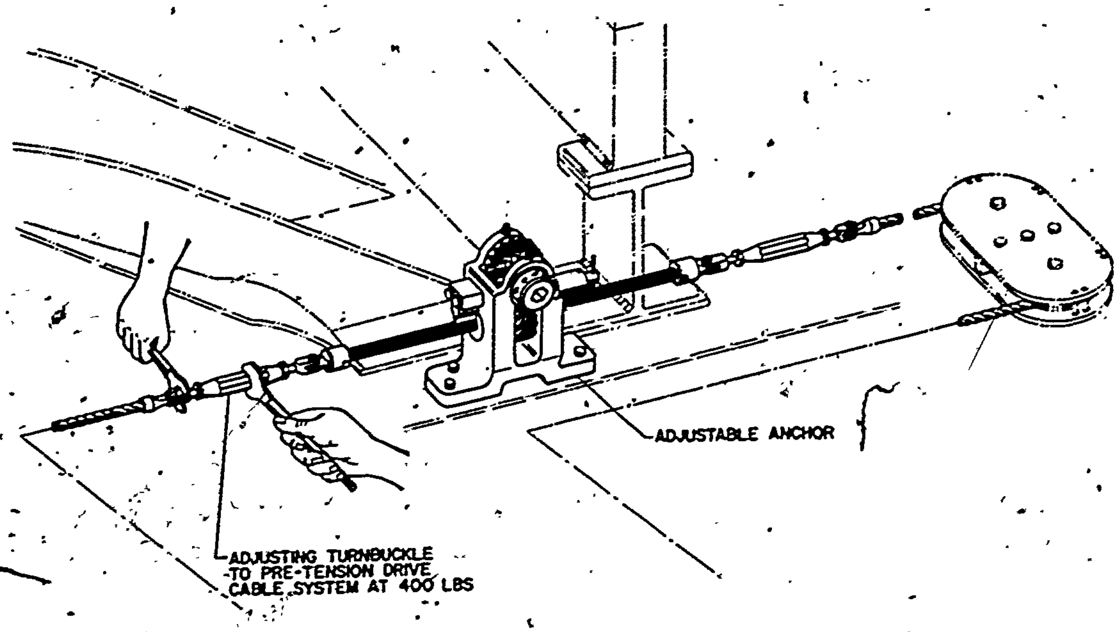

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Figure 6-35.—Adjustable anchor and tensioning turnbuckle.

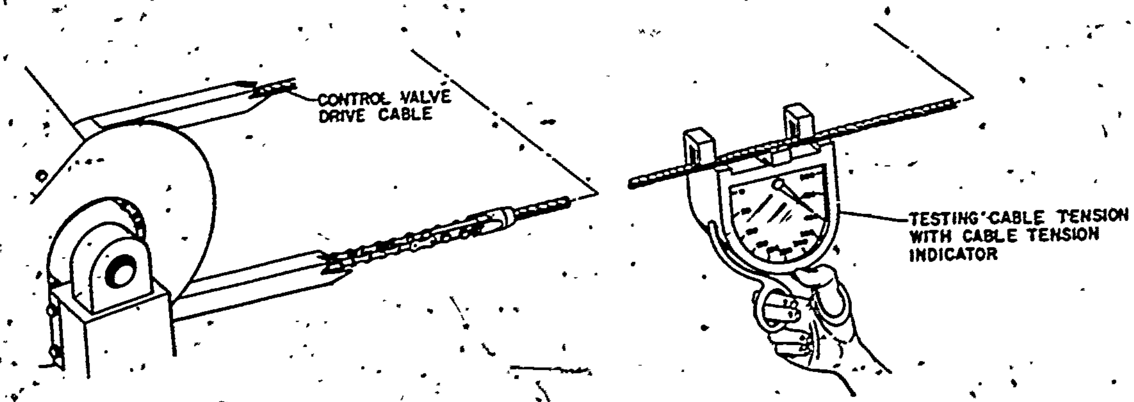

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Figure 6-36.—Drive system tension indicator.

disassembled to determine the cause of leakage. Remove and discard old O-rings. Inspect the mating surfaces for evidence of faulty contact. Clean mating faces, giving special attention to the cleanliness of O- ring grooves. Lubricate and insert new O-rings. Reassemble the joints and torque to proper value.

NOTE: The hydraulic systems must be drained to such an extent that no fluid will be present when the piping connections are disas-

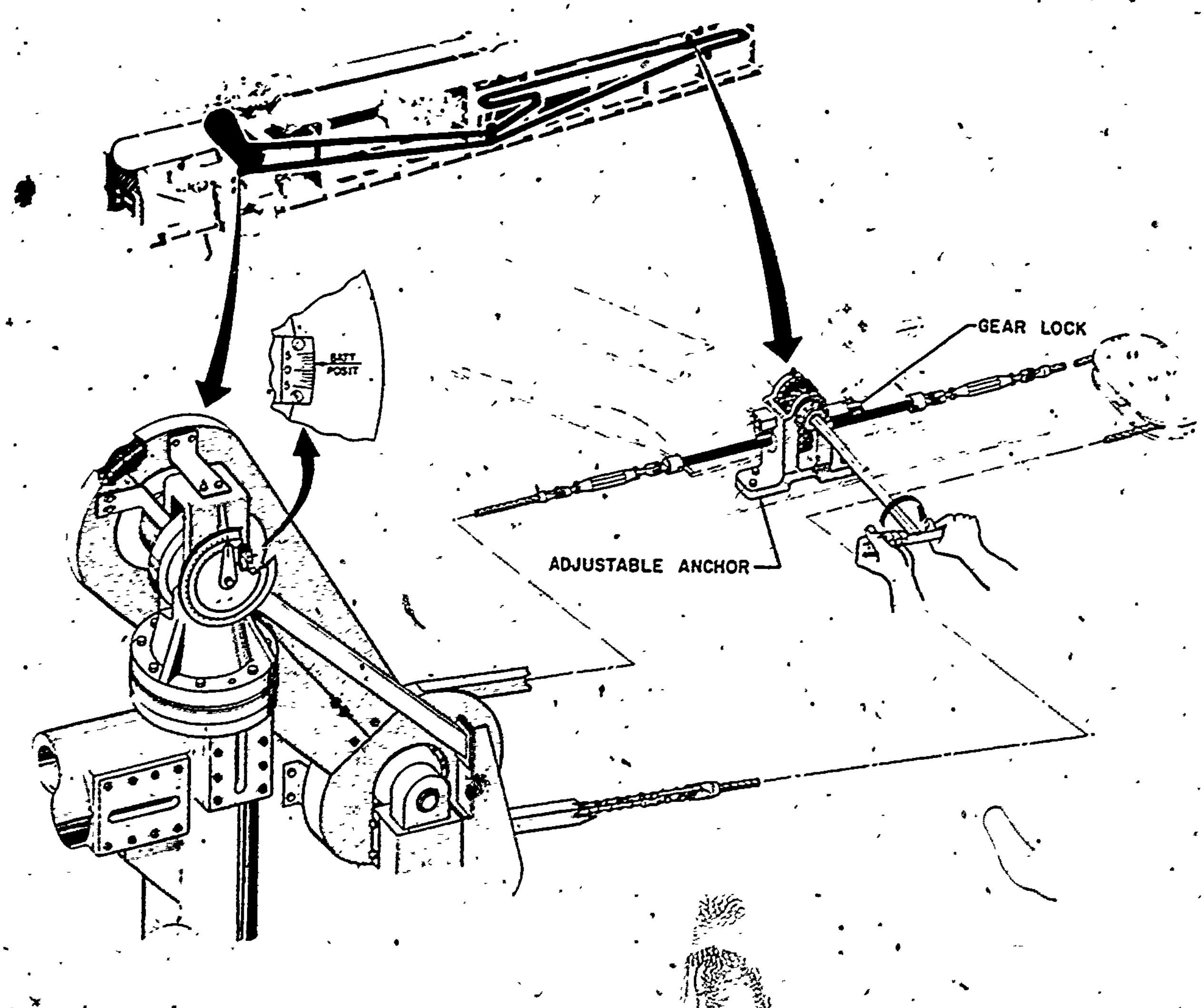


Figure 6-37.—Adjusting battery index mark. AB.406

sembled. This involves blowing off the accumulator, then draining the hydraulic system.

There are four possible points of visible fluid leakage from the operating end of the cable anchor damper. Some of these points are covered here. (See fig. 6-41.) There are two points of possible internal leakage which are invisible. In all cases, the system must be drained as necessary before disassembly can begin.

Visible fluid leakage can occur between the operating end head and the operating end flange, and is caused by failure of the O-ring or backup rings, or by excessive clearance between the flange and head in the sealing area. To replace the O-ring and backup rings, take off the removable sections of the cover and track to allow additional working space. Remove the bolts securing the flange to the head. Support the coupling assembly and move the flange, the gland, and the piston out of the head. Clean all mating surfaces of the flange and head, giving special attention to the O-ring groove. To reassemble, slip the new O-ring and backup rings over the piston to the flange. Move the piston

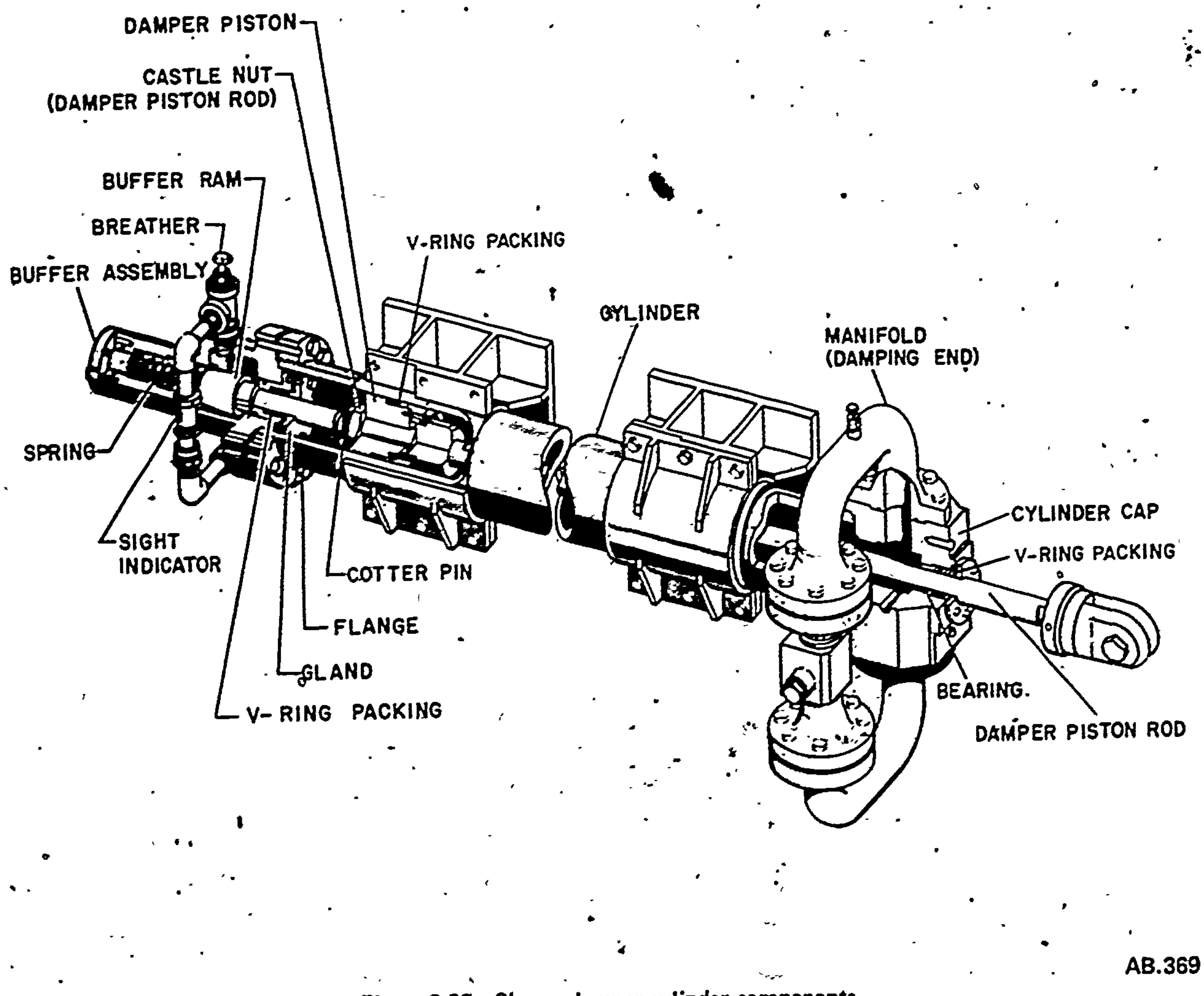
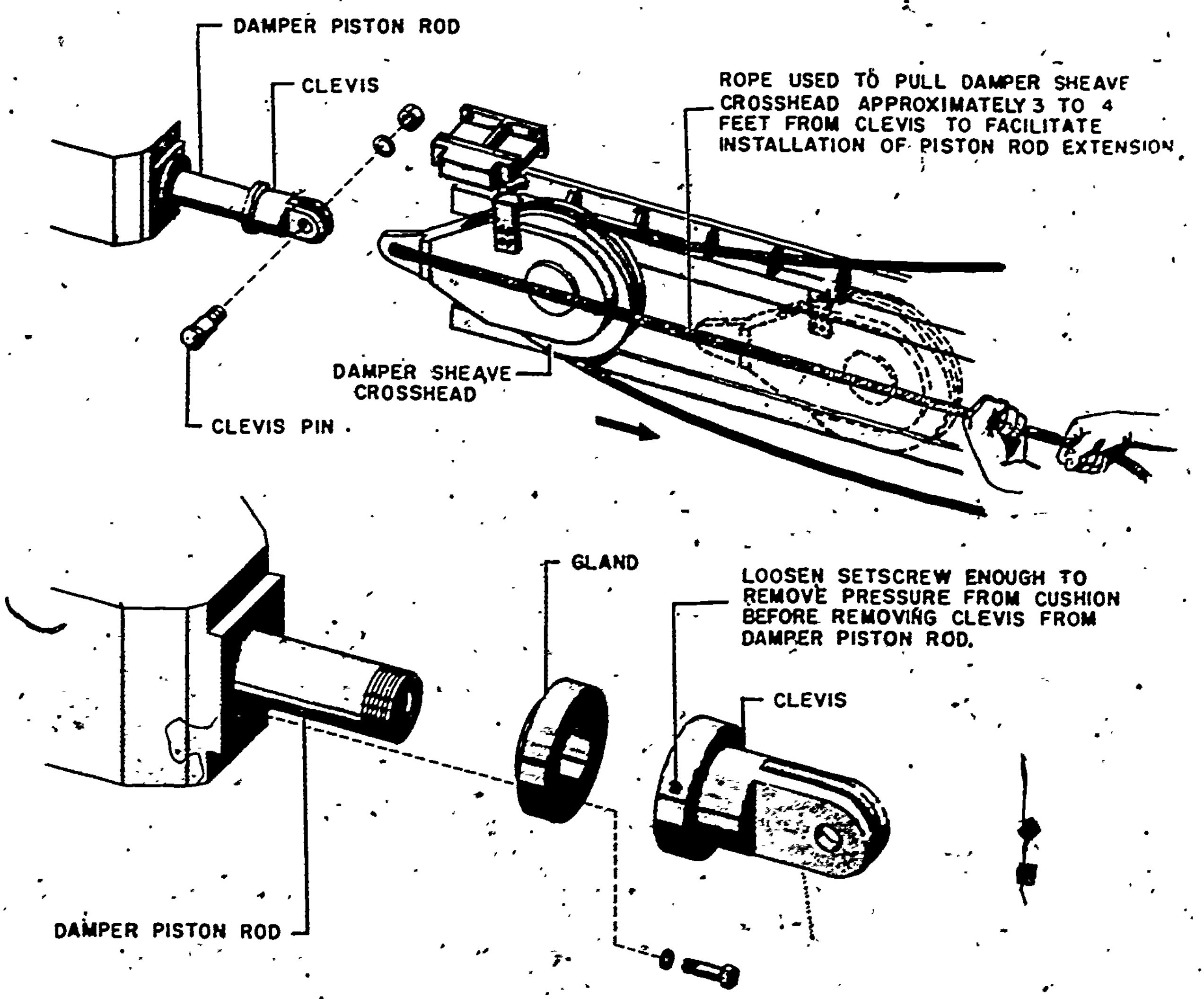


Figure 6-38.—Sheave damper cylinder components.

back into the cylinder and bolt the flange to the head. Replace the cover and track.

Fluid leakage can occur between the gland and the operating piston rod or between the gland and the flange due to failure of the V-ring packings to seat properly against engine cylinder pressure developed in the head. If adjustment of the gland fails to halt the leakage, the packings must be replaced. The removable sections of the cover and track are removed, but the gland need not be completely removed. It may be slid back along the rod and the packings split before installation. On removal of the gland, the rod must be inspected for burrs, scratches, or other surface irregularities which may have damaged the packings. Check clearances before reassembly. Lubricate and install new V-ring packings, using the retained shims and adapters. Replace the cover and track.

Fluid can leak past the operating piston and the cylinder wall into the cylinder. Leakage past the V-rings of the operating piston will be



AB.370

Figure 6-39.—Disconnecting the sheave damper crosshead.

detected only on disassembly or through malfunction. If leakage past the piston is excessive, the damper will fail to remove the slack from the cable, and engine fluid will accumulate in the damper cylinder, eventually flowing out of the cylinder through the hollow rod of the cushioning end piston and into the air container. Replacement of the V-rings on the operating piston necessitates disassembly in the same manner as replacing the O-ring between the cylinder and the operating head, with the following additional steps:

1. The piston rod must be moved farther away from the operating head to allow sufficient working space to replace the packings.
2. Disconnect the anchor cable at the coupling and pull the piston completely out of the head.

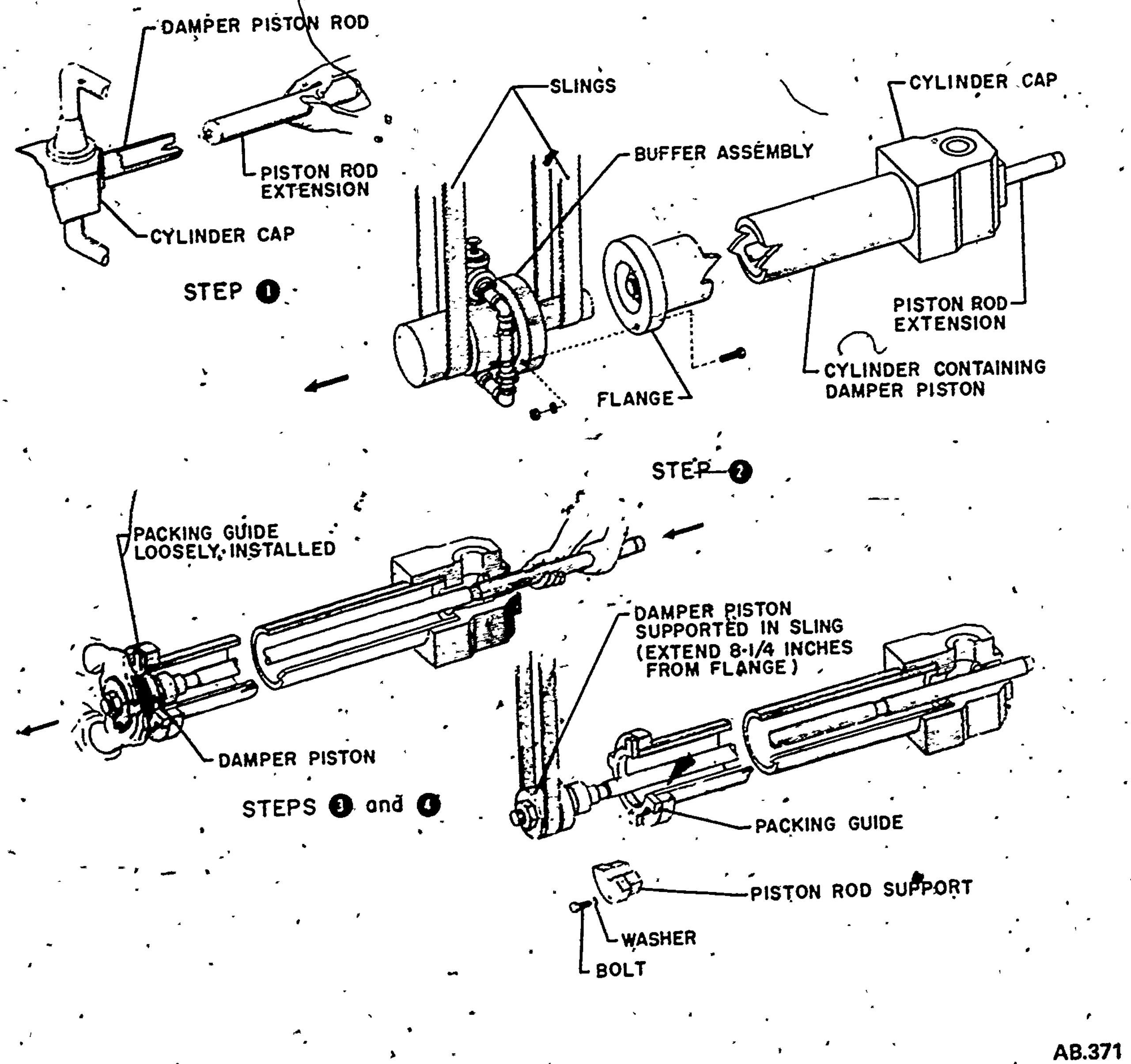


Figure 6-40.—Installation of piston removal kit.

