Dec. 6, 1966 P. W. KASEMAN 3,290,529

ELECTRON TUBE WITH EXTERNAL FLEXIBLE CONTACT ARMS FOR VIBRATION DAMPENING

Filed June 13, 1963 2 Sheets-Sheet 1

Fig. 1.

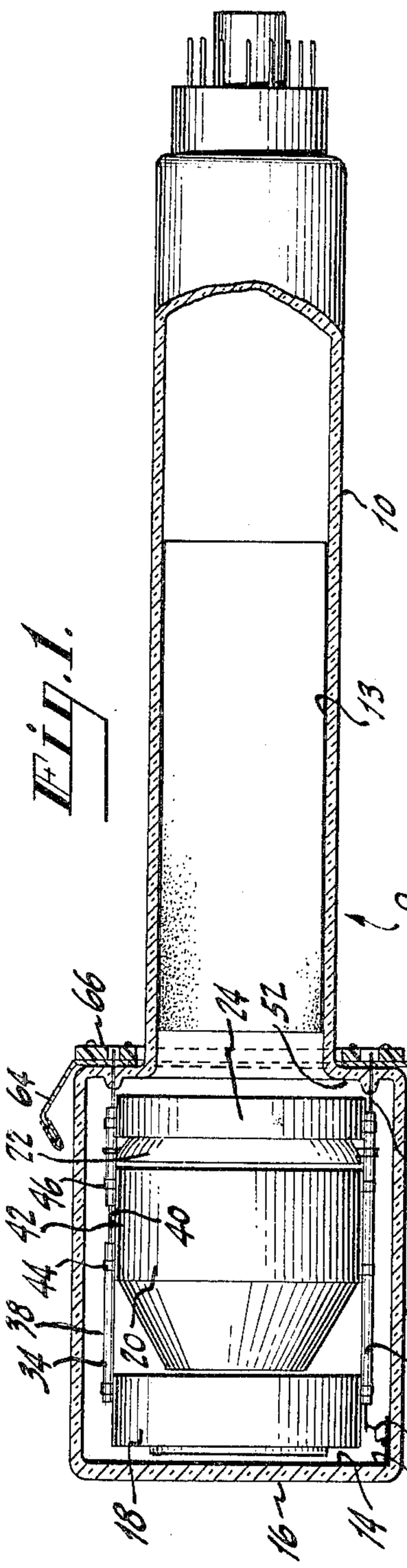
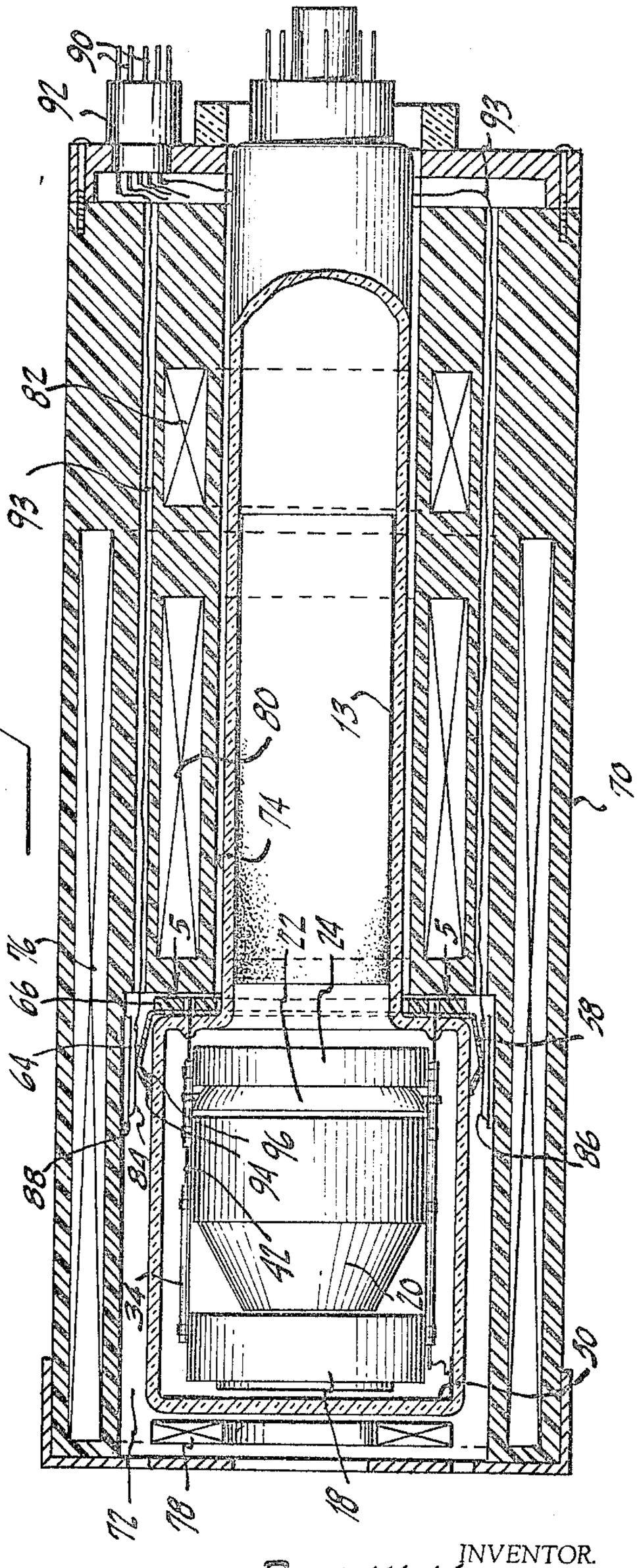



