Sept. 26, 1961 H. J. UNGER 3,002,122

SHOCK RESISTANT ELECTRON TUBE MOUNTING

Filed May 1, 1950

FIG. 2

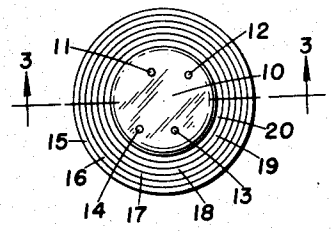


FIG. 1

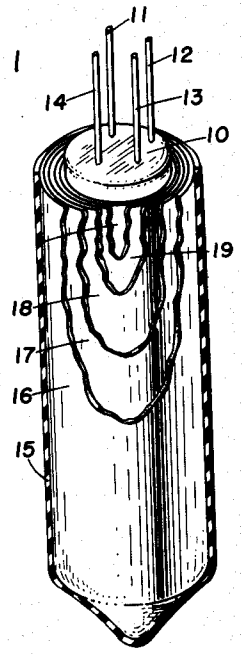


FIG. 6

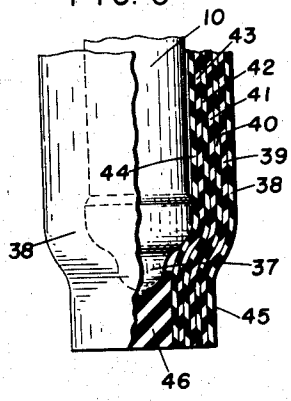
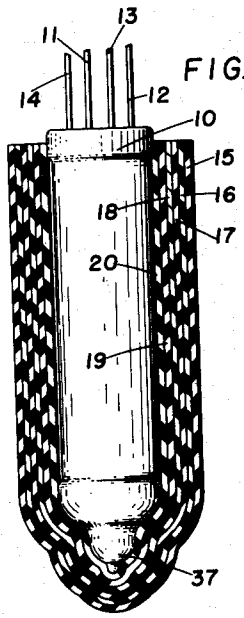


FIG. 3



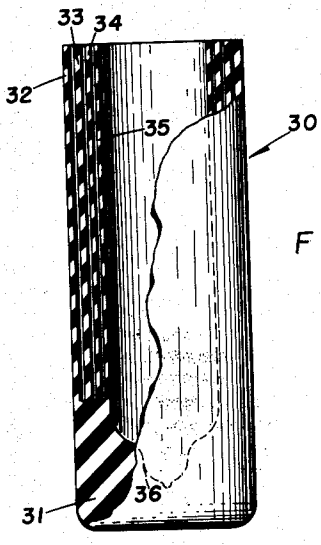
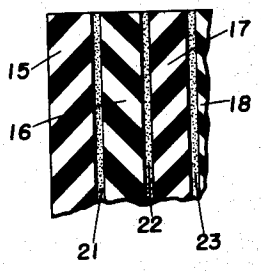


FIG. 5

FIG. 4



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SHOCK RESISTANT ELECTRON TUBE MOUNTING

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The present invention relates to an improved mounting for electron discharge tubes to afford shock protection. Specifically, the invention relates to an improved protective mounting device for use with miniature type electron discharge tubes, for example, such as are used in proximity fuzes.

Heretofore in such fuzes these electron discharge tubes have been encased in closely fitting rubber socks of a solid one-piece molded construction, and incorporated into the circuit of the fuze, all of the circuit components being ultimately housed in a metallic can. The otherwise vacant space surrounding the components of said circuit and bounded by the inside walls of said can was then completely filled with a suitable potting material.

It is well-known that set-back, due to the rapid initial acceleration of a missile carrying the fuze, generates shock waves in the above-mentioned potting material. Reflection of the shock waves occurs at the external surface of the glass envelope of each such enclosed electron discharge tube, where, at the junction of rubber and glass, there exists an abrupt change in density which sets up stresses in said glass, with a possible fracturing effect on the tube. The conventional unlaminated rubber sock affords some protection to the fragile tube due to its damping effect on the said shock waves. The relative motion of the tube in respect to the potting material, compresses the rubber sock with an ultimate conversion of most of the strain energy into heat. However, under severe conditions, the shock-absorption provided by this design may not be sufficient fully to protect the tube from damage.

An object of the present invention, therefore, is to provide an improved protective covering for electron discharge tubes. Another object is to provide laminated means for the protection of miniature type electron discharge tubes subjected to severe shock loads, such as might occur in tubes used in proximity fuzes mounted on missiles designed for high acceleration.

