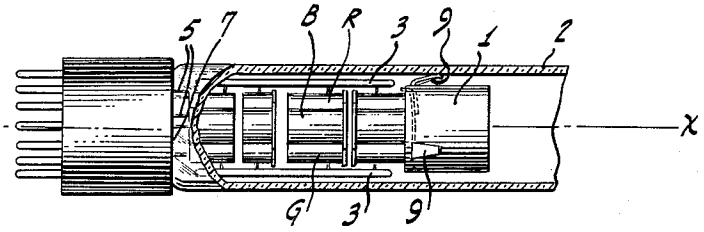
July 4, 1961 T. M. SHRADER 2,991,390

SHOCKPROOF MOUNT

Filed April 1, 1959

Fig. 1.



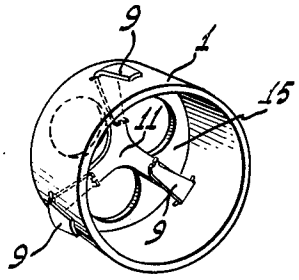


Fig. 2.

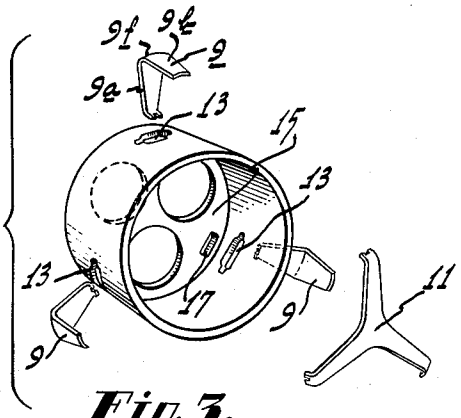


Fig. 3.

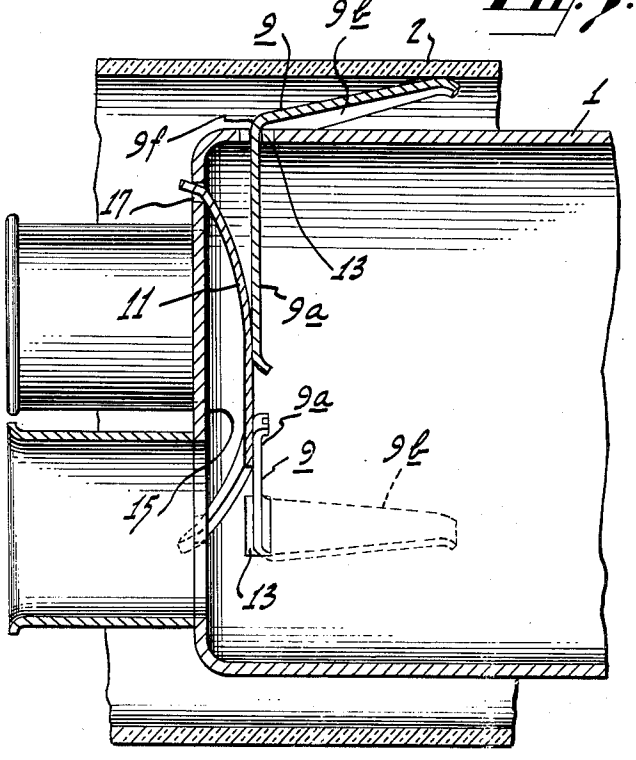


Fig. 4.

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United States Patent Office 2,991,390 Patented July 4, 1961

2,991,390

SHOCKPROOF MOUNT

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Filed Apr. 1, 1959, Ser. No. 803,534
8 Claims. (Cl. 313—254)

This invention relates to the solution of certain electrode-mounting problems encountered in the construction and operation of cathode-ray tubes and other electron tubes of the kind containing one or more electron guns or electron conduits.

The operating characteristics of an electron tube may be adversely affected if its electrodes become even slightly misaligned. For example, if the electron guns of a 3-gun tricolor kinescope become misaligned with respect to the elementary color-phosphor screen areas (at which the guns are aimed) color distortion and indeed other image defects result. Accordingly, the practice has been to support the gun assembly of such a tube not only at its proximal end (where its electrode leads pass through the stem of the tube), but adjacent to its distal end as well. Up to now, the auxiliary or distal end support has almost invariably comprised three or more spring fingers disposed in circumferentially spaced array on the outer surface of the gun and biased to bear against the inner surface of the neck of the tube. As will hereinafter more fully appear, when such a spring mounted gun assembly is thrown off-center (e.g. by shock, in shipment) it remains off-center because the restoring forces of the springs are not, and cannot be, sufficient to overcome the friction between the spring fingers and the inner surface of the (glass) neck.

Accordingly, the principal object of the present invention is to provide a truly "shockproof" mount, and one characterized by its ability rapidly and accurately to restore a displaced part to its original position.

