April 10, 1951 W. C. MARSHALL 2,548,385

MOVABLE ELECTRODE TUBE

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Fig. 1

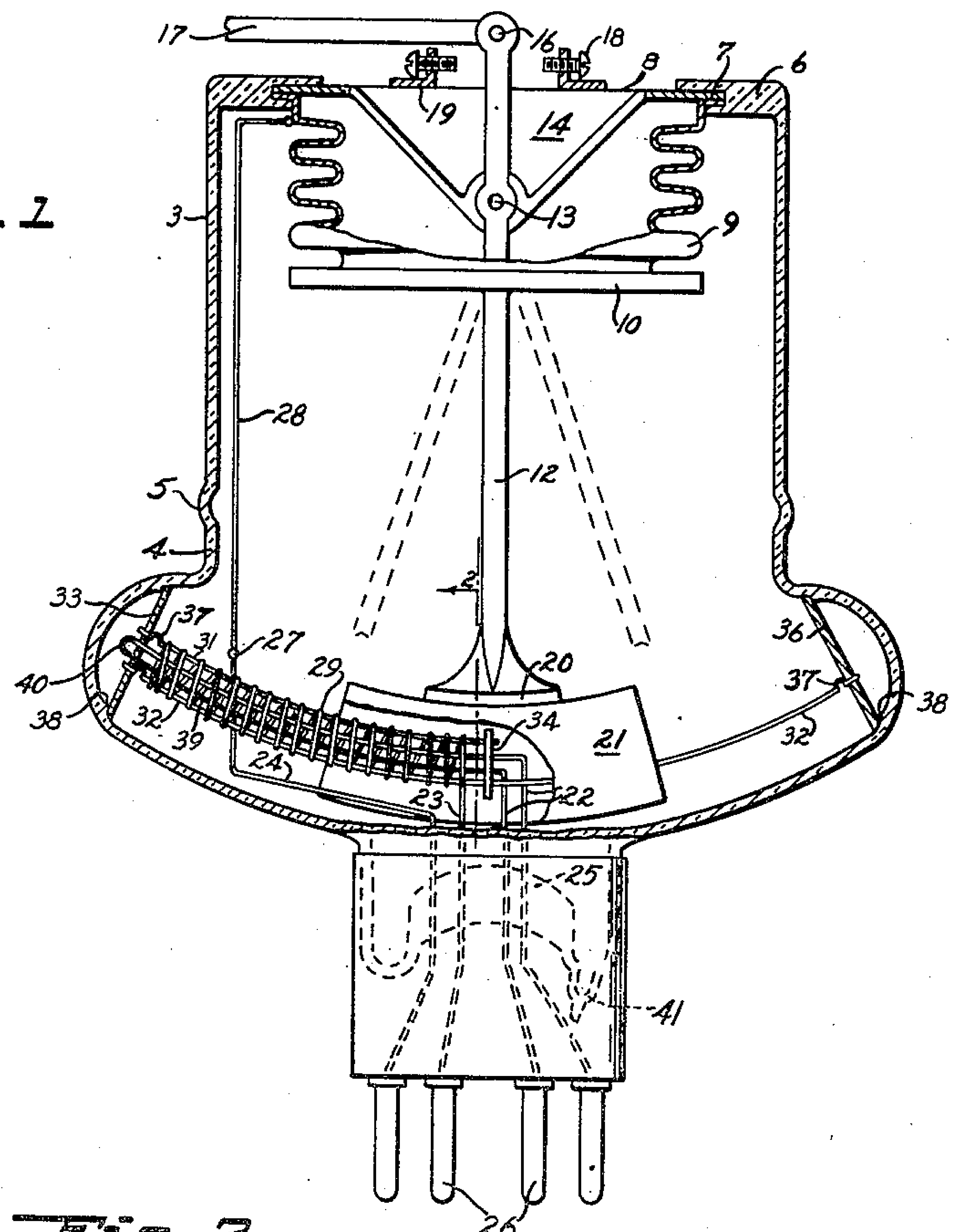
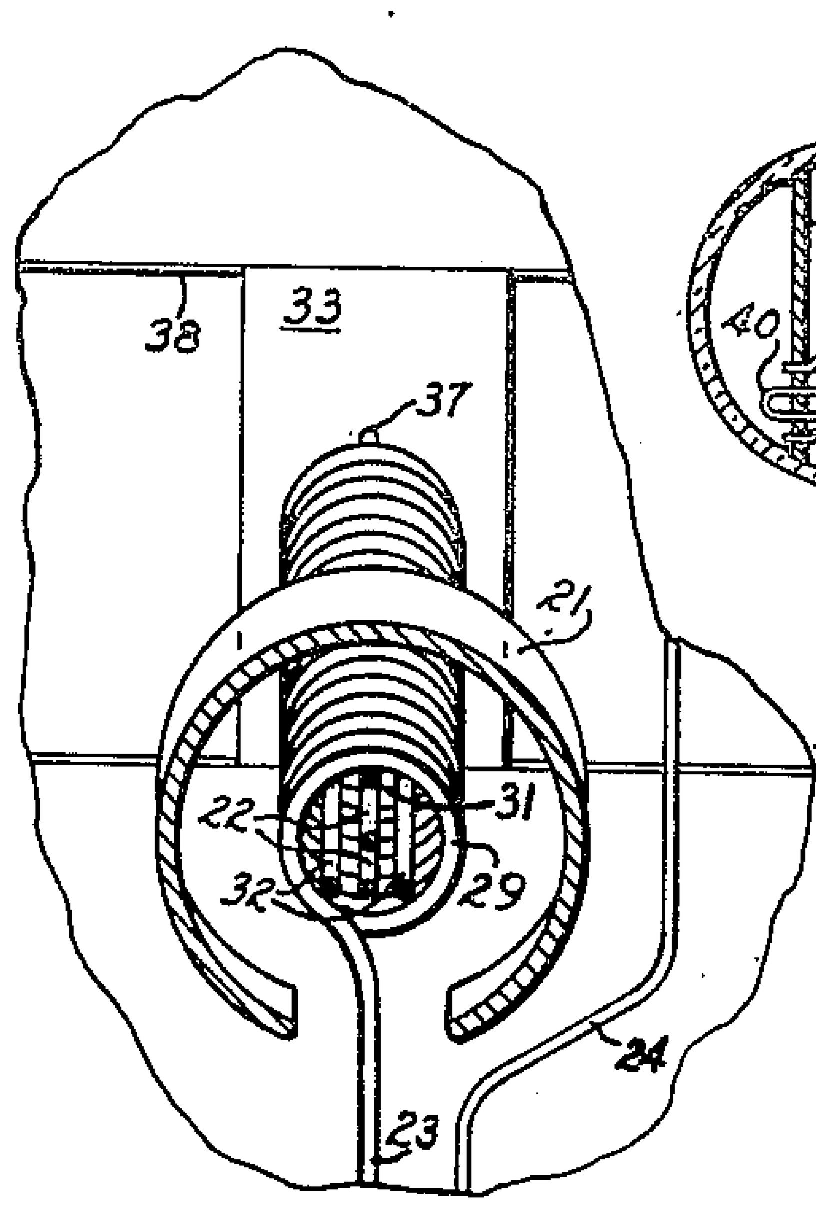


