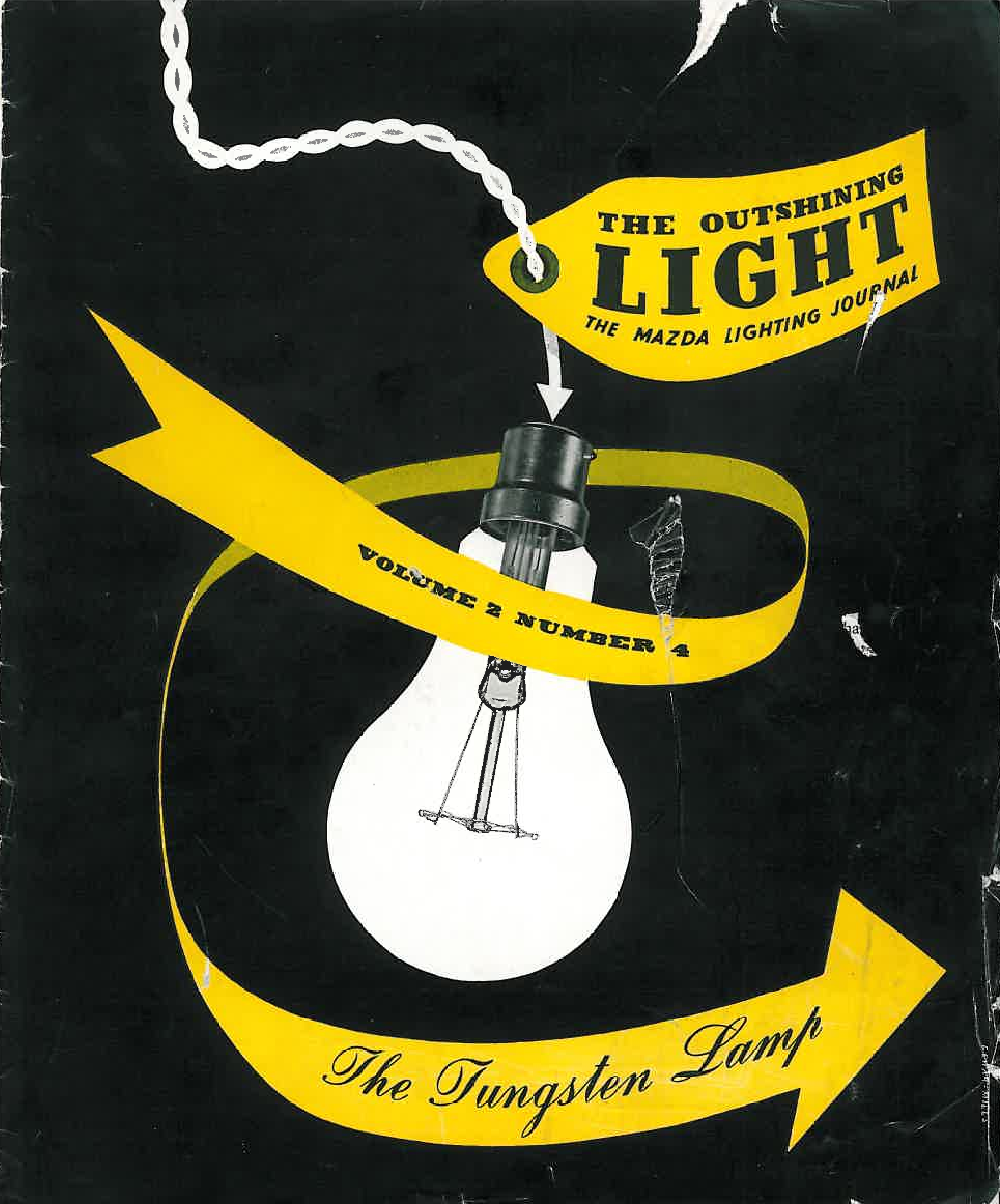
THE OUTSHINING
LIGHT
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The Tungsten Lamp

Photo: Keystone

THE OUTSHINING LIGHT

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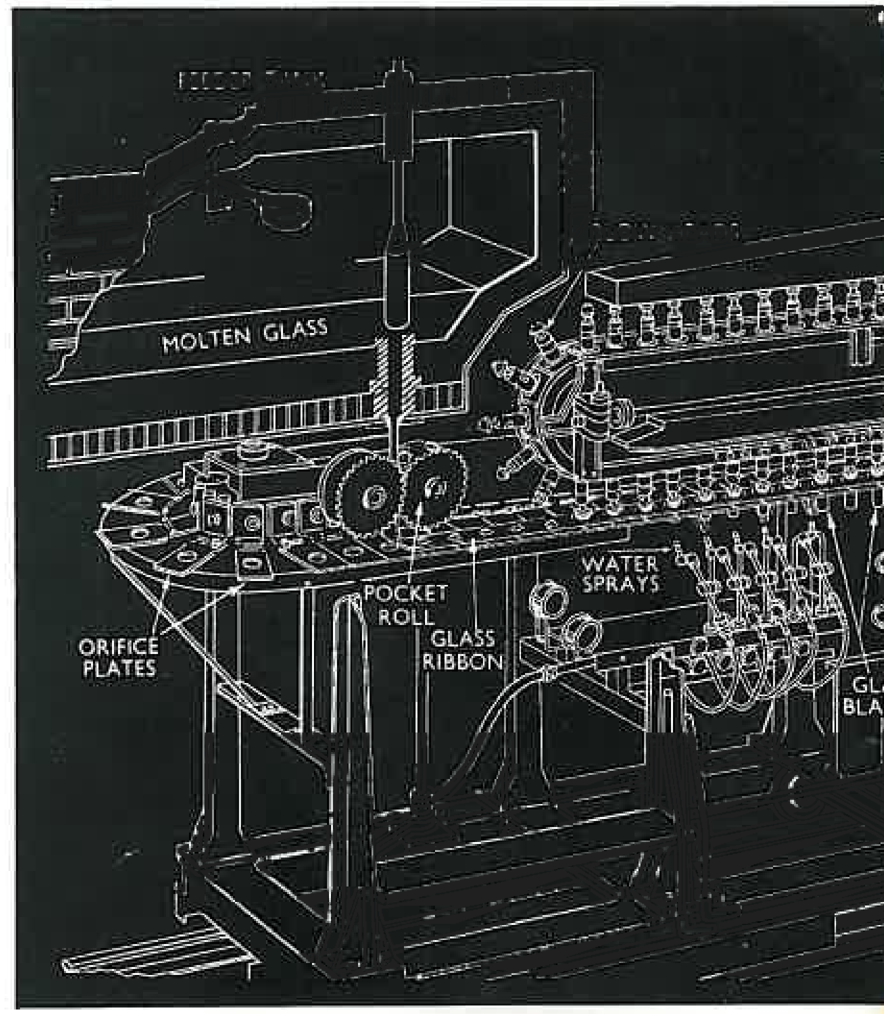
WE DEVOTE this issue of *The Outshining Light* to the tungsten filament lamp, the common-or-garden lamp which in these days of fluorescent and electric-discharge lighting has tended to become the Cinderella of its world. Such a treatment is surely long overdue. The fluorescent lamp possesses advantages which have made it one of the most important factors in speeding production in industry and in providing more satisfactory visual conditions in offices and shops. Yet, still, the filament lamp is the most widely used method of artificial lighting in the modern world. Whether in the factory or the home, office or shop, lighthouse or surgery, the street or the sports arena, it provides the increasingly efficient, and increasingly necessary, illumination by which most of our activities are carried out. There have been remarkable improvements in the performance of these lamps during recent years. From high-power projectors for film-making and floodlighting to the ordinary domestic lamp, these improvements have given rise to greater operating efficiency, better light distribution and increased economy. New types of lamps for the home, industry and commerce—such as the silica-coated Silverlight which gives a soft, even illumination whilst reducing glare and the internally silvered Reflector Spot lamp—have been introduced. Behind these and many other post-war developments have stood the vast manufacturing resources of The British Thomson-Houston Company and the ever-watching eye of Lamp Quality Control. It is with these subjects that we are mainly concerned, the manufacturing techniques and the methods of checking quality at every stage of production which combine to produce a lamp of the highest possible efficiency and reliability. We also consider some of the more familiar applications of the lamp in everyday life.

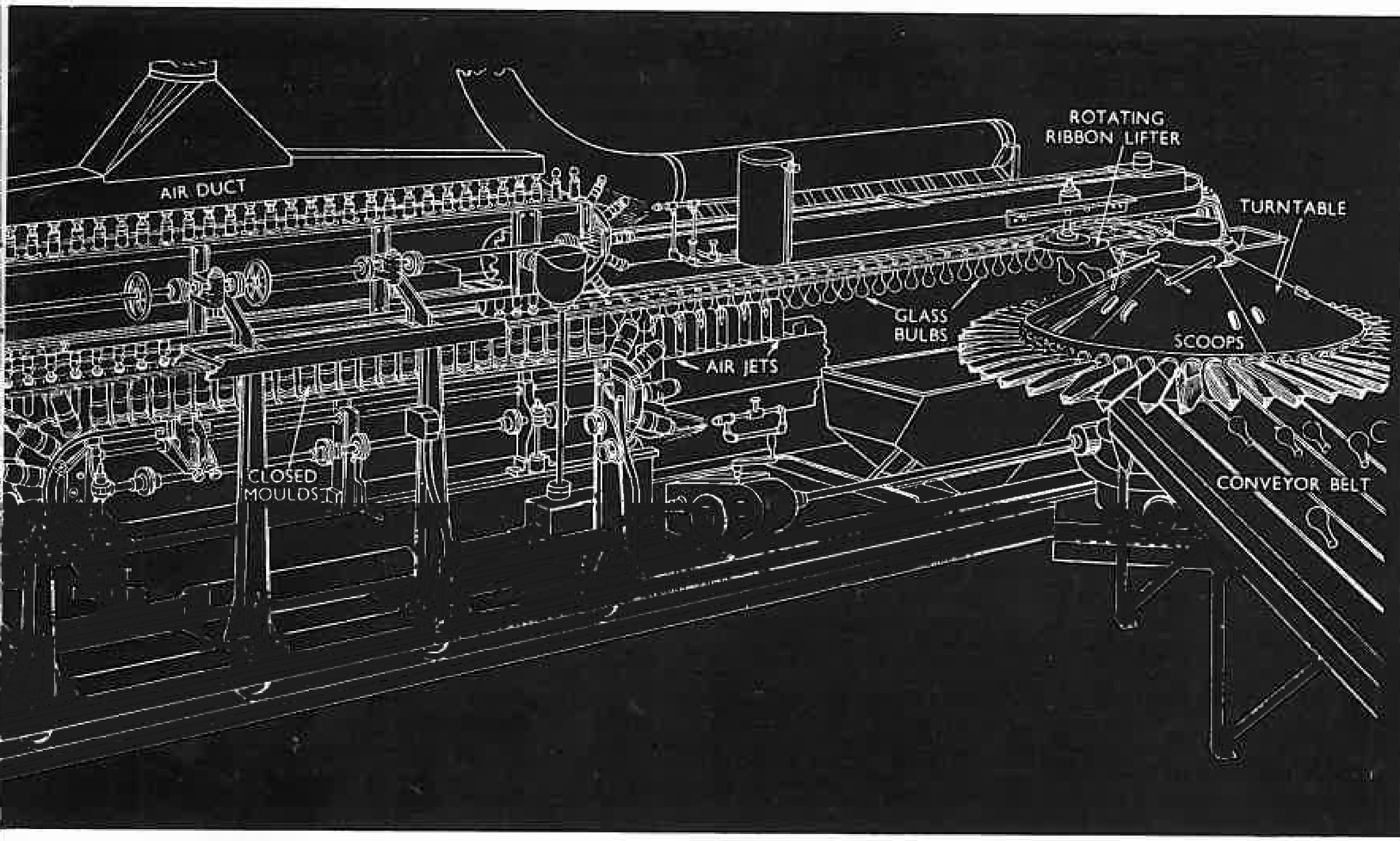
This impressive picture, taken during the Coronation procession in Westminster Abbey, provides a striking illustration of the value and importance of the filament lamp in the modern world. While clusters of ordinary filament lamps contribute to the warmth and splendour of this colourful occasion, Mazda projector lamps in Holophane fittings provide the illumination necessary for television and filming.

Filament Lamps in the Making



This is one of the ribbon machines installed at the Harworth factory of Glass Bulbs Ltd., an associated Company of BTH and The General Electric Co. Ltd. These machines can each make about a million lamp bulbs a day.

Science and engineering skill combine to produce what is one of the most ingenious and yet most taken-for-granted inventions of the modern age—the electric lamp. In this article we visit the most efficient glass bulb making factory in Europe and the Rugby Works of The British Thomson-Houston Company—among the greatest manufacturing organizations of its kind in the world—where all the care and ingenuity of present-day scientific research and engineering technique contribute to the production of some 50,000,000 electric lamps each year.



WHEN we discover that the living room light has gone out and nonchalantly plug-in a new lamp, we seldom, if ever, give more than a passing thought to the modern wonder which we are handling. Perhaps it is natural enough. For the lamp is the most commonly used and one of the least expensive amenities of the 20th Century.

Yet what a perfect example of precise engineering the common-or-garden filament lamp is! Its manufacture demands such a fine degree of exactness that some of its minute dimensions and tolerances are difficult for any but the engineer and mathematician to comprehend.

Let us take a look at some of the stages which lead from a collection of raw materials, of sand, lime, scheelite, molybdenite, a few gases, and some copper and brass, to the finished product.

Making the Bulb

Glass bulbs are required in vast numbers for the many different types and sizes of lamps which are available nowadays, and at Harworth in Yorkshire these bulbs are made by a completely automatic process in quantities which overshadow almost any other method of mass production known to modern industry.