Fig. 2.



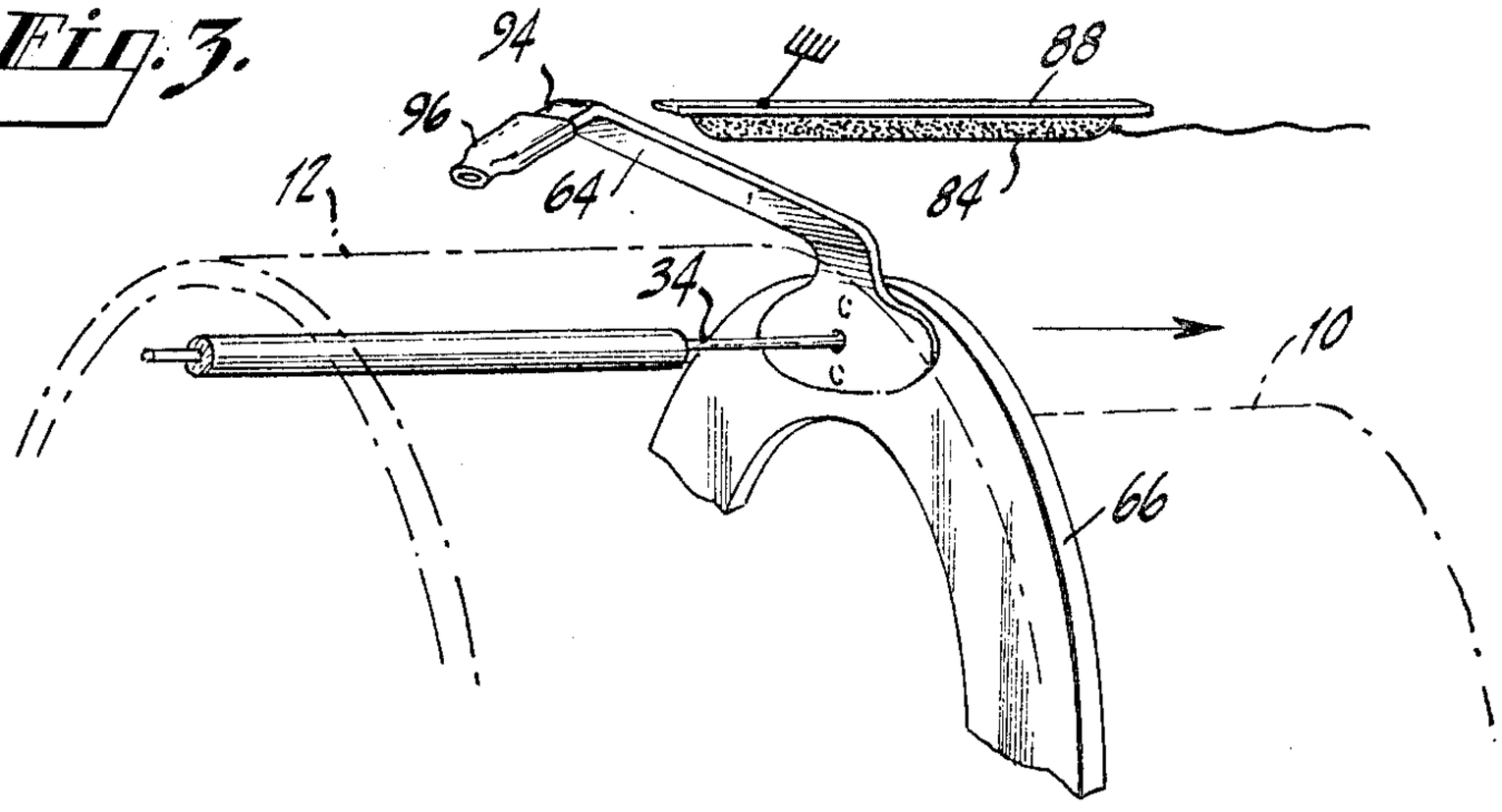

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Fig. 3.



