TUNGSTEN LAMP MANUFACTURE

THE processes used in the manufacture of tungsten lamps are of considerable interest. Owing to the fragility of the various materials used in the construction of the lamps, the machines and fixtures must be so arranged that they will perform their functions in a minimum time and with little likelihood of breaking the parts. Practically every part of an incandescent lamp requires the most delicate handling, from the tungsten filament to the glass bulb.

The processes and machines described in this article are based upon the practice developed by the United Incandescent Lamp Co., Budapest, Hungary, and while this is not secret, the writer believes that this material has never been published in detail form in this country. The various steps which are taken in connection with the manufacture of the lamp from the swaging of the tungsten billet to the final testing of the finished lamp will be described in this article and the machines used will be illustrated.

Manufacturing the Tungsten Filament from the Slug

The powdered tungsten is first weighed and then poured evenly into a mold or die like that shown in Fig. 1, after which the mold is placed under a hydraulic press and compressed at a pressure of about 6000 kilograms per square centimeter. The die is made from high-grade tool steel, hardened and ground very accurately. The mold is usually made from 1/4 to 3/8 inch square and about 5 to 8 inches long. The depth of the die is considerably more than the slug is to be, in order to give the plunger a good location in the die before the tungsten is compressed. After the bars have been compressed they are fragile and their handling requires skill. A hydrogen furnace is used to unite these bars, the temperature being about 2000 degrees C.

Heating and Swaging the Slug

A special electric furnace such as that shown in Fig. 3 is used to heat the slug to a temperature of from 1200 to 1300 degrees C. in an atmosphere of hydrogen. Referring to Fig. 2, the various parts of the tungsten lamp will be seen, and the form produced on the tungsten slug by the first swaging operation can be noted at A. One end of the slug is formed for a distance of 80 or 90 per cent of the length, after which it is...
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Fig. 6. Flies for holding Tungsten Slug while Swaging

Fig. 7. Machine used for drawing Tungsten Wire through Diamond Dies

Fig. 8. Longitudinal Section through Head of Langiger Swaging Machine

Fig. 9. Machine used for drawing Tungsten Wire

Fig. 10. Cutting Glass Tube on Hand Fixture

Fig. 11. Forming Sought Filaments

Fig. 12. Cutting Glass Tubes with Rotary Wheel

The hot tungsten wire. The sectional view shown in Fig. 6 is taken directly through the center of the spindle and shows the construction very clearly. The spindle is rotated across the enlarged end to receive a pair of hammer-blocks and dies A and B, the reciprocating action of which is in a radial direction. The spindle is driven by the pulley C, which has a heavy

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needle burner being used for this work as previously described. A part of the bulb and the short end of the anchor C are heated and inserted by hand, as indicated.

Mounting the Sigzag Filament

The sigzag filament shown at Z in Fig. 2 is taken from a drum and mounted on hooks as shown at Y; in addition, the two ends of the tungsten wire are clamped to the lead-in wires ed. This operation is done when the wire is taken off from the forming machine shown in a previous illustration. The spool H is conveniently accessible to the operator, so that the work can be done very rapidly. It will be understood that the work shown in Fig. 21 of prestressing the sigzag filament on the anchors is done after one end of the wire has been clamped, as stated.

Operations on the Bulb

After the bulb shown at Y in Fig. 22 comes from the glass mold, it is first washed. The piece shown at W is the rounded top tubing which has been cut and sorted to the proper size. This tubing is cut into three-foot lengths by the same process as was employed for cutting the glass canes.

Piercing the Bulb

Before the top tubing W is sealed on the bulb, it is necessary to pierce a hole as shown at X in Fig. 22. The method of piercing this hole is clearly shown in Fig. 22. The bulb A is placed in the nest B; the cap C is lowered, and the rubber ring D acts as a seal on the bulb. F is the air inlet to the bulb, and E is the air outlet. After the air in the bulb has been drawn out, the bulb is closed and the cap C is lowered until the rubber ring D becomes a sealing ring.

Fig. 22. Build with Tube and Stem mounted

While the bulb is being assembled, the bulb is placed in the fixture A and the part to be cracked off at X centers in a ring burner which heats the bulb all around. Then the bulb is removed and the end X is placed on a saturated stone such as that shown at C, or on any other substance which will hold moisture. As soon as the glass strikes the stone the collar breaks off, leaving a clean fracture. D is the water container intended to supply the moisture. E is a chute for scrap, and F is a scrap fall. In operating, the bulb is held on the stone C until it cracks off. The operator in the meantime having placed another bulb in the holder A, making the operation almost continuous. About twenty to thirty seconds is the time taken to perform this operation. The top tubing is used to locate the bulb during the operation of exhausting.

Sealing the Bulb

The bulb and stem are located in a rotating holder as shown at A in Fig. 24. While this is rotating, the two segmental flaps (bornholm) B and C beat the bulb until both parts are melted together as shown. There are usually four or more arms or heads D, so that the bulb can be heated gradually and the finished bulb allowed to cool while one position is being finished. The holder or head A is rotated by the gears and

and F driven by the bolts G and H. The operator always remains in the same position in relation to the holder. When the work is completed, the operator simply turns the arm D by hand for the next position. Automatic attachments for indexing are also made for machines of this kind.

Exhausting the Lamp

The method of exhausting the lamps is shown in Fig. 25. The lamps are inserted in the rubber tubes C, and the lead-in wires are wrapped around pins A through which an electric current passes. The tubes C are on a common manifold which is connected to the vacuum line D. After the lamps have been placed in their proper position, they are raised into the oven E which is held hot by gas flames. The oven temperature is raised to a great degree as the lamps stand without damaging them, and they are left here for a short time, after which the cap C is raised by removing the pressure from the treads G. The air pressure used is from 4 to 6 pounds per square inch.

Fig. 25. Cracking off Collar

The tube is inserted in the bulb on a machine shown in Fig. 24. The bulb is held by hand in the nest or case A while the tube is held by a spring chuck B. The flame C must concentrate on the center of the bulb and on the end of the tube, and when both parts are heated to the melting point the tube W is pressed lightly against the bulb by the hand-lever D. This lever is connected with the burner C in such a way that as soon as the tube is touched the flames stop burning. During the course of the operation, the bulb is turned back and forth a little until it is sufficiently hot to make the seal.

Cracking Off the Collar

The apparatus used for cracking off the bulb collar is shown in Fig. 25. The bulb is placed in the fixture A and the part to be cracked off at X centers in a ring burner which heats the bulb all around. Then the bulb is removed and the end X is placed on a saturated stone such as that shown at C, or on any other substance which will hold moisture. As soon as the

which they are lowered again and burned at about 120 per cent rate for four or five minutes. After this the lamps are tipped off, that is, the bulb G is cut off with a hand torch as shown at H, and then removed for other operations. The vacuum obtained varies according to the size of the bulbs and the shape of the lamps. A high vacuum of 0.001 millimeter, mercury pressure, is obtained in some cases. In any event, the vacuum must be as perfect as is commercially possible.

Heating the Lamp

The bases shown in Fig. 3 are filled with cement and placed on the bulbs, after which they are located in the heating fixture as shown in Fig. 26. There are two separate carriages

Fig. 26. Sealing Bulb