In fact, the Harworth factory produces sufficient to meet the needs of its parent organizations and of all other lamp manufacturers in the British Isles. In addition there is a big margin of production for export to Europe and the Commonwealth.

The system of flow production at Harworth is highly mechanized throughout its various stages.

Raw materials are delivered direct to the Works from private sidings and are raised by suction to the top of a mixing tower. Soda ash, dolomite, limestone, sand and felspar, together with cullet (surplus glass), are passed down this mixing tower to automatic weighing machines and then discharged in their correct proportions into a rotary mixing drum.

When the materials are thoroughly blended they are fed into a furnace which is capable of producing 150 tons of glass a day, and from this furnace the molten glass flows in a controlled stream between two rotating, water-cooled rollers—the first stage of its passage through the most efficient glass bulb producing mechanism in the world, the Ribbon machine. The phenomenal capacity of this machine, which runs continuously throughout the 24 hours, is 1,000,000 bulbs daily.

The ribbon of glass which leaves the rollers is carried on a continuous belt of orifice plates whilst compressed air from above begins to blow out the embryonic shape of the bulbs. As the air pressure increases, moulds close round the bulbs from both sides so that at the end of the process a line of perfectly shaped glass envelopes is revealed. The bulbs are air cooled and are passed on a conveyor belt to the packers, twenty-five of the finished products being removed every twelve minutes for examination and quality control tests.

Like many other machines used in lamp making, the Ribbon machine is a highly complex and ingenious example of precise, automatic engineering. Its initial cost is immense. But it is more than justified by the great contribution it makes to the manufacture of one of the finest products of British industry.

From Powder to Filament

In order to give a light of high intensity for the longest possible time, and at the most economical cost, a lamp must contain an extremely stable filament. For this reason, tungsten—which has a higher melting point than any element other than carbon—is used.

The long and intricate process by which miles-long strands of tungsten wire are obtained from a metallic ore can be seen at the Rugby Works of BTH. Scheelite (calcium tungstate) is ground to a uniform fineness and weighed in order to obtain exact quantities. The powdered ore is then put into vats containing concentrated steam-heated acid to produce tungstic acid which is converted to ammonium para-tungstate by running it at a controlled rate into a solution of ammonia. After evaporation in steam-heated pans, the crystalized ammonium para-tungstate is washed, dried and converted to a uniform powder.

This process is largely repeated in order to obtain the purest form of tungsten. The para-tungstate powder is added to boiling caustic potash, diluted and added to hydrochloric acid in order to re-precipitate pure tungstic oxide. After washing and centrifuging to remove excess moisture, the tungstic acid is baked to complete dryness and once more ground to a uniform powder. Silica and alumina are then added and these have the effect of 'vitalizing' the tungsten so that the resultant filament will not sag. The mixture is then passed in nickel boats through a converting furnace. A stream of hydrogen is blown through the tubes into which the furnace is divided, and this converts the tungstic acid to powdered tungsten metal of the precise degree of purity required.

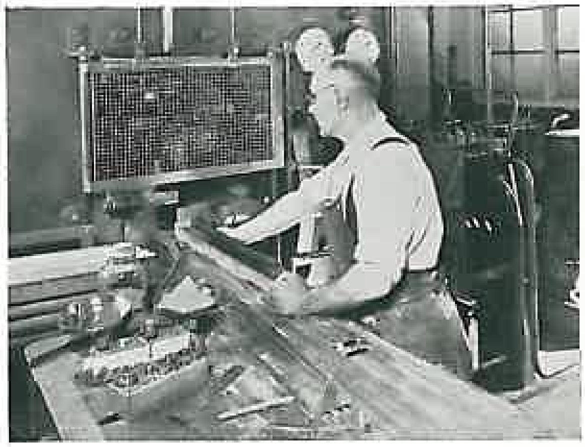
Here begins the delicate task of converting the blue-grey powder obtained by chemical processing into the minutely thin strands of tungsten wire employed in making the modern filament.

The powder is placed in a stainless steel mould, and compressed at 10 tons per square inch to obtain bars which are then pre-sintered in a furnace. Next a heavy electric current is passed through the bars in an atmosphere of hydrogen, raising the temperature to about 3000°C. They are subsequently heated and forced through pairs of rotating dies which become smaller and smaller as this swaging operation continues.

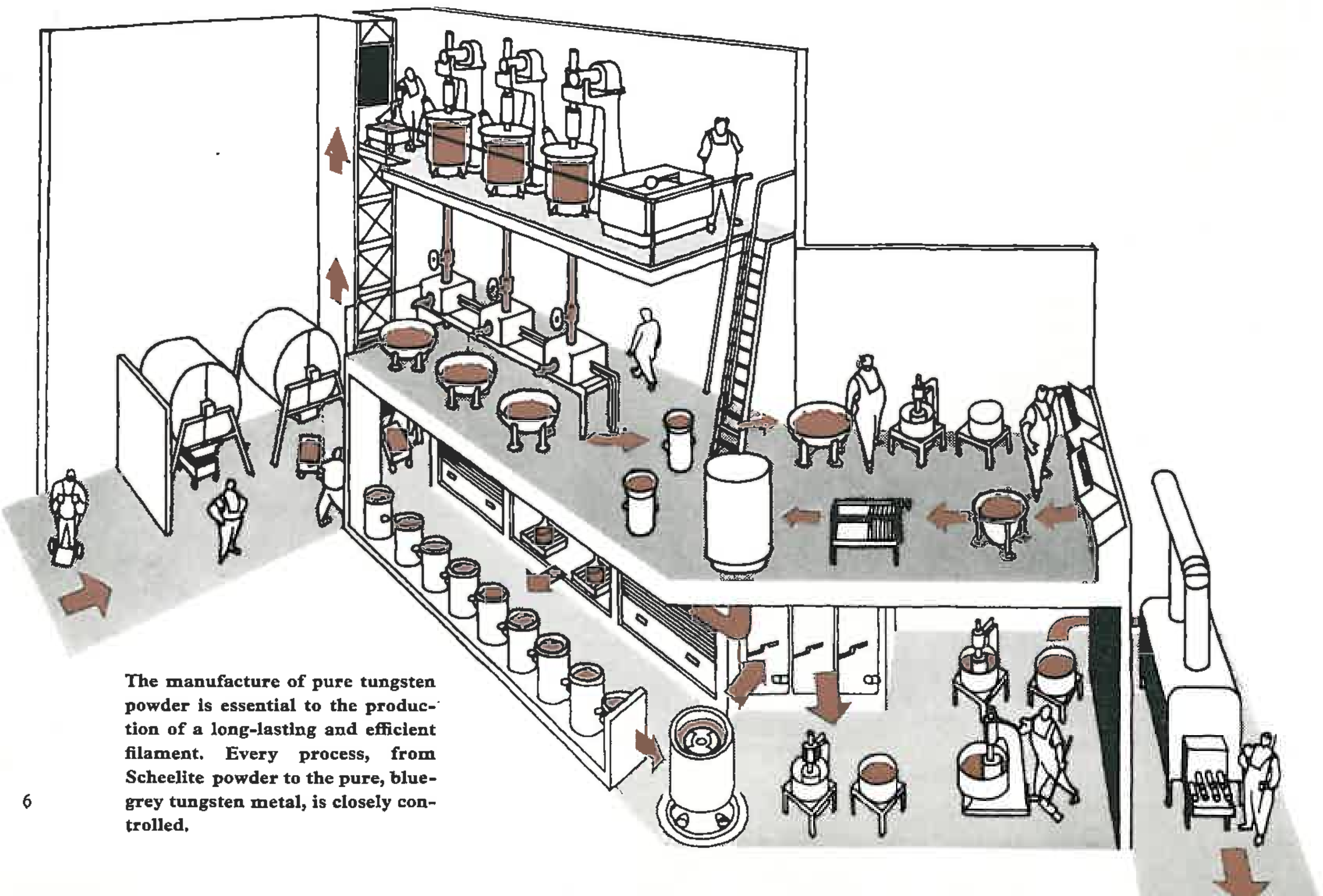
The slender rod of tungsten is now drawn into wire through carbide dies and then through diamond dies, until a wire of the minute diameter required is obtained.

Finally, the wire is cleaned. Colloidal graphite, used as a protection and lubricant during drawing, is removed in an electrolytic bath.

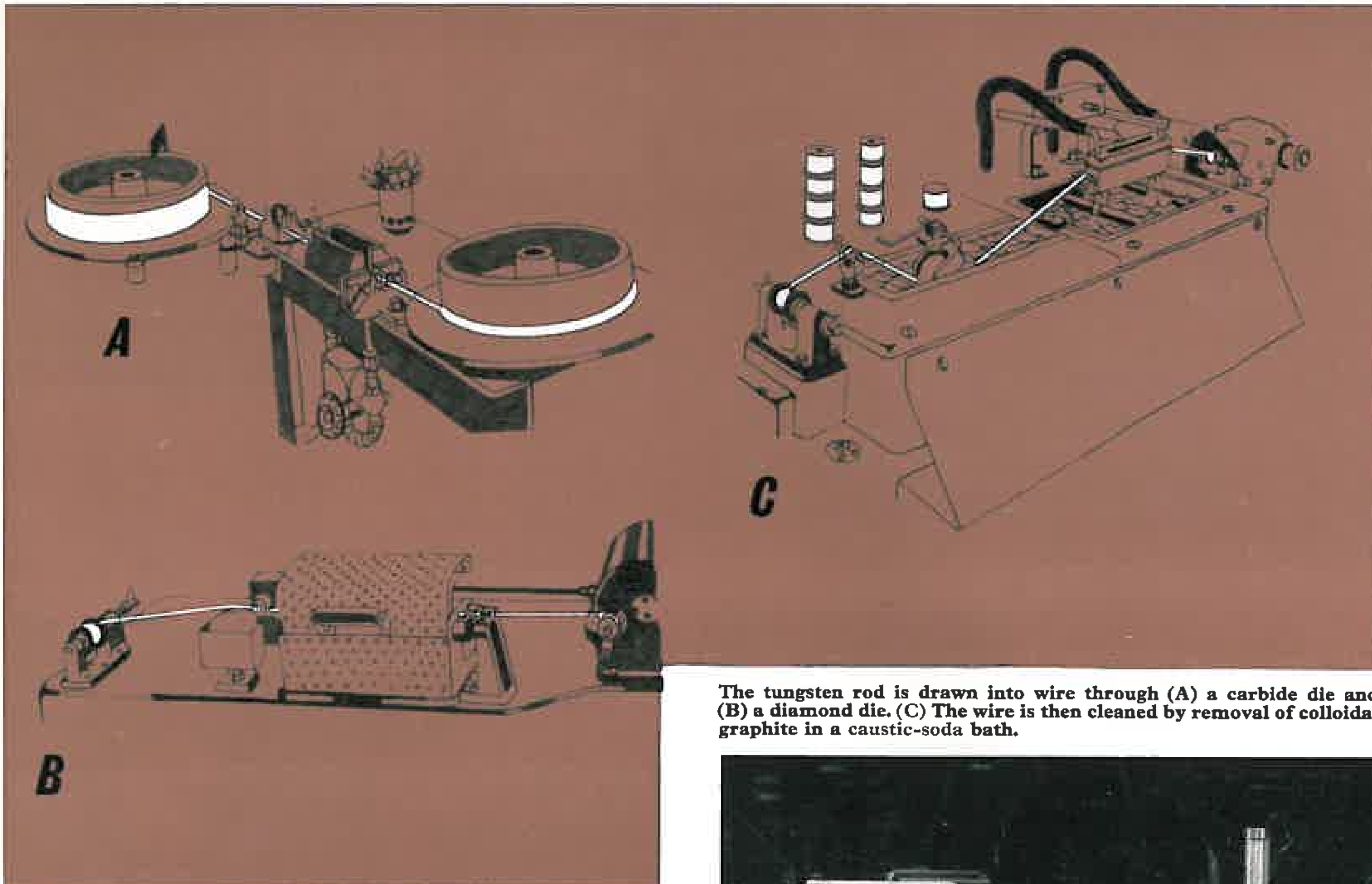
More than 80 operations are carried out on the metallic tungsten before it is ready for coiling into a filament.



Powdered tungsten is converted into metal bars by compression in this press and by pre-sintering in a furnace.



The manufacture of pure tungsten powder is essential to the production of a long-lasting and efficient filament. Every process, from Scheelite powder to the pure, blue-grey tungsten metal, is closely controlled.



The tungsten rod is drawn into wire through (A) a carbide die and (B) a diamond die. (C) The wire is then cleaned by removal of colloidal graphite in a caustic-soda bath.

Coiling the Wire

The next step in producing the parts which make up a modern lamp is perhaps the most intricate and exacting of all. It is the coiling of the wire for the filament and it involves adjustment of the machines to give, as one example of accuracy in measurement, a uniform gap between turns in the coil of 0·000265 inches.

First the tungsten is wound from spools on to a mandrel by a single coiling machine.

