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ABSTRACT

This manual of training guidelines describes the procedure for personnel intake and traces the training process which a worker must go through to become a craftsman making lampblown scientific glassware. The first section discusses the structure of the training program. Appendixes, which make up the bulk of the document, cover job description, job analysis, personnel specification (including recruitment and selection recommendations), suggested training stages, and examples of training aids and exercises. (MF)

Ceramics Glass and Mineral Products Industry Training Board

Training Guidelines

Lampblown Scientific Glassware Craftsmen

TRAINING GUIDELINES

LAMPBLOWN SCIENTIFIC GLASSWARE CRAFTSMEN

CONTENTS

INTRODUCTION

Efficient training can make a substantial contribution to the profitability of a company. Craftsmen capable of applying a high degree of skill to a wide range of products will ensure manufacturers the flexibility demanded by changing markets. The object of these guidelines is to help employers prepare progressive training schemes which will provide such people. They may be of value both when current training methods are re-examined and when new systems are considered.

The guidelines were prepared by a group of specialists appointed by the Working Party on Craft Occupations in the Glass Industry (see Appendix A).

DEFINITION OF A CRAFTSMAN

For the purpose of its Grant Scheme the Board has published a definition of a craft occupation (see Appendix B). However, local conditions which employers accept in identifying their craftsmen vary. For the purpose of training it is RECOMMENDED that a man employed in lampblown scientific glassware should be defined as a craftsman IF HE HAS BEEN THROUGH AT LEAST THREE OF THE TRAINING STAGES SUGGESTED IN THESE GUIDELINES AND HAS RECEIVED APPROPRIATE FURTHER EDUCATION.

PREPARATORY WORK

As a preliminary to designing a training programme a job description, job analysis and personnel specification must be prepared. Examples of these are given in Appendices C, D and E.

TRAINING BY STAGES

A system of training which builds up skills and knowledge in stages appears to be particularly suited to the crafts in the lamp-blown scientific glassware industry. Each of the stages suggested here consists of a skill or group of skills which analysis shows to be a viable unit in the job situation. It consists of a training element, an experience element and a further education element.

The time required to complete each stage will vary according to its content and the circumstances within an individual firm. The order in which they are tackled will also vary but satisfactory completion of a number of stages will usually provide a recognised level of qualification (Appendix F).

SEQUENCE OF TRAINING

If a trainee is to become a skilled and versatile craftsman he must pass through several phases of training and planned experience. Then, later in his career, the skilled craftsman will need further knowledge as new products are manufactured.

Training programmes should be designed not only to equip the trainee with the skills and knowledge fundamental to the performance of his job but to prepare him for wider experience within his current function and for promotion to higher skills and responsibilities. Training will probably follow a pattern of induction, preliminary training, basic job training, advanced job training and refresher courses as required.

Induction - Company

A short induction period introduces the trainee to the company, working procedures and working environment. This will normally take one or two days and will be carried out off the job, perhaps in an office or training centre (see Appendix G).

Induction - Department

The next stage is to acquaint the trainee with his immediate working environment - the department. He needs to be introduced to the process and associated equipment and helped to understand the reasons for carrying out the job in the correct manner. It is important that the trainee is fully familiar with everything which will affect his well-being within the department.

This period also provides an opportunity for assessing the trainee's potential ability.

Basic job training

A sound basis on which to build future skills and knowledge is essential. This stage of the training will normally consist of instruction off the job.

Planned experience

Skills acquired during the basic training period need to be developed and consolidated by planned experience. Much of this will be in the production situation but it should be carefully supervised and evaluated. This is an important part of training since it provides the trainee with the opportunity to acquire the degree of expertise appropriate to the job.

Advanced job training

Periods of advanced training should occur throughout the craftsman's career, whenever he needs to acquire speed and quality with new or unfamiliar products. Training will normally take the form of planned instruction off the job or the trainee may work as a supernumerary (i.e. extra to normal establishment) for short periods. Provision should be made for simple short talks giving information about market conditions and company developments, as this will help the craftsman to maintain his interest in the over-all objectives of his company and to enliven his interest in the training of newcomers and others

Job knowledge

The trainee will need knowledge right from the start about the special safety factors involved, good housekeeping, fire prevention, and he should also have a knowledge of the different types of glass, temperature control, and other basic technical information.