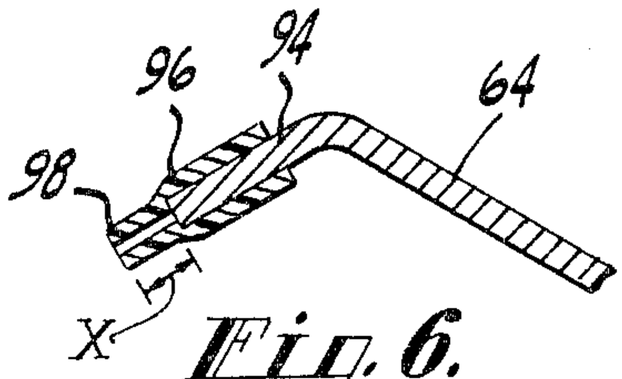




Fig. 6.

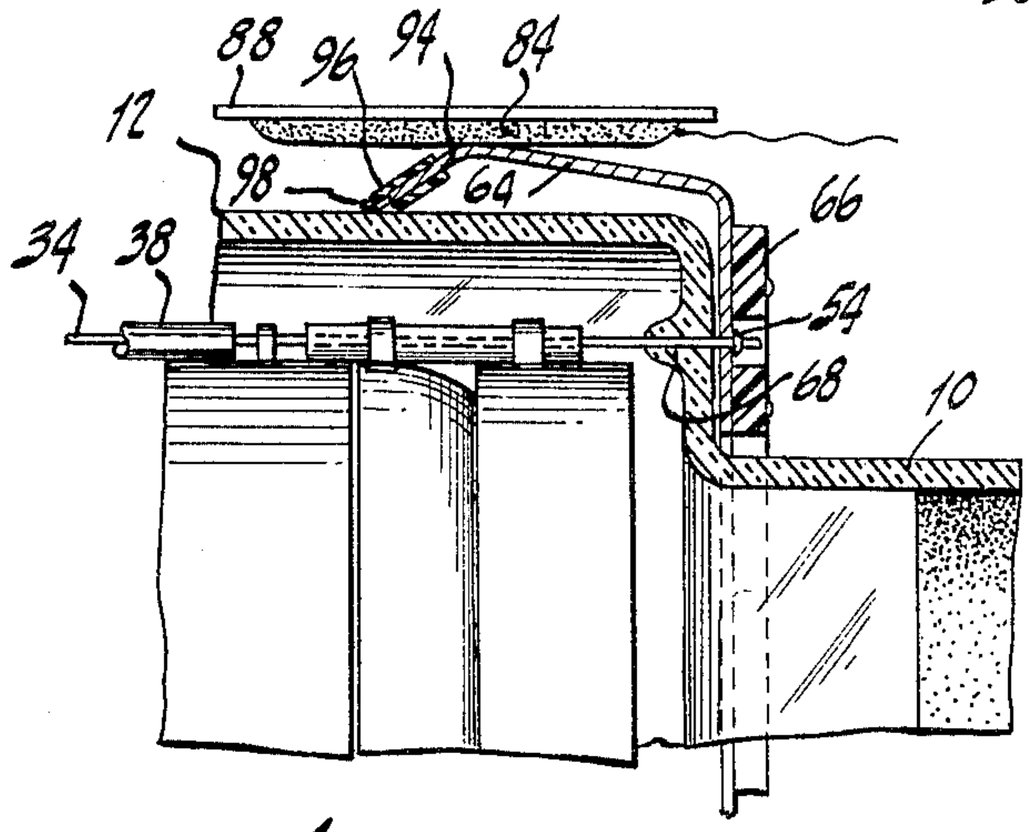



Fig. 4.

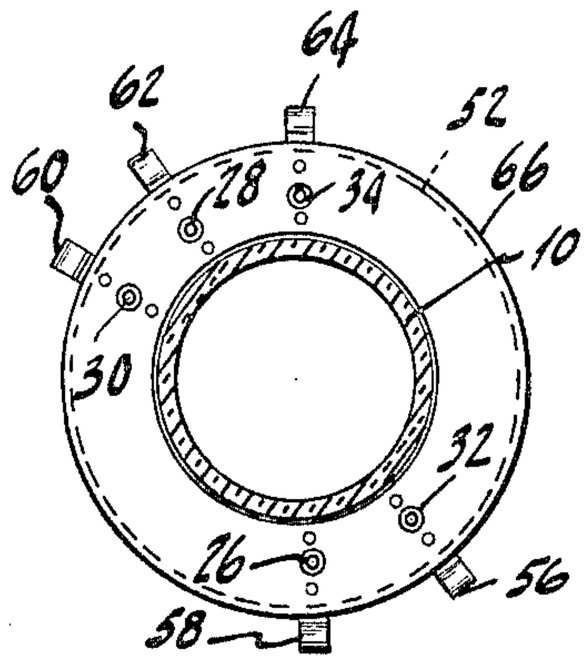



Fig. 5.