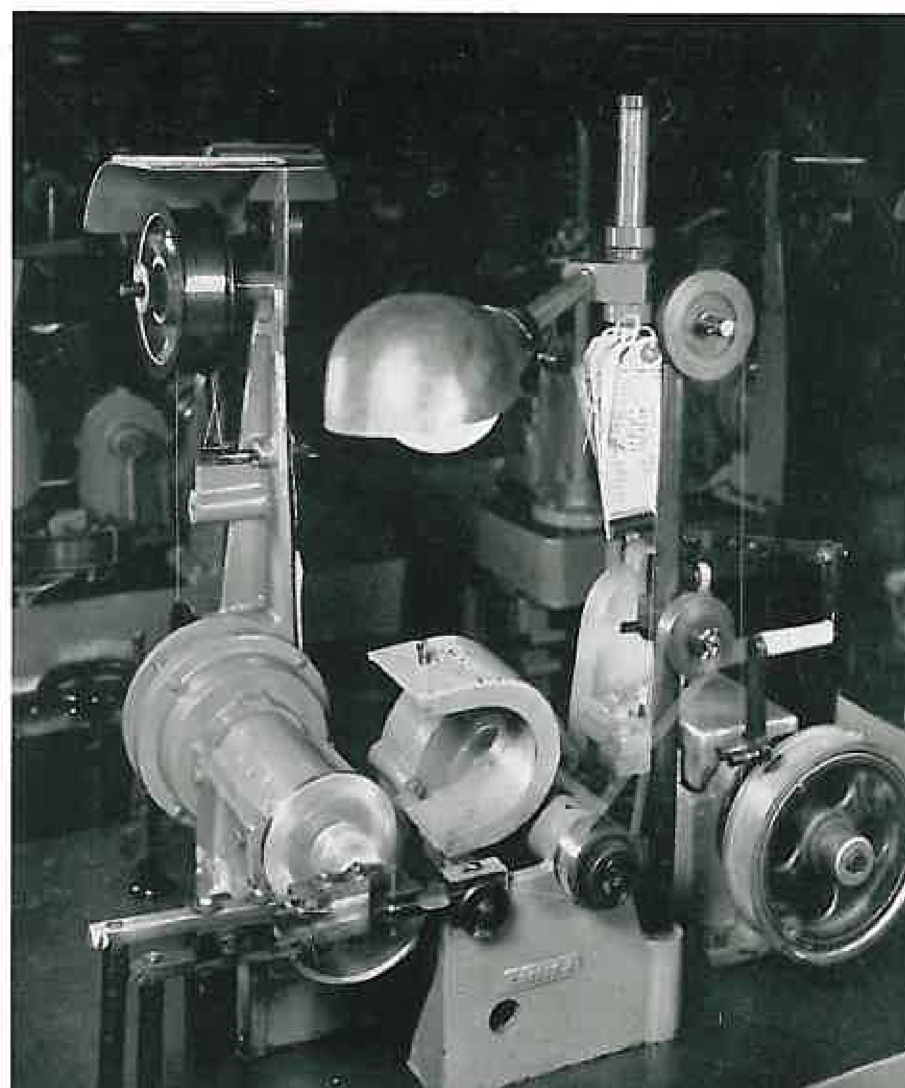
Here the mandrel may be steel or molybdenum wire and around it is wound the tungsten filament wire. During this process tension and heat are applied to a carefully gauged extent. When some three thousand feet of wire has been wound at the correct pitch, the length of filament material is annealed at a temperature of 1150°C in a hydrogen atmosphere.

For coiled-coil filaments the primary coiling is done on a molybdenum mandrel and the single coil produced by the above process is itself coiled on to a secondary molybdenum mandrel.

It is then annealed at 1650°C in a hydrogen atmosphere.

Finally the coiled material is cut into appropriate lengths and the mandrel dissolved in acid. Every filament is then thoroughly inspected.

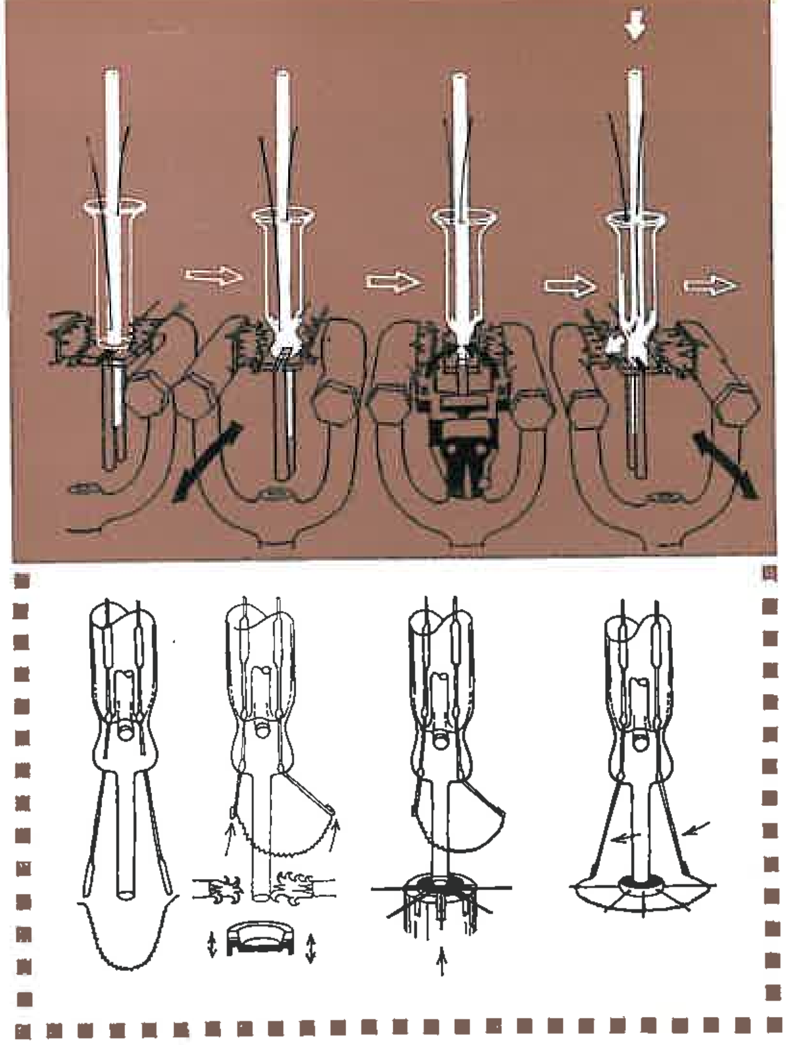
A process such as this demands machinery capable of the greatest precision. It also requires expert control and maintenance of the machines and materials to ensure that this vital part of the lamp will provide good, economical lighting over the maximum period.



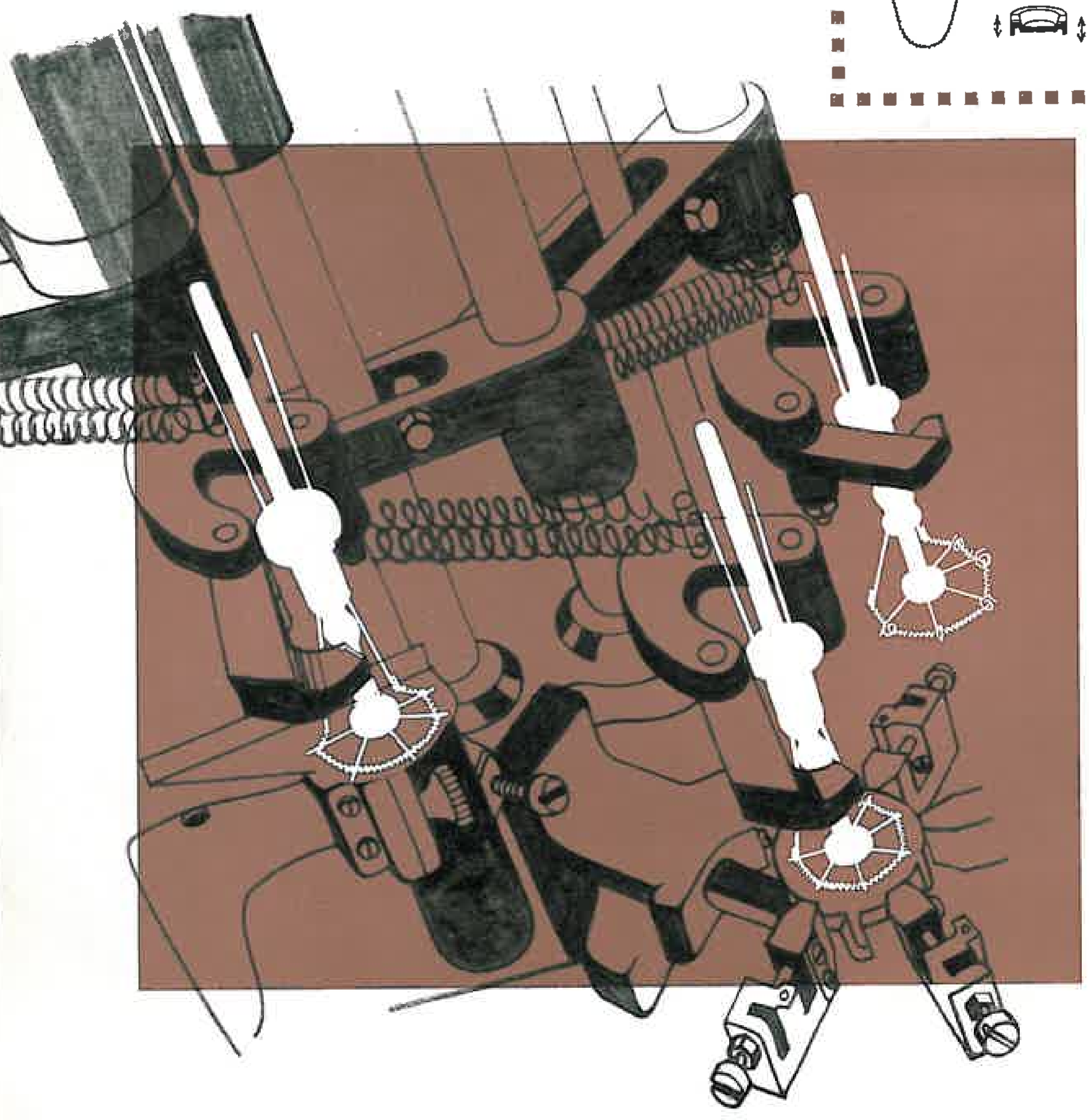
A coiling machine, with raised guard. This machine ensures a uniform gap between turns in the coil of 0·000265 in.

Assembling the Lamp

We have a glass envelope or bulb, a cap pressed out of brass (another process demanding great accuracy to ensure that there is no weakness in the finished lamp) and a filament. Before dealing with the assembly of these parts to produce the lamp, however, there is one more vital part to be considered. That is the 'flare', a glass tube which is the principal structural element of a lamp. It combines with a glass rod, two electrical leads and a glass tube through the application of heat and pressure. The filament is supported by the glass rod whilst the tube is used for the final evacuation of the lamp. Each of the leads is in four parts which are welded together lengthwise—nickel for connection to the filament, dumet metal for passing through the glass constantan fuse in a glass cartridge, and copper for connection to the cap. With the flare, rod, tube and leads assembled into a single stem, and the filament clamped to the nickel leads and supported by fine molybdenum wires, the glass bulb appears for the first time. It is passed over the mounted filament and the two separate components are sealed