TRAINING METHODS

Training methods will differ according to the local circumstances. It is however suggested that training aids (Appendix H) should be used in the programme whenever possible. Appendix I indicates a technique for using faults analysis in the teaching process.

Off the job training

Preliminary exercises, through which a trainee can acquire the basic skills of glass manipulation, should take place off the job in an area set apart from the production situation. This enables the trainee to become proficient in the use of tools and different glasses and glass products, and to gain confidence before he is placed in the production situation. For instance, one bench may be set aside specifically for training purposes under the guidance of an instructor.

On the job training - planned experience

Training will also take place on the job to ensure the trainee increases output and quality performance over a range of products. He may work as a member of a production team or as a supernumerary being trained by an instructor or individual craftsmen who are qualified to instruct. In both cases the company should devise effective programmes and test procedures.

RECORDS OF PROGRESS

Whether training is on or off the job, the trainee's progress will need to be recorded. This will enable management to observe his progress in the acquisition of basic skills, measured in speed and quality of performance, the range of products in which the trainee is involved at specific periods of his training and the job knowledge he has acquired.

It is equally important that the trainee should be aware of his own progress and fully understand the attention being given to his development. This will help to ensure a high standard of craftsmanship and versatility on completion of training.

DURATION OF TRAINING

Because of the range of ware produced and the diversity of practices in the glass industry it is not possible to recommend specific lengths of time for training. However, it should be possible, subject to local circumstances, to cover up to three of the stages shown in Appendix F in a period of six to nine months. This may be a continuous training period or a planned programme spread over about three years. During this period at least Stage 2 and part of Stage 3 should be included.

This recommended time scale will be subject to variation because of differences in local conditions, the starting point for training and company needs. The training programme should be devised to ensure that the trainee reaches a high standard of performance in each stage as quickly as possible. This will mean making the best possible use of all the internal and external facilities available. In many instances it may be necessary to follow each distinct training stage with a period of planned experience to build up speed and stamina under normal production conditions.

STANDARDS OF PERFORMANCE AND ASSESSMENT

Each employer will need to set standards of performance according to the type of product, the skills required to make it and the speeds and quality demanded by the situation. The appraisal of a trainee's performance against such standards is an accurate means of assessing his progress through the training programme. Careful assessment will indicate weaknesses which require special attention before he moves on to the next stage.

One or more of the following methods can be used in the process of assessment

a) formal and informal questionning by instructors and supervisors

b) progress reports

c) a simply designed question paper to reveal knowledge of the job (Appendix J)

d) a series of practical tests based on time and level of performance; such tests may cover a range of products of increasing complexity (Appendix J).

ASSOCIATED FURTHER EDUCATION

So that the craft trainee may acquire knowledge to complement the skills learned, he should be encouraged to attend an appropriate course of further education. Preferably this should be certificated by the City and Guilds of London Institute.

MANAGEMENT RESPONSIBILITY

Responsibility for training should be allocated to a senior member of management. His responsibilities should include:

a) identifying current and future training needs and planning suitable training programmes

b) providing qualified instructors

c) ensuring adherence to training programmes and maintenance of satisfactory standards of achievement

d) ensuring preparation of regular training reports and records of progress

e) assisting with recruitment and selection of trainees as required

f) determining the further training required at later stages of the craftsman's career.

INSTRUCTORS

The type of instructor will vary according to the circumstances. He may be a full time or part time specialist, a supervisor with instructing responsibilities or an experienced senior craftsman. In all cases management should ensure that he has the requisite knowledge and experience of the job and is qualified in methods of instruction. The Board's INFORMATION PAPER No. 4 "QUALIFIED TO INSTRUCT?" gives guidance on this subject.