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# ELECTRON TUBE WITH EXTERNAL FLEXIBLE CONTACT ARMS FOR VIBRATION DAMPENING

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14 Claims. (Cl. 313—50)

This invention relates to pickup tubes of the image orthicon type and is particularly concerned with reducing microphonics in such tubes.

Microphonics in a pickup tube are objectionable in that they induce undesired effects in the output video signal from a transmitter in which the tube is used. Such undesired effects may manifest themselves, for example, as streaks or other distortions in the received picture. Microphonics in a tube usually arises as a consequence of vibration of certain elements thereof. In one type of image orthicon such as the 4½" size, such elements are electrodes within the tube other than electrodes formed as coatings on inner surfaces of the tube envelope. Such non-coating electrodes comprise an electron gun and dynode system in one end or stem portion of the tube, and a target with three associated electrodes in the other and enlarged end of the tube. In the type of tube under consideration, the electrodes in the enlarged end of the tube are supported by and electrically connected to a plurality of relatively rugged rods that are sealed hermetically through the walls of the tube envelope. The portions of the rods extending outside of the envelope are fixed as by means of solder to flexible contact arms. These arms have free ends that are urged, when the tube is in the camera housing, to bear against an outer surface of the tube envelope by a conductive contact strip which may be considered as part of the housing.

Heretofore the source of vibrations producing microphonics in an image orthicon of this type, has eluded workers in this art. A reasonable explanation for this is that not only are the non-coating electrodes referred to ruggedly supported in the tube, but the tube itself when mounted in a camera housing was thought to be isolated effectively from impact shocks that might cause vibrations of elements within the tube.

It will be appreciated from the foregoing, therefore, that a solution to the problem of microphonics in an image orthicon tube of the type under consideration, involves not only the provision of means to prevent vibrations that produce microphonics, but also a determination of the area or areas where the objectionable vibrations occur and effective utilization of the vibration preventing means for those areas.

Accordingly, it is an object of this invention to reduce microphonics in an image orthicon pickup tube.

A further object is to isolate at least the major cause of microphonics in an image orthicon tube and to provide means for its elimination.

These objects are achieved as the consequence of a discovery by applicant that the predominant cause of microphonics is an image orthicon tube of the type referred to, resides in vibration of electrodes in the enlarged end portion of the tube. Applicant has discovered that the very ruggedness of the rods supporting the electrodes in this portion of the tube, contributes to vibration of the electrodes that result in microphonics during use of the tube. Applicant has found that the rigidity of the electrode support rods renders them effective transmitters of vibrations to the electrodes to which they are fixed in the enlarged end portion of the tube. Such vibrations, according to applicant's discovery, have their

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predominant source in relative movements or vibrations transmitted from such a source as the camera housing to the free ends of the flexible contact arms and thence through the tube envelope portions against which the free ends bear when the tube is mounted in the camera housing. The vibrations so induced in the glass envelope are transmitted by the envelope to the electrode support rods and thus to the electrodes in the enlarged end portion of the tube.

Having found a major cause of microphonics in an image orthicon tube, applicant removes it by interposing between the contact arms and the tube envelope a body of material of sufficient resiliency to prevent or absorb or damp transmission of vibrations therethrough to the tube envelope during use of the tube in a camera. Applicant discovered that one way of doing this is to telescope snugly over the free end portions of the arms, relatively short tubing of resilient material such as heat-shrinkable polyvinyl chloride tubing. Applicant found that appreciable advantage results when the tubings are advanced sufficiently along the arms for good adherence thereof to the arms and have a length to provide an extension thereof beyond the free ends of the arms. This not only assures that the free ends of the arms are covered by the resilient material, but contributes added resiliency to the engagement between the arms and the envelope wall. The utilization of the resilient tubing or boots aforementioned, eliminates substantially all microphonics during use of the tube.

Further features and advantages of the invention will become evident in the following and more detailed description of an example thereof taken in connection with the accompanying drawings, in which:

FIG. 1 is a side view partly in section of an image orthicon pickup tube embodying the present invention;

FIG. 2 is a side view partly in section of the tube shown in FIG. 1 but housed in a camera structure;

FIG. 3 is an enlarged perspective view of a flexible contact arm having a tubing or boot of resilient material on its free end portion;

FIG. 4 is an enlarged fragmentary view partly in section and shows the position of the flexible contact arm when the tube is housed in a camera;

FIG. 5 is a cross-sectional view taken along the line 5—5 of FIG. 2 and shows the complement of flexible contact arms employed in an image orthicon tube; and

FIG. 6 is an enlarged view in section of a free end portion of a flexible contact arm having a tubing of resilient material telescoped over its free end portion.

In FIG. 1 is shown an image orthicon pickup tube 9 embodying the invention. The tube includes a glass envelope having a neck portion 10 and an enlarged end portion 12. Within the neck portion 10 is disposed an electron gun and multiplier of known design and therefore requires no further description herein. On the inner surface of neck portion 10 between the gun end of the envelope and the enlarged portion 12 thereof, is a conducting coating 13.