3. Discard V-ring packings and retain shims and adapters. Inspect and clean all parts removed. Replace any damaged components.

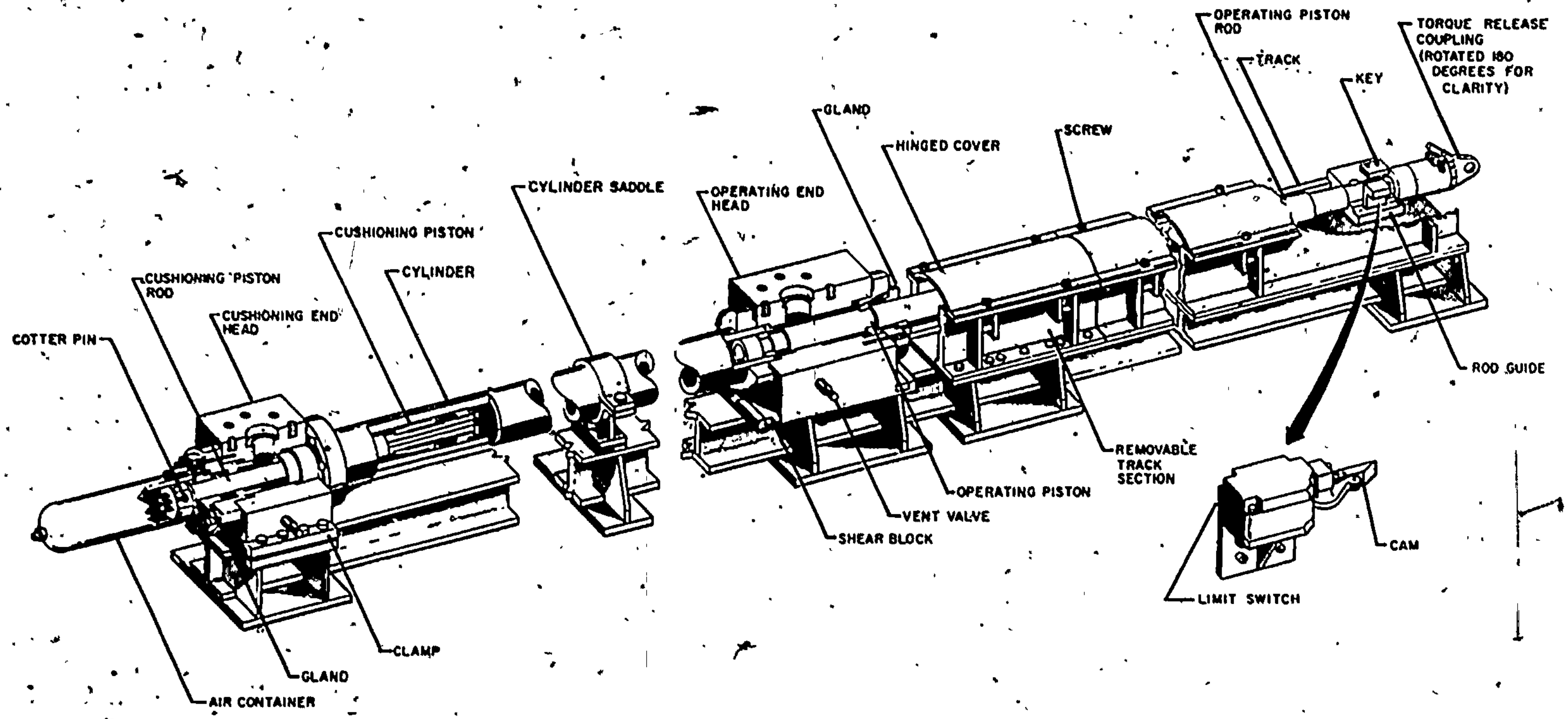
4. Install new ring packings and reusable adapters and shims.

5. Push the piston back into the head and connect the cable at the coupling assembly.

Fluid can leak past the piston and piston rod of the operating end into the cylinder due to a faulty O-ring. Disassembly to replace the O-ring is the same as that to replace piston V-rings mentioned previously, with these additional steps:

1. Remove the nut and bolt securing the piston rod nut, and remove the piston rod nut from the piston rod.

2. Back the piston off the rod and discard the O-ring.



1. Cushioning end head.
2. Cushioning piston rod.
3. Cushioning piston.
4. Cylinder.
5. Operating end head.
6. Operating end flange.
7. Operating end gland.
8. Cover.
9. Track.
10. Operating piston rod.
11. Key.
12. Coupling assembly.
13. Liners.
14. Cam.
15. Limit switch.
16. Vent valve.
17. Operating piston.
18. Shear blocks.
19. Clamp.
20. Cushioning end flange.
21. Cushioning end gland.
22. Air container.

AB.372

Figure 6-41.—Cable anchor damper assembly.

3. Clean the O-ring groove and mating surfaces.

4. Lubricate the new O-ring and insert it in the piston.

5. Replace the piston, piston rod nut, and securing nut and bolt.

6. Insert the piston in the operating head and reassemble the same as for leakage between cylinder and piston.

There are three possible points of visible fluid leakage from the cushioning end of the cable-anchor damper, and three points of possible internal leakage which are invisible. An accumulation of fluid in the air container, as noted on the sight glass, is an indication that the fluid is leaking at one or more of the invisible points.

Fluid can leak between the cushioning end head and cylinder due to failure of the O-ring or backup ring, caused from improper torque of the flanged joint, or from improper alinement. To replace the O-ring and backup ring, remove the air container, piston rod nut and washer, and bolts holding the cylinder to the head. The cushioning end head can be slid back after breaking the connection to the accumulator pressure line. Push the piston and rod into the cylinder to provide working space, and remove and discard the O-ring from the cylinder Clean mating surfaces and check the clearance in the sealing area. To reassemble, lubricate and install a new O-ring and new backup rings, pull the piston and rod out of the cylinder, and run the piston rod back through the gland. Slide the cushioning head over the cylinder and replace the bolts and washers to secure the cylinder to the head. Replace the piston rod nut and washer. Realine and shim the cushioning head, replace the air container, and reconnect the piping. Reassemble the accumulator pressure line connection, installing the orifice and two new O-rings at the orifice. Tighten the clamps to secure the cushioning end head.

Fluid leakage can occur between the flange and the cushioning end head, due to failure of the O-ring or backup ring, or from improper torque. To replace the O-ring and backup ring, remove the air container, the piston rod nut and washer, and the bolts holding the flange to the head. Then remove the flange and attached gland. Clean mating surfaces and check the clearance in the sealing area. To reassemble, lubricate and install a new O-ring and new backup rings, run the piston rod back through the gland, mount the flange to the head, and replace the piston rod washer and nut, and the air container. Reconnect the air container piping.

Fluid leakage between the adapter and the cushioning end head is caused by failure of the O-ring. To replace the O-ring, break the accumulator pressure line connection and back the adapter out of the head. Clean mating surfaces, lubricate, and install a new O-ring.

The points where invisible fluid leakage can occur and the method of correction follow.

Fluid leakage can occur between the gland and the rod due to failure of the V-ring packings. Remove the air container, then remove the cotter pin, slotted nut, and washer from the cushioning piston rod. Pass a wire through the hold in the threaded end of the rod and secure the wire so that it can be used to pull the rod out of the cushioning head flange. Carefully push the piston rod into the flange until the V-ring packings are exposed. Care must be taken not to allow the rod to fall off the flange surface and into the cushioning head. Remove the gland, shims, V-ring packings, and adapters. Pull the piston rod out by using the attached wire. Replace the V-rings and adapters in proper order over the piston rod and secure them in place with the gland and shims. Replace the washer, slotted nut, and cotter pin on the end of the piston rod. Replace the air container and reconnect the piping.

Fluid leakage can occur past the cushioning end piston into the cylinder. This is caused by the failure of the V-ring packings. It is evidenced by an accumulation of fluid in the air container and is detected by means of the sight glass. The air container and flange must be removed to allow the cushioning piston to be drawn out of the cylinder. The packings must be replaced

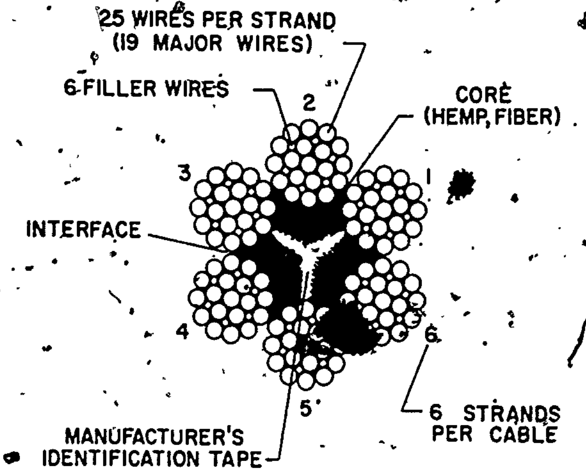
Fluid leakage past the piston and piston rod in the cushioning end is caused by a faulty O-ring. Remove the flange and slide the piston out of the cylinder. Remove the nut and bolt securing the piston rod nut and back the nut off. Back the piston off the rod, discard the O-ring, and clean the O-ring groove. Lubricate and insert a new O-ring. Reassemble the piston and insert it into the cylinder. Replace the flange and secure it to the cushioning end head.

PURCHASE CABLES

There are two ways in which purchase cables are reeved through the arresting engine—single reeving for pendant engines, and endless reeving for barricade engines. A single reeved engine has two purchase cables which are connected to a deck pendant at one end and reeved through the engine and connected to anchor dampers at the other end. (Mod 1 engines do not have anchor dampers; the engine end of the purchase cables are connected to anchor couplings.) The endless reeved barricade engines have a single purchase cable reeved through the engine with both ends terminating on the flight deck.

Purchase cables are lang lay cables, and are manufactured right lay or left lay. Right or left lay depends on whether the strands of the cable rotate to the right or left while receding from the observer and when viewed from above. Lang lay denotes cables in which the wire of the strands and the strands of the cable are twisted in the same direction so that the outer wires in the lang lay cable run diagonally across the longitudinal axis of the cable. Lang lay right-hand purchase cable is a manufactured, preformed cable.

The 1 3/8-inch diameter purchase cable is made up of 6 steel strands, each of which is a twisted bundle of 19 major wires and 6 filler wires (the filler wires provide shape stability to the strand, with little strength contribution), all twisted about an oiled hemp center within which is buried a paper or plastic tape strip bearing the name of the cable manufacturer. (See figure 6-42.) By cutting a short length of cable and unlaying the strands from around the center, the manufacturer's tape can be removed. The maker of any arresting gear cable can be determined in this fashion in case of any abnormal conditions or failure of cable. The purposes of the oiled hemp center are to provide a "cushion" for each strand (as tension in the cable acts to squeeze the strands together), and also to supply lubrication when the cable is under tension.



AB.373

Figure 6-42.—Cross section of preformed purchase cable.

Inspection and Replacement Criteria

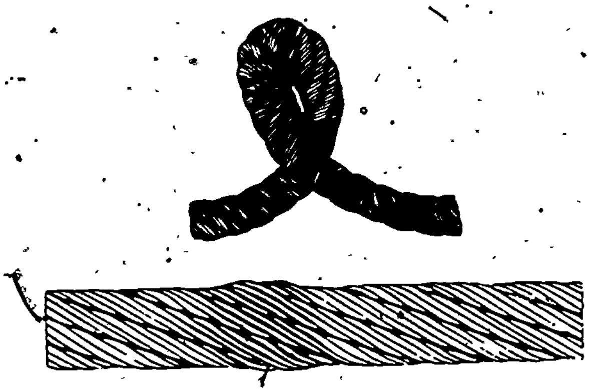
The actual replacement of purchase cables on Mk 7 arresting engines is covered thoroughly in chapter 5 of ABE 3 & 2, NavTra 10302-C; therefore, this section deals chiefly with inspection procedures and replacement criteria.

Due to high engaging speeds of aircraft being recovered, the purchase cables must be frequently inspected and replace when certain conditions exist. Inspections and replacement of purchase cables are geared to time in service, size of deck and fairlead sheaves used, number of arrestments, and types of aircraft arrested. Also, certain adverse conditions require the purchase cables to be inspected and/or replaced. The purchase cables must be inspected when any of the following occurs:

1. When an arrestment is made 20 feet or more off centerline.
2. When the engine two-blocks during arrestment.
3. After any unpredicted short runout.

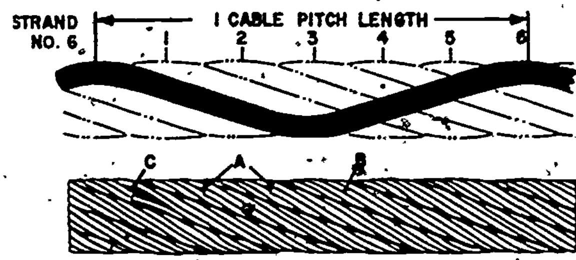
The purchase cables must be replaced under any of the following conditions:

1. KINKING. (See fig. 6-43.) Kinking is a tight, small-radius loop that may be formed by excessive torque buildup or an abruptly halted retraction cycle of the arresting engine. Newly installed purchase cables must be detorqued after the first 50 engagements (and not more



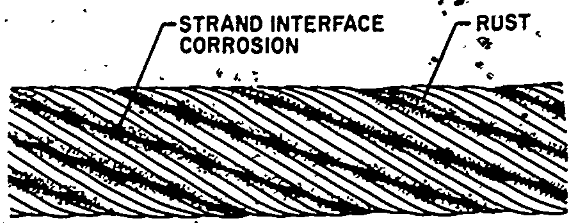
AB.407

Figure 6-43.—Kinked cable and straightened cable with kink pulled through.



AB.408

Figure 6-44.—Broken wires.



AB.409

Figure 6-45.—Strand interface corrosion.

than 60), and must be detorqued every 200 engagements thereafter.

2. BROKEN WIRES. Close inspection will reveal broken wires. Broken wires may occur at any point in the cable. The hemp core pushing out between the cable strands could be an indication of a broken wire. When this condition exists, inspect affected area carefully. Four or more broken wires within one cable pitch length is cause for replacement of the entire cable. Note broken wires (A, B, and C) in figure 6-44.

3. EXCESSIVE STRAND INTERFACE CORROSION. (See fig. 6-45.) External and internal cable corrosion, caused by trapped moisture in the fairleading system, can cause reduction in the cable strength and even subsequent purchase cable failure. Strand interface corrosion will be evident on close inspection and may occur at any point in the cable. When corrosion exists, inspect ~~the affected area~~ carefully. Corrosion on the interface of all the strands within a cable pitch length is cause for replacement of the entire purchase cable.

4. EXCESSIVE WEAR OF CABLES. Because of the angle that individual wires make with the axis of the purchase cable, the crown of these wires, when worn, is extremely elongated. Wear of lang lay cable is determined by measuring the distance between the end of the worn portion of one wire and the beginning of the fifth wire away on the same strand. This measurement is known as the "Q" dimension. Figure 6-46 shows how the "Q" dimension is obtained. The "Q" dimension decreases as cable wear increases, therefore two or more readings should be taken from each strand within a cable lay to assure that the MINIMUM "Q" dimension is obtained for each strand. Excessive wear of lang lay cable is defined as a condition in which the sum of the MINIMUM "Q" measurements taken from each strand of a cable lay is 8 inches or less when the measurements are taken from the first 15 feet of the cable (measured from the flight deck purchase cable poured terminals). When measurements are taken from the remainder of the cable, it is considered excessive wear if the sum

of the MINIMUM "Q" measurements taken from each of the six strands of cable is 9 inches or less, or if the minimum "Q" measurements on any three strands is 1 1/4 inches or less. Cable replacement is mandatory when either of the above conditions is reached.

Figure 6-47 shows the inverse relationship between the amount of cable wear and the "Q" dimension. The flat spots on the lower cable are considerably larger than those on the upper cable, indicating greater wear, however, the "Q" dimension of the lower cable is substantially less than that of the upper cable—thus; as the wear increases, the "Q" dimension decreases.

5. INSTALLED MORE THAN 12 MONTHS. The purchase cable must be replaced, regardless of condition, if it has been installed more than 12 months.

To permit study of failed purchase cables for the purpose of establishing inspection and replacement criteria, samples of the failed purchase cables are taken (fig. 6-48).

The procedure for taking samples of a failed purchase cable are:

1. Remove a 50-foot sample from each side of the break.

2. Remove a 30-foot sample, 100 feet from the topside terminal.

3. Wire a metal tag to each sample. The tag must have an identifying letter stamped on it. (See fig. 6-49.)

4. On a separate sheet of paper, record the identifying letter and the following data:

a. Carrier number.

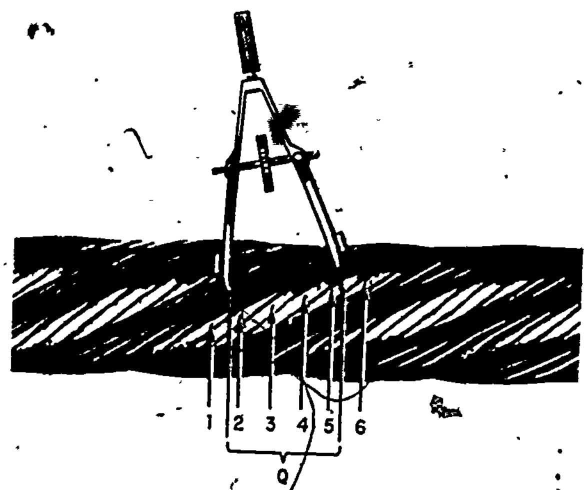
b. Engine number.

c. Date the purchase cable was placed in service.

d. Section of the failed purchase cable the sample was taken from, e.g., 50-foot, engine side of break, port cable; 30-foot, 100 feet from topside terminal, port side, etc.

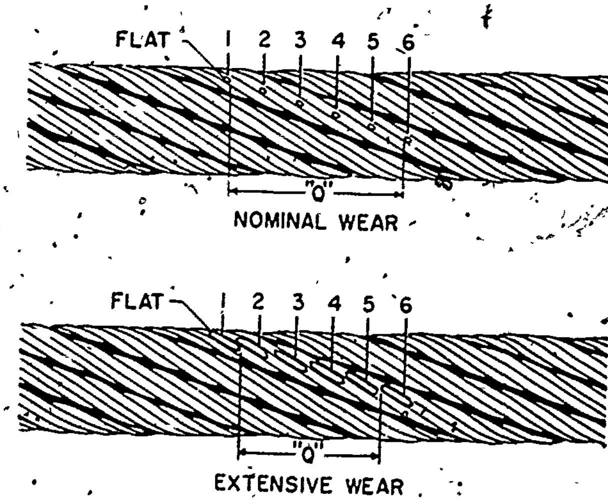
NOTE: If a break in the purchase cable occurs at a location where one of the prescribed samples cannot be taken, obtain another sample as near as possible to the one that is desired. If a sample is taken from a location other than the ones prescribed, the sample shall be clearly and precisely identified as above.

5. Insert the recorded information in a sturdy manila envelope and staple it to the inside cover of the shipping box.



AB.410

Figure 6-46.—Obtaining "Q" dimension to determine excessive wear of lang lay cable.



AB.411

Figure 6-47.—Relationship between the "Q" dimension and the extent of cable wear.

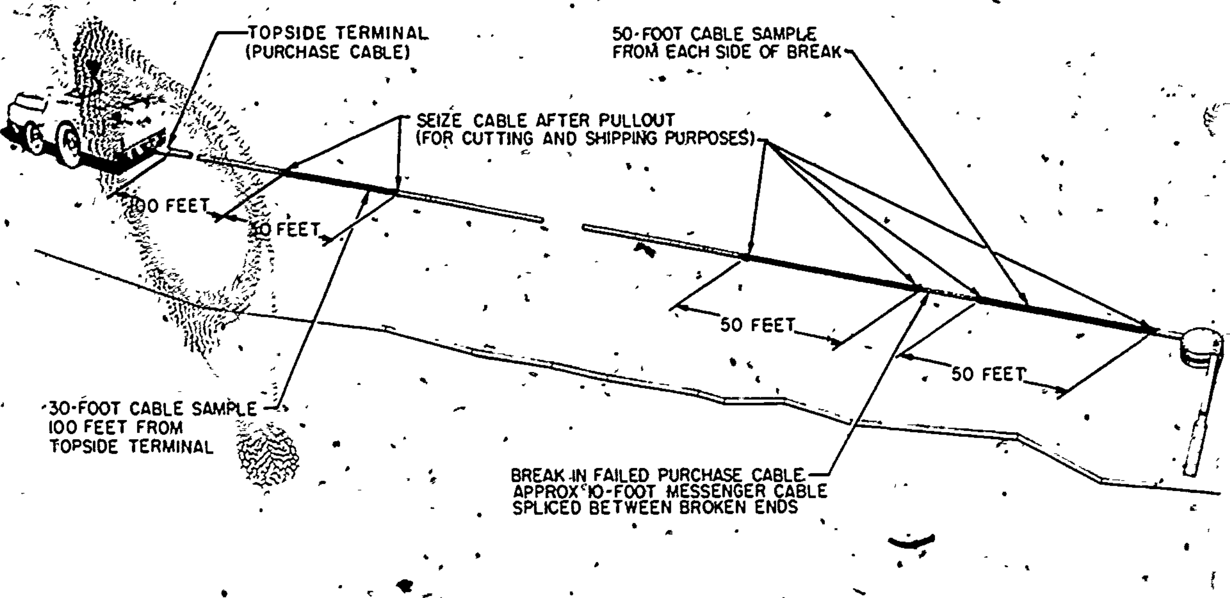


Figure 6-48.—Obtaining samples of a failed purchase cable.

