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Electronic TUBES
Techni-talk
on AM, FM, TV Servicing

OPEN HEATERS IN PICTURE TUBES DUE TO ARC-OVER

Some picture tubes have developed an open heater due to arc-over within the picture tube. This particular trouble has occurred mostly in electrostatic-focus type tubes. It is the purpose of this article to explain why an arc may develop in the electron gun of the picture tube particularly just after the receiver is first turned on. More important yet, it tells how a cure may be effected by the serviceman at a cost of only a few cents and a few minutes time.

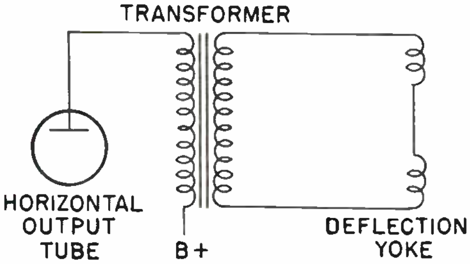

Fig. 1. Horizontal output tube, transformer and deflection yoke circuit.

BASIC THEORY

The reason why arc-over may occur within a picture tube can probably be best described by going into the basic theory underlying the action of the horizontal output, damping, and high voltage circuits. As shown in Fig. 1, the output from the horizontal output tube is used to drive the horizontal coils of the deflection yoke. A step-down transformer with a turns ratio of about 3:1 or 4:1 is used to match the impedance of the yoke to that of the tube. The wave shape is such as to cause a linear increase of current through the yoke which is necessary for linear deflection of the electron beam. The voltage required to drive the current through the deflection yoke is determined by the product of the yoke inductance and the rate of change of current.

Since the rate of change is relatively slow (compared with the flyback) a relatively low voltage exists across the coil during the forward motion of the spot. At the end of the sweep the horizontal output tube is suddenly cut off and the magnetic field in the deflection yoke collapses. The rate of change of current is now very rapid, hence a high voltage is developed across the coil. The current waveform is shown at the top of Fig. 2 and the voltage waveform is shown at the bottom.

The top waveform in Fig. 2 shows that from A to B the current through the coil is gradually building up. The bottom waveform shows that during this period the voltage across the coil remains essentially constant at some relatively low value. At B the horizontal output tube is cut off. From B to C the field in the coil collapses and a large negative pulse of voltage in the order of 1000 volts peak appears across the coil. Although at C the field has completely collapsed and the current is zero, the induced voltage then present causes the field to start building up in the opposite direction. The whole process repeats itself at the natural frequency of oscillation of the circuit, producing a voltage waveform similar to the one shown in both solid and dotted lines at the bottom of Fig. 2.

Such a waveform is obviously undesirable because the oscillation would distort the beginning of the next sweep waveform and produce striations on the left side of the raster. To eliminate this oscillation it is common practice to employ a damper tube as indicated in Fig. 3. This tube has no action over that portion of the voltage wave from B to D in the lower waveform in Fig. 2 since during this period the plate is negative with respect to the cathode. At D, however, when the plate starts to go positive the damper draws current, loads the circuit heavily, and effectively damps out the oscillation. The current and voltage waveforms then appear as shown in Fig. 4. Since damping action starts at D the circuit does not

