In order to reduce the tendency to form a chrome oxide, the end caps **30** are preferably made of such size as to completely close the ends of the tube **15**. While a hermetic seal is not desirable, it is desirable to have a close enough fit to prevent the free circulation of air. On the other hand, there must be sufficient room for escape of air so that when the air within the tube heats up, there is no danger of explosion.

The insulating discs **26** are of such size and the notches **27** are of such depth that the conductors **16** are supported relatively loosely with only the ends of each bowed length touching the inner surface of the glass tube **15** as at **42**. As these ends carry no current they operate at low temperatures and therefore have little heating effect on the glass. In the drawing the space between the glass and the bowed portion of each length is indicated at **43**. It is important that there be a minimum of contact, consistent with proper support, between the conductors **16** and the glass. With this arrangement, the members **16** are suitably supported without having any substantial portion of their surface in contact with the glass to cause local overheating or to slow up the capacity of the element to heat up quickly.

In the form of the invention of Fig. 12, the conductors **16'** are shown as rectangular in cross-section rather than arcuate as in Fig. 4. In addition, there is welded or otherwise secured to each length of the conductors **16'**, at suitably spaced intervals, radial metal fingers **50** which project or contact the inner surface of the wall **15** of the glass tube. Thus, the conductor is supported by means of the contact of the fingers with the tube. These fingers keep current carrying parts of the element out of contact with the glass and are important when high element temperatures and relatively low glass temperatures are desired.

With the form of the invention disclosed in Figs. 8 to 11 inclusive, the elongated conductor **37**, forming the heating element proper, is arranged helically within the tube. The conductor **37** is formed of the same material as heretofore described in connection with Figs. 1 to 7 and must include at least one edge flange. In the arrangement illustrated, the element is U-shaped in cross-section to provide flanges **38**. The element is positioned within one of the tubes **15** in the manner illustrated in Figs. 8 and 9 with the flanges **38** projecting outwardly. This form of the invention is particularly suited for use in horizontally disposed tubes, and by referring to Fig. 9 it is apparent that the conductor **37** sags into contact with the inner surface of the lower wall portion of the tube **15**. The diameter of the helical coil is less than the internal diameter of the tube **15** so that there is contact with the flanges **38** only on the lower side of the helix. One end of the helix is connected by a conductor strip **39** with one of the end caps **30** and the other end is connected by a similar conductor strip with the end cap **30** at the opposite end. The method of support for the ends of the element may be the same as heretofore described in connection with Figs. 1 and 2, and the same reference numerals are utilized. The end caps **30** may be identical to the end caps of the form of the invention of Figs. 1 and 2, and a perspective view of one of said caps alone is illustrated in Fig. 11.

While the construction of Fig. 1 is preferred for vertical installations, it may also be used horizontally. It is also possible to utilize a

helical construction, such as is shown in Fig. 8, but with a greater number of turns, in a vertically disposed tube. While the turns of the helix will contact one another when the element is positioned vertically, nevertheless, the natural oxide of the metal will provide effective insulation between turns. With this design, a ribbon which is U-shaped in cross-section is particularly desirable as the width of the ribbon can be varied to contain the desired number of turns for a required rating while still employing a ribbon which is thin enough to provide for quick heating and cooling.

With the form of invention of Fig. 8, it is obvious that the flanges **38** make the heating element proper substantially self-supporting and present only edge contact against the glass tube. If a flat ribbon were employed it would not have sufficient strength to be self-supporting and would heat very slowly because a flat surface thereof would be in contact with the glass tube. With the present invention, a very thin ribbon, only a few thousandths of an inch thick, is entirely practical and heating and cooling in a few seconds time is readily achieved because the ribbon has a small cross-section in relation to its surface area.

The radiant energy from any heating element operating at a moderate temperature, for example, around 1500° F., is largely in the long wave length infra-red range. Glass is not entirely transparent to this energy so the light and only part of the heat is transmitted through the glass tube **15**. The heat which is absorbed, however, causes the glass to heat rapidly and the glass itself then becomes a source of radiant heat. Glass is one of the best materials for radiant heat emission and, due to its low density, it heats up and cools off rapidly. In conventional heat lamps the energy from the high temperature filament is mostly in the short wave length range and the latter is effectively transmitted by the relatively thin glass bulb usually employed.

When the present element is installed, as shown in Figs. 1 and 8, all metal conducting parts for electricity are inaccessible from accidental contact. Therefore, the danger of shock, which is present with open-coil heating elements, is practically eliminated.

Various changes and modifications may be made without departing from the spirit of the invention, and all of such changes are contemplated, as may come within the scope of the claims.

What I claim is:

1. An electric heating element comprising a tube of heat resistant transparent material, an electric conductor within said tube in the form of thin metal ribbon having an edge flange, said ribbon comprising a plurality of connected lengths arranged in peripherally spaced relationship around a center axis within the tube, each of said lengths being inwardly bowed, insulator means arranged within said peripherally spaced lengths of ribbon pressing the ends of said lengths against the inner surface of the tube to support the ribbon in position, and means providing for the connection of the ends of said ribbon with an external source of electricity.

2. An electric heating element comprising a tube of heat resistant transparent material, an electric conductor within said tube in the form of a thin metal ribbon having an edge flange projecting toward the inner surface of the tube, said