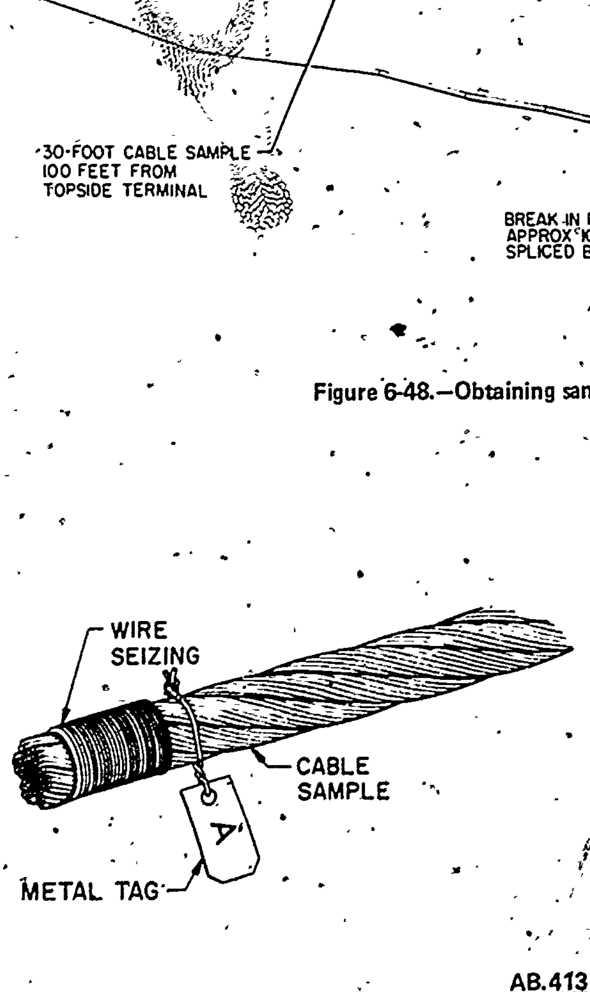


Figure 6-49.—Cable sample with identifying metal tag.

6. A report by message is made to the applicable Type Command, with information copies to NAVAIRSYSCOM and NAEC, requesting disposition instructions.

The Type Command will select the procedure best suited to the particular ship's location and the seriousness of the failure, and provide the ship with disposition instructions.

SAFETY IN INSPECTIONS

The recovery of aircraft involves various inherent dangers due to the complex coordination of men and machinery. Personnel engaged in operation of the arresting gear equipment must be thoroughly trained and initiated in the operations. Disregard for the fundamentals of caution and safety will create hazards far in excess of the inherent danger factors.

Arresting gear must be kept ready for instant use. There is only one way such a condition may be effected; that is, by constant inspection, repair, and maintenance. Prelanding and postlanding inspection of all components is a necessity and mandatory, as directed by the applicable MRC. Every section, topside, below deck, engine areas, and ready stowage must be prepared to function on command.

The necessity for accuracy of command, attention to command, and care of communication systems, whether such system be by phone, synchro signal, or lights, must be emphasized and thoroughly understood by all operating personnel. Accuracy in making proper settings of gears and indicator systems, and proper tension and pressure tests must be emphatically impressed on all personnel.

During an arrestment, all topside and deck edge personnel should be aware of all movement on and about the flight deck, with strictest attention paid to what the landing aircraft is doing Because of the possibility of pendant failure, deck edge control operators should duck below the deck level during pendant arrestments. Pendant failure could cause cable whip, or cause the aircraft to go over the deck edge.

Catwalk personnel should be as few as possible, so they can move freely and get out of the way should they be placed in jeopardy.

Hookrunners should approach aircraft from the front and side. This will place them away from danger of jet blast or broken cable backlash.

Rapid fuel consumption by jet aircraft requires highly trained, well drilled, responsible crews for the rigging of barricades. Regular drill schedules in rigging should be held to reduce rigging time to a minimum.

The greatest safety factor in the operation of the arresting engine is constant attention to inspection, maintenance, and overhaul. Preventive maintenance is particularly necessary. Daily inspection, inspection after each arrestment, and, depending on the unit involved, inspection and maintenance at regular intervals will nullify many of the conditions that may arise to endanger personnel.

Maintenance can be divided into two broad categories—preventive maintenance and corrective maintenance. Preventive maintenance consists of routine shipboard procedures designed to increase the effective life of equipment or forewarn of impending troubles. Corrective maintenance includes procedures designed to analyze and correct material defects and troubles. The main objective of shipboard preventive maintenance is the prevention of breakdown, deterioration, and malfunction of equipment. If, however, this objective is not reached, the alternative objective of repairing or replacing failed equipment—corrective maintenance—must be accomplished.

Shipboard preventive maintenance programs in the past have varied from one command to another, resulting in various degrees of operational readiness. The 3-M system, a uniform system of scheduling, recording, reporting, and managing all maintenance, is now in use.

The system is not to be considered a "cureall" for all equipment and maintenance problems. The system does, however, envision a logical, efficient approach to these problems by launching a forthright attack on electrical, mechanical, and other types of disorders. The system also produces a large reservoir of knowledge about equipment disorders, which, when fed back to the appropriate sources, should result in corrective steps to prevent recurrences.

The maintenance system, like any other system or program, is only as good as the personnel who make it work. Your role in the system as a PO1 or CPO will include the training of lower rated personnel in its use, as well as the scheduling and supervision of maintenance. As a leading petty officer, you must keep abreast of new developments and changes to the maintenance system.

CHAPTER 7

VISUAL LANDING AIDS

Visual landing aids (VLA) used to aid pilots while operating aboard carriers include deck markings, lights, lighting controls, a closed-circuit television system incorporating a video tape recorder to record and play back landing information, and other optical devices which improve operational safety on the flight deck, particularly during take-off, approach, and landing of aircraft.

The introduction of the optical landing system to carrier aviation in 1955 offered the most radical change in decades in flight operations, in that it provided consistent, standardized, and optimum carrier approaches. This capability, along with the angled deck, made it ideally suited to the increasing demands of new, high performance aircraft. Coupled with the flight deck lighting system, the optical glide indicators added appreciably to the safety of air operations around the clock from a carrier. The first type of optical landing system developed was the Mirror Deck Landing Sight (MDLS). After many years of operations it proved itself by the steady decline in landing accidents. The mirror had the disadvantage of being large and cumbersome; and when set up for some types of aircraft, it presented a hazard because it was elevated high above the flight deck level. Also, to make changes in settings for different types of aircraft a man had to make these changes at the installation itself. This was extremely hazardous with the portable mirror installed on the starboard side of the deck.

After test and evaluation, the Fresnel Lens Optical Landing System (FLOLS) was developed. As will be seen, its basic function is the same as the mirror, but it does not have to be elevated for different type aircraft. Therefore, no obstruction to aircraft is presented. Normally, all settings on the Fresnel lens are made remotely. This lends itself to greater flight deck safety for personnel responsible for the operation of the Fresnel lens.

Both of these units, the mirror and the Fresnel lens, are stabilized to compensate for ship's pitch and the vertical component of its roll. These units would be useless if the ship was moving about due to rough seas. For this reason, the Manual Meatball or manually operated Visual Landing Aid System (MOVLAS) was introduced. As the name implies, this unit is operated manually by the landing signal officer (LSO). It alerts the pilot to a high or low approach condition by the position of a meatball in relation to a row of horizontal datum lights, the same as the MDLS and FLOLS. The unit can be installed quickly with very little delay in landing operations. These units, along with the Pilot Landing Aid Television (PLAT) System, are discussed in detail in this chapter.

FRESNEL LENS

OPERATING PRINCIPLES

The Fresnel system is an electro-optical landing system for use on aircraft carriers. By use of the Fresnel system, a pilot whose aircraft is approaching a carrier may visually establish and maintain the proper glide slope angle for landing.

All of the Fresnel units are portside, permanent installations. The Fresnel system provides a horizontal bar of light that appears in the deck edge assembly. The position of this bar of light, with respect to a set of fixed horizontal datum lights, indicates to the pilot of an approaching aircraft whether he is above, below, or on the correct glide slope. The bar of light is formed by the combined actions of source lights, Fresnel lenses, and lenticular lenses. Because of the optical system, the bar of light appears above the horizontal datum lights if the glide slope angle is too great, and below the horizontal datum lights if the glide slope is too small. When the pilot alines the bar of light with the horizontal datum lights, his approach is correct for a carrier landing.

Different types of aircraft have different structural characteristics and capabilities; therefore, different glide slope angles should be established. However, as a matter of practice, the basic angle settings of 3.5 and 4.0 are most commonly used. These settings represent the basic angles that are considered to be acceptable in most recovery operations. For more information concerning the exact recommended basic angle settings for the recovery of each of the different types of aircraft, always refer to the applicable recovery bulletin.

Although the basic angle setting is seldom changed for different types of aircraft, the roll angle is changed. The roll angle compares to the height corrections made with the mirror. The reason for it being called a roll angle in the Fresnel lens is because the height of the Fresnel unit never changes. To compensate for aircraft having different hook-to-eye H/E values, the Fresnel unit is rotated about its roll axis.

The roll angle that is selected is not altered as a result of the stabilization signals received from the ship's stable element. Once the basic and roll angles are selected, they are maintained regardless of the pitch and roll of the carrier in respect to the true horizontal, in the line mode of operation The indicator assembly maintains the selected basic angle in accordance with stabilization signals received from the ship's stable element The relationship of the stabilized light plane to the horizontal plane of the deck is altered, so that the hook touchdown point is within the cross-deck pendant pattern, while maintaining a safe hook clearance above the stern ramp on approach.

The basic differences between the Fresnel lens system and the mirror is that changes to the settings are normally made remotely in the Fresnel system and the mirror is a reflection system while the Fresnel lens is a projection system All settings can be made remotely from either one of two stations. Remote control panel 1 is located in primary fly. This is where all settings are normally made. The unit is energized from this control panel and all the lights can be turned on from this station, their brightness controlled, and the basic and roll angle set into the indicator assembly. Figure 7-1 shows the general arrangement of Fresnel lens components.

Located below the flight deck in the FLOLS room is the main power panel and remote control panel 2. The power panel is the central power and signal distribution station for the Fresnel system. Remote control panel 2 is located adjacent to the power panel, and it can also be used to make all the settings and adjustments that remote control panel 1 makes. Remote control panel 2 is used only in an emergency. If remote panel 1 suffers battle damage, it can be isolated; and then all settings and adjustments would be made from remote panel 2. During normal operations, remote panel 2 is blocked in the OFF position.

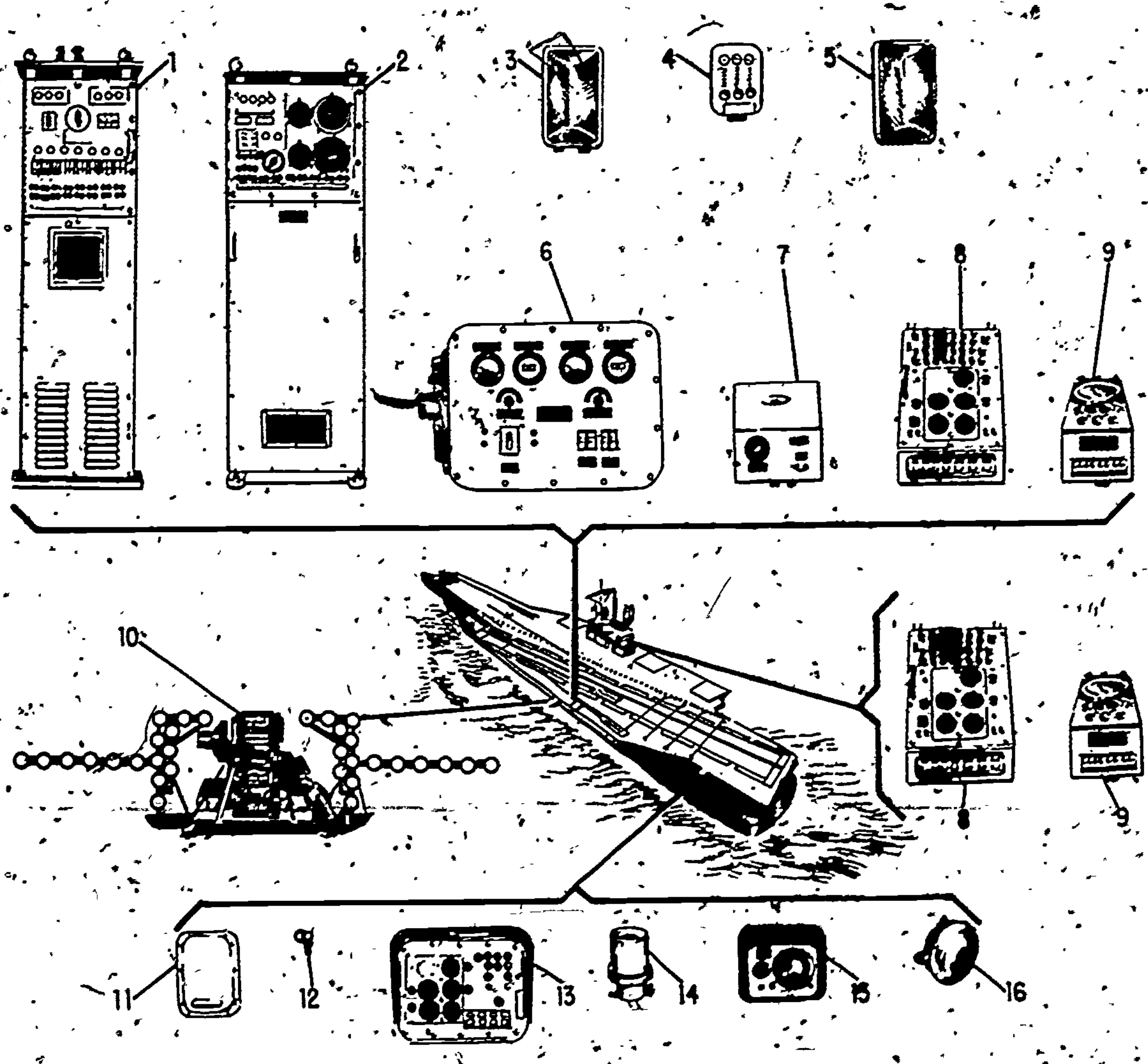
At the LSO platform, there are two indicator panels. These panels inform the LSO of the basic and roll angle set into the unit, hook-to-ramp (H/R) clearance, hook-to-eye setting, and the brightness of the source, low cell, and datum lights,

DECK EDGE UNIT

The lens unit located at the deck edge consists of a lens box approximately 22 3/4 inches wide and 4 feet high. The lens box is made up of five individual cell assemblies. A vertical column of four red waveoff lights is located on each side about 3 feet away from the lens box. (See fig. 7-1.)

Twelve green datum lights, six on each side, are mounted in line with the horizontal centerline of the lens box. Four green "cut" lights appear near the top of the display, two on each side, arranged horizontally between the top waveoff lights and the lens box.

A yellow bar of light is displayed over the full width of the lens box. The lens box may be considered a window through which the pilot views the bar of light. The bar of light appears as though it were located approximately 150 feet beyond the window. When viewed from anywhere on the prescribed glide slope, this bar of light (meatball) will appear in line with the green datum lights. (See fig. 7-2.)



1. Power panel.
2. Line stabilization panel assembly.
3. Low cell flasher assembly.
4. Source light failure indicator assembly.
5. Transformer enclosure.
6. Disconnect and monitor assembly.
7. Control box assembly.
8. Remote control panel assemblies 1 and 2.
9. H/R remote panels 1 and 2.
10. Deck edge assembly.
11. Junction box assembly.
12. Pickle switch.
13. LSO panel.
14. Waveoff monitor.
15. LSO H/R monitor.
16. Alarm bell.

AB.416

Figure 7-1.—General arrangement of FLOLS components.

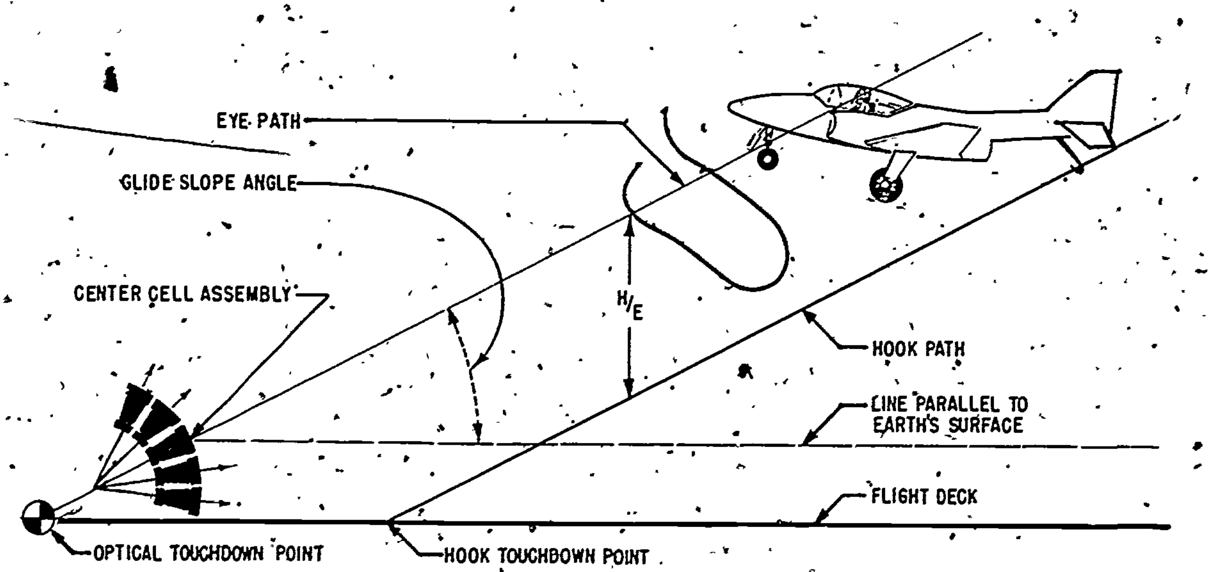


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Figure 7-2.—Principle of glide slope angle.

The bar of light will rise above the datum lights as the pilot rises above the glide slope, eventually sliding off the top of the lens box when the pilot is more than three-fourths of a degree above the glide slope. The same holds true as the pilot drops below the glide slope. The meatball will drop below the datum lights and finally slide off the bottom of the lens box. Therefore, when the meatball is high, i.e., above the datum lights, the pilot is above the glide slope, and when it is low, the pilot is below the glide slope. In either case, the object is to line up the meatball with datum lights. Because flying below the proper glide slope sets up a hazardous condition, the bottom cell in the indicator assembly has a red lens installed. Whenever the pilot can see a red bar of light, he immediately knows he is low.

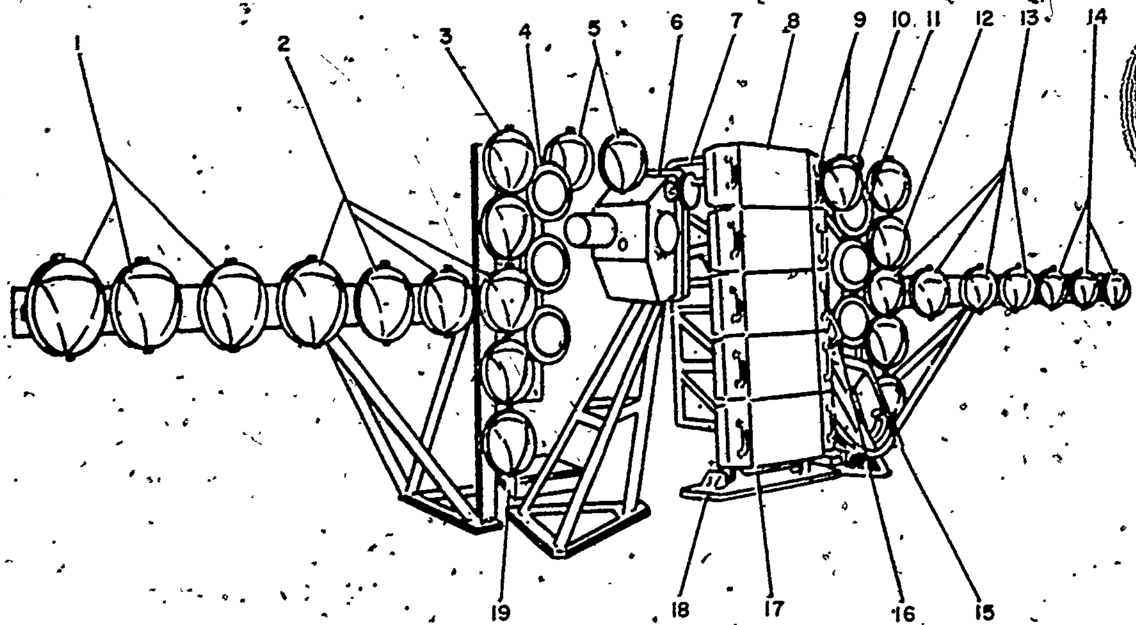
Referring to figure 7-3, the lens box (8) itself (indicator assembly) is capable of being tilted about two axes at right angles to one another. These axes correspond roughly to the pitch and roll axes of the carrier.