Within the enlarged envelope portion 12 is disposed a complement of electrodes. These electrodes include a semi-transparent photocathode 14 coated on the inside of a faceplate 16, an accelerator grid 18, a target (not shown in detail) housed within cylindrical member 20 and consisting of a thin disc of glass or other material and with a fine mesh screen very closely spaced from it on the photocathode side thereof. On the gun side of the target are spaced from the photocathode 14 in the order named a field mesh 22 and a decelerator grid 24.

The five electrodes referred to within the large end portion of the tube envelope, are electrically connected to five conducting rods, end portions of five such rods 26,

28, 30, 32 and 34 being shown in FIG. 5. Two of the rods 26 and 34 are shown in FIGS. 1 and 2. Each rod comprises a two-part metal core 36. One part is within the tube envelope and has a thickness of 40 mils. This part is made of a nickel-chromium alloy. The other part, which extends through the seal region is 50 mils thick and made of an iron-nickel-cobalt alloy. The two parts are butt welded. Rod 34 has an insulating coating 38 a portion of which is removed as shown at 40. The bare portion of the rod at 40 is electrically connected to target housing 20 by means of a bracket 42 welded to the rod and to the housing. Adjacent and insulated portions of the rod 34 are mechanically, but not electrically, connected by two further brackets 44 and 46 to the relatively massive target structure 20 for support purposes. Rods 28, 30 and 32 are similarly electrically connected to electrodes 18, 22 and 24 respectively, and mechanically connected to the other electrodes within the enlarged end portion of the tube, except for the photocathode 14. The photocathode 14 is electrically connected to rod 26 by engagement by a contact 48 on the rod and a conducting coating 50 on the inner wall of the tube envelope extending in conductive relation to the photocathode 14. The rod 26 insulatingly engages electrodes 18, 20, 22 and 24 for contributing to support thereof.

Rods 26 to 34 are hermetically sealed through an annular, shoulder portion 52 constituting an end wall of the enlarged portion of the tube envelope extending normally to the tube axis, with a portion of the rods extending outside of the envelope. The latter portions of the rods are fixed for example by a body of solder 54 (FIG. 4), to flat flexible contact arms 56 to 64 made of spring Phosphor bronze, for example, bent across their flatness dimension (FIG. 5). A portion of each of the contact arms extends along the annular portion 52 of the tube envelope, and is fixed to a ring 66 (FIGS. 3 and 4) made of insulating material. This construction protects the rod-to-envelope seals 68 from harmful stresses.

When in use, the tube 9 is disposed within a camera or tube housing 70 defining an enlarged space 72 for receiving the enlarged end portion 12 of the tube, the camera housing having a smaller diameter space 74 for receiving the neck portion 10 of the tube, as shown in FIG. 2. Between the inner and outer walls of the housing 70 are disposed focusing coils 76, 78, horizontal deflecting coils 80 and an alignment coil 82. The walls of the housing referred to may be made of insulating material or metal.

On the inner wall of the housing 70 defining the space 72 are mounted strips of conducting material made of silver, for example, and extending parallel to the axis of the tube. Two of such strips 84, 86 are shown in FIG. 2. Five of such strips are provided for engaging each of the five contact arms 56 to 64 mounted on the tube 9 when the tube is positioned in housing 70. The walls of the housing 70 may be made of a suitable insulating material or of a metal. In instances where the inner wall of the housing 70 defining the enlarged space 72, is made of metal, a body of insulating material 88 is positioned between the strips and the housing wall. Each of the conducting strips is electrically connected by a lead to one of the prongs 90 of plug 92. For example, strip 84 is electrically connected to one of the prongs 90 of plug 92 by a lead 93.

When the tube 9 is positioned within housing 70, with the five contact arms 56 to 64 of the tube engaging the five strips, two of which 84, 86 are shown in FIG. 4, appreciable pressure is exerted between the arms and the strips. It is desirable that the free end portions 94 (FIGS. 2, 3, 4, and 6) be bent inwardly toward the adjacent tube envelope. Such inward bend avoids a sharp edge engagement of the arms with the conducting strips. Such sharp edge engagement is objectionable in that it would result in excessive wear of the metal strips, particularly when the latter are made of a relatively soft material such as silver, during repeated insertions and



removals of tube 9 from the housing 70. Indeed, such sharp engagement might lock the tube within the housing and prevent removal of the tube therefrom. The inward bend in the contact arms is also desirable for supporting the tube in the housing.