Fig. 2



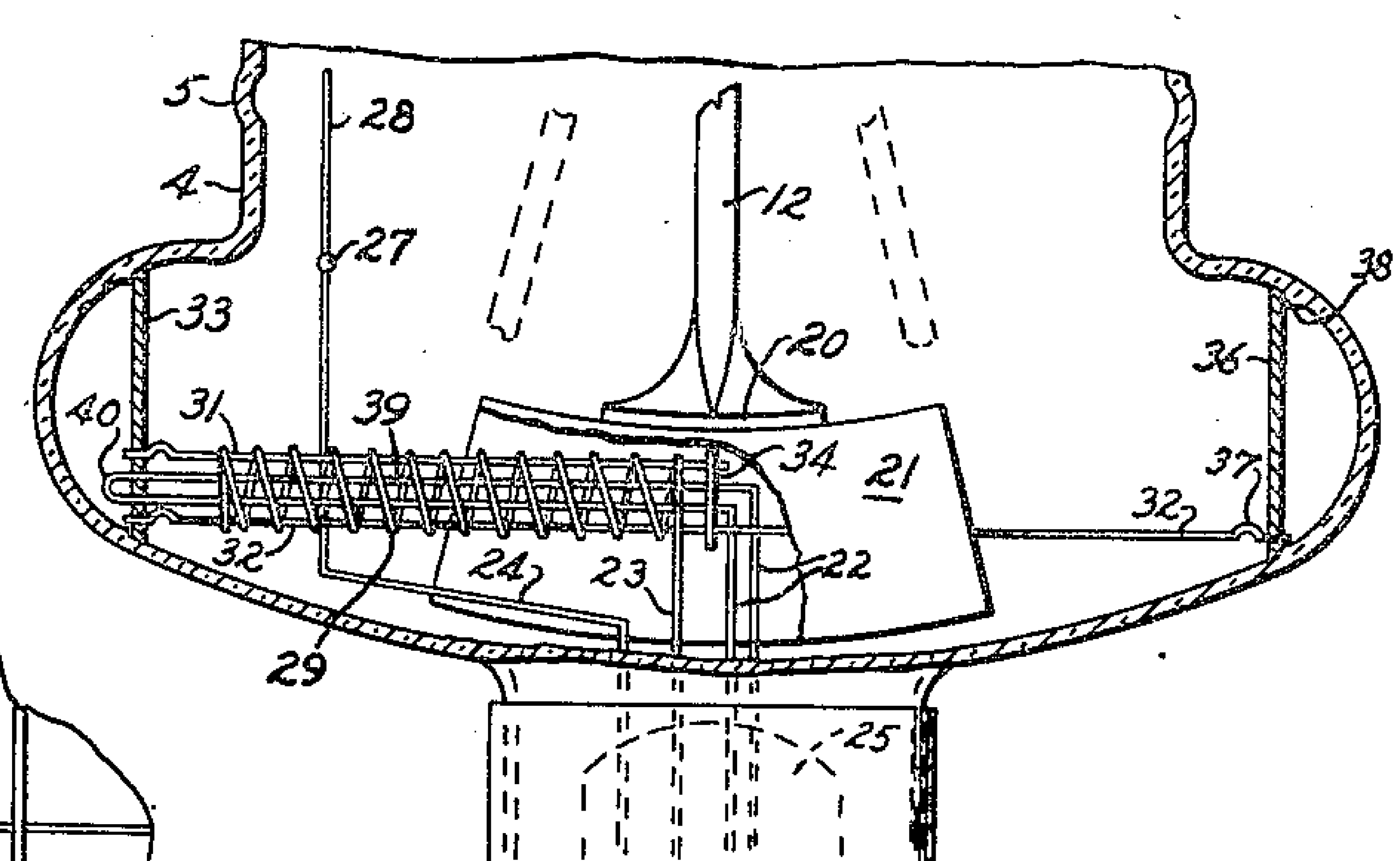


Fig. 3

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MOVABLE ELECTRODE TUBE

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8 Claims. (Cl. 250—27.5)

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My invention relates to electronic tubes; and one of the objects of the invention is the provision in an electronic tube in which one of the electrodes is movable relative to another, of means by which such movement may be effected and controlled from outside the tube.

Another object of the invention is the provision of an economical construction for an electronic tube in which fixed and movable electrodes are mounted.

Another object of my invention is the provision of an electronic tube having one electrode movable with respect to another by mechanical connection to means movable on the outside of the tube for the purpose of altering the electric characteristics of the output current in exact proportion to the extent of the movement.

In a broad sense, the object of my invention is the provision of an electronic tube in which one of the electrodes may be mechanically moved by an outside force to vary in a corresponding degree the electrical characteristics of the output current, so that such variation may be used to evaluate on a dial, or to record the degree or intensity of the moving force; and if desired, to initiate the operation of auxiliary devices to modify or apply the moving force in strict conformity to such variations of output current.

Other objects include the provision of an electronic tube such as described, characterized by low construction and installation costs, low maintenance cost, a high degree of accuracy in performance, and superior dependability.

The invention possesses other objects, some of which with the foregoing will be set forth at length in the following description wherein are explained those forms of the invention which have been selected for illustration in the drawings accompanying and forming a part of this specification. In said drawings, illustrative forms of the invention are shown, but it is to be understood that it is not limited to those forms, since the invention as set forth in the claims may be embodied in a plurality of other forms.

Referring to the drawings: Figure 1 is an elevation of my electronic tube, parts being shown in section. Figure 2 is a detail in section, the plane of section being indicated in Figure 1 by the line **2**. Figure 3 is an elevation of a portion of my tube, partly in section, and showing a straight line arrangement of the fixed electrodes.