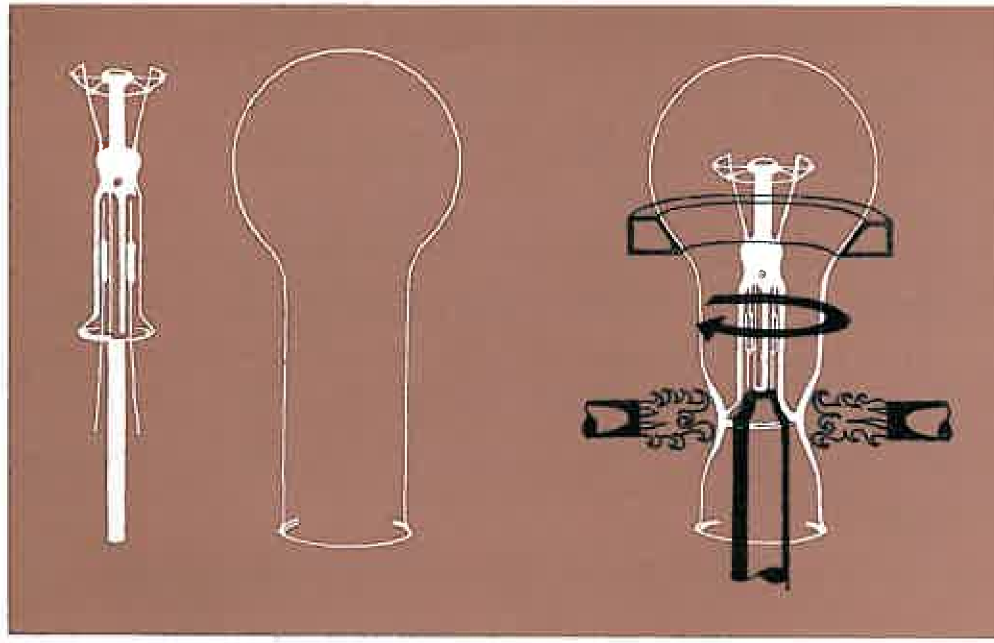


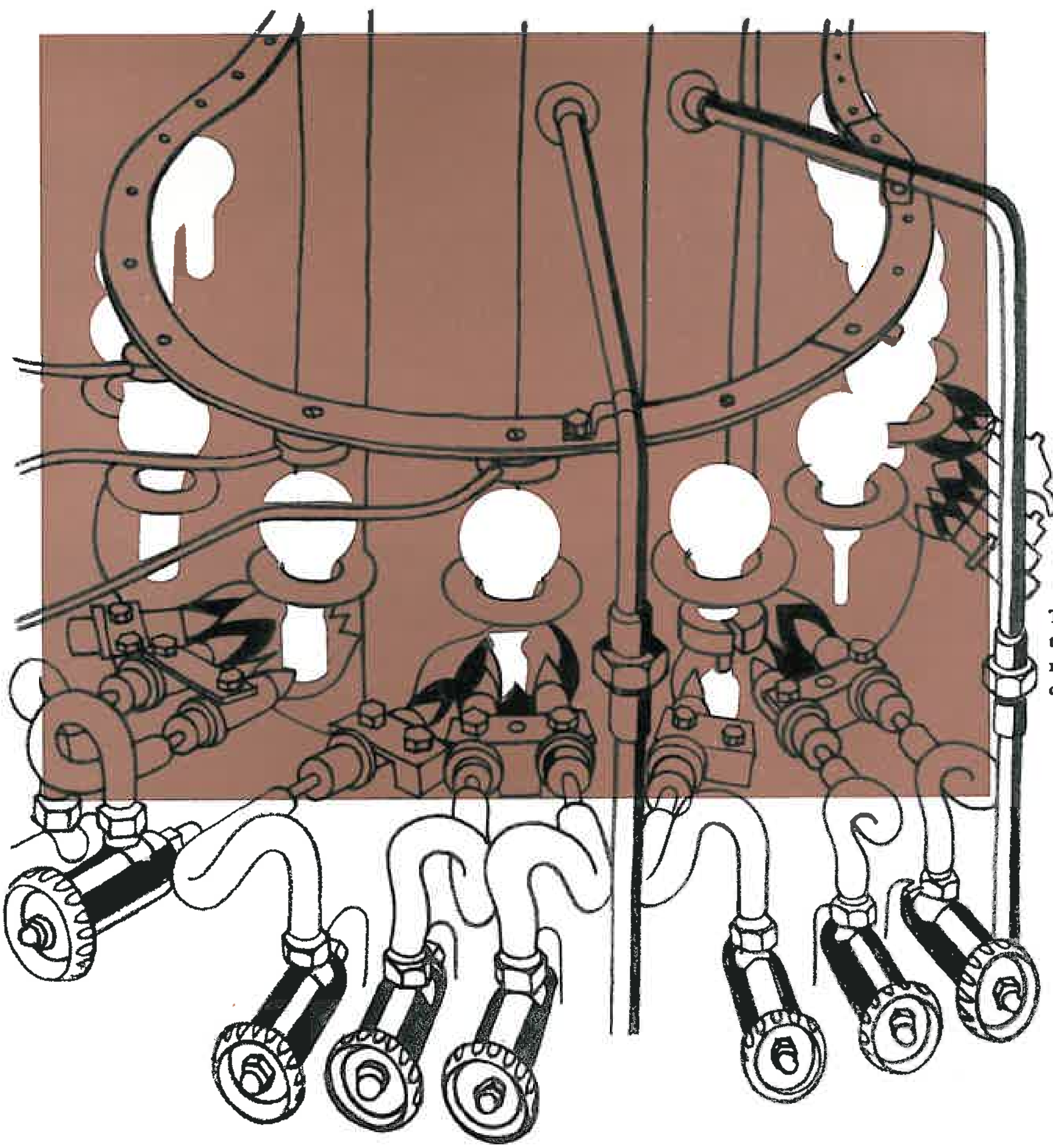
(Above) flare, rod, tube and leads are assembled into a single stem, and (below) the filament is mounted. The filament is clamped to nickel leads and supported by fine molybdenum wire. Exact positioning is vital to the efficiency and life of the finished lamp.



A close-up of the filament mounting machine. Fine adjustment and constant supervision ensure that the filament is exactly positioned.

The filament mount is sealed into the glass bulb by application of heat. The seal is shaped and then moulded to a precise contour by controlling the degree of heat and speed of rotation.

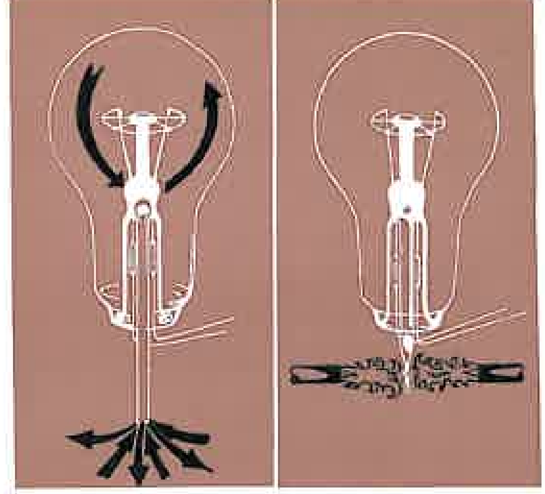




The sealing machine on which the glass bulb is passed over the mounted filament and the two components sealed together.

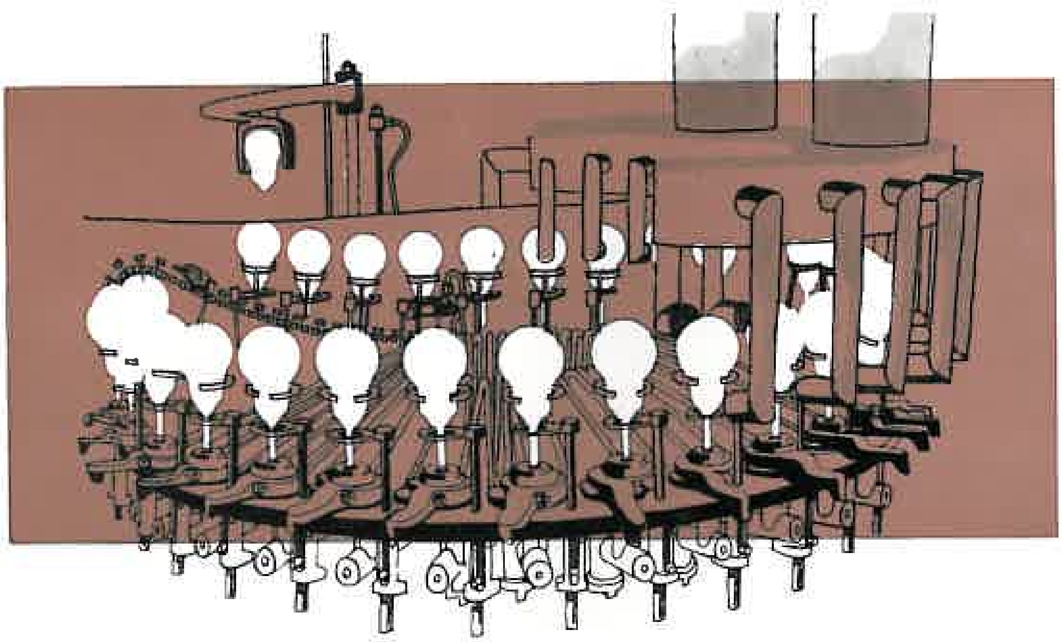
together by heating the junction and moulding the seal to a precise contour.

When the bulb has been exhausted of all air, a quantity of specially purified argon gas mixture is introduced and the glass tube is sealed. The efficiency of the lamp depends to a great extent upon this argon filling which must contain less than one part in a million of impurity. It remains only to fit the cap to the glass bulb, the neck of which is moulded to form a key for the cement fixing. Yet even this seemingly straightforward operation is carried out with a care and precision designed to ensure that the finished product is reliable and efficient in every detail. The leads are passed through the cap which has previously been loaded with a special resin cement. A metal collar shrouds the cap, receiving the direct flame and ensuring that the heating is uniform and that the cement is cured. The leads are then cut to length and the contacts fluxed and soldered.



A **B**

When the bulb has been exhausted of all air, specially purified argon gas is introduced by this machine (left) and the exhaust tube sealed and cut-off. The processes are shown above. Argon is introduced (A), and the exhaust tube sealed-off (B).

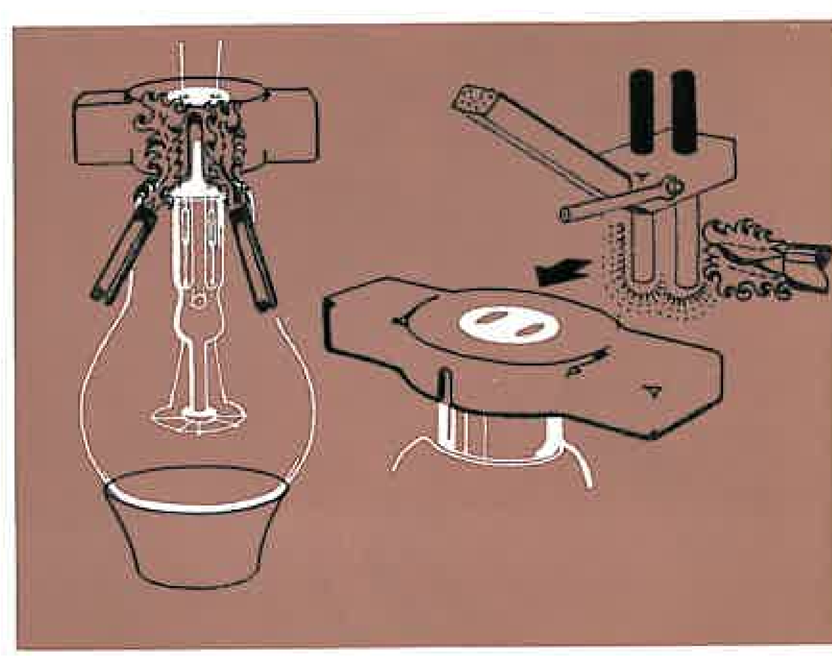


The final operation is carried out on an ageing machine. On this revolving machine, each lamp is brought to its rated voltage which is then stepped up by 10 per cent. This is maintained for a minute, thus testing the working efficiency of the bulb and the correctness of the exhaust conditions.

The finished lamp is ready to do service in the home, office, shop or factory. We have seen in broad outline how this apparently simple, but in fact so intricate, amenity of modern life is made. But we have only been able to tell part of the story. Between each operation described there are a score of others—tests and manufacturing operations—which ensure that the finest available materials give rise to the most efficient and reliable product.

There is a very important part of the lamp production story which remains to be told—the system of Quality Control which is closely allied to every stage of manufacture.

The lamp is capped. The neck of the glass bulb has already been moulded to form a key for the cement fixing. Contacts are now fluxed and soldered.



WHAT do we expect of an electric lamp when it is plugged into a socket? Long life? Of course; but then a lamp may burn for years yet give so little light for the current it consumes that it is thoroughly wasteful. Good light output? Certainly; but a lamp may give a brilliant light for a few hours and then extinguish. A well made lamp is one in which life, light output and current consumption are all balanced to give the best possible illumination over the longest period, in other words *economical lighting*. In order to ensure that this delicate balance of factors is achieved in every lamp which leaves the factory, The British Thomson-Houston Company maintains in its lamp works an extensive system of scientifically controlled tests at every stage of production, from raw material to finished product. These tests are a guarantee of the highest standard of manufacture and performance, as is shown in the following article.

LAMP QUALITY CONTROL

WE ARE all familiar with the universally used lamps which are known by the name General Lighting Service; tungsten filament lamps with single or coiled coils, a gas filling or an evacuated bulb. We have seen something of the care and accuracy which goes into their manufacture. What is not generally known, or at least recognized, however, is the importance of scientific control at every stage in their production.

A simple example of lamp behaviour under adverse or abnormal conditions demonstrates the importance of controlling the quality of every constituent part. An increase or decrease of five per cent in voltage from the rated value will have the following effects; electricity consumption will be increased or decreased by eight per cent, the light output will rise or fall by twenty per cent and the life of the lamp will be halved or doubled. These are only a few of the changes which so small a deviation from normal operating conditions will effect. There is little need to stress that the lamp itself should be consistent in all its parts and in the way in which those parts are assembled. A one per cent increase in the amount of the filament pinched into the hook during assembly is equivalent to a one per cent voltage change.

A line of complicated, high-precision machines, each doing its own particular and extremely specialized job, must produce finished lamps at the rate of well over a thousand an hour. Every lamp must conform to a pre-determined standard but it will only do this if it is subjected to strict quality control.

Methods of Control

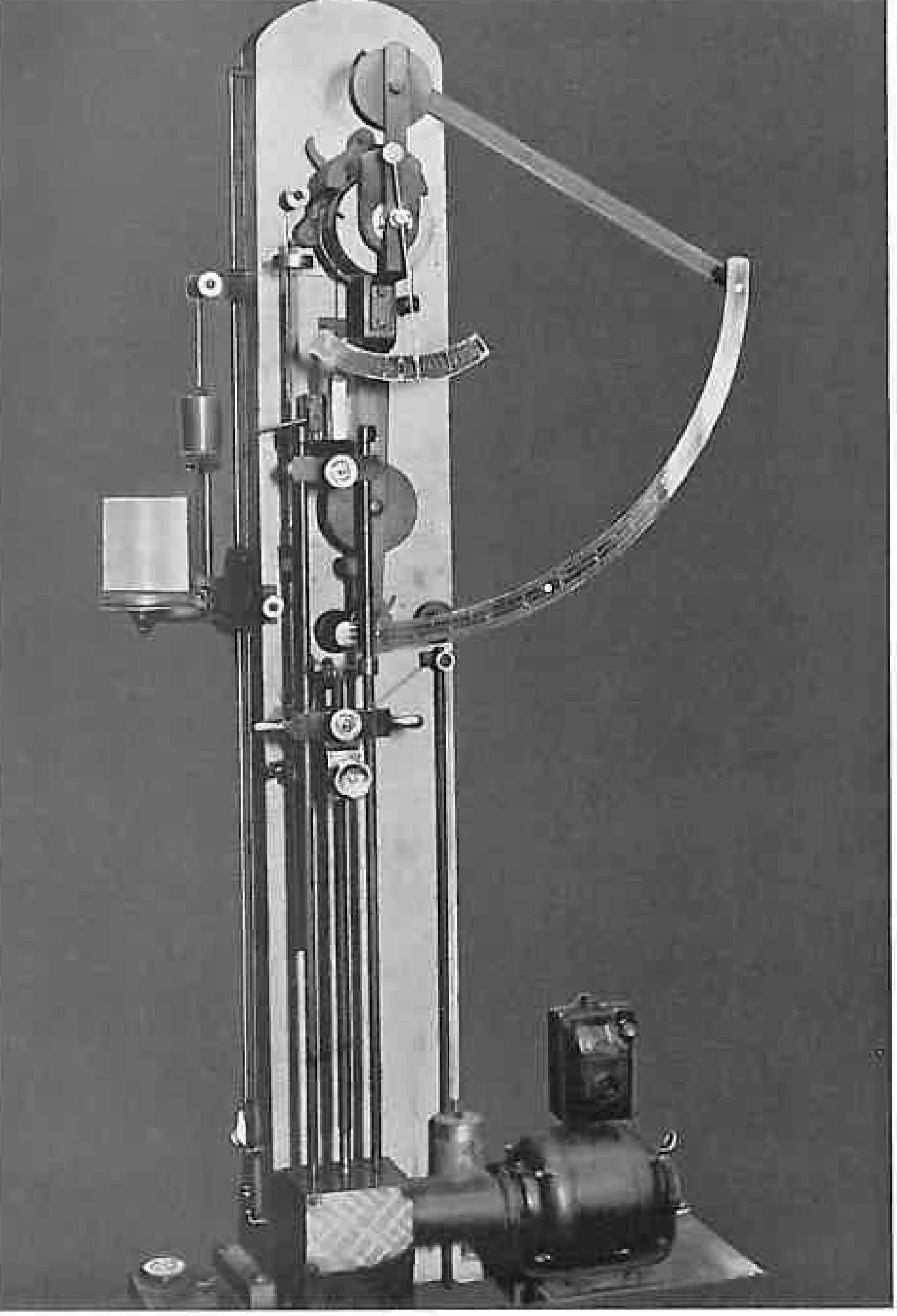
The system of quality control adopted by BTH can be divided into three complementary but separate parts. Firstly there is the comprehensive inspection carried out on the Production Line, or normal factory testing. Then there is the Control Line—samples are withdrawn from normal production and processed under conditions which are as constant as possible; on this line, for instance, sample metal is made into filaments ahead of normal production so that there is no possibility of inferior metal slipping into the production line. Finally, there is an independent inspection of raw materials and finished product.