Appendix A

WORKING PARTY ON CRAFT OCCUPATIONS

R.H. Haigh (Chairman)	-	Transport & General Workers' Union
L. Eyre	-	Nazeing Glass Works Limited
F.K. Lax	-	Lax & Shaw Limited
B.T. Love	-	Pilkington Brothers Limited
D.C. Marshall	-	G.H. Zeal Limited
G.S. Meek	-	James A. Jobling & Company Limited
K. Pearson	-	Doncaster Technical College
D. Rider	-	Glass Manufacturer's Federation
A. Wright	-	Thermal Syndicate Limited
D. Hammond	-	Thomas Webb & Sons

SUB GROUP ON LAMPBLOWN SCIENTIFIC GLASSWARE

D.C. Marshall (Chairman)	-	G.H. Zeal Ltd.
H. Goodway	-	W.G. Flaig & Sons Ltd.
V. Morgan	-	H.J. Elliott Ltd.
T. Parsell	-	Dept. of Employment & Productivity, Government Training Centre, Waddon
B. Perris	-	Fisons Scientific Apparatus Ltd.
H.W. Sturdy	-	Quickfit & Quartz Ltd.
E.D. White	-	Isleworth Polytechnic
A. Wright	-	Thermal Syndicate Ltd.

STAFF

G.C. Ward	-	Chief Training Officer (Glass)
W.R. Duncan	-	Senior Training Advisor (Glass)

Appendix B

EXCERPT FROM TRAINING GRANT SCHEME 1968/1969

SECTION H

"1a CRAFT

(1) Craft trainees may be either apprentices to the skilled crafts or others training for occupations which, although not necessarily designated as skilled crafts, have similar requirements. These occupations generally call for:

(a) a substantial degree of practical skill

(b) the ability to exercise this skill over a wide range of operations and in a variety of circumstances

(c) the capacity to apply the skills of the craft without constant and close supervision and in doing so to make intelligent use of standard forms of instruction (e.g. drawings and specifications) and where called for by the nature of the work to make routine calculations, apply measuring instruments and perform similar operations

and

(d) the ability to acquire the technical knowledge complementary to the practical skills of the craft necessary for a technically informed understanding of the materials and techniques used, and for the selection of the best method of tackling a particular job.

(This definition is based on that given in the monograph entitled 'Further Education for Craftsmen', published by the City and Guilds of London Institute in April, 1964.)

(2) A craft trainee receives planned comprehensive practical training in a recognised craft or similar occupation together with the associated further education, e.g., a City and Guilds or similar course."

EXAMPLE - JOB DESCRIPTION

JOB TITLE	Scientific Glassblower
DEPARTMENT	Production
RESPONSIBLE TO	Senior Glassblower
FUNCTION	To produce glassware or components as required
OPERATIONS	By means of lamp and tools 1) cut and join glassware 2) manipulate tubing and capillary to various angles and arcs 3) blow bulbs and flasks to specified dimensions, make internal seals and constrictions 4) anneal by flame, seal glass to metal
MATERIALS	1) Borosilicate glass tubing and rod 2) Quartz glass tubing and rod 3) Soda glass tubing and rod 4) Lead glass tubing and rod 5) Tungsten and platinum (glass to metal seals)
TOOLS & EQUIPMENT	Blowlamp, reamers, rods, paddles, calipers, verniers, protractor, forceps and tweezers, jigs, coil winding formers, rollers, carbon tools, tool lubricants, asbestos paper, asbestos wool, spectacles.
QUALITY	As determined by company specifications - interpret specifications and drawings to pre-determined dimensions.

RESPONSIBILITY	To ensure good working practice with minimum of supervision in producing articles of a consistent standard. To notify supervision of defects.

EXAMPLE - JOB ANALYSIS

EXERCISE:

Straight Join

MATERIAL REQUIRED

One 8" glass tube blocked with $\frac{1}{2}$" asbestos wool

One 6" glass tube.

	Left Hand	Attention Points	Right Hand
		Prepare lamp flame as appropriate	
1.	Pick up 8" tube at centre with glass-blowers' hold, blocked end outwards.	Tubes brought parallel to bench in correct working angle.	Pick up 6" tube at centre with glass-blowers' hold.
2.	Move end to be joined into flame working area. Commence rotation of tubes backwards and forwards.	Tube ends to be 3/8" apart in flame. Ensure even heating. Eyes on ends checking heating. Elbows steady on bench. Eyes will confirm end molten.	Move end to be joined into flame working area. Commence rotation of tubes backwards and forwards, in unison with L.H.
3.	Move to correct working angle. Stop rotation when aligned.	Eyes prepare alignment. Eyes focus on ends to be joined.	Move to correct working angle. Stop rotation when aligned, in unison with L.H.
4.	Bring tube ends together and join.	Eyes will control the join and check alignment over tubes join. Push together slightly, then commence rotation. When rotating give a slight pull apart to prevent ridge at join.	Bring tube ends together and join.
5.	Hold tube (now 1 piece)	Eyes to flame.	Release grasp.