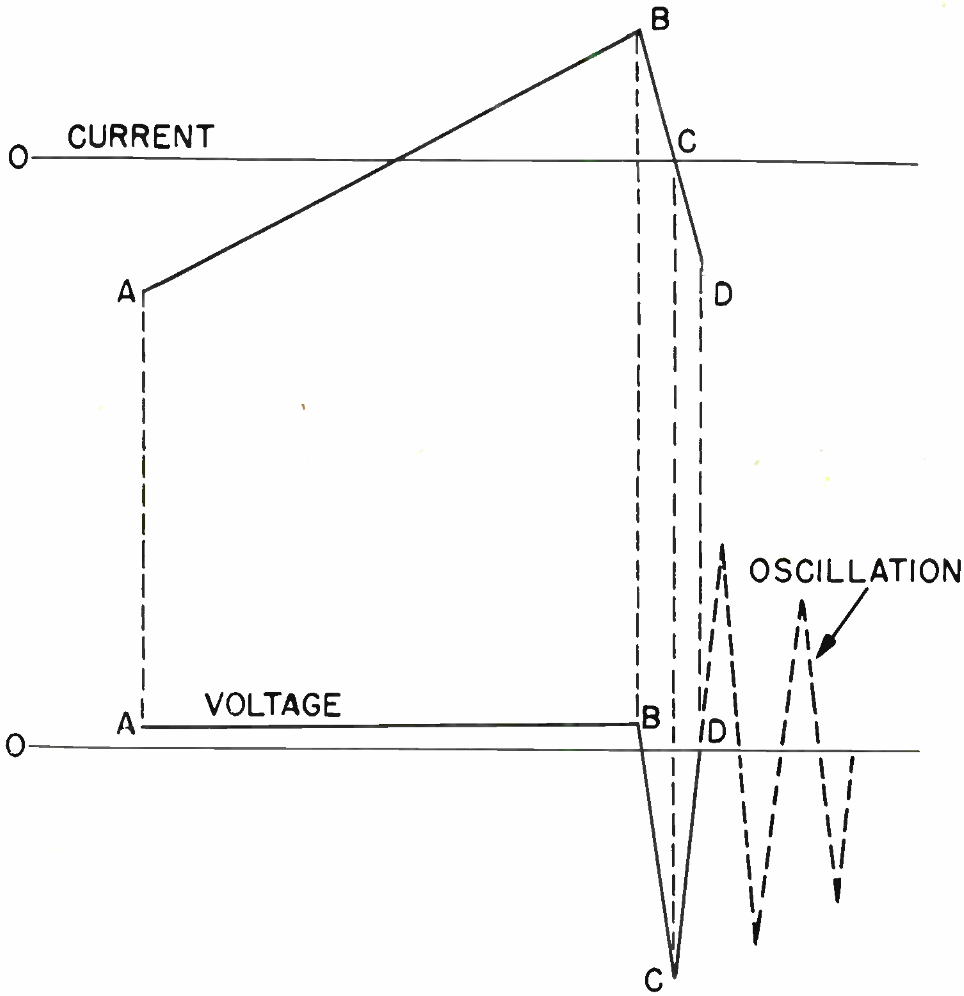

Fig. 2. Current and voltage waveforms produced by circuit in Fig. 1.

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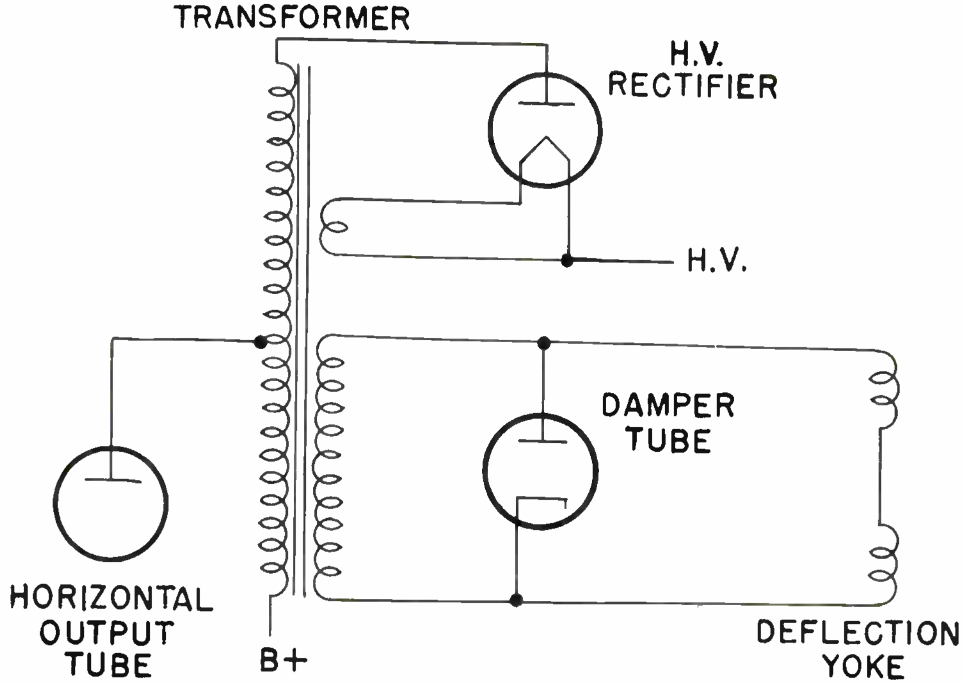

Fig. 5. Horizontal output circuit with high voltage rectifier and damper tubes.

tend to oscillate and the current waveform dies off gradually as shown at E. At approximately F, however, the horizontal output tube starts to conduct again and the current once more builds up through the coil. The over-all action of current dying off from D to E plus current building up from F to G produces the desired linear sawtooth DG.