During the pressure engagement between the arms 56 to 64 and their associated conducting strips within the housing 70, the free ends of the arms engage the outer surface of the enlarged end portion 12 of the tube 9 with appreciable pressure due to their support function with respect to the tube. Any impact shocks applied to the housing 70 therefore are transmitted through the arms 56 to 64, not only to the adjacent tube envelope but also to the rods 26 to 34 sealed through the envelope. As a consequence, the rods referred to not only have transmitted to them such impact shocks in a path comprising the contact arms 56 to 64, but also in a path formed by a portion of the tube envelope. In addition, the flexible character of the contact arms 56 to 64 may cause them to respond in a higher frequency than that of the impacts to which the housing 70 may be subjected. There is also a likelihood that sympathetic vibrations may be induced in the flexible contact arms under the conditions described, thereby amplifying the initial vibrations.

The concentration of such vibrations by the two transmission paths just described, in the end portions of rods 26 to 34, results in a further transmission of the vibrations through the rods and to the electrodes 18, 20, 22, and 24, and the contact 48. The ruggedness of the rods 26 to 34 required for support purposes, renders them particularly effective for transmission of vibrations to the areas indicated. Such vibrations produce objectionable results in these areas. For example, vibrations of contact 48 result in intermittent connection of the photocathode 14 to its associated electrical supply. Vibrations of the target and mesh within the housing 70 produce recurrent changes in their relative spacings resulting in an erratic output from the tube 9 known as microphonics. The vibrations referred to may also tend to interrupt or change the resistance of the contacts of the contact arms 56 to 64 with their associated conducting strips in the housing 70.

Applicant has found that if a body of resilient material is interposed between the free ends of the arms 56 to 64 and the adjacent tube envelope wall, an appreciable reduction in microphonics results. Not only has it been found that the body of resilient material restrains relative movement between the free ends of the contact arms and the envelope of the tube, but in addition serves to dampen the vibrations throughout the entire length of the contact arms, including the portions thereof fixed to the rods 26 to 34. These portions of the arms are additionally damped by the multiple layers of metal provided by soldered joints thereof to the rods 26 to 34.

For service as a vibration damping means, the body of resilient material should have a resiliency for effective restraint to transmission to the envelope wall, of vibrations that may be induced in the contact arms. Thus applicant has found that the resiliency of the interposed body should have a value represented by a range of from a deflection response of 1/64 inch at a pressure of 10 pounds per square inch, to a value characterized by a deflection response of 3/4 inch at a pressure of 1 pound per square inch. One material found suitable and having a resiliency within this range, is the aforementioned polyvinyl chloride.

Applicant has found that the resilient material performs best as a snubbing or vibration insulating means when it is utilized in a form in which not only the resiliency of the material itself is relied on as a vibration restraining means, but in which the structure into which the material is formed contributes to a vibration restraint. Thus applicant has found that best vibration restraint is provided when the resilient material is in the form of relatively short tubings or boots 96 (FIG. 6) that are firmly telescoped over the free end portions of

the contact arms 56 to 64. This is accomplished by threading a tubing 96 having an undersized bore, over the free ends of a contact arm 64. Of particular significance to the vibration restraining function of the tubings or boots 96, is that they be sufficiently long not only to afford an adherent engagement with the contact, but to provide a tail portion 98 extending beyond the free ends of the contact arms. The importance of this structure of the resilient tubings 96 will become evident from the showing in FIG. 4. In this showing the arm 64 is depicted in engagement with conducting strip 84 and urged against the wall of the enlarged envelope portion 12. It will be seen that the force with which the arm 64 is urged, is absorbed partly by compression of the resilient material of boot 96 and partly by a deflection or bend in the tail portion 98. This bend adds a component of resiliency to the boot 96 that supplements the resiliency of the material itself and contributes appreciably to the effective restraint to vibration transmission afforded by applicant's structure.

Ideally, the length of the tail portion 98 needs only be such as to assure the formation of an arc between the free end of arm 64 and the free end of the tail portion 98, of such radius that further elongation of the tail portion would fail to contribute to enlargement of the arc. Instead, further elongation would leave the excess tail length flat against the tube wall. This length of the tail portion 98 can be determined empirically by persons skilled in the art and will differ with materials of different characteristics of elasticity. In the absence of such determination, and as a practical matter, it is feasible to make the tail portion 98 slightly longer than the ideal length referred to. However for best results the tail portion 98 should not be shorter than the ideal length indicated. In one example utilizing polyvinyl chloride, the length of the tail portion 18 was one-eighth of an inch. This length is the dimension X shown in FIG. 6.

It is apparent from the foregoing that an improved image orthicon pickup tube is provided, in which at least one source of objectionable microphonics has been eliminated.

What is claimed is:

1. An electron tube having an envelope,
(a) electrodes within said envelope,
(b) rigid supports for said electrodes extending through one portion of said envelope,
(c) external elongated flexible contact arms connected at one end portion thereof to said supports, said arms being flat and bent across their flatness dimension to dispose the other and free ends thereof in normally spaced relation with respect to another portion of said envelope,
(d) and resilient means threaded over and extending beyond said free ends of said arms for insulating said another portion of said envelope from shocks imparted to said free ends of said arms when said free ends are urged against said another portion of the envelope.

