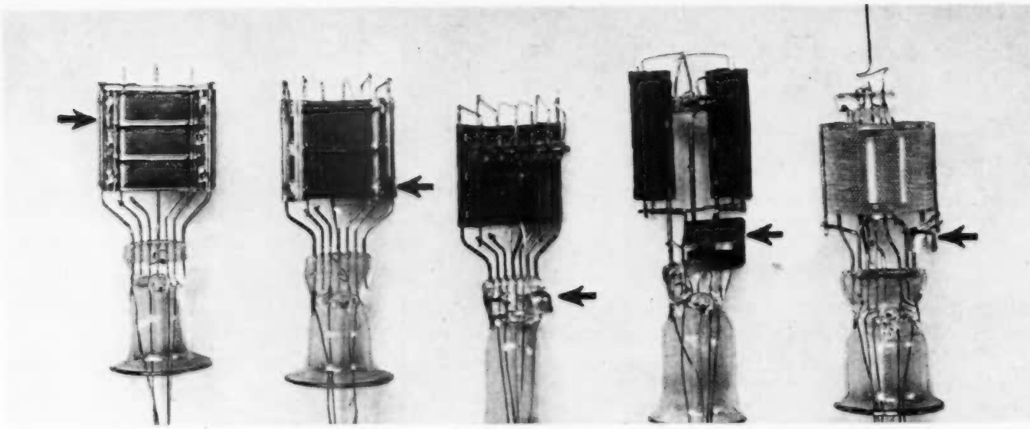

Fig. 1—Mounts of several types of tubes. The arrow indicates the position of the getter. Left to right, the mounts are of the following types—201A, 171A, 245, 280, 224

Some comments on the use of "getters"

By GEORGE D. O'NEILL

Engineering Department, Hygrade Lamp Company, Salem, Mass.

AFTER the soft audion evolved into the hard vacuum tube, the question of satisfactory getters arose and is still a topic always open for discussion among tube engineers. In the manufacture of incandescent lamps getters had been fairly well developed. Means of removing traces of water vapor and oxygen were known, as were methods of preventing the volatilized particles of tungsten from forming a continuous film on the inner wall of the bulb.

One of the materials used as a getter in lamps is red phosphorus which is applied to the filament by running it through a suspension of dried, ground red phosphorus in alcohol. As a result of lamp experience, red phosphorus was early in use as a getter for high-vacuum tubes having tungsten filaments. In coated filament tubes, lime painted on the stem press was used as a getter for the purpose of absorbing water and carbon dioxide. Both phosphorus and lime are still in use, to a limited extent, in conjunction with the magnesium. Phosphorus would be more popular but for its erratic action on the grid contact potential, while the use of lime is often of little or no value and is entirely discredited by some engineers.

In the majority of tubes made to date, magnesium has been used as a getter material, which appears in the finished tube as a silvery, mirror-like deposit on the inside of the bulb. Magnesium is inexpensive, keeps well, and is easily applied to the tube. It came into general use about the time tubes began to be produced on a large scale, and while its position is being strongly challenged by other materials, is still the most generally used of all tube getters.

Use of phosphorus and magnesium

For a time, phosphorus was used in combination with magnesium in some tubes such as the 201-A, 199 and 120. The magnesium, either in the form of a short length of wire about one fortieth inch in diameter and a quarter inch or less in length, or in the form of ribbon, was spot-welded directly to the plate of the tube and red phosphorus in alcohol was applied with a brush to the side of the plate. An alternative method was to mix the phosphorus with magnesium and aluminum powder in a binder composed of nitrocellulose in a solvent, and to place one or more drops of the mixture on the plates before sealing on the bulb. The aluminum has no action as a getter in this case, but serves, because of its small size and light weight, to keep the magnesium in suspension while the getter is being applied.

After the phosphorus and magnesium were applied, the bulb was sealed to the mount (which comprises the stem with the electrodes mounted thereon) and the tube exhausted. Just before the tube was removed from the exhaust machine by the tipping off torch, the plates were heated by high-frequency induction, which caused the phosphorus and magnesium to vaporize and condense on the bulbs.

Applying getters to the above three types of tubes is still accomplished the same way, although the use of phosphorus has been more or less abandoned, principally because of the high-grid currents resulting from its use. The magnesium alone is either welded to the plate or applied as a powder with aluminum powder and a binder.

Other methods of applying magnesium getter to the mount of a radio tube have been developed, several of which are in use at present. The method of attaching the getter to the mount is not a matter of whim or of one method being better than another; it is indicated by the type of tube in question, by the type of machine to be used for exhausting, by the time in the exhaust cycle at which the getter is to be vaporized or "flashed" and by the location on the bulb where the getter is to be deposited. Simplicity and economy in mounting expense naturally influence the choice.

During the exhausting of a tube it is necessary to heat the plate to a high temperature in order to free it of gas and, in some cases, to aid in the break-down of the coating material on the filament or cathode. If the amount of heating required is not great the magnesium may be welded directly to the plate as in the 201-A. Where somewhat longer or greater heating is required, as in the 171-A or 226, the flashing of the getter must be delayed until after the plate has had a thorough heating and the vacuum pumps have had a chance to remove most of the gas. In order to delay the flash until the proper moment the magnesium wire is crimped in a thin nickel tab which is welded, on the edge away from the magnesium, to the plate.

When it is necessary to use a considerable amount of power in heating, as when a carbonized plate is used, it is essential that the getter be so mounted that it will not flash even under the most intense heating of the plate. In the 245, for example, this is accomplished by welding the getter into a small nickel cup which is located well below the plate so that only the last heating coil, which is made especially long, will heat the cup to a temperature high enough to flash the getter. In the 280, 281 and 250 types the getter is welded to a flat tab of sheet nickel at some distance from the plate and may only be flashed by a special coil in which the axis is directed perpendicular to the getter tab.