During the time interval when the horizontal output tube is cut off, the voltage peaks at C and H are impressed

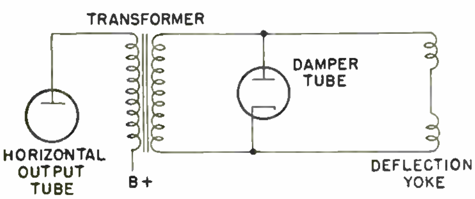

Fig. 3. Damper tube added to eliminate oscillation in voltage waveform.

on the secondary of the transformer and, due to the step-up action of the transformer in the reverse direction, appear as pulses of possibly 4000 volts peak across the primary. Use is made of these pulses by amplifying them even more by an autotransformer action in the primary as shown in Fig. 5. These amplified pulses are applied to the plate of the high voltage rectifier. In many instances more than one rectifier is used in a voltage doubling circuit but only one is shown here for the sake of simplicity.

An additional function is performed by the damper tube circuit; the current passed by the damper tube on positive peaks of the oscillation is used to charge up a capacitor as indicated in Fig. 6. The capacitor then acts as a battery and, as such, can be connected in series with the regular B+ voltage to produce what is commonly known as B+ boost (see Fig. 7). This boost voltage is usually applied to the plate of the horizontal and vertical output tubes and to the second grid of the picture tube. Sometimes an LC filter section is added to smooth out the ripples. Such a filter is not shown here to avoid complicating the issue. A complete although idealized circuit is shown in Fig. 8.

The capacitor need not necessarily be in the cathode circuit of the damper tube; it can just as well be in the plate circuit as shown in Fig. 9. The boost action is obtained again by the use of a charged capacitor in series with the regular B+ voltage as shown in Fig. 10. A complete and again idealized circuit appears in Fig. 11. It should be pointed out that the capacitor need not be physically located near the damper tube. It might even consist of two or more capacitors in series located in different parts of the chassis and having different apparent

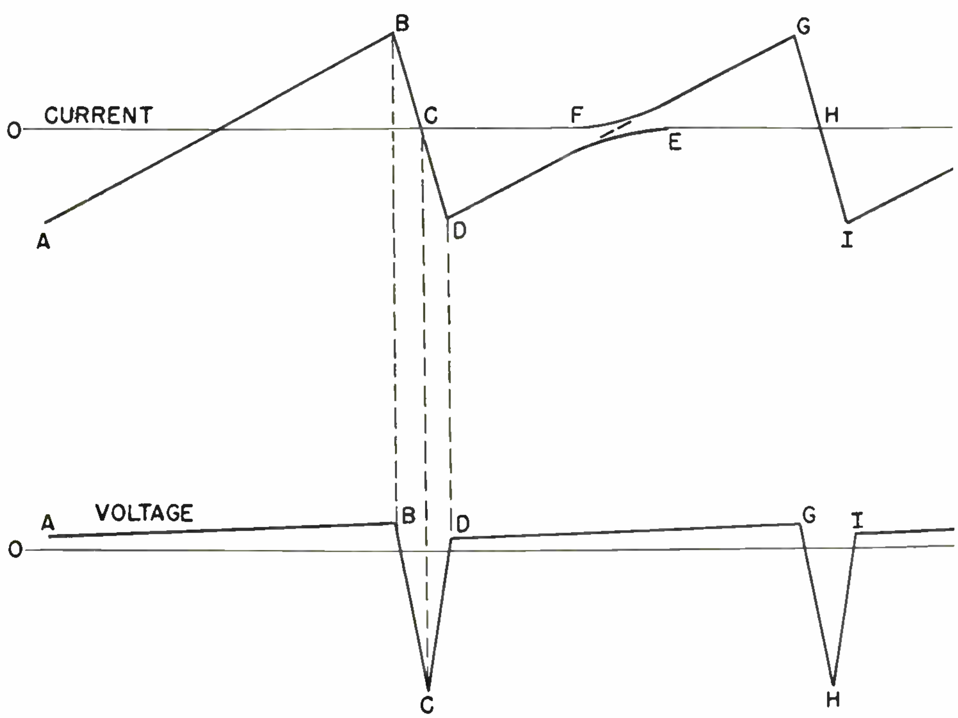

Fig. 4. Current and voltage waveforms produced by circuit in Fig. 3.