	Left Hand	Attention Points	Right Hand
6.	Hold tube.	Eyes on flame to check.	Adjust torch flame as appropriate.
7.	Hold tube, commence rotation.	Eyes remain on flame.	Grasp tube and commence rotation.
8.	Move the joint into flame working area. Continue rotating.	Eyes focus on joint. Watch for joint line disappearing then commence next move.	Move the joint into working area. Continue rotating.
9.	Move to correct working angle. Continue rotation.	Eyes still on joint.	Move to correct working angle. Continue rotation.
10.	Aliow tube to pivot (relax grasp). Continue rotation.	Hands must remain some distance apart whilst this move takes place as joint is plastic.	Bring right hand end of tube to lips. Continue rotation.
11.	Support and control.	Blow slightly till joint is over size of tube diameter (approx. 1mm).	Hold at lips. Continue rotation.
12.	Move to horizontal position as before. Pull apart slightly continuing rotation till outside wall diameter is equal over joint and tube.	Eyes on joint, checking for satisfactory join, wall thickness and alignment.	Move to horizontal position as before. Pull apart slightly continuing rotation till outside wall diameter is equal over joint and tube.
		Repeat items 7 to 12 for wall thickness, alignment and appearance. Look for parallel shadow on glass wall thickness.	

PERSONNEL SPECIFICATION - INCLUDING RECRUITMENT AND SELECTION

The considerable investment of time and money which will be spent in training a potential craftsman necessitates careful attention to selecting candidates who are mentally and physically capable of achieving high standards of performance in the limited period defined by individual employers. The following items should be considered in defining the type of individual who will be suitable for training:

(a) Physique

The physical attributes necessary are good eyesight and the ability to use arms, hands and fingers effectively. Providing these factors are taken into consideration there is no reason why disabled people could not be trained to do this work.

(b) Special aptitudes

The ambidextrous person is the ideal potential lampwork glassblower, providing he has both manual and mental adroitness and neatness of handling to develop the ability to manipulate glass tubing between the fingers of the two hands in perfect co-ordination and sychronisation with each other.

To succeed in qualifying as a top grade glassblower, the trainee must instinctively appreciate symmetry, regularity of form and harmonious proportions.

(c) Interests

A trainee who has an artistic flair in drawing, painting or modelling is likely to enjoy glassblowing and find satisfaction in this creative skill.

(d) Disposition

In view of the long period of training, the lampwork trainee should be of an even temperament, have the ability to concentrate and be systematic, tenacious and creative, with a sense of pride in a job well done.

(e) Vocational Ability

It is preferable that trainees for lampwork glassblowing begin at the earliest possible age in view of the length of training and the adaptability necessary.

The level of intelligence, mental alertness and achievements in basic subjects should be average.

Sources of recruitment will vary according to local circumstances and will include young men submitted to employers by the Youth Employment Service, school careers officers and other means of recommendation.

It is recommended that employers should select according to the merits of the individual and in making a selection should draw on all available information. This may include

(a) school record card

(b) previous job history

(c) personal interview

(d) intelligence and aptitude tests.

SUGGESTED TRAINING STAGES

Induction (see Appendix G)

Stage 1. Preliminary training

1. Use of blowlamp - flame setting and heat zones, ancillary services, safety requirements.
2. Spindle pulling (up to 15mm).
3. Glass cutting - knife wheel - thermal shock.
4. Use of vernier, caliper and rule - English and metric.