In terms of broad inclusion, the tube of my invention comprises a vacuumized tube enclosing three electrodes, anode, cathode and grid. Two of these, preferably cathode and grid are fixedly

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disposed in one end of the tube, and the remaining anode is pivotally mounted on an axis outside the tube to swing in an arc past the fixed electrodes so that the degree of coincidence or lapping of the anode over the grid and cathode varies with movement of the anode about its pivotal axis. A laterally displaceable metallic bellows is interposed between the anode mounting and the walls of the tube so as to preserve the structural integrity of the tube while permitting lateral swinging of the anode mounting. Means external to the tube are provided for mechanically moving the anode mounting to vary the arc of coincidence between the electrodes; and when a fixed potential is supplied to cathode and grid, the anode potential is changed in a degree corresponding to variation in the arc of coincidence. Such output current changes are readily applied to the control and operation of indicating and/or recording means, which evaluates the extent of anode movement in terms of the force actuating its movement, or which control other circuits. Preferably the grid and cathode assembly is so arranged that these two electrodes lie in an arc about the axis of the anode movement. This arrangement gives perfect linear fidelity to the change in output current, but for many purposes, a straight line disposition of grid and cathode is sufficient; and since the straight line construction is the cheaper, it may be used where a slight departure from the linear values is of no consequence.

Force to move the anode mounting may be derived from an infinite variety of machines or sources having a part which moves, or which fluctuates variously in response to changing conditions; and the resulting variation in output current may be devoted to the managing of devices for the control of the machine or source.

Thus if the water in a reservoir is to be maintained at a constant level, one of my tubes is suitably disposed in an electric circuit, and a float is mechanically connected to swing the anode back and forth in accordance with the rise and fall of the float. If a constant potential is then supplied to the tube, the changes in output current which correspond exactly to the degree of anode movement, can be readily utilized by means of well known accessory devices to indicate at a distant point the water level in the reservoir, record its changes, and automatically manage circuits for the operation of gates in supply or discharge lines to maintain the desired level.

In detail my electronic tube comprises an envelope conveniently made in upper part **3** and lower part 4, fused together along a line 5, after the assembly therein of the contained parts and before vacuumizing. The upper part 3 of the tube is cylindrical and the end is formed with a flange 6 in which is embedded the flange 7, extending radially from the end 8 of the bellows tube 9, so that the bellows structure hermetically closes the adjacent end of the envelope. Fixed to the plate 10 forming the inner end of the bellows is a stem 12 extending on both sides of the plate. The stem is pivoted by the pin 13 to the reentrant portion 14 of the bellows end 8; and is pivotally connected by pin 16 to the link 17 which connects the stem either directly or by intervening devices to whatever instrumentality is relied on to move it, as for example to the float in the case above referred to. Movement of the stem may be adjustably limited by set screws 18 in cross bars 19 extending across and fixed on the end 8.

The opposite end of the stem, within the envelope terminates in a small arcuate head 20 to which is fixed one of the electrode elements of my tube. This may be the anode 21, comprising a split, slightly curved tubular plate. The curve is in an arc centering at the axis of movement of the stem; and the split is opposite the head 20 and provides a freeway to permit the anode to swing freely past the leads 22, 23 and 24 for the cathode, grid and anode respectively.

These leads pass downwardly through press 25 to the terminals 26 by which the tube is connected in circuit in the usual way. Inside the envelope the lead 24 is carried to the side of the envelope and connected at 27 to the extension 28 which is connected to the metal wall of the bellows.

The grid lead 23 is extended into coils 29 forming the grid of the tube. These coils are wound about and supported by slender arcuate rods 31 and 32 seating at one end in a mica end plate 33. There is but one rod 31 which seats at its inner end, adjacent the central long axis of the envelope, in a mica plate 34. There are two similar arcuate rods 32, passing through and supporting the mid plate 34; and seating in the mica end plate 36, on the opposite side of the envelope from the plate 33. Small kinks 37, near the ends of the rods help to maintain them in position in their supporting plates. The plates are seated against very small flanges 38 spun or molded in the wall of the envelope part 4, and the supporting structure is so planned and arranged that the resilient tendency of the long supporting rod 32 to straighten out, is relied on to help hold the assembled parts in position. The cathode leads 22 are extended into a long loop 39 lying within the grid coils 29, the end 40 finding support in the mica plate 33 as shown.

It will be observed that the bellows and anode may readily be assembled in the envelope part 3; and the grid and cathode assembled in the envelope part 4, ample space and work room for the assembling being provided by the open ends of the envelope parts. The parts are suitably aligned in chucks on the glass lathe, with their open ends close, but spaced apart sufficiently to permit pulling over the end of the lead 24 and joining it to the projecting end of the extension 28. After this union 27 by tie or weld, the adjacent envelope edges are brought together and fused into a single envelope wall. The line of this fusing is indicated at 5 in Figure 1; and is generally evidenced by a low bead surrounding the envelope at that level. It is of course quite practicable to run the anode lead on the outside of the envelope connecting its upper end to the exposed bellows end, and thus avoiding the more delicate operation of connecting the leads through the narrow space before final closing together of the envelope parts.