The tilt in pitch determines the glide slope angle to be flown. This is known as the basic angle setting of the lens unit. The tilt in roll causes the glide slope at the centerline of the landing area to be raised or lowered. This is possible because the center of the bar of light from the indicator assembly is shining parallel to the centerline of the landing area. (See fig. 7-4.)

Rolling the indicator assembly makes it possible to accommodate the hook-to-eye values (H/E) of the various aircraft models without having to elevate the indicator assembly. (See fig. 7-2 for H/E distance.) This is known as the roll angle indicator setting of the lens unit.

The prescribed glide slope is defined as the glide slope dictated by the lens unit when viewed from the vertical plane of the landing area centerline. This means that to be on the prescribed glide slope, THE PILOT MUST BE LINED UP WITH THE LANDING AREA CENTERLINE while maintaining the meatball in line with the datum lights. Once again, the Fresnel lens unit does not line the pilot up with the centerline. If he is to either side of the center of the landing area, he will be flying a glide slope parallel to but much higher or lower than that prescribed by the lens settings.

The indicator assembly consists of five cells and a stacking frame. Each cell contains three source lamps with associated lenses to provide a bar of light at the front of the indicator



1. Outboard fixed datum lights.
2. Outboard conditional datum lights.
3. Outboard waveoff lights.
4. Outboard auxiliary waveoff lights.
5. Outboard cut lights.
6. Pitch power drive assembly.
7. Roll power drive assembly.
8. Source light indicator assembly (lens box).
9. Inboard cut lights.
10. Waveoff indicator.
11. Inboard auxiliary waveoff lights.
12. Inboard waveoff lights.
13. Inboard conditional datum lights.
14. Inboard fixed datum lights.
15. Indicator junction box.
16. Auxiliary waveoff junction box.
17. Inboard junction box.
18. Stowlock assembly.
19. Outboard junction box.

AB.230

Figure 7-3.—Fresnel lens deck edge assembly.

assembly. Each cell is provided with a heating system to maintain a constant temperature for the Fresnel lens.

There are two types of lenses used in the optical portion of the Fresnel system—the Fresnel lens and the lenticular lens. The Fresnel lens is composed of a lightweight and relatively thin sheet of transparent Lucite. The Fresnel lens differs in configuration from a planoconvex as shown in figure 7-5.

One surface of the Fresnel lens consists of a number of stepped facets. These facets are circular (similar to a phonograph record), concentric grooves that extend from the center of the lens to the edges. The slope of each facet is independent of the slope of all the other facets. These slopes are designed to provide a perfect focus of the light rays which pass through the lens. This provides an advantage over a convex spherical lens as shown in figure 7-5.

A convex spherical lens has spherical aberation. When the rays of light parallel to the principal axis of a convex spherical lens pass through zones near the edge, the principal focus occurs at a point which is closer to the lens than the focus for rays which pass through the lens near the principal axis. Therefore, the light rays from a convex spherical lens tend to scatter.

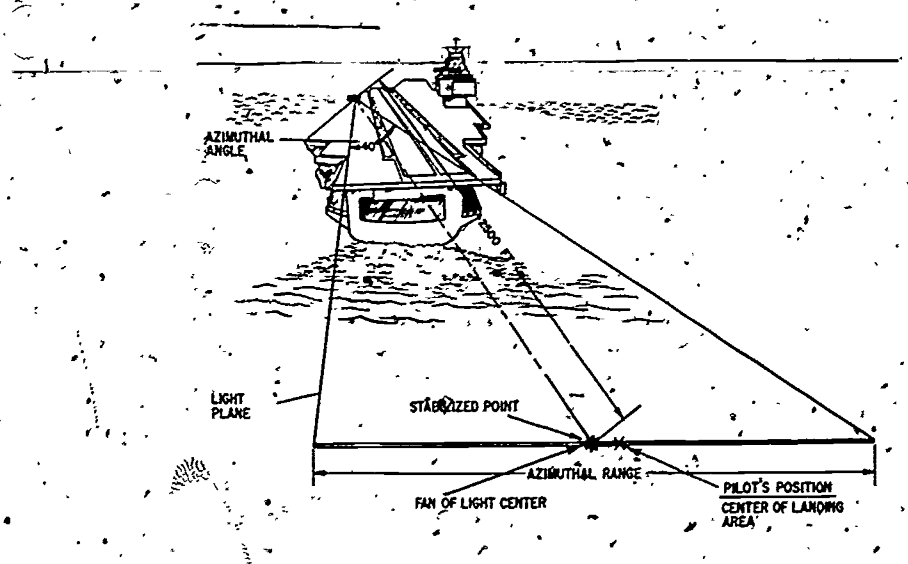


Figure 7-4.—Characteristics of stabilized light plane.

The Fresnel lens can also be formed around a suitable radius to minimize astigmatism. Astigmatism of a lens is the inability of the lens to bring all of the light rays from a point on an object to a sharp focus at the image.

A lenticular lens is placed in front of the Fresnel lens. It is sometimes referred to as a spreader lens. Even though the lenticular lens is molded in one piece, it consists of several long, convex, cylindrical lenses placed side by side as shown in figure 7-6. Each individual lens has the same short focal length. The viewing area of the object is spread by the short focal length of the lenticular lens. The object consists of a multiple light source with spacing between the lights, as in the Fresnel lens landing system (three source lamps in a cell); but the object appears to an observer looking into the lens as a continuous band of light which fills the width of the lens. The object appears as a continuous band of light regardless of the observer's position in the azimuthal range of view of the lenticular lens. The azimuthal range of the lenticular lens used in the Fresnel system is 40°. The appearance of the height of the object is not affected by the lenticular lens.

The lenticular lens in each cell assembly is colored aviation yellow during manufacture to eliminate the need for a color filter. The bottom cell, as mentioned previously, has a lenticular lens colored red in manufacture as a safety feature to indicate to a pilot that he is below the proper glide slope. Also, the sunglare from the lenticular lens is reduced due to its shape. If a smooth filter were used to cover the Fresnel lens, the sun's reflection might obliterate the image.

The indicator assembly contains 15 source lamps, the Fresnel and lenticular lenses, and a heating system. The interior of the cells is painted black to reduce internal reflections from the source lamps.

The 15 source lamps are contained in five separate cells, each cell containing three source lamps arranged horizontally. The cells are stacked vertically to provide a light source which is three lamps wide and five lamps high. The top four lamps are wired in three vertical series strings. As the lamps age, there is a tendency for adjacent coils of the filaments to short together. The net result is that the lamps age together. As the lamps age, the inner surface of the envelope blackens, and the light output is greatly reduced. If one lamp fails during operation, the top four lamps in that vertical series will go out, but no appreciable effect is noticeable on the bars of

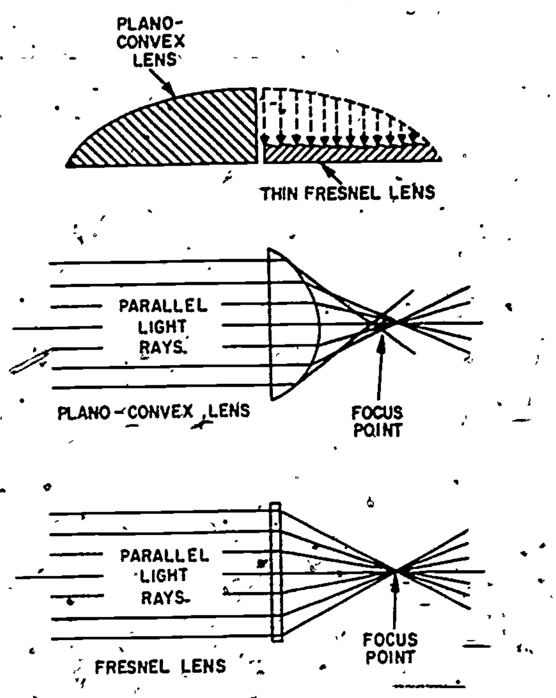


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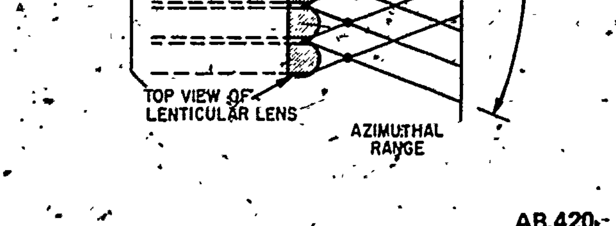
Figure 7-5.—Comparison of plano-convex lens to Fresnel lens.



AB.420

Figure 7-6.—Characteristics of a lenticular lens.

light formed by the lenses. The bottom cell (low cell) has its three lamps connected in parallel.

The arrangement of the lenses with respect to the source lamps and the physical properties of the lenses cause the source lamps to appear as a narrow bar of light 12 inches across the front of the cell assembly.

The optical characteristics of the Fresnel lenses will vary appreciably with a change in temperature.

To maintain design characteristics of the Fresnel lenses, lens-heating compartments are maintained at a relatively constant temperature. The Fresnel lenses are each enclosed in a separate compartment with the lenticular lens as the front and optical glass as the back of the compartment. Hot air is circulated in the compartment under thermostatic control.

A source light failure indicator is used to indicate source light failure. The indicator is located in the FLOLS room. In the event of an open lamp filament, a loss of current to a sensing circuit causes the failure indication lamp to light.

REMOTE CONTROL PANELS

Two remote control panels are included in the Fresnel system. Because the operation of the two panels is identical with the exception of the low cell "steady/flash" mode switch and the interlock block for the remote panel selector switch located on remote control panel 2, only the operation of remote control panel 1 located in pri fly is discussed. (See fig. 7-1.)

When remote control panel 1 is in use, the remote panel selector switch is in position 1. The datum, cut, and waveoff lights clutch, source light clutch, and low cell clutch (all slip clutches) are mechanically engaged. When the circuit breakers in the power panel assembly are closed, current is applied through fuses to the panel illumination transformer, datum, cut, and waveoff brightness synchro, low cell brightness synchro, and the source light brightness synchro. The cell temp, unit ON, source light, waveoff light, cut light, and datum light indicators on the remote control panel will light only if the corresponding switches are actuated. The cell temp indicator will light only after the cells in the indicator assembly have reached the proper operating temperature.

The light intensity dial indicators on the remote control panel are calibrated dials which are connected to the rotor shaft of the datum, cut, and waveoff brightness synchro, low cell brightness synchro, and source light brightness synchro, respectively. The datum, cut, and waveoff intensity dial, low cell intensity dial, and the source light intensity on the LSO panel and remote control panel 2 track the movement of the datum, cut, and waveoff brightness control, low cell brightness control, and source light brightness control of remote control panel 1.

When the unit ON pushbutton on remote control panel 1 is pressed and released, a relay in the power panel assembly is energized. A current path is completed to light the unit ON indicator. Contacts in the power panel assembly close, and current is applied to other circuits in the Fresnel system. With these contacts energized, the stabilization circuits begin to operate, and the source lights, datum lights, waveoff lights, and cut lights can be operated. The waveoff light ON push switch and cut light ON push switch are momentary switches. When the source light ON push switch and the datum light ON push switch are set to position ON and released, latch relays are energized. The waveoff light ON push switch and the cut light ON switch must be held in position ON to keep the waveoff and the cut light relays energized.

Control of the Fresnel system may be switched to remote control panel 2 by setting the remote panel selector switch on remote control panel 1 to position 2. This permits remote control panel 2 to be used for all the functions described above except for remote control panel selection. This can be performed at remote control panel 2 by removing the interlock block. Another function of remote control panel 2 is to switch the low cell mode of operation to either steady or flash.

When remote control panel 1 is in position 1, the roll angle lever switch and the basic angle control are energized. When this lever switch is held in position INCREASE and "Push to Set R/A" is pressed, the roll drive motor is operated and produces a torque which increases the roll angle readings. As soon as the roll angle dial reaches the required setting, the lever switch is released. A spring returns the switch to position OFF, and the roll drive motor is stopped. There is a small amount of overshoot which can be anticipated with a little practice. Holding the lever switch in position DECREASE reverses the roll drive motor direction. The roll angle dial is calibrated from 0 units to 15 units. When the dial reads 7 1/2 units, the indicator assembly is perfectly vertical. The dials in both remote control panel 2 and the LSO panel track the dial of remote control panel 1, giving remote readings.

All changes to the basic angle are made from the remote control panel in operation and the dial at the LSO panel and the other remote control panel track the dial in operation.

H/R REMOTE CONTROL PANEL

Even though this is a separate control panel from the remote control panels previously mentioned, it is located alongside remote control panel 1 and remote control panel 2, and for all general purposes it is a part of that station. Because the operation of the two H/R remote control panels is identical, only the operation of H/R remote control panel 1 is discussed. H/R remote control panel 1 is in use when the remote panel selector switch on remote control panel 1 is in position 1.

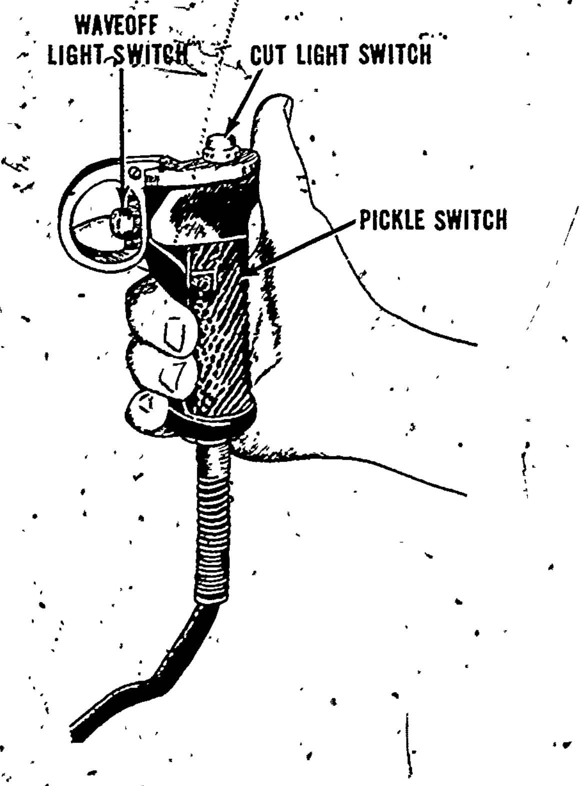
All aircraft have a specific hook-to-eye value (H/E). This is the vertical distance from the path of the pilot's line of sight to the path of the tailhook. (See fig. 7-2.) To compensate for this H/E factor, the H/R remote control panels are used to indicate clearance of tailhooks from the aft end (ramp) of the carrier.

LSO PANEL

The LSO panel supplies a visual indication of system status to the landing signal officer. Operation of the waveoff lights and the cut lights and control of the brightness of source, datum, waveoff, low cell, and cut lights can be performed from the LSO panel. The indicators on the LSO panel indicate the positions of the corresponding controls and switches on the remote control panel which is in use.

When the unit ON pushbutton on the remote control panel in use is pressed and released, the circuit is completed to the unit ON indicator. When the lens temperature in the indicator assembly at the deck edge reaches a preset level, a set of contacts closes and provides a current path which lights the system GO on the LSO panel.

When the waveoff light momentary switch on the remote control panel in use, the pushbutton on the LSO panel, or the hand held pickle switch is pressed and held, a relay in the power panel assembly is energized, a set of contacts closes, the waveoff light ON indicator on the LSO panel lights, and the waveoff lights flash. When the cut light momentary switch on the remote control panel in use, the pushbutton on the LSO panel, or on the hand held pickle switch is pressed and held, the cut light ON indicator on the LSO panel and the cut lights come on. (See fig. 7-7.)



AB.421

Figure 7-7.—Pickle switch.

POWER PANEL ASSEMBLY

The power panel assembly (fig. 7-1) is located below the flight deck in a compartment in the vicinity of the deck edge unit. It is commonly referred to as the FLOLS room. The power panel comes under the cognizance of the IC electricians in the V-2 division.

The A100 power panel assembly is the central power and signal distribution station for the Fresnel system. It contains the circuit breaker and fuse assemblies for all the components; the light control assemblies for source, datum, cut, and waveoff lights, the controls that cause the waveoff lights to flash, the computer assembly for point stabilization; the dimmer synchro assembly; and the hook to ramp monitor assembly. The A500 power panel contains the necessary electronics and computors for line operation.

MANUALLY OPERATED VISUAL LANDING AID (MOVLAS)

The manually operated visual landing aid system (MOVLAS) is an emergency signaling system intended to be used when the primary optical landing system is rendered ineffective. As a substitute for the Fresnel lens optical landing system, it provides two basic visual displays.

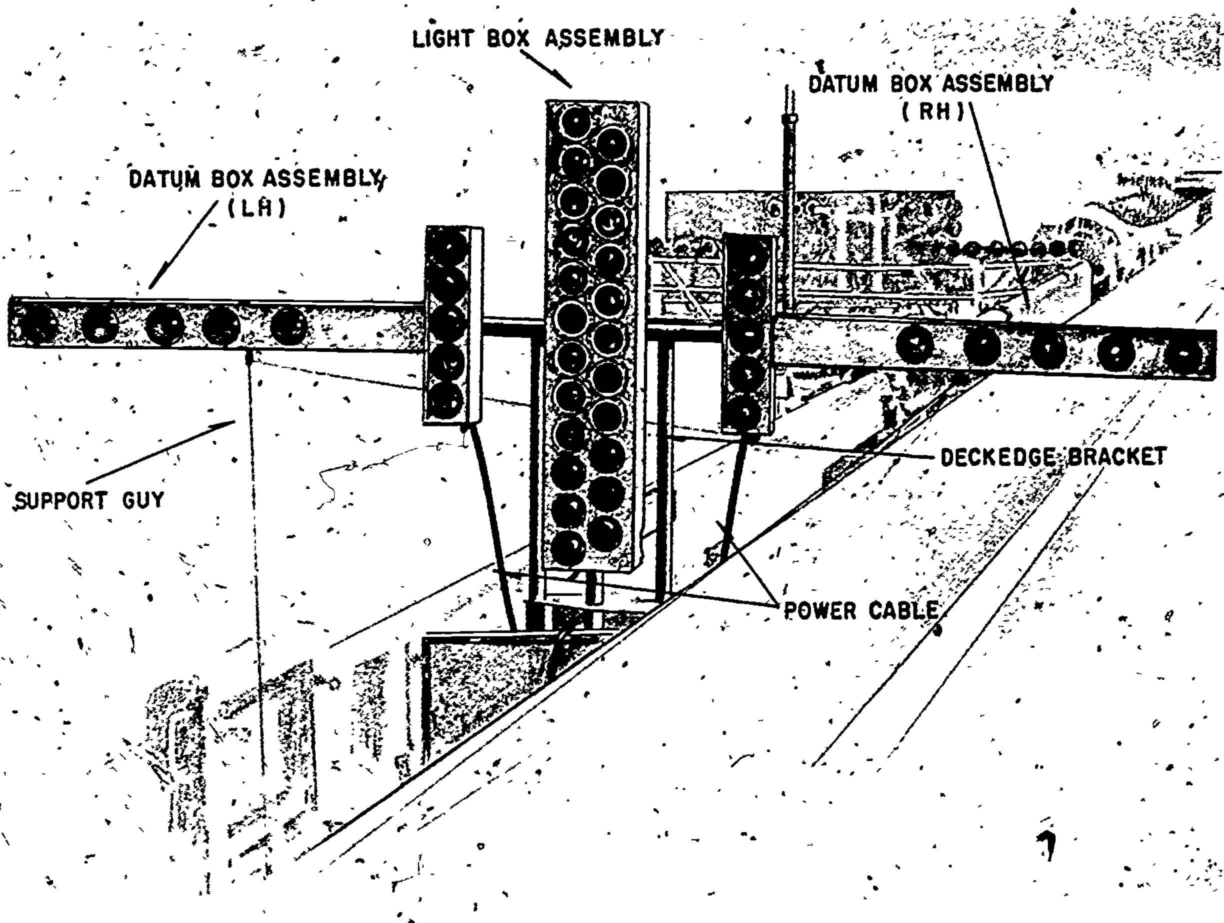
The first of these displays is the source light image or "meatball" seen by the pilot when making an approach with the lens system. The second display, "datum," consists of reference lights, cut lights, and waveoff lights.

The meatball display is provided by three principal items of equipment—the light box visual display unit, a power control box, and the LSO controller, which controls the movement of the meatball picture up and down the face of the light box.

The datum display is provided by four principal items of equipment—two datum box visual display units, a datum control box, and a transformer box.

The equipment is designed so that the meatball display elements (light box assembly) may be used in conjunction with an existing lens unit, or the entire system may be used completely independent of Fresnel lens at either the port or starboard installation fixtures. Figure 7-8 illustrates an independent manually operated visual landing aid system (port installation).