Stage 2. Basic job training

1. Form test tube from spindle.
2. Straight join equal diameter tube (15mm).
3. Straight join unequal diameter tube (10 - 25mm).
4. Angled bends and U tubes (10 - 15mm).
5. Hooks, pips, spacers and buttons using solid rod on tubing.
6. Bulb and flask blowing on tube ends.
7. Single and series bulb blowing in middle of tube.
8. T & Y joins, equal diameter tube (15mm).
9. T & Y joins, unequal diameter tubes (7 - 15mm).
10. Internal and external seals.
11. Test piece incorporating above exercises to agreed standard and times.

The company should provide the following supporting information:

Safety, good housekeeping, elementary glass technology, including strain and annealing, interpretation of drawings and specifications, faults analysis.

Stage 3. Advanced job training

The further development of basic training as related to company products e.g. lathe work, graduation.

Stage 4. Specialisation and further planned experience. Additional job training as required.

INDUCTION COURSE

It is important that during an individual's early employment a short induction course be used.

The course should be designed to familiarise the trainees with their general environment and the overall working conditions and it might consist of much of the following:

1. Working rules and conditions. Company rules and regulations. Factories Act. Time keeping. Hours of work. Areas of supervision and responsibility.

2. Welfare - sickness and pension benefits. Travel and holidays. Committees - social and sports club. Canteen.

3. Pay and conditions - how his pay will be made up. Stoppages, P.A.Y.E. How and where he is paid. Where he can query the make up of his pay.

4. Safety - workshop safety and relevant legislation. Hygiene and industrial health. Accident prevention and occupational hazards. Elementary first aid and location of facilities. Lifting and carrying. Reporting accidents.

5. Consultation and negotiating arrangements. Trade unions. Shop stewards. Grievances and disputes procedure. Joint productivity councils.

6. Promotion possibilities. What is possible. What is available - training and education courses.

7. The importance of the job. The company, its products and achievements. Where the products go; how they are used. What it means to the country. Where he fits in the company. What his part means to the whole.

8. Geography. Tour of the works. The working place. The relevant offices. The facilities. The appropriate supporting service departments.

EXAMPLES OF TRAINING AIDS

1. Selection of completed products in ascending order of complexity and related to the training programme.

2. Examples of advanced products produced by experienced craftsmen.

3. Photographs of the firm's product as a component part of a customer's complete apparatus, plant or equipment.

   Note: The identification of the component with the customer's total requirement increases the interest and understanding of the trainee. The inclusion of visits to customer's factories or apparatus on site is also advocated.

4. Films

   (a) Elementary Glassblowing. 16mm sound/colour - 20 minutes.
   (Made for Leeds University)

   A teaching film for students, on the making of T joints, bends and small items of apparatus for qualitative inorganic micro-analysis. Provides close-up views for large groups.

   Hire charge £3 from The Yorkshire Film Co. Ltd.,
   12 Queen Street,
   Huddersfield,
   Yorkshire.

   (b) Volumetric Glassware. 16mm sound/black & white - 20 minutes.

   Describes the cleaning, calibration and use of graduated flasks, pipettes and burettes.

   Hire charge £2 from The Yorkshire Film Co. Ltd.,
   12 Queen Street,
   Huddersfield,
   Yorkshire.