Special adaptation for 224 tube

The 224 tube presents a special case necessitated by its design for securing low inter-electrode capacitance. As the grid lead is brought out through the top of the bulb it is of importance that the upper part of the bulb be kept free from magnesium, as its presence acts as a coupling medium between grid and plate leads. In order to do this, a getter cup like that used in the 245 is placed below the outer screen in such a manner that all of the magnesium which leaves the cup condenses on the lower part of the bulb.

It is of considerable importance that in any of the larger tubes, such as the 245, 280 and 250, a considerable portion of the bulb be not entirely covered by getter so that the heat radiated from the plates will have a chance to get out of the bulb without heating it up to too high a temperature. When this feature is overlooked loose bases or short life are apt to become evident.

The getters already described are not by any means the only ones known or used. Aluminum has been successfully used in high-power tubes. It has not come into common use for receiving tubes as it presents little or no advantage and is difficult to flash. One process of flashing aluminum is to vaporize it by heating a molybdenum-aluminum alloy, which breaks down only at a very high temperature, the aluminum then being in an extremely active condition. The process, which is very effective, is not readily applicable to receiving tubes.

Misch metal, a mixture composed of several rare metals of the cerium group, is a satisfactory getter although its greatest field appears to be in gas filled tubes.

Probably the most effective and widely used getter which has come into use since magnesium became standard is barium. The value of this material as a getter has been recognized for some time, although its use did not become general until within the past two years.

Barium an effective getter

While barium is considerably more expensive than magnesium the cost is often offset by lower factory shrinkage or improved life, especially when high exhaust machine speeds are used or where the speed of the vacuum pumps is low.

The writer conducted tests about five years ago in which barium was used to obtain a good vacuum in the 201-A tube on a machine running at very high speed, the barium being obtained within the tube by heating a pellet of barium salt and misch metal. This process seemed advantageous for a time but eventually was abandoned in favor of magnesium, the latter proving more satisfactory after the pumping, bulb heating, and bombarding had been properly developed.

Other workers at this time were obtaining excellent results from a standpoint of getter action with barium obtained by decomposing barium azide in the tube. As this process had an undesirable effect on the grid poten-

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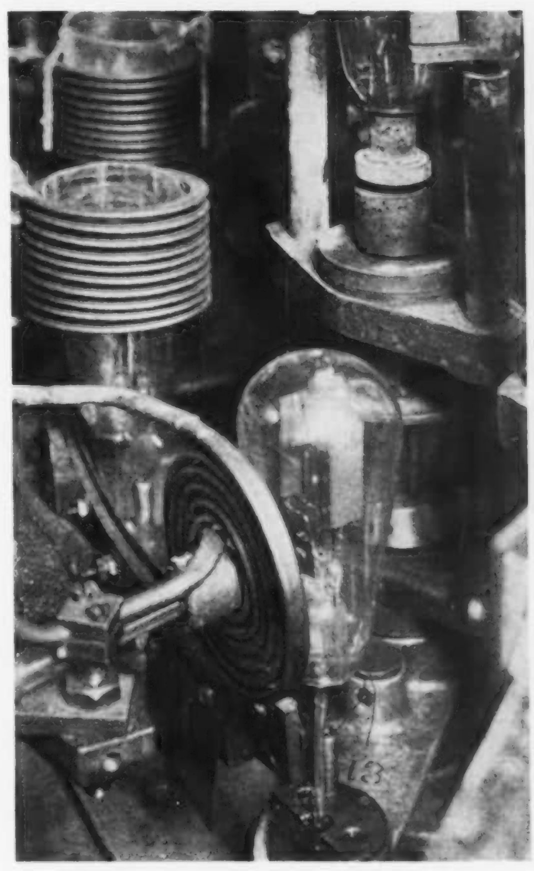

Fig. 2—Flashing the getter in the 280. The getter tab is seen behind the edge of the pancake coil, which heats the tab by high-frequency induction. The two helical coils are for heating the plates

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this process had an undesirable effect on the grid potential and plate current of the tubes it was reluctantly abandoned.

More recently, barium in metallic form became available for use in tubes, being supplied in a closed copper sheath to protect it from being spoiled by air or moisture. In this form barium came into considerable use, although it was expensive and difficult to flash. With the development of the present magnesium-barium and aluminum-barium alloy getters supplied in pellet form, the copper clad barium passed out of use. The barium alloy pellets are easy to handle and produce the desired gettering effect.

Other getters which have been used are calcium, both pure and in alloy form, lithium, active charcoal, and cerium. Some especially good results have been obtained with the calcium alloys. Like barium, the calcium alloys are most effective in tubes which operate with the bulb at a temperature high enough to keep the getter in an active condition. Caesium, potassium, and sodium also have a gettering action, although when used in tubes their primary function is not that of a getter.

While getters are of vital importance in tube manufacturing, too much reliance should not be placed upon them. Most tube engineers admit that there is no substitute for thorough firing or "degassing," proper baking or bulb heating, and bombarding. They do not agree however, as to *what* constitutes proper firing, exhausting, etc. It is often difficult to draw conclusions from comparative tests, as the sum total of the degree of thoroughness is largely what counts. Just how thoroughly these processes should be carried out without unnecessary expense is largely a matter of judgment and experience. It is the writer's contention that the above processes should at least be carried to the point where the question of getter is no longer of primary importance, and that if there is any question as to the effectiveness of magnesium getter in a receiving tube, the proper procedure does not lie in the direction of a substitute getter but is along the line of improving one or all of the vital processes in the manufacture of the tube.