Other objects and many of the attendant advantages of this invention will be appreciated readily as the same becomes understood by reference to the following detailed descriptions, when considered in connection with the accompanying drawings, wherein:

FIG. 1 is a perspective view, greatly enlarged, of one embodiment of the invention applied to an electron discharge tube, certain elements of the invention being shown partially broken away;

FIG. 2 is a plan of the device as embodied in FIG. 1, on a similar enlarged scale;

FIG. 3 is a corresponding section of the device taken in the plane 3—3 of FIG. 2, the electron discharge tube being shown in elevation;

FIG. 4 is a fragmentary section, in the same plane as FIG. 3, but enlarged very much more, showing the individual layers of rubber or the like, with intervening particles of a lubricant;

FIG. 5 is an elevation, on an enlarged scale, of a modified one-piece form of the device, shown partially in axial section and partially in elevation and designed to receive and protect an electron discharge tube; and

FIG. 6 is an elevation, partly in axial section, of a further modification, wherein the nested protecting tubes are open-ended, the bottom being closed by a separate resilient plug.

It is a well-known principle of physics that whenever and wherever there is a change in the physical properties, elasticity and/or density, of a medium in which a wave is travelling, a part of the energy of the wave is reflected, the remainder being transmitted, usually with refraction, and frequently with absorption and dissipation of energy. Consequently it follows that if a delicate electron discharge tube is covered by many layers of very thin resilient and elastic material, such as rubber or Neoprene, severe externally applied shock waves will be reflected successively at a great number of surfaces before reaching the glass envelope of said tube, whereby the ultimate intensity of said waves is greatly reduced.

For example, a transmitted strain-amplitude, A, would be multiplied, at each reflecting surface, by a factor, P, which is always less than unity. Therefore, the residual intensity I, after the shock wave has passed through N layers of such laminated structure, would be expressed approximately by the equation: $I=AP^N$. From this equation it is found that:

If $P=0.9$ and $N=10$, $I=A(0.9)^{10}=0.35\ A$ and
If $P=0.95$ and $N=10$, $I=A(0.95)^{10}=0.60\ A$

Of course, reflection and absorption would take place also within the layers themselves. However, this would merely still further reduce the intensity of the wave in the material.

It has been further noted that when an electron discharge tube is restrained in its motion, with respect to the inner surface of its mounting sock, it will fractiure on setback. The use of laminated socks provides protection to the tube in this respect since the thin layers can slip on each other, thereby reducing the shearing strain on the sock material.

It has been proposed to mount radio tubes in sponge rubber. However, such material due to its very nature is relatively bulky, and the present invention affords a much more efficient protection for a given total volume of nested socks than would a single sock made of such sponge rubber. This is a very important matter in the case of proximity fuzes, where space is exceedingly limited. Moreover, tests show that sponge rubber allows excessive motion and itself thereby causes breakage.

Referring now to FIGS. 1, 2, 3 and 4 of the drawings in detail, and more specifically to FIG. 3, there is shown an electron discharge tube **10** of a conventional design with wire leads **11**, **12**, **13** and **14** extending therefrom. It will be understood that all the figures are necessarily partly diagrammatic in nature, for the reason that there is a great disparity between the dimensions of the electron discharge tube and the thickness of a single layer of the protective material which makes it necessary to grossly exaggerate said thickness on the drawings, and consequently makes it practically impossible to show said thickness to the same scale as the other dimensions of the structure.

Surrounding said tube **10**, and enveloping the same, is an arbitrary number of nested socks. For example, six such socks **15**, **16**, **17**, **18**, **19** and **20**, are here shown. They are fabricated from thin elastic and resilient material such as rubber, or preferably Neoprene, of a suitable hardness, or so-called "durometer-rating." A very thin wall, for example, one that is two one-thousandths of one inch thick, is especially suitable. Usually an adherent film of air would for the most part separate the mating surfaces of adjacent socks. However, to insure positive separation of the socks, a very thin film of finely divided talc or other suitable firm, non-hygroscopic, preferably solid, material may be applied to said mating surfaces when the socks are being assembled one on the other. As such material here acts somewhat like a lubricant, this term will be applied to designate it. It

must be understood that in this construction the inside diameter of the innermost sock would be slightly smaller than the external diameter of the electron discharge tube to be covered, and snug fits should also exist between successive socks when said electron discharge tube is covered by the same, so that all the socks will be in tension.