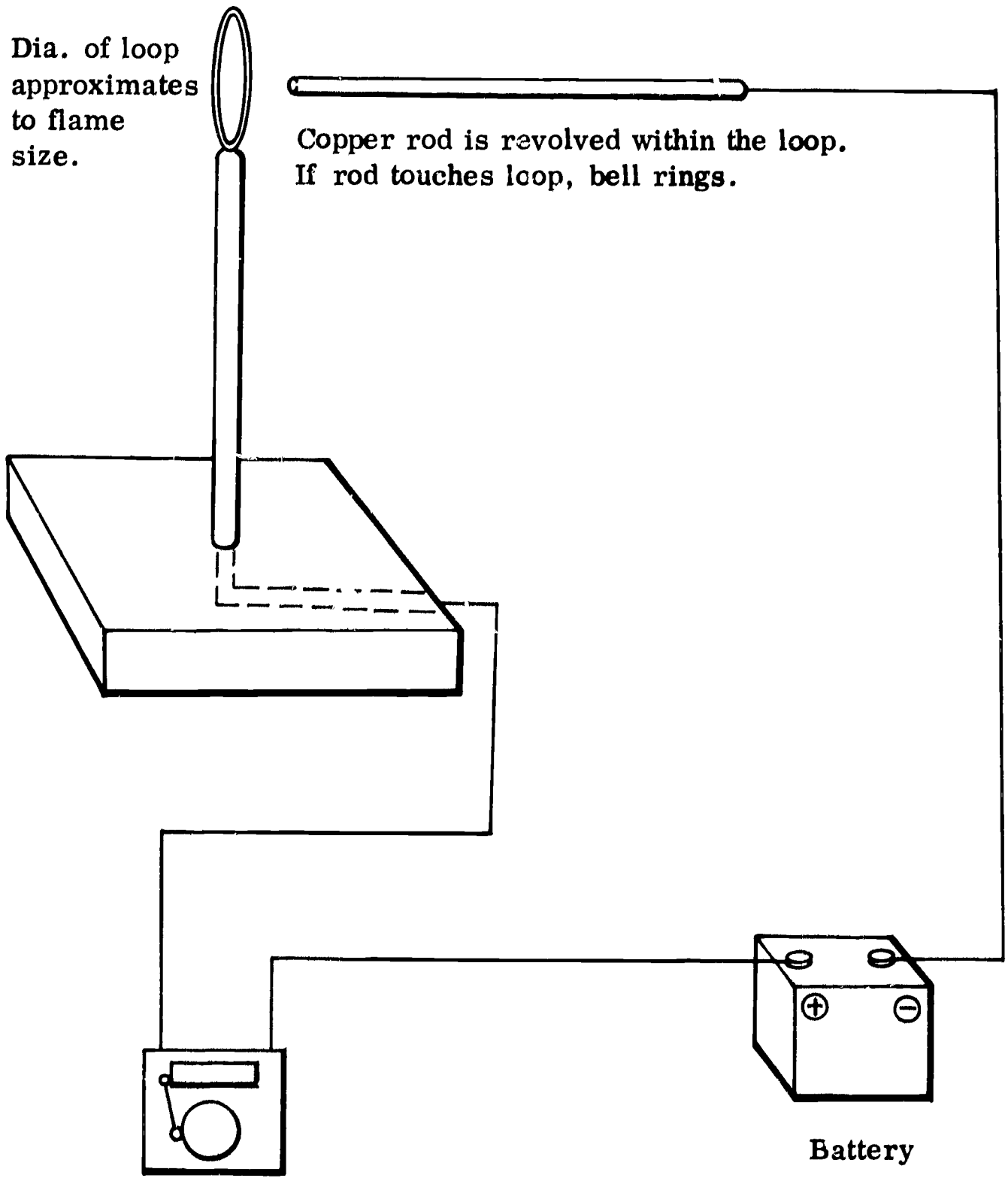
5. Apparatus to develop manipulative skills

Every effort should be made to analyse the skills of the experienced craftsmen and to re-create these off the job. This accelerates the acquisition of skills and provides important self-confidence in the early stages of training.

The following exercises have proved their value and others may be devised. In all cases, target times should be set to assist in building up speed and stamina:-