After the union of the envelope parts, the envelope is exhausted through the tubulation 41 in the usual way.

In assembling the bellows and anode, the parts are arranged as shown in Figure 1, with the arc of coincidence between the fixed and movable electrodes equal to about one-half the possible total; and stresses in the bellows equalized. If now a constant potential be supplied to the cathode and grid, any movement of the anode results in a corresponding and exactly proportional change in the output current, an increase if the swing of the anode is to the left so as to increase the arc of coincidence, and a decrease if the anode swings to the right to lessen the arc of coincidence. Dotted lines in Figure 1 suggest the extremes of right and left movements of the anode. The output current may be utilized through the conventional relays or in connection with other conventional electronic tubes for the control and management of a power circuit supplying a motor.

In Figure 3, I have shown a tube in which the structure is the same and the anode swings over the grid-cathode assembly in the same way as in Figure 1; except that the grid and cathode are disposed in a straight line instead of in an arc. The straight unit is both simpler and cheaper to make and assemble and for most purposes the very small deviation in output current, due to changing separation distance between the electrodes, is negligible. Since the only difference between the parts of Figures 1 and 2 is the small difference in shape of the grid-cathode assembly, the same reference numerals are used in both figures.

I claim:

1. An electron discharge device comprising a vacuumized tube one end of which is enlarged in an annular bulge to provide inside the tube an annular recess, a pair of end plates disposed diametrically in said recess, a pair of spaced rods carried by said plates in a generally diametral position with respect to said annular bulge, a mid plate mounted on the rods between their ends, a third rod carried by the mid plate and an end plate and triangularly spaced from the other two rods, and a grid electrode coiled about the spaced three rods.

2. An electron discharge device comprising a vacuumized tube one end of which is enlarged in an annular bulge to provide inside the tube an annular recess, a pair of end plates disposed diametrically in said recess, a pair of spaced rods carried by said plates in a generally diametral position with respect to said annular bulge, a mid plate mounted on the rods between their ends, a third rod carried by the mid plate and an end plate and triangularly spaced from the other two rods, a grid electrode coiled about the spaced three rods, a cathode electrode supported within the grid coils on the mid plate and end plate, and an anode mounted for movement in the tube and relative to the grid and cathode.

3. An electron discharge device comprising a vacuumized tube, an electrode fixedly mounted within the tube, and a movable electrode mounted for movement in an arc adjacent the fixed electrode and about a fixed center of the arc outside the tube.

4. An electron discharge device comprising a

vacuumized tube, an electrode fixedly mounted within the tube, a movable electrode mounted in close overlapping relation to the fixed electrode and for pivotal movement about a fixed axis external to the tube, and means for rocking the movable electrode.

5. An electron discharge device comprising a vacuumized tube, an electrode fixedly mounted within the tube, a stem mounted for pivotal movement about a fixed axis external to the tube, a second electrode carried by the stem inside the tube and in close overlapping relation to the fixed electrode, and means outside the tube for rocking the stem to vary the degree of overlapping between the electrodes.

6. An electron discharge device comprising a vacuumized tube, cathode and anode electrodes arranged within the tube in overlapping relation, means in the tube fixedly mounting one of the electrodes, and means external to the tube for mounting the other electrode for movement about a fixed axis to vary the amount of overlapping.

7. An electron discharge device comprising a vacuumized tube, cathode and anode and grid electrodes arranged within the tube, two of said electrodes being fixedly mounted and the other electrode being mounted in overlapping relation to the fixed electrodes and for movement to vary the amount of overlapping about a fixed axis

external to the tube, and mechanical means for moving said other electrode about said axis.

8. An electron discharge device comprising a vacuumized tube, a bellows including a movable end wall constituting a portion of the vacuumized tube, a stem fixed to and extending through the wall, means outside the tube for mounting the stem for pivotal movement about a fixed axis, cathode and anode electrodes arranged within the tube in overlapping relation, means for fixedly mounting one of said electrodes, the other electrode being mounted upon the inner end of said stem, and means for moving the outer end of said stem to rock the stem about its axis to vary the amount of overlapping of said electrodes.

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