2. An electron tube having an envelope,
(a) an electrode within said envelope,
(b) a rigid support for said electrode extending through one portion of said envelope,
(c) an external elongated flexible contact arm connected at one end portion thereof to a portion of said support extending outside of said envelope, said arm being flat and bent across its flatness dimension to dispose the other end portion thereof in normally spaced relation with respect to another portion of said envelope,
(d) and resilient means between said other end portion of said arm and said other portion of said envelope for insulating said other portion of said envelope from shocks imparted to said other end portion of said arm when said other end portion is urged against said another portion of the envelope, said resilient means extending beyond the free ends of said other



end portion to provide insulation between said free end and said another portion of said envelope.

3. An electron tube having a glass envelope,
(a) electrodes within said envelope,
(b) supports for said electrodes extending through one portion of said envelope to the exterior of said envelope,
(c) external elongated flexible contact arms connected at one end portion thereof to portions of said supports exterior of said envelope, said arms being bent to dispose the other end portions thereof in normally spaced relation with respect to another portion of said envelope,
(d) and resilient means covering said other end portions of said arms including the free ends thereof for insulating said another portion of said envelope from shocks imparted to said other end portions and said free ends of said arms when said free ends are urged against said another portion of the envelope, said resilient means comprising a tubular structure made of resilient material, said structure and said material contributing to the resiliency of said means.

4. An electron tube having a glass envelope,
(a) electrodes within said envelope,
(b) supports for said electrodes extending through one portion of said envelope,
(c) external elongated flexible contact arms connected at one end portion thereof to said supports, said arms being bent to dispose the other end portions thereof in normally spaced relation with respect to another portion of said envelope,
(d) and resilient means covering said other end portions of said arms for insulating said one portion of said envelope from shocks imparted to said other end portions of said arms when said other end portions are urged against said another portion of the envelope,
(1) said resilient means comprising a tubular structure made of resilient material, said structure and said material contributing to the resiliency of said means,
(2) the resiliency of said structure being within a range measured by a deflection of said material of from 1/64 inch in response to a pressure of 10 pounds per square inch to 3/4 inch in response to a pressure of one pound per square inch.

5. An electron tube having a glass envelope vibration transmissive from one portion thereof to another portion,
(a) electrodes within said envelope,
(b) rigid supports for said electrodes extending through said another portion of said envelope,
(c) external elongated flexible contact arms connected at one end portion thereof to said supports, said arms being bent to dispose the other end portions thereof in normally spaced relation with respect to said one portion of said envelope,
(d) and resilient flexible boots covering said other end portions of said arms and extending beyond the free ends of said other end portions for insulating said one portion and said another portion of said envelope from shocks imparted to said other end portions and free ends of said arms when said other end portions are urged against said one portion of the envelope.

6. An electron tube including an envelope having a side wall and an end wall,
(a) electrodes within said envelope,
(b) support means for said electrodes extending through and outside of said end wall,
(c) elongated flexible contact arms connected at one end thereof to said support means outside of said envelope, said contact arms having free end portions curved towards the outer surface of said side wall and normally spaced therefrom, said contact arms being adapted to be flexed to cause the free ends thereof to

engage said outer surface when said tube is disposed in a housing,

(d) and resilient flexible means between said wall and said free ends for insulating said side wall from shocks transmitted to said arms.

7. An electron tube including a glass envelope having a side wall and an end wall,

(a) electrodes within said envelope,

(b) support means for said electrodes sealed through said end wall,

(c) elongated flexible contact arms connected at one end thereof to said support means outside of said envelope, said contact arms having free end portions curved towards the outer surface of said side wall and normally spaced therefrom, said contact arms being adapted to be flexed to cause the free ends thereof to engage said outer surface when said tube is disposed in a tube housing,

(d) and tubings of resilient material threaded over said free end portions and having tails free from engagement with said free end portions, said tails being adapted to bend when said arms are flexed toward said side wall surface, whereby said tubes insulate said side wall from shock transmitted to said arms.

8. An electron tube including a glass envelope having a side wall and an end wall,

(a) electrodes within said envelope, the functions of said electrodes being adversely affected by vibration thereof,

(b) rigid support means rigidly engaging said electrodes and sealed through said end wall,

(c) elongated flexible contact arms connected at one end thereof to said support means outside of said envelope, said contact arms having free end portions curved towards the outer surface of said side wall and normally closely spaced therefrom, said contact arms being adapted to be flexed to cause the free ends thereof to engage said outer surface when said tube is disposed in a tube housing,

(d) and tubings of resilient material threaded over said free end portions and having tails free from engagement with said free end portions, said tails being adapted to bend when said arms are flexed toward said side wall surface, whereby said tubes insulate said side wall and said end wall from shock transmitted to said arms and said electrodes are preserved from vibration.