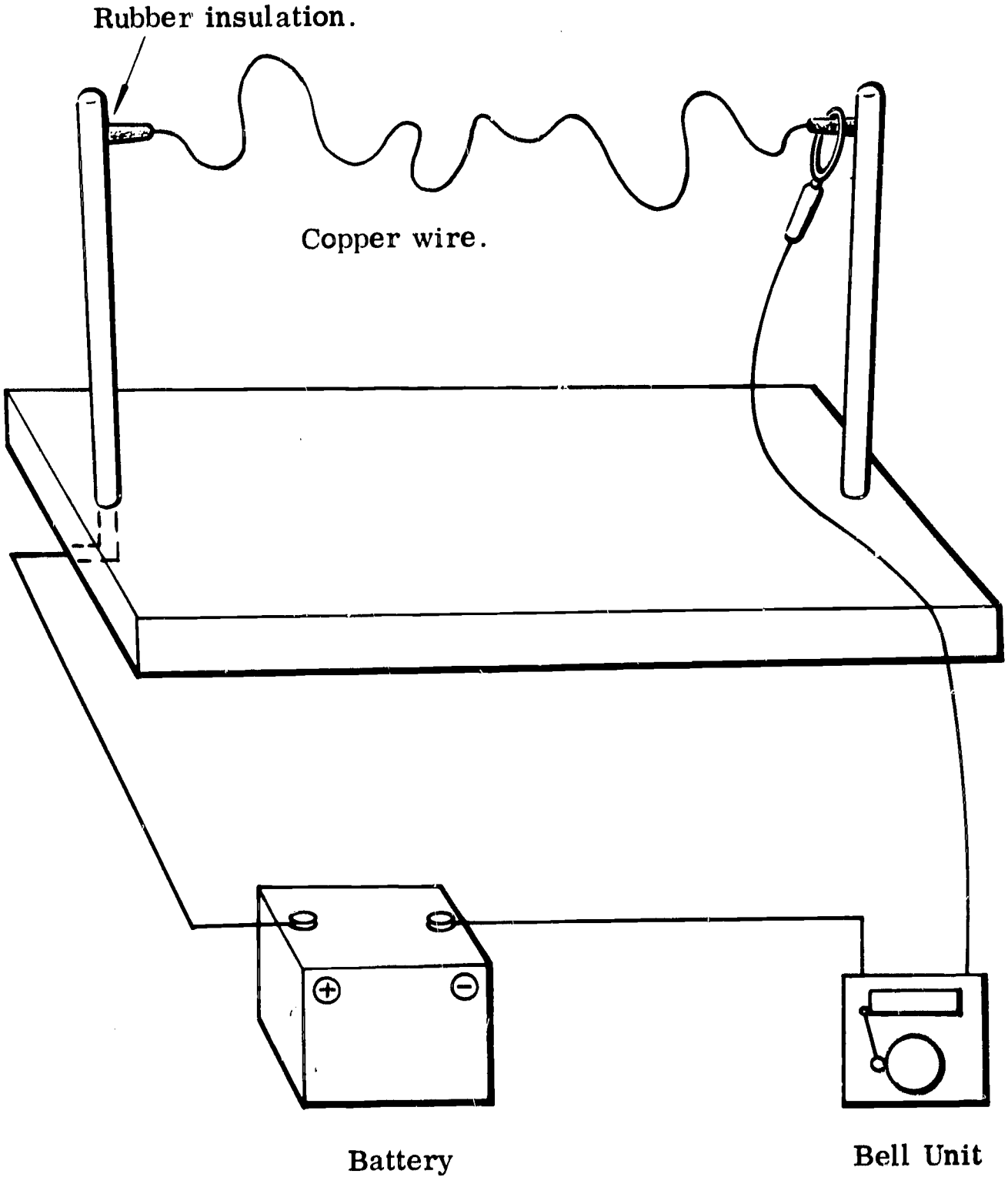
EXERCISE 1

ROTATING ROD WITHIN FLAME



EXERCISE II

THE DEVELOPMENT OF HANDS: EYES CO-ORDINATION



The loop should be passed along the wire without touching it.
If the loop touches the wire the bell will ring.

SPECIMEN FAULTS ANALYSIS

Appendix I

JOB: Straight Join

Name	Appearance	Cause	Effect	Responsibility	Action	Prevention
Misaligned join.	Join, although parallel, is misaligned.	Incorrect positioning of ends prior to join.	Scrap	Operator to observe.	Inform instructor/ supervisor.	Proper alignment.
Rippled join.	Series of rings or ripples at join area.	Applying pressure inward on join.	Reclaim.	Operator to observe.	Inform instructor/ supervisor.	Pull the join to correct size.
Overheated join.	Thickened internal wall.	Holding the join for too long in the flame.	Scrap.	Operator to observe.	Inform instructor/ supervisor.	Remove the join at correct temperature.
Uneven wall thickness join.	Elongated bubble.	Moving the hands apart during blow process.	Scrap.	Operator to observe.	Inform instructor/ supervisor.	Keep hands a constant distance apart at all times during join process.
Uneven wall thickness join.	Squat flat bubble.	Moving the hands towards each other during blow process.	Possible to reclaim.	Operator to observe.	Inform instructor/ supervisor.	Keep hands a constant distance apart at all times during join process.