The seemingly exhaustive tests carried out along the mainflow of production would appear to the casual observer to ensure a perfect finished product. Every length of filament wire is checked for size, regularity and roundness. In what other product of everyday use would one expect to find a constituent which has a diameter of 0·0005 in. checked for the uniformity of its roundness? Every filament is inspected for length, pitch and regularity. Every lamp is lit and checked for defects.

At the same time as these routine factory tests are being carried out, however, the Control Line is making its own independent assessment. There are the Initial Rating Trials. Six filaments from each batch destined for the Production Line are carefully mounted by hand and made into lamps under closely controlled and completely standardized conditions. Only when photometric tests show these lamps to be up to the necessary standard of quality (for wattage and luminous efficiency) is the batch from which these filaments were taken released for production.

When the filaments have been approved, it is still necessary to ascertain that the methods of assembly are operating with absolute accuracy. The mount and exhaust machines are the key points in this control.

A selection of six mounts is taken from the mount machine, the iden-



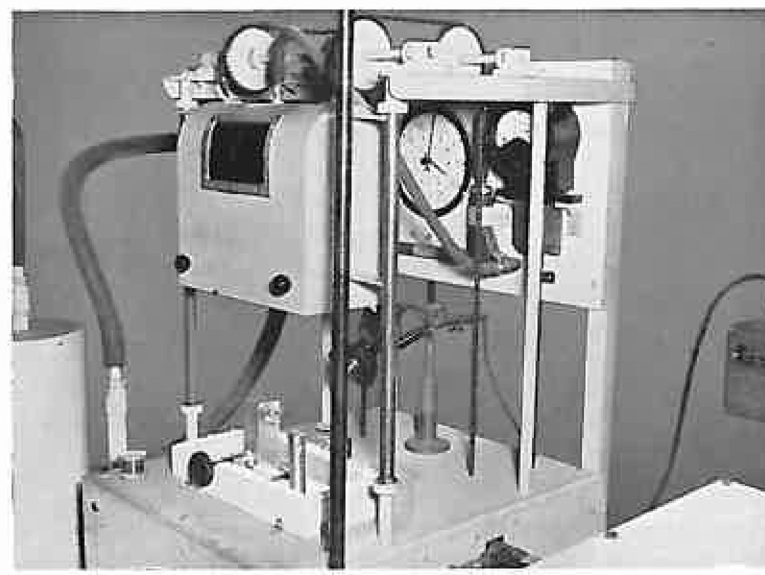
The wire from which the filament is wound is regularly subjected to tensile strength tests at various stages of manufacture. The force needed to break the wire is registered on this machine and even a slight variation in processing is revealed.

tification number and rating noted, and the manufacture of the lamps completed on the control line. The results are then compared with the original rating trial.

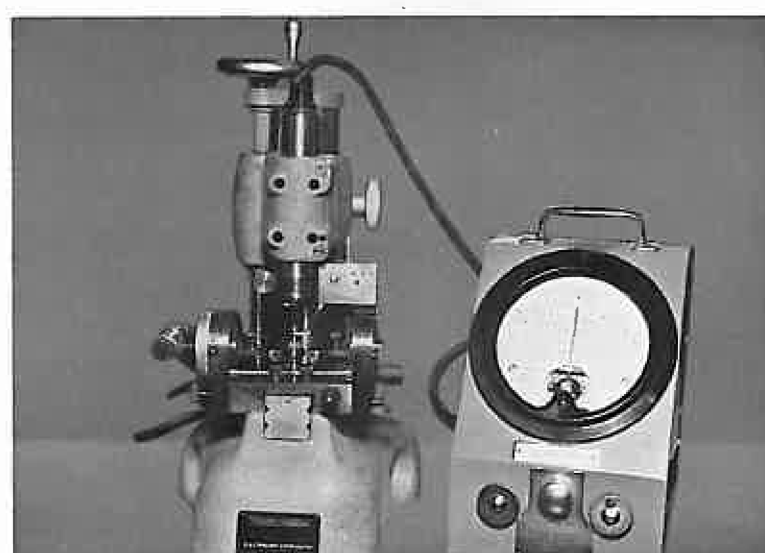
The exhaust machine, which removes all air and impurities from the lamp and then fills it with argon mixture of a carefully determined composition and pressure, is subjected to the same stringent tests as the mount machine. Filaments of known characteristics are taken at regular intervals and hand mounted on the control line; they are then exhausted and filled by the machine under test. The lamps are photometered and life-tested, and any deviation from normal is corrected. The argon filling of a lamp is a vitally important process and one which, without proper controls to ensure the right amount and quality of gas filling can give rise to inefficiency and early failure. Although the argon delivered to the lamp works at Rugby is of a high degree of purity it is nevertheless processed still further in the factory so that in its final state it is triple purified.

These tests alone ensure that in each main component of the lamp the intrinsic quality and the method of assembly are of the highest standard.

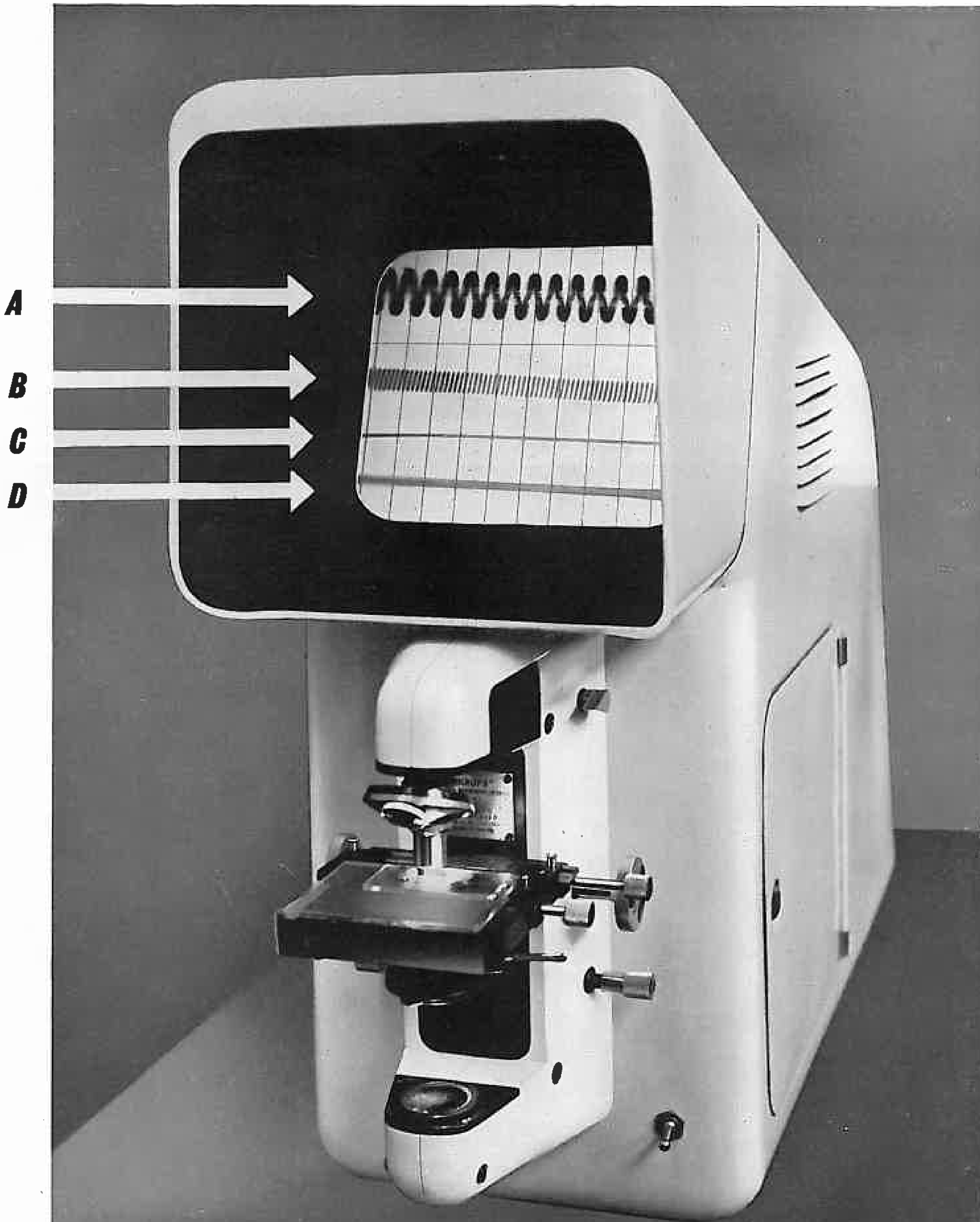
The length of filament wire may be drawn through as many as sixty dies, each of a smaller diameter than the previous one. At each stage a test length of the wire is carefully weighed on a micro-torsion balance so that its size can be accurately determined. This test shows that the correct reduction in the diameter of the wire has been made and that the final diameter is accurate and conforms to the required rating.



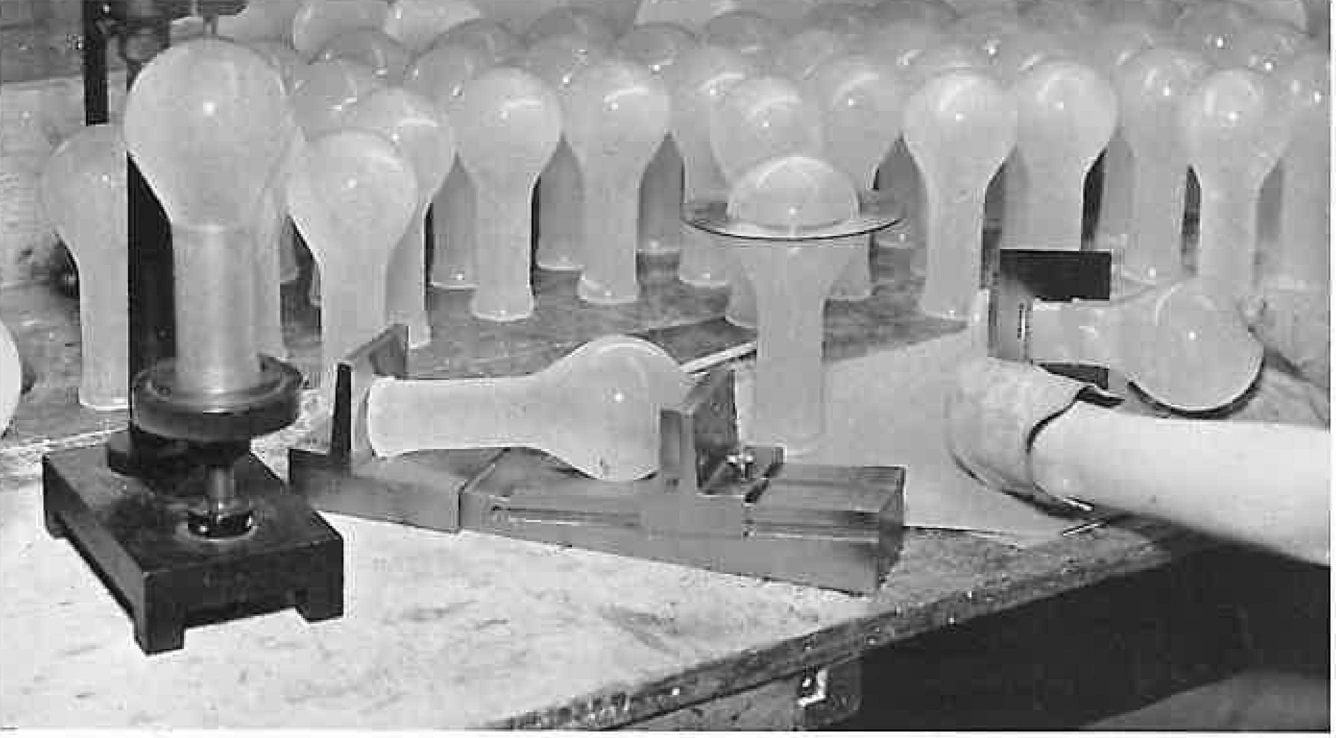
Tungsten filaments must operate at a high temperature without sagging. This is achieved in Mazda lamps by vitalizing the filaments with silica and alumina at 6000°F. The machine tests the sag-resisting quality of the wire before it is passed for filament coiling.