Another and important object of the invention is to provide a simple, inexpensive, trouble-free, shockproof, supporting contrivance, and one which can be assembled without the use of welding equipment, or indeed without the use of tools of any kind.

The foregoing and related objects are achieved in accordance with the principle of the invention by the combination with a first part and a second part having a hollow interior within which said first part is to be mounted, of a plurality of levers disposed in circumferentially spaced array on said first part, and means common to all said levers for applying a supporting force to said first part through said levers.

The lever type mount of the invention is described in greater detail in connection with the accompanying single sheet of drawings, wherein:

FIG. 1 is a plan view of a batery of three electron guns in the neck portion of a color-kinescope, the battery or assembly of guns being provided with a shockproof mount embodying the invention;

FIG. 2 is a view in perspective of the front or distal end of the gun assembly of FIG. 1, which the levers and lever actuating spring in position therein;

FIG. 3 is an exploded view showing the several parts of the assembly of FIG. 2, disassembled; and

FIG. 4 is a fragmentary view on an enlarged scale of the distal end of the shockproof gun assembly of FIG. 1.

In the drawings, 1 designates the cylindrical, cup-shaped distal end-piece or common anode of a battery of three electron guns R (red, B (blue) and G (green), which are disposed delta (Δ) fashion at the apices of a triangle whose center lies on the longitudinal axis X—X of the cylindrical glass neck 2 of a tri-color kinescope. The cone portion and the screen assembly of the kinescope are not here shown since they form no part of the present

invention. As is conventional, a number (usually three) of glass rods 3 unite the several parts of the three guns into a rigid assembly; hereinafter referred to as the "gun assembly." As is also conventional, the gun assembly will be understood to be supported at its proximal end, as by means of its electrode leads 5 which are embedded in and extend through the glass stem 7 at the closed end of the neck 2.

It will be apparent that if the gun assembly were to be supported only at its proximal end, its mere weight, in this mode of support, would render it extremely sensitive to shocks and tremors of external origin. Accordingly, as previously mentioned, the prior art dictates the use of a number of "bulb spacers" in the form of spring fingers (not shown) welded to the distal end piece 1 of the gun and biased to bear against the inner cylindrical surface of the glass neck 2. As shown, mathematically, later on in this specification, if the gun assembly, thus supported, is thrown off center it will remain off center, since the restoring forces of the spring fingers are not (and cannot be) sufficient to overcome the friction between the fingers and the inner surface of the glass neck. Spring finger "spacers" are also objectionable if they need to be welded to the part which they support. Welding impairs their resiliency (to an unpredictable degree) so that their tension is seldom uniform, which makes it difficult to achieve accurate centering of the gun assembly even in the absence of any disturbing force.

In overcoming the foregoing and other less apparent objections to present day methods of supporting a first part within the hollow interior of a second part, the present invention dictates the use of a plurality of levers 9 disposed, say 120° apart, in circumferentially spaced array on said first part 1 in a position to engage the inner surface of the second part 2 and a single spring 11 common to said levers for applying a supporting force to said first part 1 through all of the levers 9.

The levers 9 are of the "first kind" and are preferably in the form of bell cranks. When made of sheet metal (e.g. stainless steel) they may be dished, traversely, to enhance rigidity. One arm 9*a* of each lever is accommodated within the end-piece 1, of the gun assembly; the cylindrical walls of said piece or part 1 being provided with three holes 13, spaced 120° apart to permit the three lever arms 9*a* to be entered therein. When thus arranged, the other arm 9*b* of each lever 9 is positioned to bear against the cylindrical inner surface of the glass neck 2, and the fulcrum 9*f* of each lever is in a position to bear against a boundary surface of its hole 13, in the inner cylinder 1. The single spring 11 which supplies the supporting force to the inner cylinder 1 through the three levers 9 may be of any suitable type. In the instant case it is in the form of a bowed trefoil 11 whose three radially extending lobes are so positioned within the cylinder that they are out of the way of the three electron beams (not shown) which emerge from the separate conduits R, B and G of which the gun assembly is comprised. To establish this desired location of the lobes of the trefoil 11, the apertured end plate 15 of the gun assembly is provided with three suitably located slots 17 (see FIGS. 3 and 4) into which the free ends of the lobes are received. The spring 11 is of course mounted on the end plate 15 before the arms 9*a* of the levers 9 are entered into the cylinder 1 through the holes 13. Prior to entering this assembly into the neck 2 of the tube the levers 9 are quite loose, but upon being entered into the neck the levers exert their force against the spring 11.

The common spring 11 acts only on one of the levers 9 when the gun assembly is displaced in a direction to compress the spring; thus, there is no frictional force on the other two levers which might oppose restoration of the gun to its original position. By contrast, with three in-

dividually sprung fingers (of the prior art) there is frictional force on the two expanded fingers, which limits the return of the gun toward its centered position. Thus, within the range of displacements for which Hooke's law is valid, the restoring force acting on a finger compressed by a displacement Δx can be written:

$$k(x_0+\Delta x) \quad (1)$$

where: kx_0 is the compression force on each of the three fingers in the centered position.