TESTS

Throughout the periods of planned training it is necessary to test for:

a) manipulative skills - showing progress in quality and speed

b) knowledge content - showing an understanding of the scientific factors associated with the skills.

The following tests may be set on the completion of the first 3 months' training - mainly off the job interspersed with production experience.

PRACTICAL

The tests (1) to (5) (page 23 and 24) are examples which may be used but individual employers will determine suitable tests to meet their own needs.

GENERAL KNOWLEDGE

Suitable test papers should be designed, according to the qualifications of the trainees, to indicate knowledge acquired in respect of:

1. Strain: flame annealing.

2. Causes of strain:

   e.g. Local heat.
   Thickness and diameter of material.
   Temperature change during cooling.

3. Methods of relieving stress:

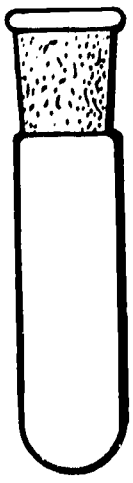
   e.g. Shredding.
   Flame manipulation.

4. The protractor and its uses:

   e.g. Set test drawing.

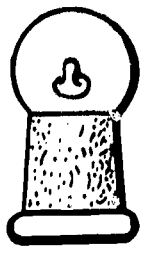
5. Standards required by customers.

TEST TUBES (1)



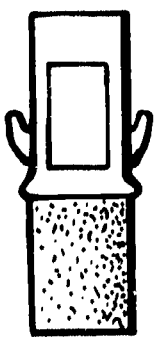
Mark to length. Part and remove waste from round bottom end.

SOCKET CAPS WITH HOOKS (2)



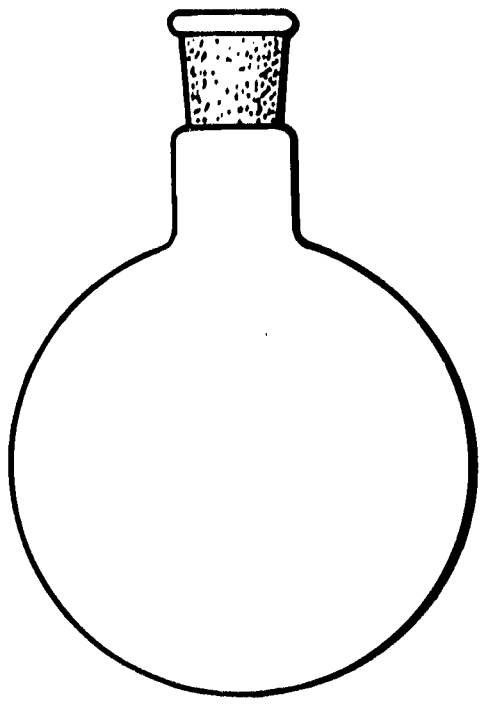
Mark to length. Part and remove waste from round bottom end to form bulb. Heat solid rod and form hooks on opposite sides of bulb.

STOPPERS WITH HOOKS (3)



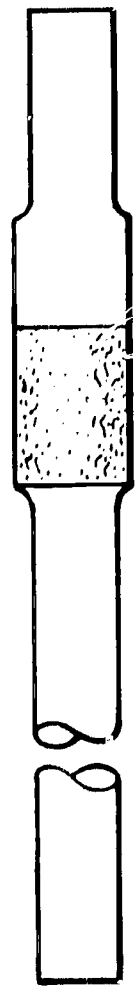
Heat solid rods and form hooks on opposite sides of moulded blanks provided. Heat moulded blank to expand air. Part moulded blank at length required. Form flat top using flat carbon and expansion of air inside stopper.

FLASKS, ROUND BOTTOM, SHORT NECK (4)



Mark shank of B14 socket to appropriate length allowing for thickening of glass. For blowing bulb - seal off to length, melt, thicken and form flask to size.

CONES WITH STEM, REDUCED SHANK, SINGLE (5)



Extend length of tube at bottom of cone by making equal joint and fire end.
Prepare shank by forming round end. Blow hole in centre of round end.
Join tubing to form unequal joint. Cut to length and fire.