NOTE: MANUALLY OPERATED VISUAL LANDING AID SERVICE CHANGE #9 (applicable to MOVLAS Mark 1 Mod 1 shipboard system) provides the technical information to



AB.236

Figure 7-8.—Manually operated visual landing aid system (port installation).

accomplish the addition of a starboard installation. The reason for this change is to increase the operating effectiveness of the MOVLAS by adding the starboard installation, thus providing PORT or STBD operating capabilities.

The system contains the light box, LSO controller, datum box assemblies, and power control boxes, together with adequate mounting facilities. The principal unit of the system is the light box. The light box is designed to present landing glide slope information to the pilot of an approaching aircraft in the same visual form presented by the FLOLS unit. The second unit of the system is the LSO controller, used to adjust the presentation of the light box. The LSO controller functions when a control handle is positioned by the landing signal officer. Power to operate the system is regulated by the power control box. The selection for use of the port or stbd MOVLAS installation is accomplished by the dual connector box, which is bulkhead mounted at the landing signal officer control area.

NOTE. It is mandatory that the location of this box be in an area that is readily viewed by the LSO and accessible to the installation crews.

There are two MOVLAS systems—the Mark 1 Mod 2, designed for shipboard use, and the Mark 2 Mod 1, designed for land-based operation.

When the system is needed, it takes only a few minutes to install the components and have it in operation. Mounting and power receptacles should be previously installed. A good feature of the system is its light weight. The two components that have to be handled and installed when the primary optical landing system fails is the light box, which weighs only 46 pounds, and the LSO controller which weighs 25 pounds.

The light box can be mounted in front of the indicator assembly of the Fresnel lens system, directly into a receptacle provided. The light box is shown in figure 7-9.

The front of the light box contains a pair of perforated doors which may be latched in either a closed position in front or an open position against the sides of the box. When the doors are closed, the light output from the unit is reduced to approximately 3.5 percent of the light intensity obtained with the doors open. This effectively doubles the range of light intensity control available from the power control box. A large adjustable range is necessary for satisfactory performance over the extremes of night and day operations. The front plate of the light box contains 23 lamps, individually mounted in position by separate retaining rings. Electrical power and control are supplied to the light box through a multiple pin type connector, located at the rear of the unit. The light box may be quickly disconnected, dismounted, and stowed to permit normal landing operations.

The LSO controller consists of an aluminum casting, housing a series of 23 switches cam operated through individual actuators, a support tube, and a control handle. It installs into the deck at the LSO platform (shipboard) by inserting the mounting tube into a receptacle which has been welded into the deck. A series of holes in the support tube allows the unit to be pinned at various heights to suit the operator. The unit is free to rotate through 360° in the deck fitting, allowing the LSO to move about while holding the control handle. The control handle itself has 25° of vertical travel in controlling the full range of light positions on the light box. This handle is terminated in an adapter which attaches to the pickle switch.

The LSO controller is designed to be removed and stowed when not in use. The electrical connections to the unit are made by means of a multiple pin type connector located on the bottom of the housing. A second connector is also located on the connector plate of the unit.

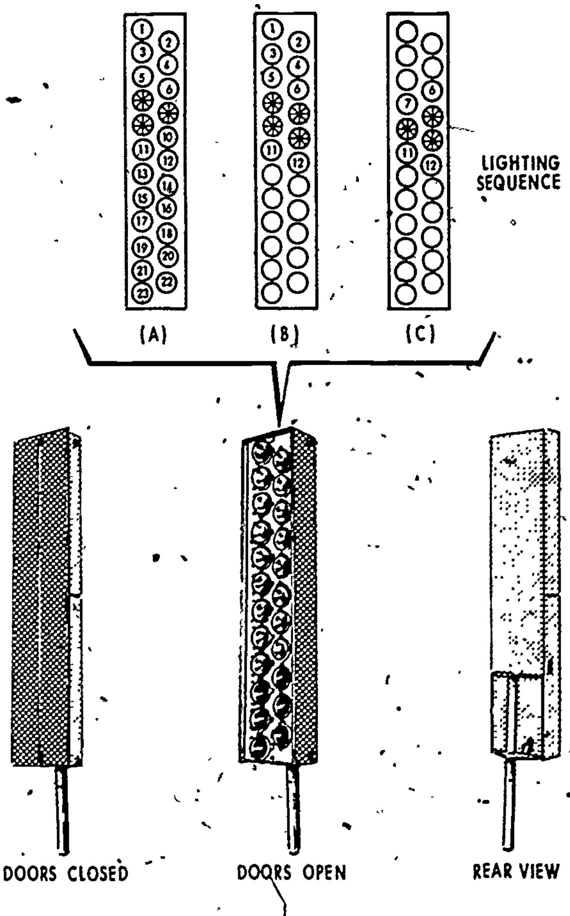


Figure 7-9.—Light box.

This connector provides an alternate path for the pickle switch wiring. This wiring is for use with the portable datum light unit. This is a complete unit in itself and is not dependent on the lights supplied with the Fresnel lens unit.

A switch is located on the connector plate to allow the LSO to change the mode of operation. This switch, when thrown, shuts off power to the bottom three lights on the light box. This means that when the LSO has the handle all the way down, there will be no light indication to the pilot approaching. It also means that when the LSO leaves the unit unattended and the handle at the bottom, there is no chance of an erroneous presentation being presented to a pilot approaching an unattended unit. (See fig. 7-10.)

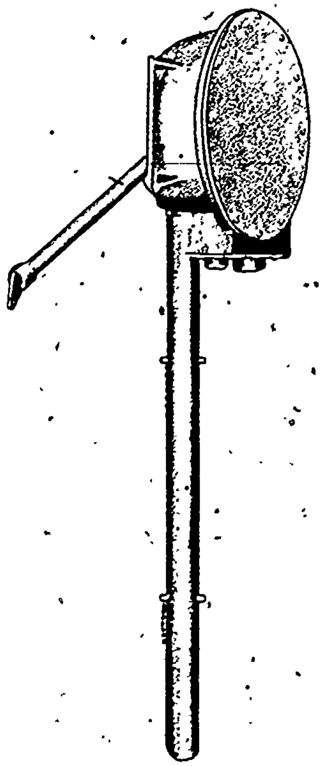


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Figure 7-10.—LSO controller.

A ball and detent arrangement is provided on the controller handle so that the LSO can readily identify the ROGER MEATBALL position. A thumbscrew adjustment on the ball allows the LSO to set the feel of the control handles as desired.

POWER CONTROL BOX

The power control box is normally mounted on a bulkhead in the lens control room. The front cover serves as the mounting for the light intensity control adjustment dial, two yoked circuit breakers, and a power indicator light. The front cover is a door, hinged to allow easy access to internal components. (See fig. 7-11.) This is the unit that supplies controlled power to the LSO controller and the light box.

FUNCTIONAL OPERATION

The visual display element of the system is the light box, containing 23 lamps arranged in two rows. The light box is mounted directly in front of the Fresnel lens face, and substitutes for a normal "meatball" presentation. The light box replaces the lens unit of the Fresnel lens optical landing system.

In operation, only three adjacent lamps in the light box are normally turned on at any one time. Individual lamps cannot be distinguished in the light box at a distance of 100 or more feet; therefore, the pilot sees a single ball of light. Each lamp is lighted by a separate, cam-operated switch in the LSO controller. The existing datum, waveoff, and cut lights continue to be used for the system as they were for the Fresnel system.

The pilot continues to fly the "meatball." The difference is that the position of the meatball with relation to the datum lights is controlled directly by the LSO. If the approaching aircraft is high, the LSO must give the pilot the indication by manually moving the controller lever up. As soon as the pilot corrects this high altitudes and the LSO thinks the pilot is on a proper glide slope, he then gives a ROGER indication by moving the controller lever down to the midpoint position, lining the lights (meatball) with the datum lights and therefore giving the approaching pilot a ROGER indication.

In actual practice, a slight overlap of switch positions exists, so that a fourth lamp is turned on for a small period of time before the corresponding lamp at the other end of the cluster is shut off. The results of a typical switching sequence is shown in figure 7-9.

The bottom lamps in the light box are red to quickly alert the pilot of a dangerously low approach.

Operation of the circuit breaker switch on the power control box provides ship's power to the preheat transformer and the intensity control. The preheat transformer is always supplying some voltage to all of the lamps. The voltage is not enough to visibly light the lamps but it does keep the lamps warm. Then, as the LSO moves the controller lever, the lamps (by being warm), light immediately.

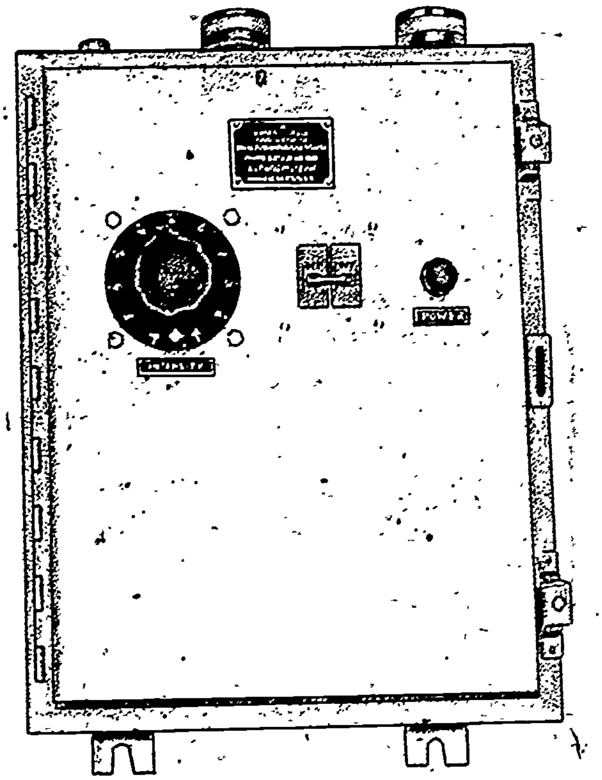

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Figure 7-11.—Power control box.

The arms of the switches are connected through the power control box to the individual lamps in the light box. The position of the control handle determines which lamps have full voltage applied to them. Therefore, under the conditions described above, every lamp in the light box has power applied to it continuously; either preheat voltage, or full lamp voltage. Normally, three lamps have full lamp voltage and the remaining 20 are in the preheat condition.

The equipment includes provisions for continuously adjusting the intensity of the presentation at the power control box. A switch on the connector plate of the LSO controller allows the LSO to change the mode of operation. When the switch is in one position, the system operates as described above. When the switch position is reversed, the three bottom lamps on the light box are removed from the circuit. When the bottom lamps are removed from the circuit, and when the LSO controller handle is moved to its extreme down position, the meatball appears to move toward the bottom of the light box and then disappear completely. The described change in the mode of operation results in the pilot apparently seeing the meatball go off the bottom of the lens. The change in the mode of operation may also be used by the LSO to leave the system unattended and be assured that no erroneous presentation is being presented to an approaching aircraft by the light box. A detent position is reached just before the control handle moves into this "off the bottom" position, warning the LSO that he is about to present this condition.

SETUP INSTRUCTIONS

Under normal operating conditions, the light box and the LSO controller will be stowed in the lens control room. To use the manually operated visual landing aid, it is only necessary to mount and connect the power cables to the units after ascertaining which installation is to be used (port or starboard).

If it is to be used in front of the Fresnel lens system, mount the unit according to the following steps:

1. Remove the light box from its stowed location and mount it immediately in front of the Fresnel lens by inserting the end of the support tube into the deck receptacle.
2. Check that the light box has seated all the way into the deck mounting receptacle, and that the slotted end of the support tube has located the deck receptacle pin so that the light box will not rotate.
3. Remove the connector caps from the connectors on the rear of the light box and connect the power cable to the light box.
4. For daylight operations, the doors on the light box are latched in the open position.
5. If the light box is mounted in front of the Fresnel system, its height will be correct so that the datum arms of the Fresnel system are at the center of the light box.
6. Install the tiedown cable on the rear of the light box.

WARNING: Failure to secure a tiedown to this unit may allow it to come out of the mount during operations with resulting loss, damage, and/or possible injury to personnel.

If the MOVLAS is to be used as an independent unit, mount the unit according to the following steps at either the port or starboard installation:

1. Remove the light box from its stowed location and install it in the base assembly. The light box must be secured by use of the tiedown eyebolts on the rear of the light box.

2. Install the datum boxes on the support tubes in the base assembly.

3 Secure the datum boxes with the four auxiliary tiedown cables to the flight deck padeyes (two fwd, two aft).

4. Secure the forward eyebolt on the base assembly to a forward padeye, and the aft base eyebolt to an aft flight deck padeye. (Starboard installation only, see fig. 7-12.)

5. Remove the connector caps from the connectors on the rear of the light box and datum boxes and connect the appropriate power cables.

6. For daylight operations, the doors on the light box are latched in the open position.

To mount the LSO controller, the following steps are followed:

1. Remove the LSO controller from its stowed location and mount it in the LSO area by inserting the end of the support tube into the deck receptacle.

2. Adjust the unit to the proper height by inserting the adjustment pin in the appropriate holes of the supporting tube.

3. Remove the connector caps and connect the power cable to the controller.

4. Mount the LSO's pickle switch on the LSO controller handle adapter. Slip the notch in the finger guard over the adapter and insert the retainer pin.

The system requires no warmup time, and may be checked and operated immediately after turning on the power.

WARNING: Before operating this system, verify that the source lights for the Fresnel lens system have been turned OFF. Failure to do this may result in the presentation of conflicting double image glide slope information, resulting in aircraft damage or the loss of a pilot's life.

Turn the system on by throwing the circuit breaker switch on the power control box to ON. Check that the power light illuminates.

Adjust the light intensity control knob on the power control panel as instructed by the LSO to obtain the desired brightness setting. It may be necessary to open or close the perforated doors on the light box to obtain a satisfactory setting.

At the LSO platform, slowly move the control lever on the LSO controller over its extremes of travel while observing the light box.

Move the control lever to the center or detent position and verify that the meatball lines up with the datum arms. Move the control lever through the bottom detent position and verify that the mode is as desired. Adjust the control lever handle friction setting as desired.

To secure the system, throw the circuit breaker switch on the power control box to the OFF position. If shutdown is other than momentary, close and latch the doors to prevent damage to the lights in the light box. If the system is to be stowed, reverse the steps for setting up the unit.

PILOT LANDING AID TELEVISION (PLAT) SYSTEM

Experience with a new closed-circuit television system has shown that video tape recording can be effectively employed to increase the safety of aircraft landing and improve both pilot and landing control personnel proficiency. The Pilot Landing Aid Television (PLAT) is a completely integrated system of electronic picture and sound recording designed to monitor and simultaneously record aircraft landing operations from approach through final touchdown, under day and night conditions, and to immediately play back the recording for post-flight analysis and evaluation.

The PLAT system, introduced as a landing aid to pilots during carrier operations, consists of four television cameras with associated power supplies, monitoring, control synchronization, and distribution equipment, and a standard video tape television tape recorder. (See fig. 7-13.)

Two unmanned centerline cameras (one regular, one emergency), stabilized to the ship's optical landing system, pick up and follow aircraft through approach and landing. Aircraft attitude and glide slope are displayed on picture monitors in combination with the output of a

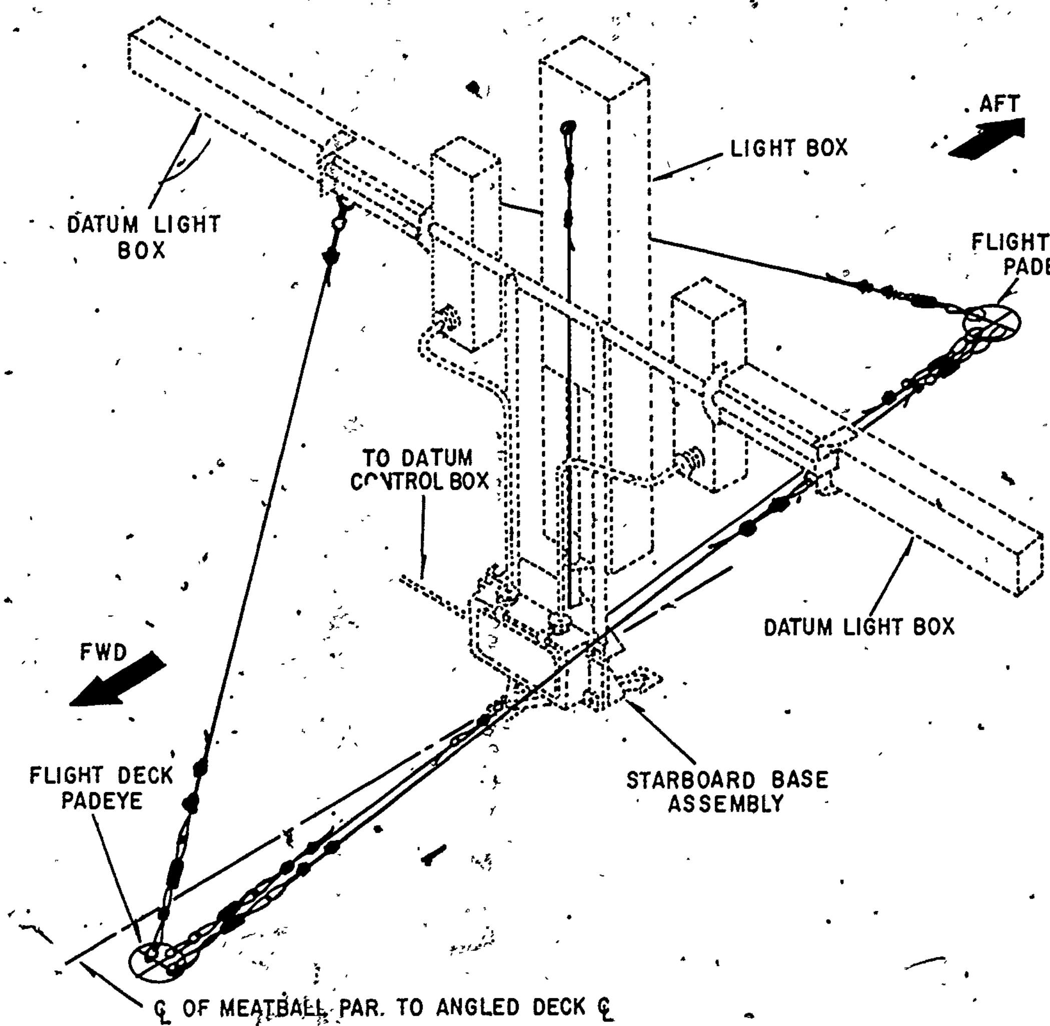

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Figure 7-12.—Independent MOVLAS (starboard installation).

special effects camera focused on a data board carrying time, date, wind velocity, and aircraft landing speed. After touchdown and during recovery, the aircraft is monitored by a fourth (manned) camera on the ship's island structure as it passes over the centerline cameras and the information is again displayed with the output of the data board camera. The entire operation is recorded on video tape at the same time it is monitored by the television cameras.

Prior to the introduction of PLAT, carrier landings and takeoffs were recorded on 16mm film. Processing of the film took a minimum of 3 hours. The time lag between recording and presentation was an obvious drawback since the film could not be used for immediate debriefing of pilots. In addition, no permanent visual record of approach speed and other data board information was available. With the development of the PLAT system, limitations of the standard

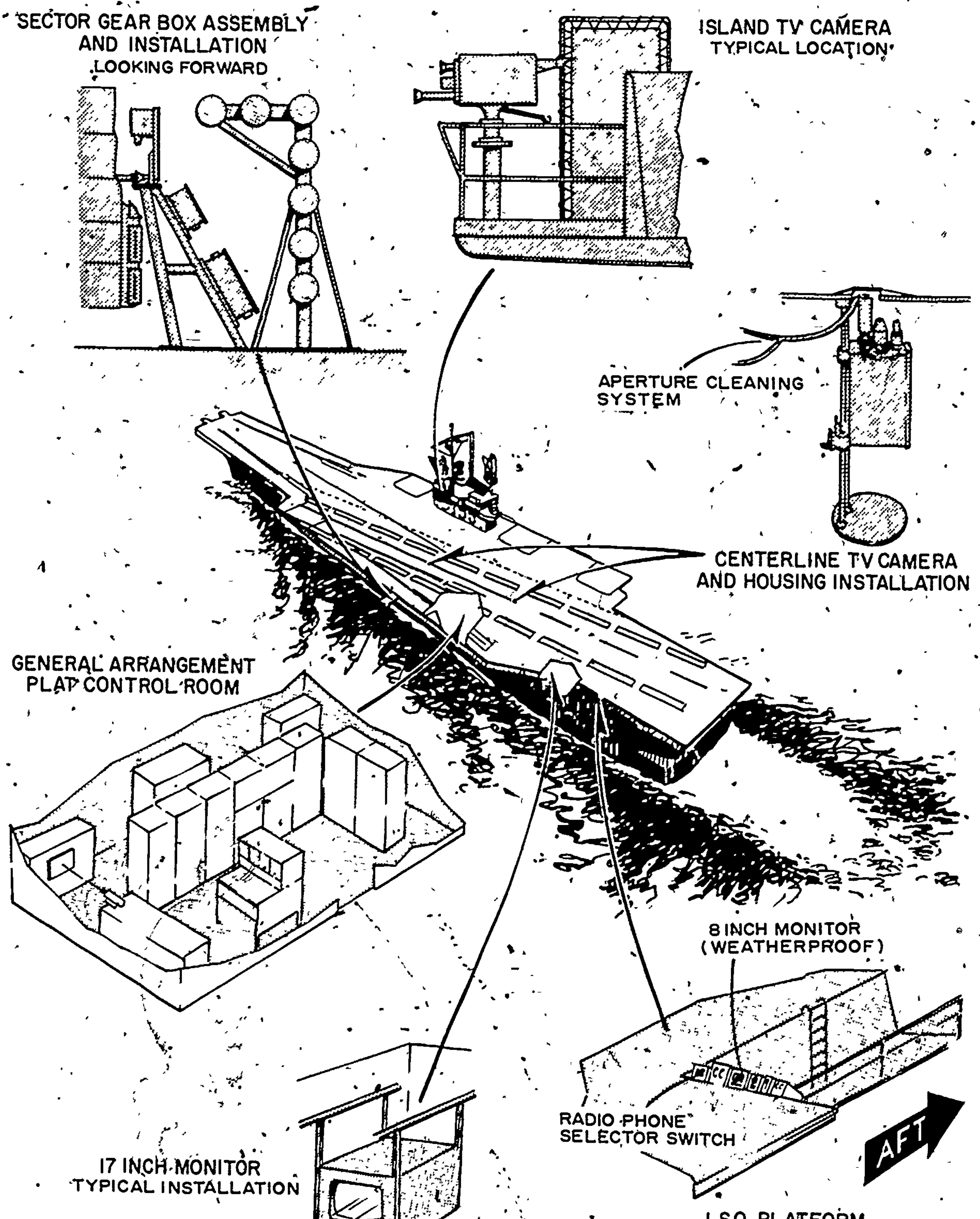


Figure 7-13.—PLAT system, general arrangement.

gun camera were overcome. Video tape recordings of landings, complete with minute-by-minute visuals of numerical data and audio recordings of conversation between pilot and carrier landing personnel, could be played back within minutes of the actual operation.