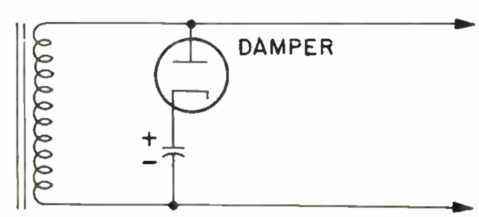

Fig. 6. Capacitor added to cathode circuit of damper tube.

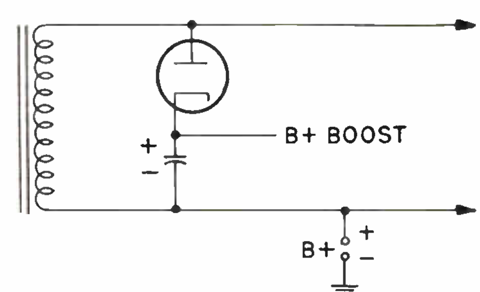

Fig. 7. Utilizing capacitor in Fig. 6 to produce B+ boost voltage.

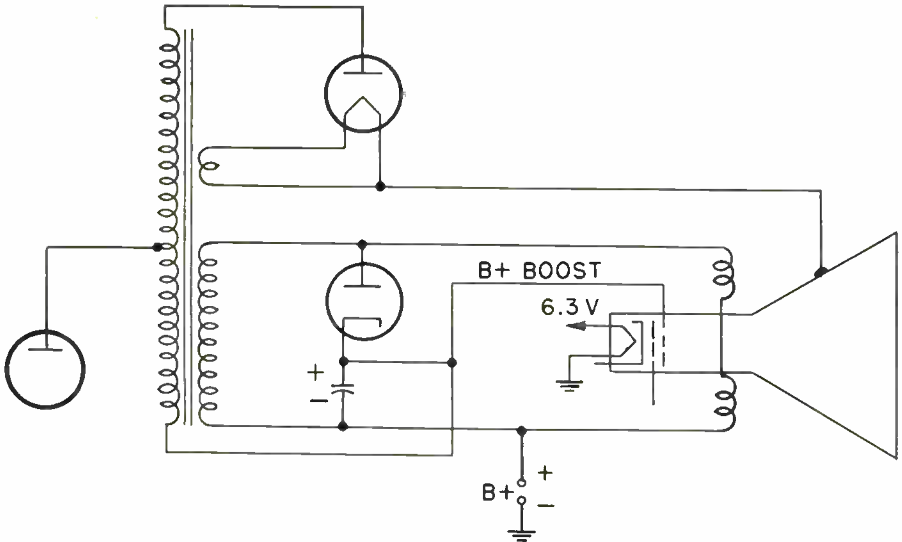

Fig. 8. Horizontal output circuit with B+ boost voltage applied to G_2 of picture tube and plate of horizontal output tube.

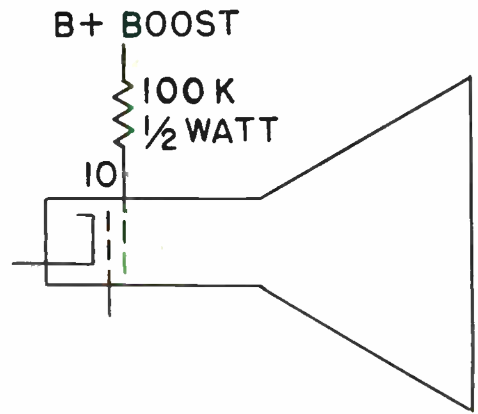

Fig. 12. Addition of 100K resistor to protect picture tube heater.