The meticulous care with which a lamp is tested at every stage of manufacture is well illustrated by this machine which records the roundness of the filament wire—often no more than 0·0005 inches in diameter. This is the most accurate known method of assessing roundness.

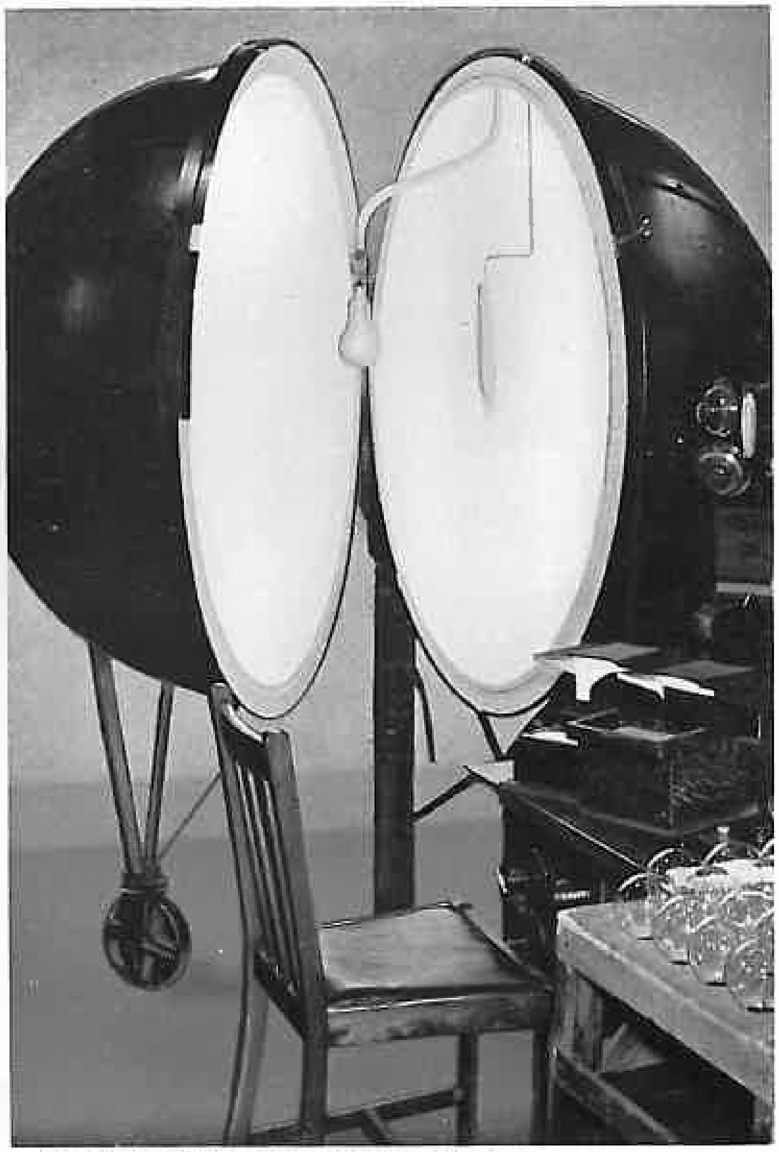


Filaments are examined on a micro-projector before being passed for lamp manufacture. The projector screen is calibrated so that the operator can count the number of turns per inch. Magnification here is one hundred times. (a) coiled-coil filament (b) single coil filament (c) single strand of filament wire (d) human hair for comparison.



The glass bulbs, although made to a fine degree of accuracy, are tested for roundness, thickness, length and diameter on reaching the Lamp Works.

Measuring the light-centre length ensures that the filament is in exactly the correct position. With pearl lamps the filament position is checked by projecting a shadow of the filament on to the wall of the bulb.



An integrating photometer—a perfect sphere used in conjunction with a photo-electric cell—is used to measure the total amount of light emitted by the lamp.

Even this is not sufficient, however. Additional tests still have to be made by independent inspectors who are outside of factory supervision. They draw their own samples of materials and finished lamps and examine them for compliance with appropriate specifications. Further photometric and life tests are made and independent reports submitted so that there is, in fact, a check on the factory inspectors themselves.

More is still to come. In the Life Test Room for instance, sample batches of lamps are subjected to some of the most arduous operating conditions which can be devised. Calculated over-voltages make them perform in a few hours the work that would normally be asked of them over a period of months or even years. They are given shock tests in which they are bombarded with heavy ball-bearings whilst the filament is alight, or crashed against a hard surface with increasing momentum. They are "aged" by continuous burning at rated voltage. They are flashed many hundreds of times to test the strength of the filament (and it is interesting to note in this connection that when flashing beacons came into existence special lamps were considered necessary until it was shown that ordinary Mazda G.L.S. lamps operated with slight voltage adjustment could be flashed, literally, millions of times). Then there is the torsion test for determining the firmness of the cap fixing. There is no single part of the lamp which is not checked and re-checked—in all, more than 500 separate tests are made—from the raw material stage to the finished product.

The Effect

What does all this care in controlling the quality of lamp production amount to? It does not prove that the lamp or the method of manufacture is perfect (the fact that BTH maintains one of the world's leading research organizations to delve into the more fundamental problems of improving the lamp shows that there is no complacent belief in the perfection of the product). It demonstrates that every possible precaution is taken to ensure that the lamps give efficient lighting over the longest period consistent with this luminous efficiency at an economical current consumption. Used at the correct rated voltage they will combine efficient service with economy—whatever the use to which they are put.

Lamps made under conditions lacking the scientific controls employed by BTH have been found to be: 50 times more likely to be of incorrect wattage, 10 times more likely to be inefficient and 3 times more likely to burn out prematurely. The excess current consumption for the amount of light given amounted to between 50 and 100 per cent of the cost of the lamp. That is the meaning of Lamp Quality Control to the consumer.

The glass neck of a Mazda lamp has moulded ridges which provide a key for the special heat and damp resisting cement which holds the cap. The firmness of cap fixing is put through this torsion test.

Life tests are carried out on sample batches of lamps under the most varied and adverse conditions. Some of the lamps are run at calculated over-voltages so that in the course of a few hours they are made to do the work that would normally be asked of them in several months. Others are run at rated voltage and operators take regular light output readings. Allied to these life tests are shock tests during which the lamps are bombarded with heavy ball-bearings whilst the filament is alight, or crashed against a hard surface with increasing but carefully measured momentum. Severe as these tests on sample lamps may seem, they are necessary to ensure that the millions of lamps leaving the factory achieve the supremacy rightly expected of all BTH products.

DESIGN OF FITTINGS

However well made, however reliable a lamp may be, it will only give efficient service if it is properly housed in a well-designed fitting or reflector, and if it is properly applied to its particular lighting task. It is essential that a lamp of appropriate wattage should be used and it is equally important that the fine performance of the type of lamp we have described in production should be supplemented by efficient performance on the part of the reflector.

Designing a Fitting

What, then, constitutes a well-designed reflector? Indeed, what constitutes a good design? One thing is certain, simplicity is the essence. It is all very well for the aesthetes to insist that, since a light fitting is one of the most prominent features of any interior, elegance of shape should be the dominating factor. But the most elegant shape is not always the one which ensures the best use or distribution of the light. On the other hand there is little merit in the assumption that a fitting has only to do its job properly, irrespective of appearance, in order to qualify as a good design.

Obviously the requirements of the factory will differ from those of the office, and the office from the home, but certain basic considerations must govern the development of any fitting.

Firstly, there are the practical considerations of manufacture. Many are the ingeniously conceived drawing board designs which find, or should find, their way into the waste-paper basket because of sheer impracticability. There is also the question of price. A fitting which is complicated and difficult to produce will almost certainly be too costly for any normal commercial use. And, perhaps most important of all, efficiency of operation must to a great extent dictate the approach to shape and to methods of manufacture.

In other words, a fitting should be designed with the practical considerations of manufacture, operation and maintenance in mind and, where necessary, the theoretical design must be modified to suit sound engineering practice on the construction line. These are the principles by which Mazda fittings are made—principles applied with the same care and stringency as in the manufacture of lamps.

Optical Performance

In order to obtain the required distribution from any lighting fitting, two main methods may be used—reflection and refraction.

Reflection will vary in accordance with the nature of the reflector's contours and surface material. Several materials can be employed, anodized aluminium, chromium, rhodium, silver plate, vitreous and stoved enamel, mirror glass and nickel. Of these, anodized aluminium and vitreous and stoved enamels are by far the most important in the construction of light fittings since the other materials are either liable to deterioration or have too low a reflectivity.

Refraction, or the bending of light rays, by means of glass refracting panels and bowls, is sometimes used to ensure the desired light distribution. This method is especially useful in streetlighting where refractor bands with horizontal prisms and refractor bowls with vertical prisms collect the light which otherwise would be wasted, and direct it on to the road surface.

Having decided on the material for the reflector and whether or not to employ a system of refraction, we have to consider shape. There are certain obvious essentials. The reflected light should not, for instance, strike the lamp or the other side of the reflector, with consequent loss of efficiency. The reflector should provide adequate clearance around the lamp and yet be of reasonable size at the outer edge. The angle at which the light strikes the reflecting surface—or the angle of incidence—should be as small as possible. And when these factors have been taken into consideration, it may be necessary to modify the proposed shape to ensure the most attractive possible appearance, or the easy removal of lamp and reflector for maintenance, or to accommodate mechanical requirements such as safe operation in gaseous or overheated conditions.

Testing

We have dealt with the quality control exercised in the manufacture of Mazda lamps. The tests used to ensure the correct performance of fittings are equally important and just as thorough. One device for testing the performance of a fitting is the Polar Co-ordinate Photometer. It consists of mirror assembly and a rotating head upon which the fitting is mounted. As the fitting rotates both vertical and horizontal angles of light reflection are measured on scales while a light-sensitive cell enables the engineer to measure the amount of reflected light.

Another testing instrument, this time for determining the total reflectivity, is the Sphere Reflectometer. This is a small sphere with a highly reflective white inner surface, in one side of which is placed the sample fitting and in the other a light-sensitive cell. The total reflectivity is measured by comparison with the brightness of a standard surface of magnesium oxide. For determining the specular reflectivity of a sample part of a fitting a Specular Reflectometer is used. This consists of a rotating head which carries a small sample of the reflecting material under test, a photo-electric cell which also rotates about the same axis, and an optical system to throw a small, parallel beam on to the sample. The intensity of the beam is first measured directly, and then again after being reflected by the sample at various angles of incidence. Specular reflection is expressed by the ratio of reflected to direct light.

These various tests, applied to samples taken regularly and methodically from the production line, ensure fittings which will with correct use give complete satisfaction.

The light distribution of each new fitting is carefully plotted during the development stage to ensure maximum efficiency.

Mazda Dustfree Reflectors

Efficient, dustfree operation and easy maintenance are the principal features of these carefully designed fittings. Normal lamp heat is utilized to cause a convected current of air to flow through the fitting, thus maintaining the reflecting surfaces. Shown here is a Mazda High-Bay Reflector which incorporates this method of combating air-borne dust. Designed for use with a high-wattage G.L.S. lamp, it includes a calibrated focusing device and an anodised aluminium Overlamp reflector.

Other Mazda Dustfree Fittings are available with vitreous enamelled Overlamp reflectors, either concentrating or dispersive. A number of considerable reductions have recently been made in the list prices of these fittings.

Special features of low temperature Overlamp fittings . . . .

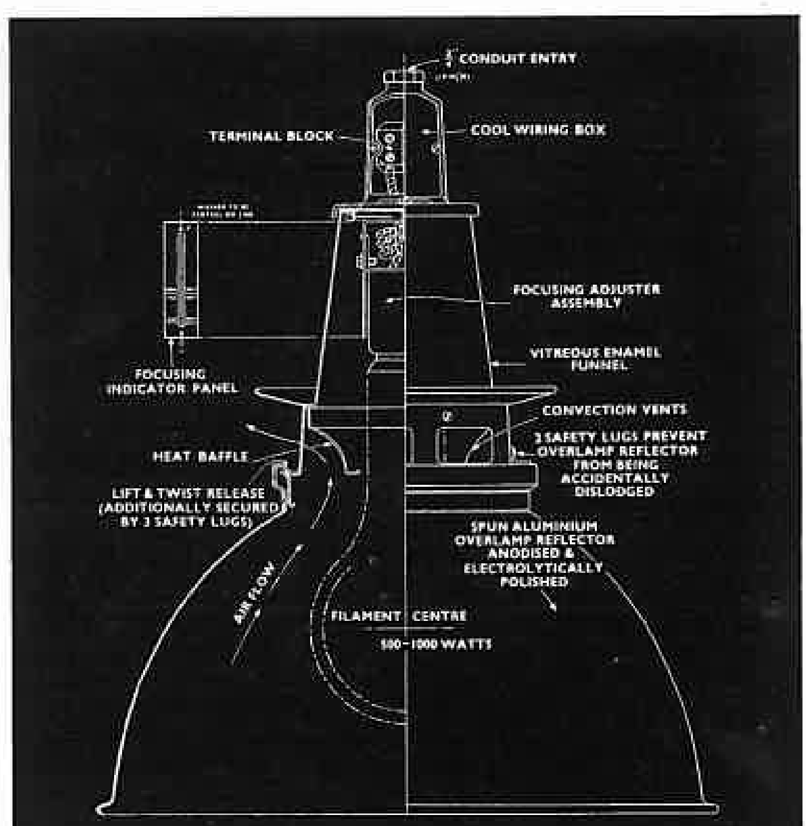
Reflector easily removable for maintenance without disturbing lamp

Cables protected from lamp heat

Funnel design keeps lamp cap temperature within safe limits

Patent internal heat baffles on higher-wattage fittings

Concentrating or Dispersive



Mazda Dustproof Reflectors

Strongly built and totally-enclosed, these fittings will operate efficiently in atmospheres which are heavily laden with dust. They are of the low temperature Overlamp type and give a concentrating light with 300 or 500-watt tungsten lamps, or a dispersive light with 250 or 500-watt mercury vapour lamps.