Landing a jet with a touchdown speed of over 130 knots on a pitching deck is a demanding task for the pilots despite the improved angled decks and optical landing system of modern carriers. Installation of the PLAT system on carriers has resulted in fewer incorrect approaches, quicker assimilation of landing techniques by pilots, and provided indisputable accident investigation evidence. PLAT's value in the possible saving of pilot's lives cannot be estimated in monetary terms. It is demonstrably evident, however, that the cost of the PLAT system is minor to replacement of even one aircraft.

OPERATION

Essentially, PLAT is four television cameras in different locations aboard an aircraft carrier, connected to a closed circuit television system incorporating a video tape installation to record and play back landing information.

Two unmanned cameras, each fitted with a relay lens and mirror assembly, are mounted on vertical rails approximately 50 feet apart under the flight deck (landing area) centerline. Adjustable crosshairs with variable illumination are positioned in the center of the relay lens. Mirrors on top of each relay lens look through windows mounted in the flight deck, and are stabilized with signals generated by the Fresnel Lens Optical Landing System.

A horizontal crosshair, boresighted along the glide slope, identifies the "on course" glidepath. A vertical crosshair is alined to coincide with the centerline of the angled deck. As the pilot sights the optical landing system and follows it down, the aircraft is picked up by the centerline cameras. The aircraft's lineup with the crosshairs displayed on the ship's monitor screens coincides with the pilot's optical landing system alinement.

A small camera is permanently focused on the data board in the control room to record date, time, wind velocity, aircraft approach speed, and waveoff signal. This camera output is displayed simultaneously with the output of either the centerline cameras or the island camera.

A manned camera, located on the island structure approximately 40 feet above the flight deck, picks up the aircraft as it passes over the centerline cameras, "zooms in" for a closeup, and follows the arresting wire back to its battery position to determine which of the four wires was engaged. If the aircraft bolters, the cameraman follows it as it departs the ship. The island camera is also used to pick up launches, providing the ship's combat information center with immediate takeoff information and permitting all ready rooms to keep direct contact with deck operations.

The video tape recorder, located in the PLAT control room, records one video signal and two audio signals on a standard 90-minute reel of video tape 2 inches wide. As the tape requires no processing, the recording can be played back immediately. Later it can be erased and the tape used again to capture the next landing operation. One of the two audio channels records conversation between landing operation personnel and the pilot. The second is a "cue" track which can be used for additional commentary during pilots' debriefing or for accident analysis.

An integrated system of picture monitors (TV sets) keeps carrier control and information centers in constant touch with each step of landing or takeoff. A monitor in the combat information center, for example, lets below deck technicians actually see aircraft approach as well as read it on a conventional radar screen. Landing operation personnel cross-check the "physical" landing with the monitor picture while movement of the arrested aircraft to forward areas can also be plotted from the same screen. Readyroom monitors allow personnel not involved in the operation to evaluate a pilot's general performance or reaction to specific emergencies.

After a mission is completed, pilots and landing operation personnel can watch a minute-by-minute playback of the entire landing operation. Errors in judgment or procedure can be pointed out while the operation is still fresh. Details impossible to remember are re-created in their entirety on tape to lend authoritative reference to the hasty and often cryptic notes made during the operation. Later the same tape can be used to help train new pilots long before their first carrier landing is ever attempted. These tapes can also be invaluable for training new personnel who have never seen aircraft making actual carrier arrestments.

CHAPTER 8

SPECIAL TESTS AND TEST PROCEDURES

TESTING HYDRAULIC FLUID

Catapult hydraulic fluid is a water-base synthetic fluid. The fluid is 50 percent water, which provides its fire resistance. The remaining 50 percent is made up of a water soluble polymer which increases the viscosity of the water, a freezing point depressant, and selected additives that provide lubrication and protect against corrosion.

With use, the water-base fluid loses water and other volatile inhibitors. Water losses, which are the most pronounced, are indicated by an increase in fluid viscosity. Loss of inhibitors is indicated by a change in the pH number of the fluid. (External contamination also causes a change in the pH number.) Normal values for the viscosity and pH number of unused fluid are: viscosity (fluid temperature 100° F) 190 to 210 Saybolt seconds; pH number 8.8 to 9.2.

The fluid is nontoxic and no special handling procedures are necessary. Leakage or spillage can be cleaned up easily with a wet cloth, or flushed down the drain with water. If the catapult hydraulic fluid or any part of it is removed from the catapult for any reason, it must be placed in clean containers and filtered with a fine metal screen before being returned to the system.

NOTE. Do not use a galvanized screen, fuller's earth, or similar earth type filter.

All activities operating steam catapults are required to have the hydraulic fluid of each catapult analyzed in accordance with the applicable MRC's and during shipyard overhaul to determine if the viscosity and pH number are within safe operating limits and to insure that residual oil is within the tolerable limit. If water was added as a result of the viscosity analysis, the viscosity should again be checked to insure that the proper amount of water was added.

NOTE. Added water must be thoroughly mixed into the system prior to making the final check.

For catapult hydraulic fluid analysis, a 1-quart sample is removed from each gravity tank IMMEDIATELY after launching operations and placed in a clean plastic bottle. The identified samples are sent to the materials laboratory at the nearest shipyard, naval air station, naval operating base, or naval air rework facility for determination of:

1. Viscosity in Saybolt Seconds at 100° F.
2. pH number.
3. Percentage residual oil present by volume.

SHIPBOARD TESTING OF HYDRAULIC FLUID

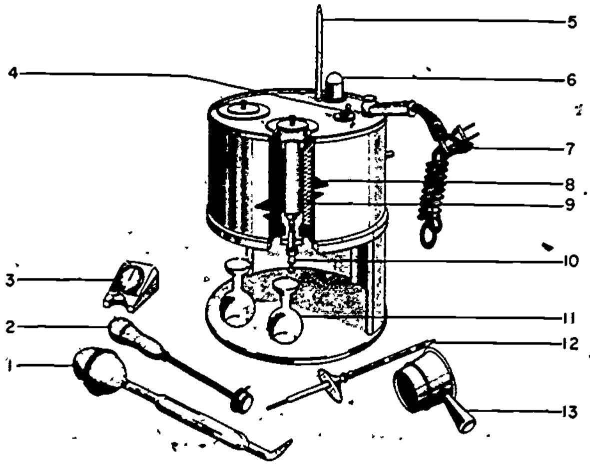
During an extended cruise, or when conditions are such that the facilities of an industrial test laboratory cannot be used, analysis may be made on shipboard by the use of Saybolt Viscometers. (These are available in the ship's engineering department on all carriers.)

Viscosity

When using the Saybolt Viscometer (fig. 8-1), viscosity is determined by noting the amount of time required for a known amount of fluid, at a known temperature and head (initial height), to flow through an orifice of a known cross-sectional area.

To test the viscosity of the hydraulic fluid, proceed as follows:

1. Place the stopper (10, fig. 8-1) in the bottom of the Saybolt Viscometer so that it will trap air in the small chamber beneath the orifice when the fluid sample is poured into the well (9). This will prevent the flow of oil through the outlet tube until the stopper is removed at the beginning of the test. Be sure the stopper is not inserted far enough to touch the orifice. Place



1. Drawoff pipette.
2. Well cleaner.
3. Timer.
4. Immersion heater ON-OFF switch.
5. Thermometer.
6. Neon bulb.
7. Immersion heater power cord.
8. Immersion heater.
9. Well.
10. Stopper.
11. Flask.
12. Thermometer and guard.
13. Strainer.

AB.426

Figure 8-1.—Saybolt Viscometer.

the instrument as level as the motion of the ship will permit.

2. Plug in the power cord (7) and turn on the switch (4) to start the electrical immersion heaters (8). The heaters will go on and off automatically to maintain temperature. The neon bulb (6) at the top of the viscometer is used to indicate this cycling.

3. Pour a volume of the fluid sample through a strainer (13) into the well of the viscometer. Insert a bath thermometer (12) into the viscometer to test the temperature of the bath surrounding the hydraulic fluid. Allow the sample to remain in the viscometer well until it attains a temperature of 100° F. Turn the well or table to agitate the fluid and maintain an even temperature.

4. Using the drawoff pipette (1), carefully remove fluid from the enlarged area (gallery) around the top of the well until the well is exactly full. This will provide the correct head and volume to begin the test.

5. Place a flask (11) beneath the proper orifice. Prepare to start the timer (3) and remove the stopper (10) simultaneously.

6. Note the temperature on the thermometer (5). When fluid and bath temperature have been held at 100° F for 1 minute, remove the stopper and start the time at the same instant.

7. When fluid has filled the flask to the height of the etched mark near the top, stop the timer and note the exact elapsed time. Allow the remainder of the fluid to flow through into the flask. (The timer reading is in Saybolt Seconds Universal (SSU), and a normal reading is 190 to 210 SSU.)

8. At the completion of the test, clean the Saybolt Viscometer thoroughly and carefully by first removing the orifice from the bottom of the well (using the special T-wrench provided) and then cleaning the well with the special well cleaner (2). (To prevent scarring the sides, use only the cleaner provided.)

When the viscosity becomes 235 Saybolt Seconds or greater, add distilled or de-ionized (boiler feed) water in accordance with the WATER ADD CHART. (See table 8-1.) Water of potable quality from the ship's distilling plants is acceptable. Viscosity less than 190 SSU indicates either excessive water addition or water leakage into the system. If the latter condition exists, the cause should be determined and repaired. If analysis reveals the viscosity to be as low as 170 SSU, immediate steps must be taken to discard and replace the fluid.

CAUTION: Do not use tap water from shore installations to reduce the viscosity number; such water is not sufficiently pure for this purpose.

Table 8-1.—Water add chart

Saybolt seconds universal at 100° F	Gallons to be added per 100 gal of catapult hydraulic fluid
235	4.5
240	5.2
245	5.9
250	6.6
255	7.3
260	8.0
265	8.7

pH Number

If a fluid sample test shows a pH number less than 8.8 or greater than 9.2, the Naval Air Engineering Center (Ship Installation) must be notified immediately by message, with a copy to the cognizant Type Commander. In addition to the message notification, a 1-quart sample must be forwarded to NAEC (SI). The fluid sample must be clearly identified, and the information shown in figure 8-2 must accompany the sample. No corrective action is to be taken if the pH number is outside the limits unless specified by NAEC after laboratory analysis of the sample.

RESIDUAL OIL

To make a residual oil test, pour some of the fluid sample into a transparent graduated cylinder, or any convenient straight-sided clear receptacle. Allow the sample to stand in the receptacle for a minimum of 8 hours. Measure the height of any oil that appears on top of the fluid. Compute percent by volume. Note oil in excess of 1 percent.

When the residual oil exceeds 1 percent by volume, remove some of the oil as follows:

1. Completely fill the gravity tanks with fluid. Allow the fluid to settle for a minimum of 8 hours to permit residual oil to rise to the surface. NOTE. Increasing the length of settling time will permit better separation of oil and fluid.

2. After the oil has separated, slowly drop the level of the fluid in the gravity tanks to within 2 inches of the bottom of the liquid level gage, either by pumping fluid back into the system or into clean drums for temporary storage.

3. Drain the fluid and its oil from the gravity tank into containers by opening the petcock on the bottom of the liquid level gage or by removing the gage glass.

4. Slowly increase the level of the fluid in the tanks to permit removal of any oil trapped below the exit port.

5. Add sufficient clean fluid to the system to make up for the fluid drained as above.

QUANTITATIVE AND QUALITATIVE ANALYSIS

All vessels and activities operating steam catapults must submit fluid samples in accordance with the applicable MRC's and immediately prior to a shipyard overhaul. Each sample must be placed in a clean plastic container, packed in a carton, and sent to E. F. Houghton and Co., 303 West Lehigh Ave., Philadelphia, Pa., marked Attention: Control Laboratory. The information shown in figure 8-2 must accompany each sample. Mark the outside of the shipping carton "CATAPULT HYDRAULIC FLUID SAMPLE (FIRE RESISTANT)." Do not use a red label.

NONDESTRUCTIVE TESTING OF METALS

It is highly important that all metallic parts of a catapult or arresting gear machine be free of corrosion, cracks, and other defects that might cause failure during operations. Several methods of nondestructive testing of metallic parts are in use for detecting flaws that are invisible to the naked eye. Two of these methods—the dye penetrant and magnetic particle—are discussed in the following paragraphs.

DYE PENETRATION INSPECTION

Dye penetrant inspection is a nondestructive test for defects open to the surface in parts made of any nonporous material. In addition to being used on all nonmagnetic metals, it may be used with equal success on ceramics, plastics, molded rubber, powdered metal products, or glass.

CATAPULT HYDRAULIC FLUID

HISTORY REPORT

Vessel or Unit	CVA-66
Catapult Number	#4
Sample Removed From	GRAVITY TANK
Sample Number	15
Date Sample Removed	3/23/73
System Capacity	1600
Date Last Complete Fluid Replacement	3/30/71
Water Added (Gal/Date)	4 GAL 12/15/72
Fluid Added (Gal/Date)	NONE
Total Launches Since Complete Replacement	4,321

Reason for Analysis (please check (x) one block):

[X] Periodic 9 month test

[ ] Pre-overhaul test

[ ] pH outside acceptable limits

[ ] Sea water contamination

NOTE: Mark outside of shipping container "CATAPULT HYDRAULIC FLUID SAMPLE (FIRE RESISTANT)". Do not use red label.

AB.427

Figure 8-2.—Catapult hydraulic fluid history report.

Dye penetrant inspection detects such defects as surface cracks, porosity, and through leaks. These defects may be caused by fatigue cracks, shrinkage cracks, shrinkage porosity, cold shuts (a portion of the surface of a forging that is separated, in part, from the main body of metal by oxide or a discontinuity that appears on the surface of cast metal as a result of two streams of liquid meeting and failing to unite), forging and heat-treat cracks, seams, forging laps, and bursts. Also important is lack of bond between joined metals.

The main disadvantage of the dye penetrant inspection is that the defect must be open to the surface for the penetrant to get into the defect. For this reason, if the part in question is made of a magnetic material, use of the magnetic particle inspection is generally recommended.

Success of the dye penetrant inspection depends upon a penetrating liquid entering the surface opening and remaining in that opening, making it clearly visible to the operator. The penetrant used in this process consists of a solvent base to which a visible dye has been added. This dye penetrant is a brilliant red, visible under ordinary light after the necessary processing.

The materials used in the dye penetrant inspection are available in Aviation Supply stock in the form of a kit. Included in the kit are two spray cans of dye penetrant, dye remover-emulsifier, and developer. For replenishment purposes, these materials are also available as individual items.

Briefly, the steps to be taken when performing a dye penetrant inspection are:

1. Thoroughly clean the metal surface.
2. Apply the penetrant.
3. Remove excess penetrant with remover-emulsifier.
4. Dry the part.
5. Apply the developer.
6. Allow sufficient time for the developer to indicate the penetrant in cracks of the metal surface.
7. Inspect and interpret results.

Types of Processes

There are two basic processes of penetrant inspection—the visible type penetrant and the fluorescent dye penetrant. However, variations of the basic types further divide the processes into seven types. The selection of the process to be used depends on the sensitivity required, the number of parts to be inspected, the surface condition of the part, the configuration of the part, the effect of penetrant chemicals on the material or system being inspected, and the availability of water, electricity, compressed air, and suitable area for inspection.

The seven types of processes are discussed in detail in Chapter 3 of ABE 3 & 2, NavTra 10302-C.

MAGNETIC PARTICLE INSPECTION

Magnetic particle inspection is a rapid nondestructive means of detecting discontinuities in parts made of magnetic materials, such as iron and steel. These discontinuities may have been put into the parts or metal during fabrication or processing, or may have been formed by actual use. They may be at or near the surface and may be shallow or extremely deep. If the inspection process is performed correctly, the usefulness of the part will not be affected by the inspection and all harmful discontinuities will be revealed. If, however, the principles of the method are not clearly understood by the operator, and unsound methods are used, then some discontinuities may not be detected and defective parts may be accepted which could fail in use, causing loss of equipment and personnel.

It is, therefore, vitally important that every operator, inspector, and supervisor know the principles of magnetic particle inspection and how to apply these principles to specific inspection problems.

In rapidly rotating, reciprocating, vibrating, and other highly stressed parts, small defects often develop to a point that they cause complete failure of the part. Magnetic particle inspection has proved extremely reliable for the rapid detection of such defects on or near the surface. In using this method of inspection, the location of the defect is indicated, and the approximate size and shape are outlined.

The inspection process consists of magnetizing the part and then applying ferromagnetic particles to the surface of the part. If a discontinuity is present, the magnetic lines of force will be disturbed and opposite poles will exist on either side of the discontinuity. The magnetized particles thus form a pattern in the magnetic field between the opposite poles. This pattern, known as an "indication," assumes the approximate shape of the surface projection of the discontinuity.

The ferromagnetic particles (indicating medium) may be held in suspension in a liquid that is flushed over the part, the part may be immersed in the liquid, or the particles, in dry powder form, may be dusted over the surface of the part.

NOTE: A discontinuity may be defined as an interruption in the normal physical structure or configuration of a part such as a crack, forging lap, seam, inclusion, porosity, and the like. A discontinuity may or may not affect the usefulness of a part.

Development of Indications

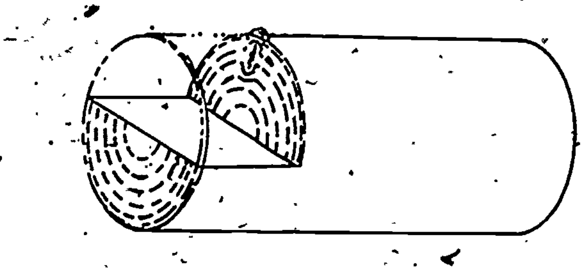
When a discontinuity in a magnetized material is open to the surface and a magnetic substance in the form of an indicating medium is available on the surface, the flux leakage at the discontinuity tends to form the indicating medium into a path of higher permeability. (Permeability is a term used to refer to the ease with which a magnetic flux can be established in a given magnetic circuit.) Because of magnetism in the part and the adherence of the magnetic particles to each other, the indication remains on the surface of the part in the form of an approximate outline of the discontinuity that is immediately below it.

The same action takes place when the discontinuity is not open to the surface; but since the amount of flux leakage is less, fewer particles are held in place and a fainter and less sharply defined indication is obtained.

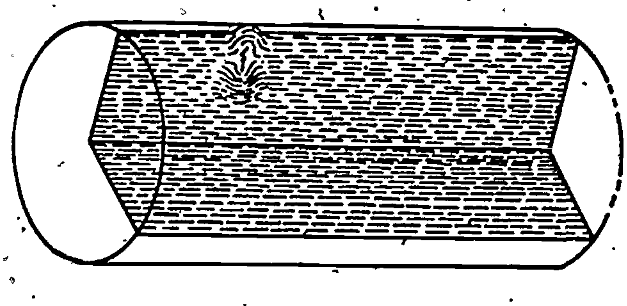
If the discontinuity is very far below the surface, there may be no flux leakage and therefore no indication on the surface. The flux leakage at a transverse discontinuity is shown in figure 8-3. The flux leakage at a longitudinal discontinuity is shown in figure 8-4.

Types of Discontinuities Disclosed

The following types of discontinuities are normally detected by the magnetic particle test:



AB.431
Figure 8-3.—Flux leakage at transverse discontinuity.



AB.432
Figure 8-4.—Flux leakage at longitudinal discontinuity.