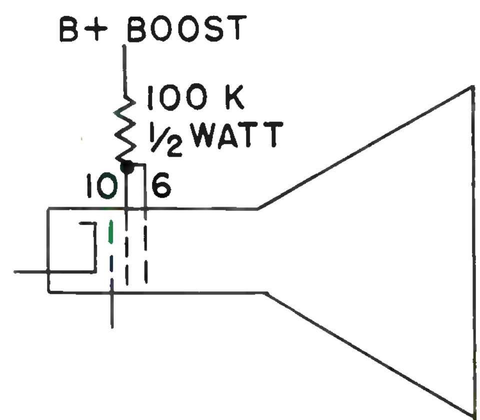

Fig. 13. Placement of 100K resistor when focusing electrode is connected to B+ boost voltage.

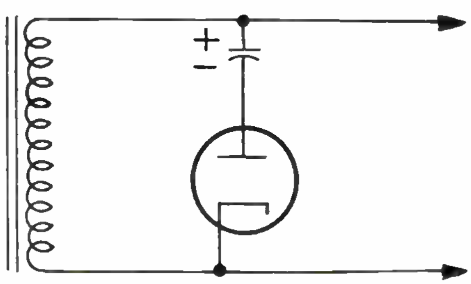

Fig. 9. Capacitor added to plate circuit of damper tube.

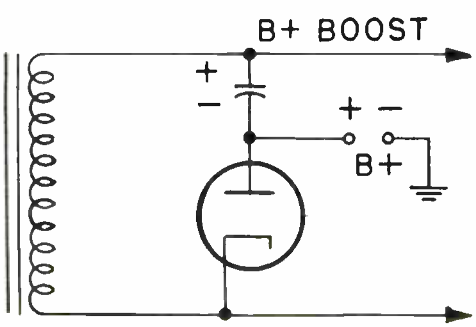

Fig. 10. Utilizing capacitor in Fig. 9 to produce B+ boost voltage.

functions. They do exist, however, and may be considered as part of the boost circuit.

DEVELOPMENT AND LOCATION OF ARC-OVER

Now we come to the crux of the matter! When the receiver is first turned on it is perfectly plausible that several sweep cycles may occur before the damper tube warms up sufficiently well to start conducting on positive peaks. This means that, for a few cycles, at least, the positive oscillatory peaks shown in Fig. 2 are not damped out. Notice that if the circuit shown in Fig. 11 is used these positive peaks, which can have an amplitude of about 1000 volts, are applied directly to the second grid on the picture tube. If an arc occurs in the picture tube during this positive excursion, it will discharge through the lowest impedance path to ground which is the tube heater. For a short while, then until the damper tube starts conducting there may be several brief high current arcs struck in the picture tube between the heater and the second grid. Since the heater usually has one side grounded, it is this element which is closest to ground potential. The high current resulting from the arc flows through part of the heater wire which was designed to carry only 600 milliamperes. This can easily result in a heater burn out.

CURRENT LIMITING RESISTOR

The cure is simple. A 100K, ½-watt resistor should be added in series with the lead supplying B+ boost to G_2 (pin 10) of the picture tube as shown in Fig. 12. This limits any current surge during arc-over to a level which cannot damage the picture-tube heater. To avoid possible shading difficulties, the resistor should be connected close to the picture-tube socket. It is suggested that the lead to pin 10 be broken about one inch from the picture-tube socket. Insert the resistor in series with the lead, solder and cover with either spaghetti or tape.

If the best focus is obtained by connecting the focusing electrode to B+ boost rather than ground, it is important that it be done by connecting pin 6 (focusing electrode) directly to pin 10 (G_2) at the socket as shown in Fig. 13. In this way the B+ boost voltage for the focusing electrode must also pass through the 100K resistor. If this is not done an arc may be struck between the focusing electrode and the heater which could also burn out the picture-tube heater.