They should be installed with a mounting height/spacing ratio which does not exceed 1 in 1·5.

These fittings are especially designed for use in . . . .

Brick Works

Cement Works

Coal Screening Plant

All dust-laden atmospheres where a heavy duty fitting is required

Special features of low temperature, heavy-duty Dustproof Overlamp fittings . . . .

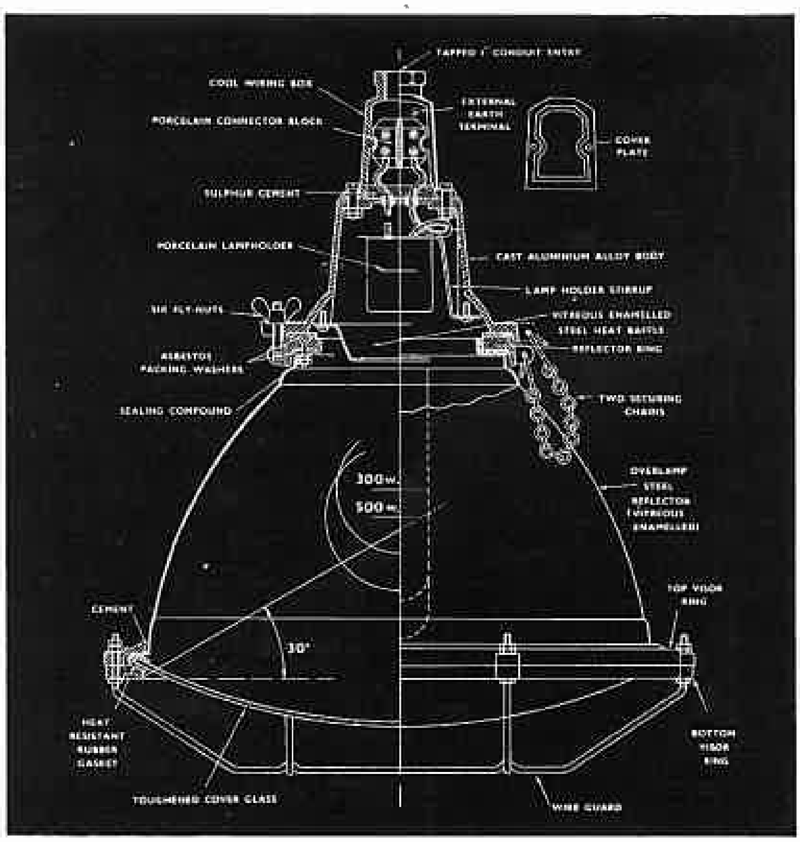
Completely dust-tight, clamped and sealed

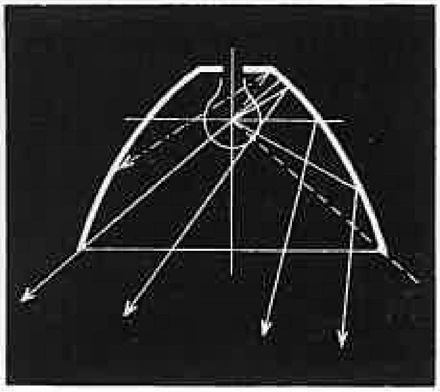
Exceptionally robust construction

Protected cover-glass

Easy maintenance—securing chains hold Overlamp reflector during lamp changing

Concentrating or Dispersive





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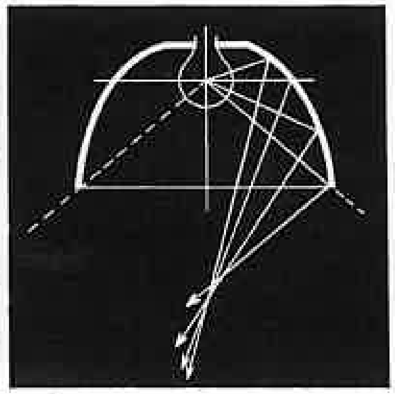

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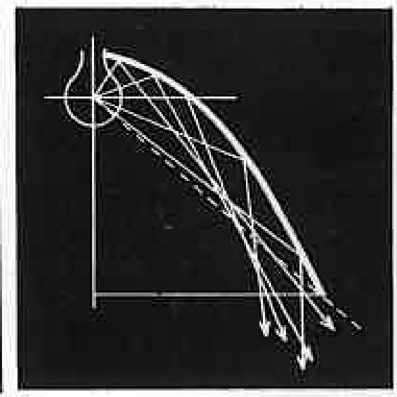

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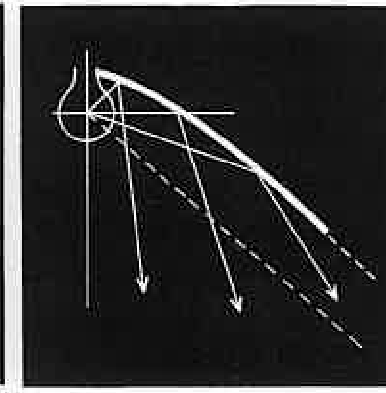


D

Mechanical Design

Having achieved the desired light distribution, the designer is still confronted with many important problems. More than efficiency is required of a good light fitting. It may have to operate in high ambient temperatures. Reflectors will have to be cleaned and lamps replaced with a minimum of time wastage. Excessive dust may be present in the atmosphere. These and many other aspects of operation must be taken into consideration.

Perhaps the most important mechanical features in the design of some of the principal Mazda fittings are the overlamp reflector and the cool wiring box. The overlamp feature enables the reflector to be removed for cleaning purposes in a matter of seconds, leaving the lamp completely undisturbed. No screws or other loose parts are used and the reflector cannot be accidentally dislodged. The cool wiring box enables the fitting to operate at temperatures up to 50°C without in any way endangering the insulation. The low-temperature assembly also ensures that the heat of the lamp cap will not exceed safe limits.

Fittings which well illustrate these design characteristics are the Dustfree series. Here, the mechanical features include a system of vents near the lampholders. These, with the normal heat of the lamp, cause a continuous flow of convected air to rise through the fitting, thus preventing dust and grime from being deposited on the lamp and reflecting surface.

Other fittings, such as the Dustproof series, are equipped with cover glasses which also have the effect of reducing contamination by dust.

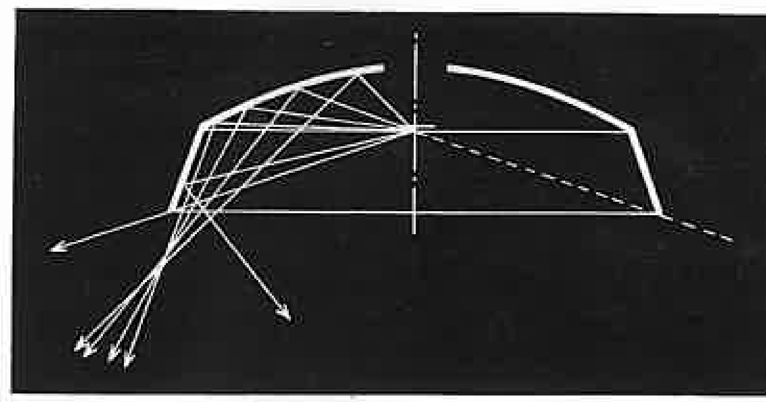
Here are examples of fittings in which all the features of good design —efficient light distribution, resistance to external conditions and easy maintenance—are combined. Compromise is obviously essential. The use of a cover-glass, for instance, may diminish light output to a small extent. Similarly, elaboration of a fitting to make it dust or flameproof, or resistant to vapours and acids, will add to its cost. But easier maintenance and longer service offset this. As with the lamp, it is the balance of efficiency and economy (in terms of reasonable cost, long service and easy maintenance) which distinguishes a thoughtfully designed and well-made fitting from an indifferent product.

Maintenance

Two essentials of good lighting practice clearly emerge. A lamp made with all the precaution and care exemplified by the methods of the BTH Lamp Works must be used in conjunction with a fitting which is manufactured and tested with comparable thoroughness if it is to give full lighting value, and the fitting must be chosen and positioned according to the particular requirements of each lighting task—whether it be for reading in the home or working at a factory bench. Having achieved an installation which gives perfect balance of good lighting and economical running costs, however, there remains the problem of maintenance.

Profile B is a better design. The small amount of light in the upper zone is used to light the comparatively small area at the centre of the circle, and, for the most part, clears the lamp bulb. The angles of incidence are smaller and both the depth and the diameter are less.
Profiles A and B are called "cross beam" reflectors, that is, the reflected light is directed back across the axis of symmetry.
Profiles C and D illustrate unwieldy forms for the same light distribution. The light strikes the surfaces at very glancing angles and, particularly in the case of the profile D, the reflector becomes enormous. It will be seen that the reflected light is not directed back across the axis of symmetry in these cases.
The specular reflectivity of vitreous enamel at glancing angles has already been mentioned, and in the design of vitreous enamel dispersive reflectors for general industrial use high angles of incidence are aimed at. A typical profile is shown in Fig. D. It will be seen that the light is reflected from the dome portion at glancing angles as in profile C. That is, the light is re-directed at angles on the same side of the axis. If the dome is carried out to a point where the necessary 20° cut-off is obtained, the diameter would be enormous, and it is therefore usual to restrict it to a more economical size and finish the reflector with a skirt which reflects the light back across the axis as in profile A.

E



We have seen how, for example, the Dustfree fittings are made with an eye not only to efficient operation but also to easy maintenance. The same principle has guided the development of all Mazda fittings. Each of the types mentioned above allows of quick and easy lamp replacement and of dissembling for cleaning purposes. The overlamp principle, for instance, ensures that reflector maintenance in no way interferes with the lamp, thus eliminating one of the main causes of premature lamp failure. This, added to economical running costs, makes it possible for a lighting scheme to defray its installation and capital cost in a very short time.

The correct planning of any lighting scheme calls for a programme and a date schedule. It also demands the regular attendance to lamp replacement and to ancillary services which affect lighting efficiency such as the decoration of walls and ceilings. And only light fittings which have been expertly designed so as to facilitate maintenance as well as to give the right amount of illumination should be used.

Now let us look at some of the results of planned lighting in modern life . . . .

MODERN industry needs lighting fittings for a multitude of different tasks. The requirements of the general workshop obviously differ from those of the laboratory or warehouse. But even in one section of a factory there may be a wide variety of tasks which demand separate treatment as far as lighting is concerned. A high level of overall illumination may have to be supplemented by special local lighting for close-up or particularly intricate work. Seeing is a large part of efficiency in industry—and slapdash lighting is perhaps the greatest enemy of smooth production as well as of safety.

A range of lighting fittings which is intended to provide for these varied needs is not, however, complete or comprehensive in itself. There are the problems of dust, heat, vapours and other unusual conditions to be met. It is the combination of high-quality lighting for every purpose and resistance to any of the conditions likely to be encountered in service which makes the Mazda range of industrial fittings comprehensive in the fullest sense.

Fittings for use with tungsten filament lamps form a part of this range, although it should not be forgotten that electric-discharge and fluorescent lamp fittings also have an important function in many industrial lighting schemes. In this installation in one of the rolling mills of the Northern Aluminium Company, Mazda tungsten lamp reflectors are mounted and spaced to give the maximum illumination on the working plane from 750 and 1000 watt lamps.

Industry

For general lighting in industry—and particularly for high-bay applications—Mazda Blended Light units, for use with tungsten filament and horizontally operated mercury vapour lamps, give lighting of extremely high efficiency. Several variations can be built around a single tungsten lamp fitting to give different combinations of tungsten and mercury lighting. The mercury components of these units are specially made to ensure high efficiency, correct distribution, cool wiring, simple installation and maintenance.

Railway Travel Centre

Many architects, interior designers and lighting consultants are finding that the use of combined filament and fluorescent lighting provides visual effects which give a greatly enhanced sense of interest and spaciousness. In areas where work has to go on in an atmosphere of comfort (and sometimes of leisure) such as this British Railways Travel Centre, mixed lighting both attracts attention from outside and makes for efficient yet restful conditions within.

Furniture Showroom

On the right is the showroom of Hille Ltd., famous London furnishing house, who make use of tungsten reflector spotlamps in swivel fittings to highlight the show pieces. This type of lamp is most effective for display lighting.

Ships

Fittings for use with tungsten lamps have been made by BTH for many of the great liners of the world. Here, in the Mermaid Bar of R.M.S. Queen Mary, 60-watt lamps provide a warm and inviting atmosphere.

Car Showroom

This garage showroom also uses reflector spotlamps to give emphatic display lighting, though here they are recessed in spun aluminium housings.

(1) In the living room a good general illumination is most easily provided by a central light fitting which should not look a great deal brighter than its surroundings. But this must always be supplemented by local lighting of a much higher order for reading, writing and sewing in comfort.

Lighting in the home

How many householders give sufficient thought to the question of lighting? Indeed, how many fully understand the dangers of indiscriminate illumination, or the comparative ease and economy with which an inadequate and harmful lighting system can be turned into one which gives rise to pleasant and safe seeing?

The answers to many of the problems of interior illumination are to be found in 'Lighting to Measure'—a method of approach which forms the basis of a nation-wide campaign conducted by The British Thomson-Houston Company to impress upon the public the urgent need for improved lighting standards in the home.

The correct methods of approach were stressed by an Exhibition recently organized by The British Thomson-Houston Company. Rooms serving different functions were illuminated in the correct manner and sometimes, by way of contrast, incorrectly.