9. An electron tube including an envelope having a side wall and an end wall,

(a) electrodes within said envelope,

(b) support means for said electrodes extending through said end wall,

(c) elongated flexible contact arms connected at one end thereof to said support means outside of said envelope, said contact arms having free end portions curved towards the outer surface of said side wall and normally spaced therefrom, said contact arms being adapted to be flexed to cause the free ends thereof to engage said outer surface when said tube is disposed in a tube housing,

(d) and tubings of resilient material threaded over said free end portions and having tails free from engagement with said free end portions, said tails being adapted to bend when said arms are flexed toward said side wall surface to isolate said free end portions from said side wall by a distance greater than the thickness of the wall of said tubings when said contact arms are flexed.

10. An electron tube having an envelope including a cylindrical portion and an annular portion extending inwardly of said cylindrical portion,

(a) a plurality of generally cylindrical electrodes within said cylindrical portion and spaced along an axis common to said cylindrical portion,



(b) a plurality of relatively rigid support rods extending parallel to said axis and fixed to peripheral portions of said electrodes, said rods being hermetically sealed through said annular portion and including end portions extending outside of said envelope,

(c) elongated flexible contact arms each having one end fixed to a different one only of said end portions, said arms being bent to provide portions thereof extending substantially parallel to and in spaced relation with said side wall of said cylindrical portion, said arm portions having a curvature therein to cause end portions thereof to extend towards said side walls.

(d) and boots of resilient material telescoped over said end portions, said boots having a length to provide tail portions free from engagement with said end portions, whereby said boots engage said side wall when said arms are urged against said side wall for preventing transmission to said side wall of vibrations imparted to said arms.

11. An image orthicon pick-up tube comprising

(a) a glass envelope having a neck portion and an enlarged end portion, said envelope including an annular portion joining said neck and enlarged end portions and lying in a plane substantially normal to the longitudinal axis of said envelope,

(b) a plurality of electrodes in said enlarged end portion,

(c) a plurality of rods extending parallel to said axis and fixed to said electrodes, said rods being each connected electrically to a different one only, of said electrodes, said rods being sealed hermetically through said annular portion of the envelope, and having end portions extending outside of said envelope,

(d) a flexible contact member fixed to each of said end portions of the rods, said contact member including a first portion extending parallel to said annular portion and a second portion bent with respect to said first portion and towards the outer wall of said enlarged end portion, said second portion having a curvature therein towards said outer wall, of a magnitude to cause a line parallel to the envelope axis to be tangent thereto, whereby said second portion when urged against said outer wall engages said wall at its free end only, in a relatively sharp contact,

(e) and a boot of resilient material adherently telescoped over the free end portion of said contact member, said boot having a tail portion extending beyond the free end of said contact member, for isolating said free end of the contact member from the wall of said enlarged end portion when said contact member is pressed against said wall, whereby vibrations transmitted to said contact member are restrained from passage to said wall.

12. An electron tube adapted to be received within a housing when in operative position and having an elongated envelope,

(a) a plurality of electrodes within one portion of said envelope,

(b) rigid support and conducting members connected to said electrodes for supporting said electrodes and supplying voltage thereto, said conducting members extending through the wall of said envelope,

(c) external flexible contact arms connected at one end to said conductors and extending away from said envelope,

(d) and flexible means attached to the other ends of said flexible contact arms and extending beyond said other ends, said flexible means being in contact with said envelope when said electron tube is in operating position, whereby shocks imparted to said tube will be absorbed by said flexible means and said contact arms.

13. In a television camera,

(a) a housing,

(b) an electron tube having an envelope within said housing,
(c) electrodes within said envelope,
(d) rigid supports for said electrodes extending through one portion of said envelope,
(e) external elongated flexible contact arms connected at one end portion thereof to said supports, said housing having contact strips on the inner wall thereof, said arms being flat and bent across their flatness to provide a contact surface engaging said contact strips, said arms having a length to dispose the other end portions thereof in contact relation with respect to another portion of said envelope,
(f) and resilient means between said other end portions of said arms and said other portion of said envelope for insulating said other portion of said envelope from shocks imparted by said housing to said other end portions of said arms.

**14.** In a television camera,
(a) an elongated housing having conductive strips extending along the inner wall of said housing,
(b) an electron tube having an elongated envelope within said housing,
(c) electrodes within said envelope,



(d) rigid supports for said electrodes extending through one portion of said envelope,
(e) external elongated flexible contact arms connected at one group of end portions thereof to said supports, and urged against said conduction strips, said arms being flat and bent across their flatness dimension to provide an intermediate portion thereof in engagement with said strips, and to dispose the other end portions thereof in contact engagement with another portion of said envelope,
(f) and resilient means between said other end portions of said arms and said other portion of said envelope for insulating said other portion of said envelope from shocks imparted to said other end portions of said arms by said housing.

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