The compression force on the other two spring fingers (of the prior art) will be reduced to:

$$k\left(x_0-\frac{\Delta x}{2}\right) \quad (2)$$

so that the net tangential frictional force will be:

$$\sigma k\left(x_0-\frac{\Delta x}{2}\right) \quad (3)$$

at each of the two fingers, where: σ is the coefficient of friction of the fingers on the glass neck.

If this frictional force is sufficient to balance the net restoring force, i.e., if:

$$\sigma k\left(x_0-\frac{\Delta x}{2}\right)=\left[(1/2)k(x_0+\Delta x)-(1/2)k\left(x_0-\frac{\Delta x}{2}\right)\right] \quad (4)$$

the gun will be unable to return to its centered position. The maximum displacement from which the gun will not return toward a centered condition is:

$$\Delta x=\frac{8\sigma}{4\sigma+3\sqrt{3}}x_0 \quad (5)$$

or, for a coefficient of fraction of 0.5,

$$\Delta x=0.56x_0 \quad (6)$$

which expresses the residual displacement of the gun in terms of the compression of the spring fingers in their normal centered condition. The two quantities are seen to be of the same order of magnitude, whereas for the levered type mount of the present invention (with perfectly rigid levers):

$$\Delta x=0 \quad (7)$$

It should, therefore, now be apparent that the shockproof mount of the present invention is characterized (*a*) by its ability accurately to center the supported part, upon initial insertion into a cylinder, (*b*) by its ability rapidly and accurately to restore said part to its original position, if it is displaced by shock, (*c*) by the simplicity and economy of its parts, and (*d*) by its ease of assembly.

In conclusion, it need scarcely to be pointed out that if the proximal support (provided in the instant case by the leads embedded in the stem of the tube) is inadequate, or is entirely omitted, a second shockproof support, constructed in accordance with the invention, may be provided at or near that end of the structure.

What is claimed is:

1. An electron tube comprising, an electrode, an evacuated envelope within which said electrode is contained, a plurality of levers of the first class each having one arm positioned to bear against an inner surface of said envelope and its fulcrum cooperatively associated with said electrode, and means for applying supporting forces to said electrode through the other arms of said first class levers.

2. An electon tube comprising, an electrode, an evacuated envelope having a hollow interior within which said electrode is adapted to be received, a plurality of levers disposed in circumferentially spaced array on said electrode and adapted to bear against the inner surface of said envelope, and means common to said plurality of levers for applying a supporting force to said electrode through said levers.

3. The invention as set forth in claim 2 and wherein said last-mentioned means comprises a single spring.

4. An electron tube comprising, an electrode, an evacuated envelope having a cylindrical portion within which said electrode is contained, at least three levers of the first class each having one arm positioned to bear against the inner surface of said cylindrical portion of said envelope and its fulcrum cooperatively associated with said electrode, and spring means carried by said electrode for applying a supporting force to said electrode through the other arm of each lever.

5. An electron tube comprising a hollow electrode, an evacuated envelope having a cylindrical portion within which said hollow electrode is contained, a plurality of bell cranks, one arm of each bell crank being positioned to bear against the inner surface of said cylindrical portion of said envelope and its other arm extending into the hollow interior of said electrode and its fulcrum positioned to bear against said electrode, and a spring disposed within said electrode in a position to apply a supporting force to said electrode through said other arms of said bell cranks.

6. An auxiliary support for an electron gun whose proximal portion is supported at the closed end of the neck of a cathode ray tube, said auxiliary support comprising a plurality of levers of the first class disposed in circumferentially spaced array about the distal portion of said electron gun with one arm of each lever positioned to bear against the inner surface of said neck, and means common to the other arms of said levers for applying supporting forces to said distal portion of said electron gun through said levers.

7. In an electron tube of the kind comprising an envelope having a cylindrical neck portion terminating in a stem and containing an electrode assembly supported at one end upon said stem and including a distal portion spaced from the inner surface of said neck, the improvement which comprises an auxiliary support for said electrode assembly comprising a plurality of levers of the first class disposed in circumferentially spaced array about the distal portion of said electrode assembly with the fulcrum and one arm of each lever cooperatively associated with said electrode assembly and the other arm of each lever positioned to bear against said inner surface, and spring means biased to bear against said first-mentioned lever arms for applying supporting forces to said distal portion of said electrode assembly through said levers.

8. An electron discharge device comprising an envelope having a tubular neck, an elongated electrode assembly mounted coaxially within said neck, said electrode assembly including a tubular electrode having a plurality of spaced apertures in the periphery thereof, radially extending levers extending through said apertures with the outer ends of said levers in contact with the inner surface of said tubular neck, and a resilient member mounted within said tubular electrode between said electrode and the inner ends of all of said levers for exerting substantially equal pressure against the inner ends of each of said levers.

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