While rubber and Neoprene have been mentioned specifically, it will, of course, be understood that other materials, such as various "synthetic rubbers" and rubber substitutes, may in many instances be interchangeable therewith, and therefore the invention is not limited to either natural rubber or neoprene.

In FIG. 4, some of the lubricating or separating layers of finely powdered talc, zinc stearate, graphite or other suitable material are shown at 21, 22 and 23, between the socks 15, 16, 17 and 18. These materials may be dusted or otherwise applied on the outer and/or inner surfaces of the successive socks, preferably just prior to assembly thereof on the electron discharge tube 10. If Neoprene is used, hydrocarbon oils or jellies may be provided as lubricants, if preferred, as Neoprene is not injured by contact therewith.

In assembling, the inside rubber sock 20 is fitted over the electron discharge tube 10 so that the upper end of said tube with the wire leads extends from said sock. Successive additional socks 19, 18, etc., are then applied one over the other, until a desired or permissible maximum overall diameter of the assembly is reached. The exact number of socks is dependent upon the thickness of the individual socks and also upon the maximum diameter permissible by the space available for the assembly; however, as the number of layers increases, the resulting protection provided thereby also increases. The covered tube may then be incorporated in a circuit made up of the component units required in the proximity fuze. Said circuit, as previously mentioned, is then inserted into the shield can of a missile fuze and held in place therein by the potting material.

In FIG. 5 there is shown a modified one-piece sock 30 embodying the invention. The modified sock 30 consists of a solid or continuous base portion 31, with a series of concentrically spaced cylinders 32, 33, 34 and 35, of very small wall thickness and designed to extend from the said base portion 31 along the side wall of the electron discharge tube, to the upper end of the electron discharge tube protector. The base portion 31 of the sock 30 is shown provided with an indentation 36 to accommodate the dome-shaped end 37 (FIG. 3) of the electron discharge tube.

The inside diameter of the innermost cylinder 35 of the series of cylinders is slightly smaller than the external diameter of the electron discharge tube, whereby a light but snug fit exists between said sock and the electron discharge tube, to hold the latter in place within the protective sock. Suitable lubricants may be introduced into the vacant spaces between the successive cylinders 32, 33, 34 and 35 before assembly on the electron discharge tube, or if preferred the separating effect of the layers of air initially present may be relied on. For completeness, it may be mentioned that FIG. 2, aside from obvious differences in reference characters, would also represent the FIG. 5 form in plan.

Referring finally to the modification shown in FIG. 6, the laminated sock here consists of a plurality of concentric nested tubes 38, 39, 40, 41, 42, 43 and 44 of resilient elastic material, open at both ends, and applied over the electron discharge tube 10 as before, with a suitable lubricant between successive layers.

Upon choosing these rubber or Neoprene tubes of small enough bores, so that they must be stretched to go over the electron discharge tube 10, the portions below the tip 37 of said tube will form a contracted neck 45, as shown. This neck has an opening that may be closed by a suitable plug 46 of similar material, to provide a seat for the tip 37 of the tube 10, and also to prevent entry of the potting compound while the covered tube is being potted in the fuze.

Obviously many other modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A shock-absorbing protector for an electron discharge tube consisting of a multi-ply tubular sheath made of resilient elastic material, with the individual plies unsecured to one another.

2. A shock-absorbing protector as defined in claim 1, wherein the successive individual plies are separated from one another by a thin layer of lubricant.

3. A shock-absorbing protector for an electron discharge tube, comprising a snugly fitting elastic and resilient casing for said tube, the wall of said casing consisting of a plurality of layers of elastic, resilient material, separated by layers of lubricant.

4. A shock-absorbing protector for an electron discharge tube, comprising a series of open-ended nested tubes of elastic, resilient material, the innermost of the nested tubes being designed to fit closely on the electron discharge tube, the successive nested tubes being designed to fit closely on one another, thin layers of lubricant between the successive tubes, and an elastic, resilient plug closing one end of said series of nested tubes.

5. A shock-absorbing protector for an electron discharge tube, comprising a plurality of concentrically arranged tubes of elastic, resilient material, with layers of lubricant between successive tubes, said tubes being integrally connected at one end by a continuation of said material, to form a closure at said end of the plurality of tubes.

6. A shock-absorbing protector for an electron discharge tube, consisting of a multi-ply tubular sheath made of resilient material.

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