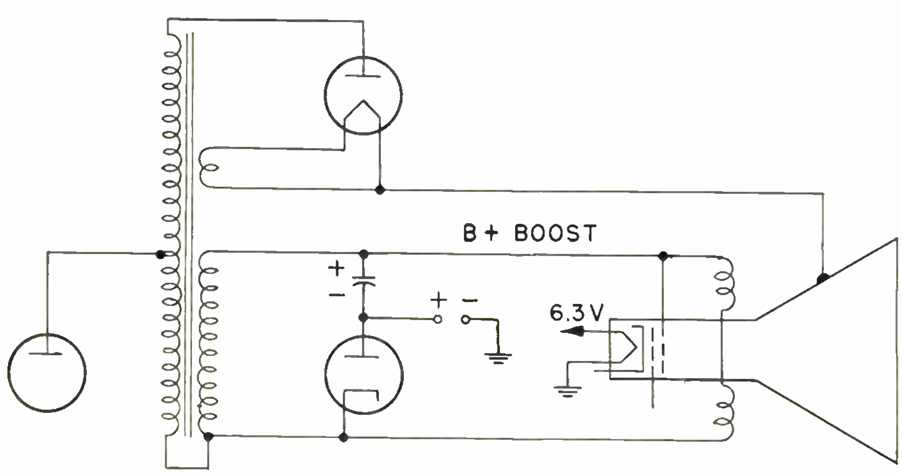

Fig. 11. Same circuit as Fig. 8 with capacitor in plate circuit of damper tube.

BENCH NOTES

Contributions to this column are solicited. For each question, short-cut or chronic-trouble note selected for publication, you will receive $10.00 worth of electronic tubes. In the event of duplicate or similar items, selection will be made by the editor and his decision will be final. The Company shall have the right without obligation beyond the above to publish and use any suggestion submitted to this column. Send contributions to The Editor, Techni-talk, Tube Department, General Electric Company, Schenectady 5, New York.

DIM PICTURE

I had a General Electric 17T1 set with a picture that looked like low emission on the picture tube. The picture tube was replaced but this didn't help. The H.V. checked about 12KV which was normal and the voltage on G_1, G_2 and cathode was also normal. Finally, unable to think of anything else, I checked the filament voltage and found only 2V on the picture tube heater. I proceeded to check the other tubes and finally after about 5 hours work found a heater cathode short in the 6SQ7 tube.

Charles Rogers
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SUBSTITUTING HIGHER RATED SELENIUM RECTIFIERS IN EARLY G-E TV SETS

I have noticed the relatively short life (1½ to 2 years)—of 250 MA selenium rectifiers used in early model G-E TV sets. Later model sets use higher rated 350MA and 450MA rectifiers. I have also noticed that receivers with the higher rated rectifiers give satisfactory performance for a considerably longer time. Whenever replacement is necessary I use the higher rated type even in the early models. To install the larger rectifiers in some sets, it has been necessary to cut away a portion of the sheet insulation surrounding the rectifiers. This has worked very well, and to date, I have not had to replace any of the higher rated rectifiers although several have been in service for more than three years. The owners of these sets are very pleased with the increased life and trouble-free performance of the higher rated rectifiers.

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INTERMITTENT RASTER

Two Philco TV Receivers, Model No. 52-1820, were repaired recently. Both had the same complaint of good sound but no raster. After the set was in operation for approximately 15 minutes the raster would appear, and then cut out again. The trouble was traced to an intermittent capacitor across the cathode winding of the horizontal oscillator transformer. This capacitor is listed as C-807 in the schematic. Finding this trouble was time-consuming and I know it will help others on this model.

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VERTICAL SYNC

Model GE-17T2. The first trouble, corrected in the home, was a 25BQ6GT with an open filament which was replaced with a new 25BQ6-GA. However, further checking revealed extremely sensitive vertical sync. and severe noise on high channels similar to electrical interference.

After pulling the chassis and taking it to the shop the trouble was found to be caused by the new 25BQ6-GA tube. The additional height of this tube had placed the bakelite plate cap about $\frac{1}{32}$ inch from the globar resistor. Enough corona was being radiated from the cap to cause interference, yet not enough to cause a hissing sound or arcing normally encountered when checking for corona.

REMEDY—Bend the globar resistor ¼ inch further away from the bakelite cap of the 25BQ6-GA.

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KNOB SPRINGS

If you have had to fuss and use match covers to replace missing knob springs, here is an economical solution.

The very next time you pass the receiving room, look in the trash pile for a short section of ½-inch banding strip, the kind most manufacturers use for crating up their products. Cut off a strip a foot long and throw it in among your tools.

You will find this an ideal material for making up a spring, for it will break with a few flips between your pliers for correct length and width. Then bend it into a slight radius for proper spring action. If you do it right it will go into the knob flat rather tightly so it won't slip out the next time you remove the knob. This stuff seems to have just the right amount of carbon steel, and makes a real honest-to-goodness looking knob spring. One thing for sure, you will always have a plentiful supply of this around.

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