Cracks, laps, seams, cold shuts, inclusions, splits, tears, pipes, and voids. All these may affect the realiability of parts in service.

Cracks, splits, burst, tears, seams, voids, and pipes are formed by an actual parting or rupture of the solid metal. Cold shuts and laps are folds that have been formed in the metal, interrupting its continuity.

Inclusions are foreign material formed by impurities in the metal during the metal processing stages. They may consist, for example, of bits of furnace lining picked up during the melting of the basic metal, or of other foreign constituents. Inclusions interrupt the continuity of the metal because their presence prevents the joining or welding of adjacent faces of the metal.

Preparation of Parts for Testing

All parts must be cleaned of grease, oil, and dirt before they are tested. Cleaning is important

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since magnetic particles may adhere to any grease or other foreign material present and thereby produce nonrelevant indications.

Grease or foreign material in sufficient amount over a discontinuity may also prevent the formation of a pattern at the discontinuity. Even if the wet method is used, it is not advisable to depend upon the magnetic particle suspension to clean the part. Cleaning by the suspension will not be thorough, and the foreign materials removed from the part will contaminate the suspension and reduce its effectiveness.

In the dry procedure, thorough cleaning is necessary as grease or other foreign material will hold the magnetic powder, causing nonrelevant indications and making it impossible to evenly distribute the indicating medium over the surface of the part.

All small openings and oil holes leading to obscure passages or cavities should be plugged with paraffin or other suitable nonabrasive material.

Primers, paints, enamels, and similar nonmetallic coatings, as well as coatings of cadmium, copper, tin, and zinc, do not interfere with the satisfactory performance of magnetic particle inspection, unless the coatings are unusually heavy, or the discontinuities to be detected are unusually small.

Chromium and nickel plating will not generally interfere with the formation of indications of cracks open to the surface of the base metal, but will prevent the formation of indications of fine discontinuities, such as inclusions. Because it is more strongly magnetic, nickel plating is more effective than chromium plating in preventing the formation of indications.

Magnetization

EFFECT OF DIRECTION OF FLUX (LINES OF FORCE).—In order to locate a defect in a part, it is essential that the magnetic lines of force pass approximately perpendicular to the defect. It is therefore necessary to induce magnetic flux in more than one direction since defects are likely to exist at any angle to the major axis of the part. This requires two separate magnetizing operations, referred to as circular magnetization and longitudinal magnetization. The effect of direction of flux is illustrated in figure 8-5.

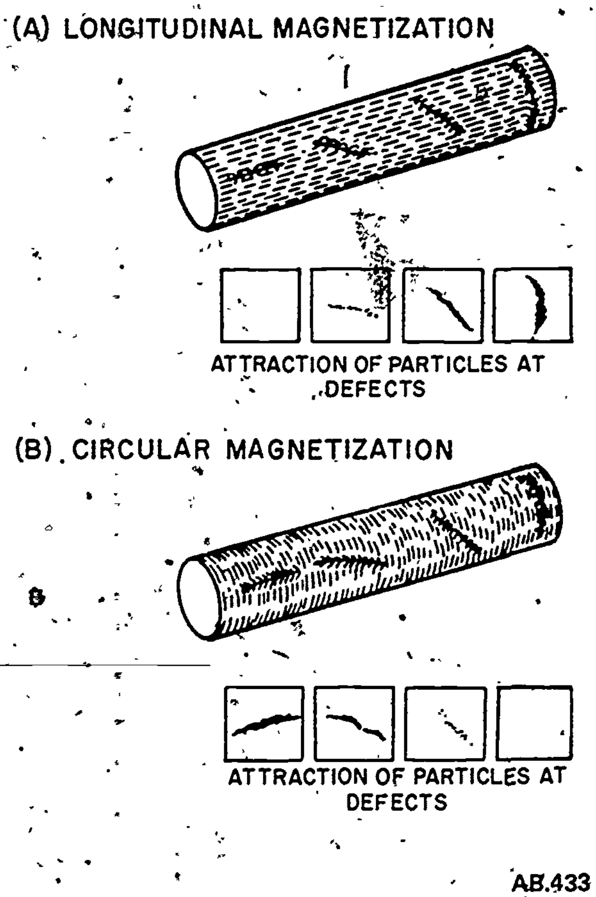


Figure 8-5.—Effect of direction of flux on strength of indication.

EFFECT OF FLUX DENSITY.—The effectiveness of the magnetic particle inspection also depends on the flux density or field strength that exists at the surface of the part when the indicating medium is applied. As the flux density in the part is increased, the sensitivity of the test increased because of the greater flux leakages at discontinuities and the resulting improved formation of magnetic particle patterns.

Excessively high flux densities, however, may form nonrelevant indications; for example, patterns of the grain flow in the material. These indications will tend to interfere with the detection of patterns resulting from significant discontinuities. It is therefore necessary to use a field strength high enough to reveal all possible harmful discontinuities, but not strong enough to produce confusing nonrelevant indications.

MAGNETIZING METHODS.–When a part is magnetized, the field strength in the part increases to a maximum for the particular magnetizing force and remains at this maximum as long as the magnetizing force is maintained.

When the magnetizing force is removed, the field strength decreases to a lower residual value, depending on the magnetic properties of the material and the shape of the part. These magnetic characteristics determine whether the continuous or residual method is used in magnetizing the part.

In the continuous inspection method, the part is magnetized and the indicating medium applied while the magnetizing force is maintained. The available flux density in the part is thus at a maximum. The maximum value of flux depends directly upon the magnetizing force and the permeability of the material of which the part is made.

The continuous method provides greater sensitivity than the residual procedure, particularly in locating subsurface discontinuities, and may be used in practically all circular and longitudinal magnetization procedures. The highly critical nature of catapult and arresting gear parts and assemblies and the necessity for subsurface inspection in many applications have resulted in the continuous method being more widely used by ABE's.

Inasmuch as the continuous procedure will reveal more nonsignificant discontinuities than the residual procedure, careful and intelligent interpretation and evaluation of discontinuities revealed by this procedure are necessary.

The residual inspection procedure involves magnetization of the part and application of the indicating medium after magnetizing force has been removed. This procedure relies on the residual or permanent magnetism in the part and is more practical then the continuous procedure when magnetization is accomplished by flexible coils wrapped around the part.

In general, the residual procedure is used only with steels which have been heat treated for stressed applications.

IDENTIFICATION OF INDICATIONS.–The correct identification of indications is extremely important, but is sometimes difficult to make from observation of the appearance of the indications alone. The principal distinguishing features of indications are shape, buildup, width, and sharpness of outline. These characteristics, in general, are more valuable in distinguishing between types of discontinuities than in determining their severity. However, careful observation of the character of the magnetic particle pattern should always be included in the complete evaluation of the significance of an indicated discontinuity.

The most readily distinguished indications are those produced by cracks open to the surface. These discontinuities include fatigue cracks, heat-treat cracks, shrink cracks in welds and castings, and grinding cracks.

FATIGUE CRACKS give sharp, clear patterns, generally uniform and unbroken throughout their length and with good buildup. They are often jagged in appearance as compared with the straight indications of a seam and may also change direction slightly in localized areas. Figure 8-6 illustrates a fatigue crack in a gear.

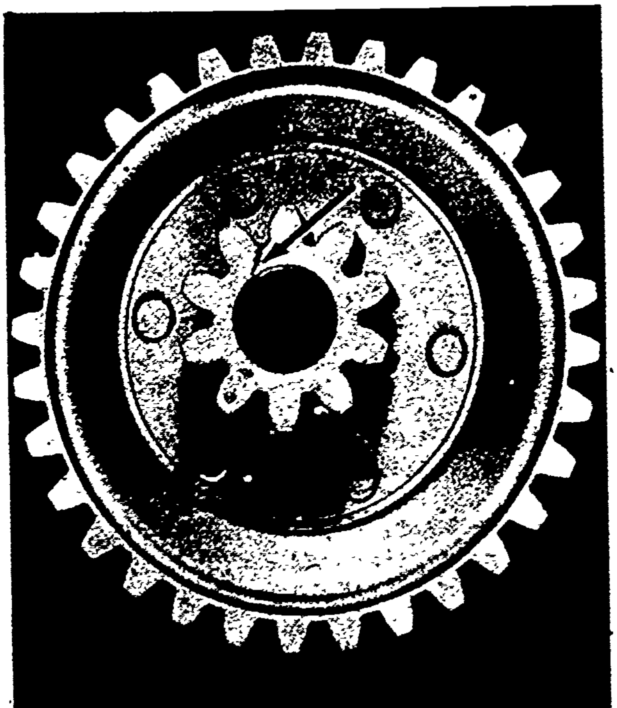
Fatigue cracks are found in parts that have been in service, but are never found in new parts. They are usually in the ~~high stressed~~ areas of the part, or where a stress concentration exists for some reason. It is important to recognize that even a small fatigue crack indicates positively that failure of the involved part is in progress.

GRINDING CRACKS are fine and sharp, but seldom have a buildup because of their limited depth. They vary from single line indications to a heavy network of lines and are generally related to the direction of grinding. For example, the crack usually begins and continues at right angles to the motion of a grinding wheel, giving a rather symmetrical pattern. Indications of grinding cracks can frequently be identified by means of this relation.

Indications of seams are usually straight, sharp, and fine. They are often intermittent and sometimes have very little buildup.

Magnetizing Equipment

STANDARD GENERAL-PURPOSE UNIT.– A standard general-purpose magnetizing unit is used extensively at naval air activities. This unit provides direct current for wet continuous or residual magnetization procedures. Either circular or longitudinal magnetization may be used,



AB.434

Figure 8-6.—Fatigue crack in a gear.

and it may be powered with rectified alternating current as well as direct current.

GENERAL-PURPOSE PORTABLE UNIT.—It is often necessary to perform the magnetic particle inspection at locations where the standard general-purpose unit is not available. The general purpose portable equipment which supplies both alternating-current and direct-current magnetization is suitable for this purpose.

This unit is only a source of magnetizing and demagnetizing current and does not provide a means of supporting the work or applying the suspension. It operates on 200-volt, 60-hertz alternating current and contains a rectifier for producing direct current when required.

The magnetizing current is supplied through the two flexible cables as shown in figure 8-7. The cable terminals may be fitted with probes, or with contact clamps. Circular magnetization may be developed by using either the probes or clamps. Longitudinal magnetization is developed by wrapping the cable around the part.

The strength of the magnetizing current is controlled by an 8-point tap switch, and the length of time for which it is applied is regulated by an automatic cutoff.

This portable unit also serves as a demagnetizer and supplies high-amperage, low-voltage, alternating current for this purpose. For demagnetization, the alternating current is passed through the part and gradually reduced by means of a current reducer.

Magnetizing Materials

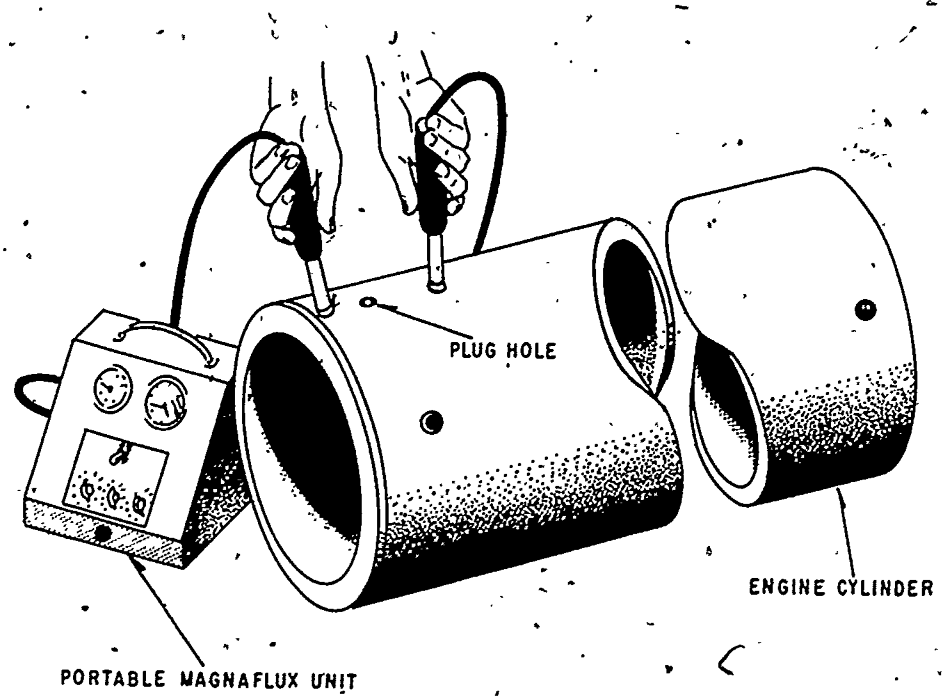
LIQUID VEHICLE FOR WET SUSPENSION.—The liquid vehicle used in the wet procedure provides the mobility for the suspended magnetic particles. Although most any liquid of a viscosity approximating that of kerosene may be used when making the magnetic particle inspection test, the MIL specification covering magnetic particle inspection requires that the liquid be a drycleaning solvent, a light oil such as kerosene, or an acceptable equivalent.

INDICATING MEDIUMS.—The various types of indicating mediums available for magnetic particle inspection may be divided into two general types—wet process materials and dry process materials. The basic requirement for any indicating medium is that it produce acceptable indications of discontinuities in parts.

The contrast provided by a particular indicating medium on the background or part surface is particularly important. The colors most extensively used are black and red for the wet procedure; and black, red, and gray for the dry procedure.

For acceptable operation, the indicating medium must be of high permeability and low retentivity. High permeability insures that a minimum of magnetic energy will be required to attract the material to flux leakage caused by discontinuities. Low retentivity insures that the mobility of the magnetic particles will not be hindered, that is, the particles themselves will not become magnetized and attract one another.

It is important that new magnetic substance always be used in preparing suspensions When the suspension becomes discolored or otherwise contaminated to the extent that the formation of magnetic particle patterns is interfered with,



AB.436

Figure 8-7.—Applying probes to a cylinder.

the unit should be drained, cleaned, and refilled with clean suspension.

Demagnetization

NECESSITY FOR DEMAGNETIZATION.—Parts of operating mechanisms must be demagnetized to prevent magnetized parts from attracting filings, grindings, or chips inadvertently left in the system, or steel particles resulting from operational wear. An accumulation of such particles on a magnetized part may cause scoring of bearings or other working parts.

STANDARD DEMAGNETIZING PRACTICE.—The simplest procedure for developing a reversing and gradually decreasing magnetizing force in a part involves the use of a solenoid energized by alternating current. As the part is moved away from the alternating field of the solenoid, the magnetism in the part gradually decreases.

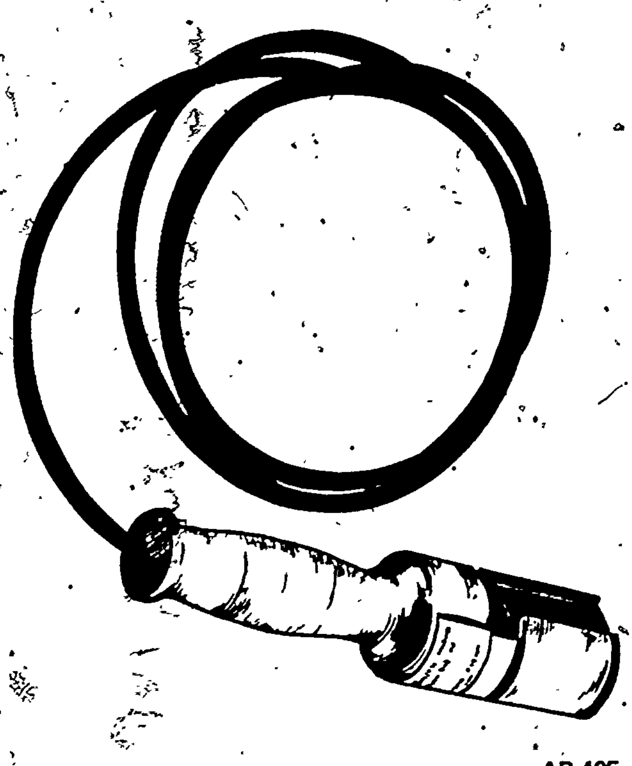
Parts that do not readily lose their magnetism should be passed slowly in and out of the demagnetizer several times, and at the same time tumbled or rotated in various directions. Allowing a part to remain in the energized demagnetizer accomplishes very little practical demagnetization.

The effective operation in the demagnetizing procedure is that of slowly moving the part out of the coil and away from the magnetizing field. As the part is withdrawn, it should be kept directly opposite the opening until it is 1 or 2 feet from the demagnetizer.

The demagnetizing current should never be cut off until the part is 1 or 2 feet from the opening; otherwise the part will most likely be remagnetized.

PORTABLE ELECTROMAGNET TYPE DEMAGNETIZER.—A portable electromagnet type demagnetizer is shown in figure 8-8. It consists of a flat slab electromagnet, wound in the long direction. The faces of the exposed pole ends are rounded to permit access into localized areas, such as holes or corners.

The demagnetizer produces an external alternating field when excited by alternating current. When it is slowly moved away from the



AB.435

Figure 8-8.–Hand type demagnetizer.

part, it demagnetizes the adjacent area in the usual manner.

This tool is convenient for use on localized areas difficult to demagnetize by the standard procedure. It requires a power source of about 3 amperes and 100 volts at 60 hertz, and may thus be plugged into most lighting circuits.

Inspecting Arresting Engine Cylinder

During the overhaul of an arresting engine, the cylinder drain plugholes and vent holes are subjected to a magnetic particle inspection to determine if there are any cracks, hard spots, or other defects. Any defects found are sufficient ~~cause to reject the~~ cylinder.

This inspection procedure requires the use of a portable Magnaflux unit having two cables, each equipped with a lead sheathed probe approximately 4 inches long and 1 inch in diameter. (See fig. 8-7.) At least two persons are needed to handle the equipment; one to hold the probes while the other brushes on Magnaflux fluid.

The cylinders are tested as follows:

1. Remove the cylinder plugs from plug holes, using a wrench.

WARNING: NEVER use an acetylene torch or other means of applying local heat on the cylinders to facilitate the insertion or removal of any plug.

2. Abrade and clean the surfaces about the hole areas to insure clean, positive probe contact.

3. Grasp a probe firmly in each hand and apply probes simultaneously to the cylinder periphery. The probes should be 6 to 8 inches from the edge of the hole and 180 degrees apart before the current is turned ON, as shown in figure 8-9.

WARNING: Do not apply probes to cylinders after the current is turned ON because this will cause arcing of the probes and produce hard spots in the cylinder.

4. Apply 800 amperes minimum magnetizing current.

5. While current is turned ON, brush on Magnaflux fluid around the cylinder hole areas being tested as shown in figure 8-9.

NOTE: Fluid must be flowing when current is ON.

6. Visually inspect the cylinder hole areas for sub-surface cracks, as shown in figure 8-10

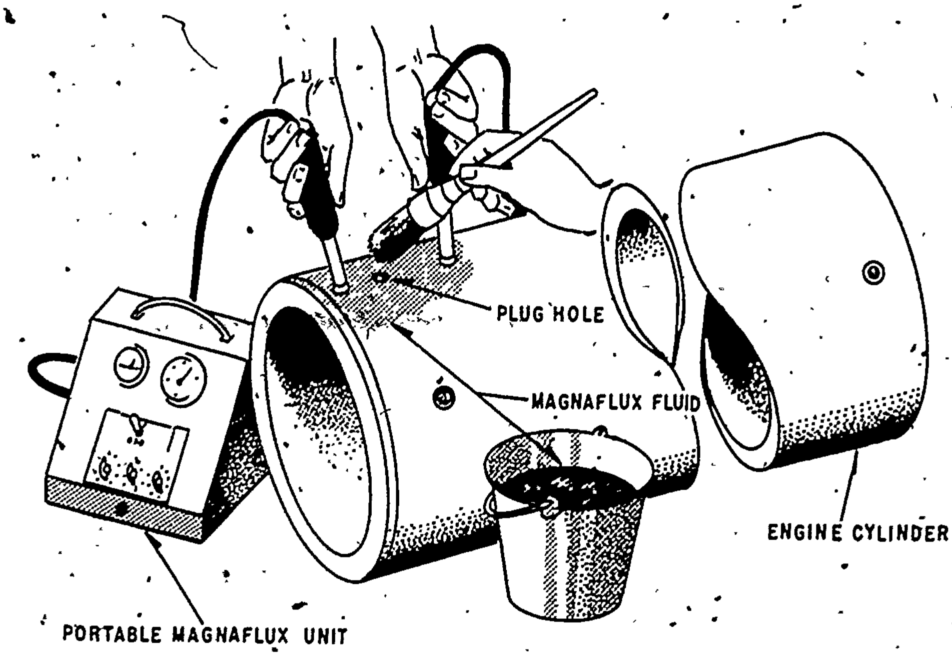
7. Repeat steps (1) through (6) for each 45-degree application of the probes about each cylinder hole being tested. (See fig. 8-11.)

Indications as shown in figure 8-10 would be cause for immediate cylinder replacement.

HARDNESS TESTING

Hardness testing is a method of determining the results of heat treatment as well as the state of a metal prior to heat treatment. Since hardness values can be tied in with tensile strength values and, in part, with wear resistance, hardness tests are an invaluable check on heat-treat control and of material properties

Practically all hardness testing equipments utilize the resistance to penetration as a measure of hardness. Included among the better known hardness testers are the Brinell and Rockwell,



AB.437

Figure 8-9.—Applying Magnaflux to cylinder.