The pictures on these pages, demonstrate the kind of lighting effects which can be achieved by thought and the selection of reputable lamps of the correct rating.

2	3
4	5




The dining alcove to this room (2) shows the correct positioning of a diffusing shade over the table—a 150-watt Silverlight lamp should be used. For general lighting in a bedroom (3) a 150-watt Pearl or Silverlight lamp should be used with a shade which allows a reasonable amount of upward illumination. Architectural lamps are excellent for wall mirror lighting and for reading in bed each person needs a 60-watt Pearl or Silverlight reading lamp.

The bed-sitting room (4) needs a high level of lighting for writing and sewing in comfort and less powerful supplementary illumination for the dressing table and for reading in bed. Here, central lighting comes from a pendant which holds a 100-watt Silverlight lamp. A 150-watt Silverlight in a floor standard may be used at the sewing-table or by an armchair. Two table standards house 60-watt Silverlight lamps and a wall-bracket over the bed also uses a 60-watt Silverlight. In the study (5) lights are seen correctly positioned for reading and writing in comfort. A central pendant houses two 100-watt Pearl lamps which throw the majority of their light onto the ceiling. The desk fitting, with a 100-watt Silverlight lamp, and the floor standard with a 150-watt Silverlight, give excellent local illumination.

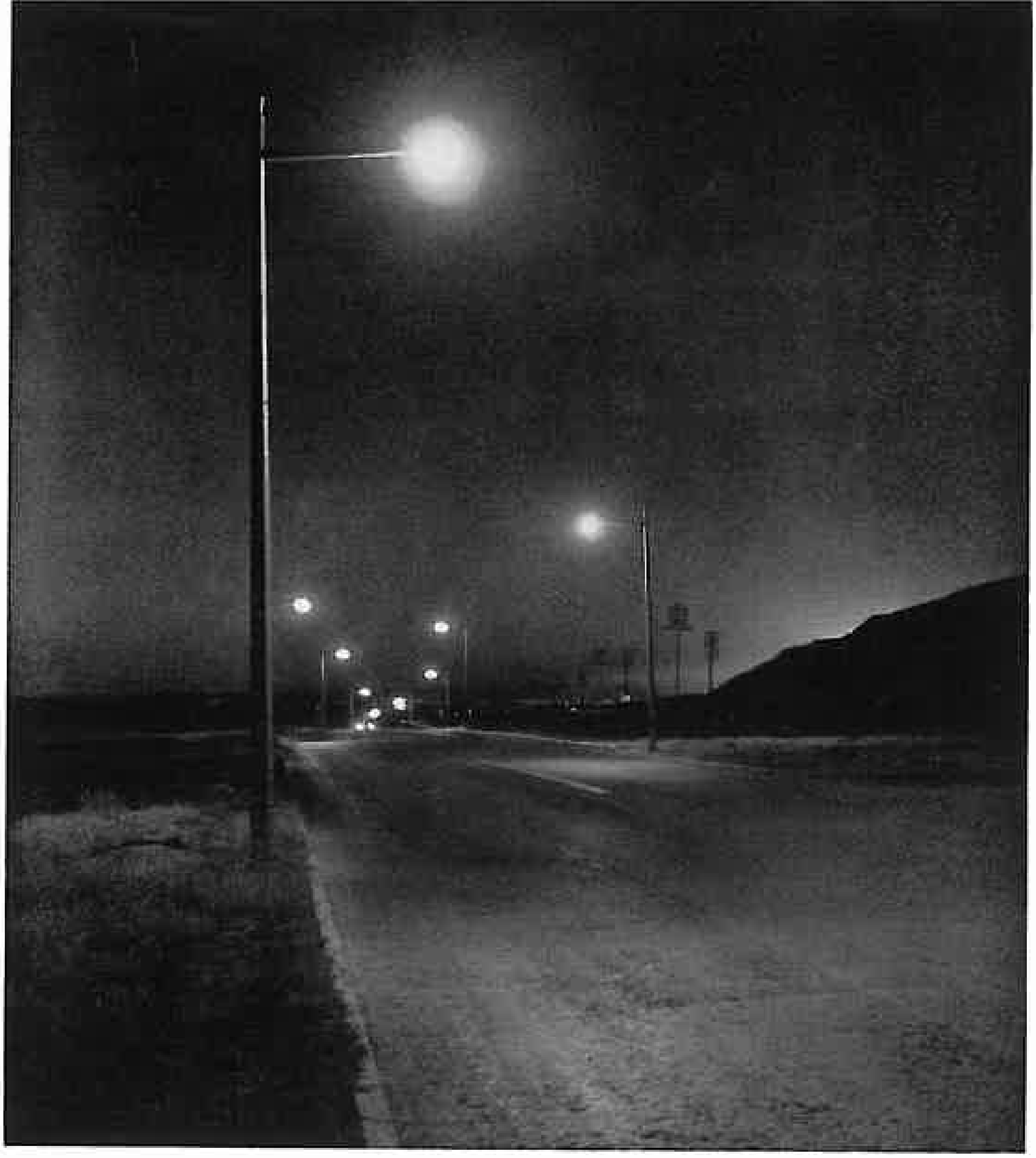
7

6

8 | 9 | 10

(6) A suitable diffusing shade with a 100-watt Silverlight lamp gives adequate illumination in the average nursery. It is often advisable, however, to place a Neon "nightlight" in the darkest corner of the room to relieve any impression of gloominess. In this kitchenette (7) one light fitting with a translucent, totally-enclosed shade is used with a 100-watt Pearl lamp. For larger areas, up to 140 sq. ft. two such fittings are desirable. (8) Shows a good reading position with lighting from a Silverlight lamp in a floor standard. A 100-watt Silverlight is also used on the writing desk to ensure evenly distributed illumination which will obviate shadows from pen or pencil. The adjustable arm reflector fitting is ideal for sewing and other close work. The correct position for this type of fitting is shown in (10). A Reflector type spotlamp should be used.

Outdoors



In outdoor lighting too, the filament lamp has an extensive and important role. Streets in many parts of the world are illuminated by Mazda tungsten lamps—and here planning, the correct positioning of lamps and fittings, is as essential to safety as it is to efficiency. The streetlighting for the Iraq Petroleum Company's oilfield at Kirkuk shows how the planned use of these lamps in correctly designed fittings gives even illumination over the entire surface.

And for pleasure, the tungsten lamp still has its part to play. At the Watford Football Ground and others, the most modern of all floodlighting systems, evolved by BTH research over a period of two years, enables the game to go on during the hours of darkness in visual conditions which are as good as daylight.

SOME PRESS COMMENTS ON THE NEW FLOODLIGHTING AT WATFORD FOOTBALL GROUND.

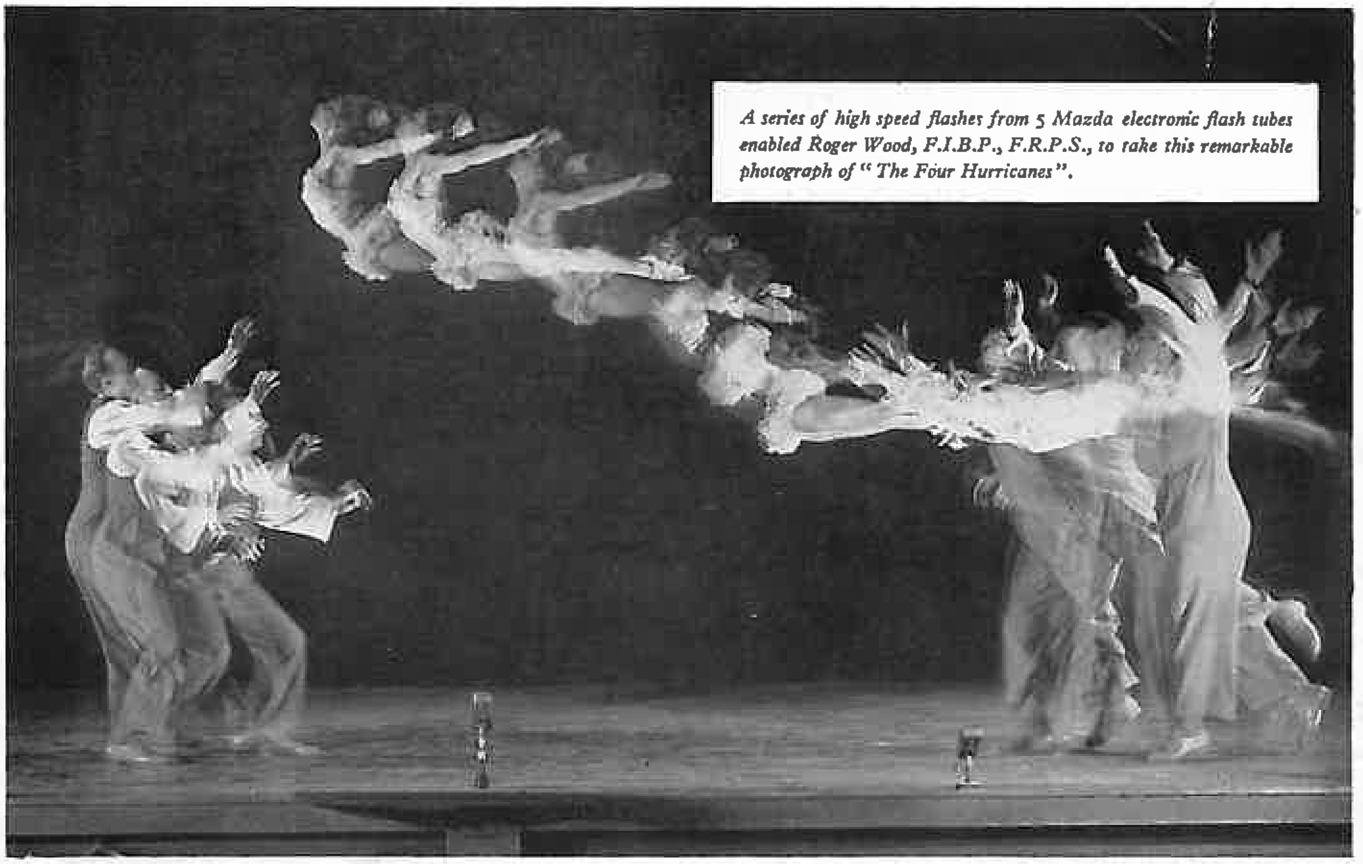
DAILY EXPRESS Oct. 13th
"It is the best in Britain — not the slightest glare from any position" says a Watford official.

DAILY MAIL Oct. 14th
"Watford's first experiment with floodlighting was an unqualified success".

WEST HERTS. AND WATFORD OBSERVER Oct. 16th
"The lights themselves, devised on non-glare lines, impressed the visitors from Arsenal, Burnley, Sheffield Wednesday, Chelsea, Brentford and Queen's Park Rangers, and they certainly pleased the ordinary spectator".

David Williams DAILY HERALD Oct. 14th
....the lighting, the best I have seen anywhere....

THE IRISH PRESS Terry Ward Oct. 17th
"The soft even lighting and low overall cost of the installation has already aroused interest among clubs whose names are household words".



A series of high speed flashes from 5 Mazda electronic flash tubes enabled Roger Wood, F.I.B.P., F.R.P.S., to take this remarkable photograph of "The Four Hurricanes".

Almost every important lighting development in the last 50 years owes something to BTH

THE SAME RESEARCH and manufacturing resources which produced the first jet engine of Whittle design and the electrical power system of the Comet are also behind Mazda lamps.

For half a century BTH has maintained its reputation for leadership in lighting. During that time many of its developments have become standard throughout the world.

Here are three examples from literally hundreds of recent achievements in the field of lighting.

A LAMP BRIGHTER THAN THE SUN

British Thomson-Houston is now making, in regular production, a lamp no more than six inches long, but some 25 *per cent brighter than the sun*. This lamp is prosaically catalogued as the Mazda FA.5, but it gives *the brightest light on earth*.

What is the Mazda FA.5 used for? Ophthalmologists wanted to photograph the inside of the human eye in colour. But colour photography needs a lot of light. If a bright light is shone into the eye, the pupil will automatically close, so the light must be a flash fast enough to beat the pupil. But if the flash is short enough to do this it must have extreme brightness to compensate.

It took BTH Research eighteen months to produce the Mazda FA.5 and thus solve the problem.

CLEVER DESIGN BEATS THE TIDE

At the new oil refinery at Shell Haven large numbers of tankers and oil barges have to be unloaded. At first the highly inflammable cargo could only be unloaded in daylight because the risk of fire from an artificial light was too great. They missed the night tide, and this caused a great delay in the turn round of the vessels.

Then the Oil Company brought BTH into the picture. Drawing on their experience of fluorescent lighting in mines, where safety is of paramount importance, BTH Engineers designed a Mazda Flameproof Fitting. BTH research tested this fitting over and over again by deliberately trying to cause explosions under the most carefully thought out and diabolical conditions. It also underwent the most exacting tests at the Buxton Testing Station of the Ministry of Fuel and Power, and came through with flying colours.

They unload now by day and night at the Shell Haven jetties.

MILLIONS OF FLASHES FOR ZEBRAS

All over the country the zebra crossings are getting their flashing beacons. There might not seem to be anything difficult about that.

But there was a problem indeed. Was there a lamp that would stand up to such sustained flashing? Could such a lamp be made?

The answer was surprising: the most suitable lamp was the perfectly normal Mazda lamp that we all buy in the shop. This lamp, operated with a slight voltage adjustment, can be flashed literally millions of times. It is not said for nothing that Mazda lamps stay brighter longer.

Mazda

the lamps and lighting fittings with

B T-H

behind them

THE BRITISH THOMSON-HOUSTON CO. LTD.
(*Member of the A.E.I. Group of Companies*)
4494

L883/10

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