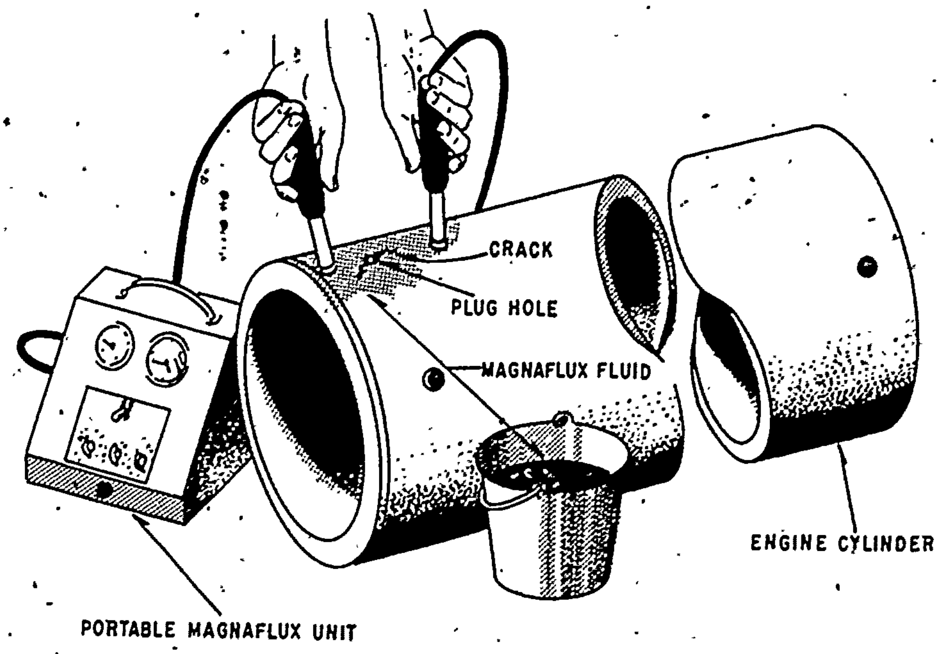


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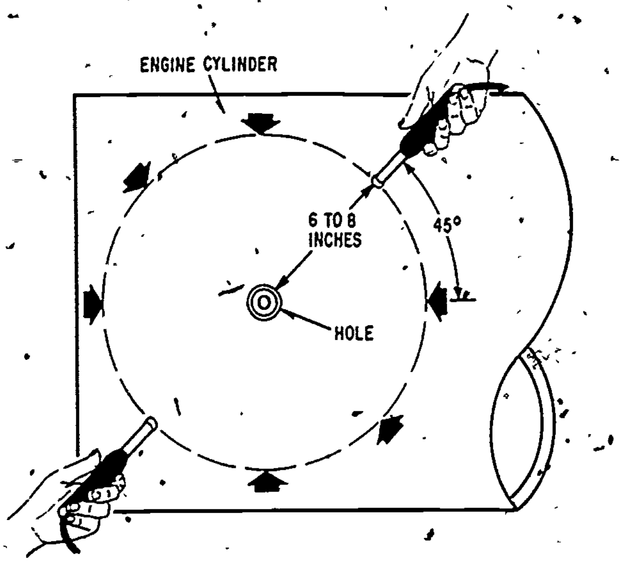
Figure 8-10.—Indications of subsurface cracks.



AB.439
Figure 8-11.—Locating probes about cylinder hole.

both of which are described and illustrated in this section. Also included are two popular portable type hardness testers being used by many operating activities.

BRINELL TESTER

The Brinell tester (fig. 8-12) uses a hardened spherical ball, 10 millimeters (0.3937 inch) in diameter, which is forced into the surface of the metal. A pressure of 3,000 kilograms maintained for at least 10 seconds is used for ferrous metals, and 500 kilograms maintained for at least 30 seconds for nonferrous metals. The load is applied by means of hydraulic pressure built up by a hand pump or an electric motor, depending on the model of tester. Included with the tester is a pressure gage to indicate the amount of pressure, a release mechanism for relieving the pressure after the test has been made, and a calibrated microscope for measuring the diameter of the impression in millimeters. The machine has various-shaped anvils for supporting the specimen and an elevating screw for bringing the specimen in contact with the ball penetrator. Also included are attachments for special tests.

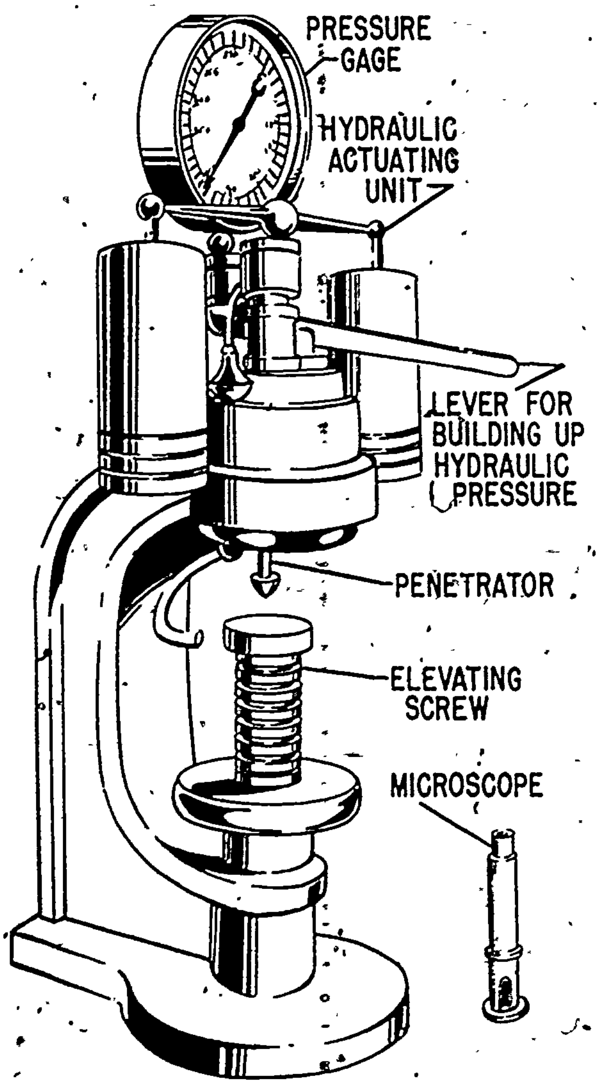


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Figure 8-12.—Brinell hardness tester.

In order to determine the Brinell hardness number for a metal, first measure the diameter of the impression. Figure 8-13 illustrates an impression as seen through the microscope. After measuring the diameter of the impression, convert the measurement into the Brinell hardness number utilizing the conversion table furnished with the tester. A portion of the conversion table is shown in table 8-2.

Table 8-2.—Portion of conversion table furnished with Brinell tester

Diameter of ball impression (mm)	Hardness number for load of kg	
	500	3000
2.0	158	945
2.05	150	899
2.10	143	856
2.15	136	817
2.20	130	780
2.25	124	745
2.30	119	712
2.35	114	682
2.40	109	653
2.45	100	627

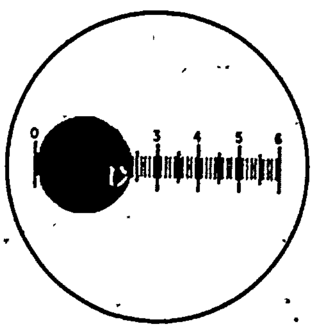

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Figure 8-13.—Impression as seen through the Brinell microscope.

ROCKWELL TESTER

The Rockwell hardness tester (fig. 8-14) measures the resistance to penetration as does the Brinell tester; however, instead of measuring the diameter of the impression, the Rockwell tester measures the depth, and the hardness is indicated directly on a dial attached to the machine. The shallower the penetration, the higher the hardness number.

Two types of penetrators are used with the Rockwell tester, one being a diamond cone, the other a hardened steel ball. The load which forces the penetrator into the metal is called the major load and is measured in kilograms. The results of each penetrator and load combination are reported on separate scales, designated by letters. The penetrator, the major load, and the scale vary with the kind of metal being tested.

For hardened steels, the diamond penetrator is used, the major load is 150 kilograms, and the hardness is read on the C scale. When this reading is recorded, the letter C must precede the number indicated by the pointer. The C-scale setup is used for testing metals ranging in hardness of C-20 to the hardest steel (usually about C-70). If the metal is softer than C-20, the B-scale setup is used. With this setup, the 1/16-inch ball is used as a penetrator, the major load is 100 kilograms, and the hardness is read on the B scale.

In addition to the C and B scales, there are other setups for special testing. The scales, penetrators, major loads, and dial numbers to be read are listed in table 8-3. The dial numbers in the outer circle are black, and the inner numbers are red.

The Rockwell tester is equipped with a weight pan, and two weights are supplied with the machine. One weight is marked in red; the other is marked in black. With no weight in the weight pan, the machine applies a major load of 60 kilograms. If the scale setup calls for a 100-kilogram load, place the red weight in the pan. For a 150-kilogram load, add the black weight to the red weight. The black weight is always used in conjunction with the red weight, it is never used alone.

Practically all testing is done with either the B-scale setup or the C-scale setup. For these scales, the colors may be used as a guide in selecting the weight (or weights) and in reading the dial. For the B-scale test, use the red weight and read the red numbers. For a C-scale test, add the black weight to the red weight and read the black numbers.

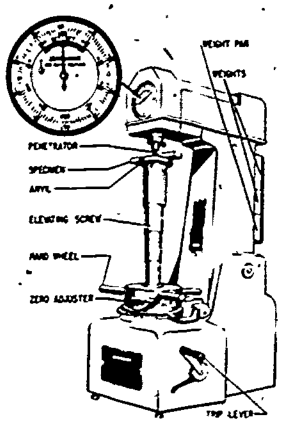

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Figure 8-14.—Rockwell hardness tester.

In setting up the Rockwell machine, use the diamond penetrator for testing materials which are known to be hard. If in doubt, try the diamond, since the steel ball may be deformed if used for testing hard materials. If the metal tests below C-22, then change to the steel ball.

Use the steel ball for all soft materials–those testing less than B-100. Should an overlap occur at the top of the B scale and the bottom of the C scale, use the C-scale setup.

Before the major load is applied, the test specimen must be securely locked in place to prevent slipping and to properly seat the anvil and penetrator. To do this, apply a load of 10 kilograms before tripping the lever. This preliminary load is called the minor load. The minor load is 10 kilograms regardless of the scale setup. When the machine is set up properly, it automatically applies the 10-kilogram load.

The metal to be tested in the Rockwell tester must be ground smooth on two opposite sides and be free of scratches and foreign matter. The surface should be perpendicular to the axis of penetration, and the two opposite ground surfaces should be parallel. If the specimen is tapered, the amount of error will depend on the taper. A curved surface will also cause a slight error in the hardness test. The amount of error depends on the curvature–the smaller the radius of curvature, the greater the error. To eliminate such error, grind a small flat on the curved surface if possible.

RIEHLE TESTER

The Riehle tester is a portable unit, designed for making tests comparable to those of the Rockwell bench type machine. The instrument is quite universal in its application, being readily adjustable to a wide range of sizes and shapes which would be difficult, or impossible, to test on a bench type tester.

Figure 8-15 shows the general arrangement and identifies the various components of the tester. It may be noted that the adjusting screws (4) and the penetration indicator (12) are set back some distance from the penetrator end of the clamps. This makes it practicable to use the tester on either the outside or inside surface of tubing as well as on many other applications where the clearance above the penetrator or below the anvil is limited. The indicator brackets are arranged so that it is possible to turn the indicators to any angle for greater convenience in a specific application, or to facilitate its use by a left-handed operator. Adjustment of the lower clamp is made by the small knurled knob below the clamp. The larger diameter knob, extending through the slot in the side of the clamp, is used for actual clamping.

Each Riehle tester is supplied with a diamond penetrator and a 1/16-inch ball penetrator. The ball penetrator should not be used on materials harder than B-100, nor on a load heavier than 100 kilograms. This is to avoid the danger of flattening the ball.

The diamond penetrator, when used with a 150-kilogram load, may be used on materials from the hardest down to those giving a reading of C-20.

When the hardness of a material is completely unknown to the operator, it is advisable to take a preliminary reading on the A scale as a guide in selecting the proper scale to be used.

Testing Procedure

The basic procedure in making a test with the Riehle tester is as follows:

Table 8-3.—Standard Rockwell hardness scales

Scale symbol	Penetrator	Major load (kg)	Dial number
A	Diamond	60	Black
B	1/16-inch ball	100	Red
C	Diamond	150	Black
D	Diamond	100	Black
E	1/8-inch ball	100	Red
F	1/16-inch ball	60	Red
G	1/16-inch ball	150	Red
H	1/8-inch ball	60	Red
K	1/8-inch ball	150	Red

1. Apply a minor load of 10 kilograms.
2. Set the penetration indicator to zero.
3. Apply a major load of 60, 100, or 150 kilograms (depending on the scale), and then reduce the load back to the initial 10-kilogram load.
4. Read the hardness directly on the penetration indicator The hardness reading is based on the measurement of the additional increment of penetration produced by applying a major load after an initial penetration has been produced by the minor load. In reporting a hardness number, the number must be prefixed by the letter indicating the scale on which the reading was obtained.

Removal and Replacement of Penetrator

The penetrator is retained in the tester by means of a small knurled clamp screw extending from the end of the weight bar. To remove a penetrator, there should be at least 2 or 3 inches of space between the upper and lower clamps so that one hand can be placed underneath the upper clamp to catch the penetrator when it is released. Two or three turns of the clamp screw will release the penetrator. The two contact pins which extend through the penetrator on either side of the point are retained in the tester when the penetrator is removed.

To replace a penetrator, it must be turned so that the flat side faces the clamp screw, and the locating pin on the penetrator is in line with the slot provided to take the pin. The contact pins should be guided into their respective holes through the penetrator. With the penetrator in place, it should then be clamped securely by turning the clamp screw. Before making an actual test, one or two preliminary tests should be made to properly seat the penetrator.

BARCOL TESTER

The Barcol tester (fig. 8-16) is a portable unit designed for testing aluminum alloys, copper, brass, and other relatively soft materials. Approximate range of the tester is 25 to 100 Brinell. The unit can be used in any position and in any space that will allow for the operator's hand. The hardness is indicated on a dial conveniently divided into 100 graduations.

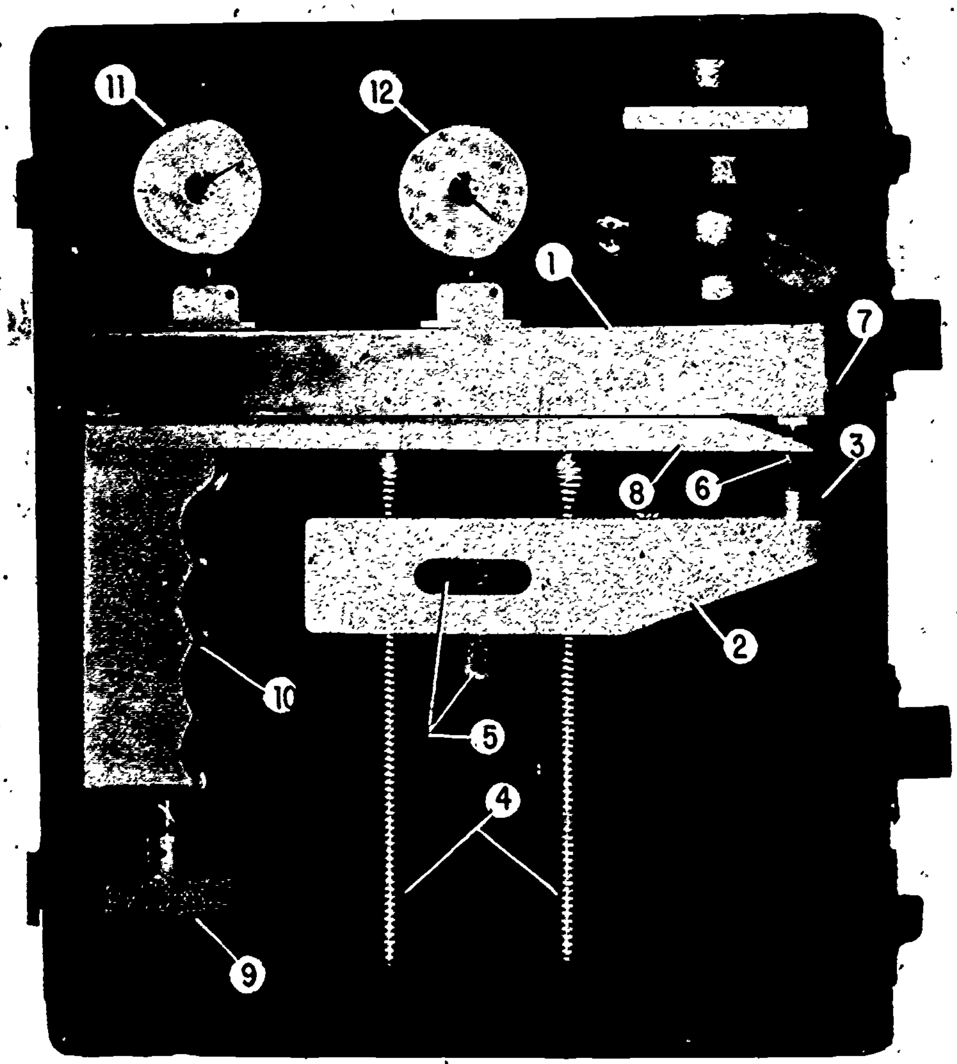
The lower plunger guide and point are accurately ground so that attention need be given only to the proper position of the lower plunger guide within the frame in order to obtain accurate operation when a point is replaced.

The frame, into which the lower plunger guide and spring tensioned plunger are screwed, holds the point in the proper position. Adjustment of the plunger upper guide nut, which regulates the spring tension, is made when the instrument is calibrated at the factory; the position of this nut should not be changed.

The leg is set for testing surfaces which permit the lower plunger guide and the leg plate to be on the same plane. For testing rivets or other raised objects, a block may be placed under the leg plate to raise it to the same plane. For permanent testing of this type, the leg may be removed and washers inserted. The point should always be perpendicular to the surface being tested.

Testing Procedure

The design of the Barcol tester is such that operating experience is not necessary. Only a



1. Upper clamp.
2. Lower clamp.
3. Anvil.
4. Adjusting screws.
5. Adjusting knob.
6. Penetrator.
7. Penetrator clamp screw.
8. Weigh bar.
9. Loading screw.
10. Grip.
11. Load indicator.
12. Penetrator indicator.

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Figure 8-15.—Riehle portable hardness tester.

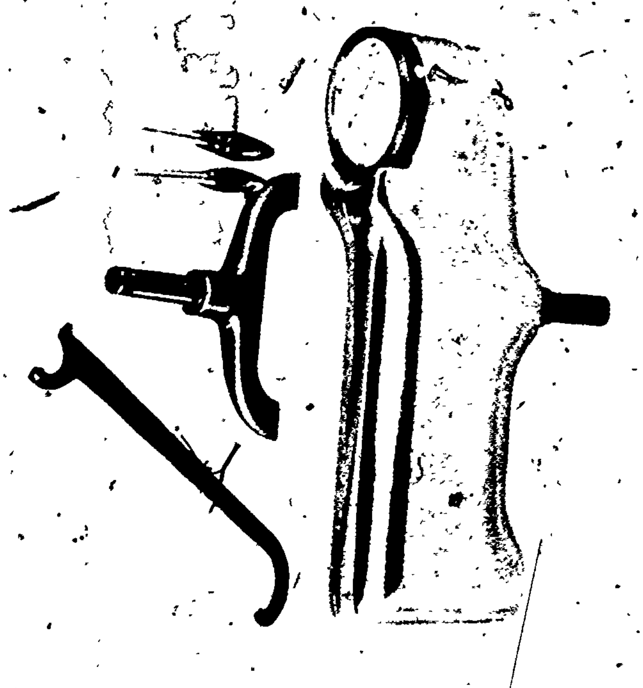

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Figure 8-16.—Barcol portable hardness tester.

light pressure against the instrument is needed to drive the spring-loaded indenter into the material to be tested. The hardness reading is instantly indicated on the dial.

To prevent damage to the point, avoid sliding or scraping when it is in contact with the material being tested. If the point should become damaged, it must be replaced with a new one. No attempt should be made to grind the point.

Each tester is supplied with a test disc for checking the condition of the point. To check the point, press the instrument down on the test disc. When the downward pressure brings the end of the lower plunger guide against the surface of the disk, the indicator reading should be within the range shown on the test disk.

To replace the point, remove the two screws which hold the halves of the case together. Lift out the frame, remove the spring sleeve, loosen the locknut, and unscrew the lower plunger guide, holding the point upward so that the spring and plunger will not fall out of place. Insert a new point and replace the lower plunger guide, screwing it back into the frame. Adjust the lower plunger guide with the wrench that is furnished until the indicator reading and the test disk average number are identical. After the lower plunger guide is properly set, tighten the locknut to keep the lower plunger guide in place. This adjustment should be made only after installing a new point, any readjustment on a worn or damaged point will give erroneous readings.

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