

May 10, 1949.

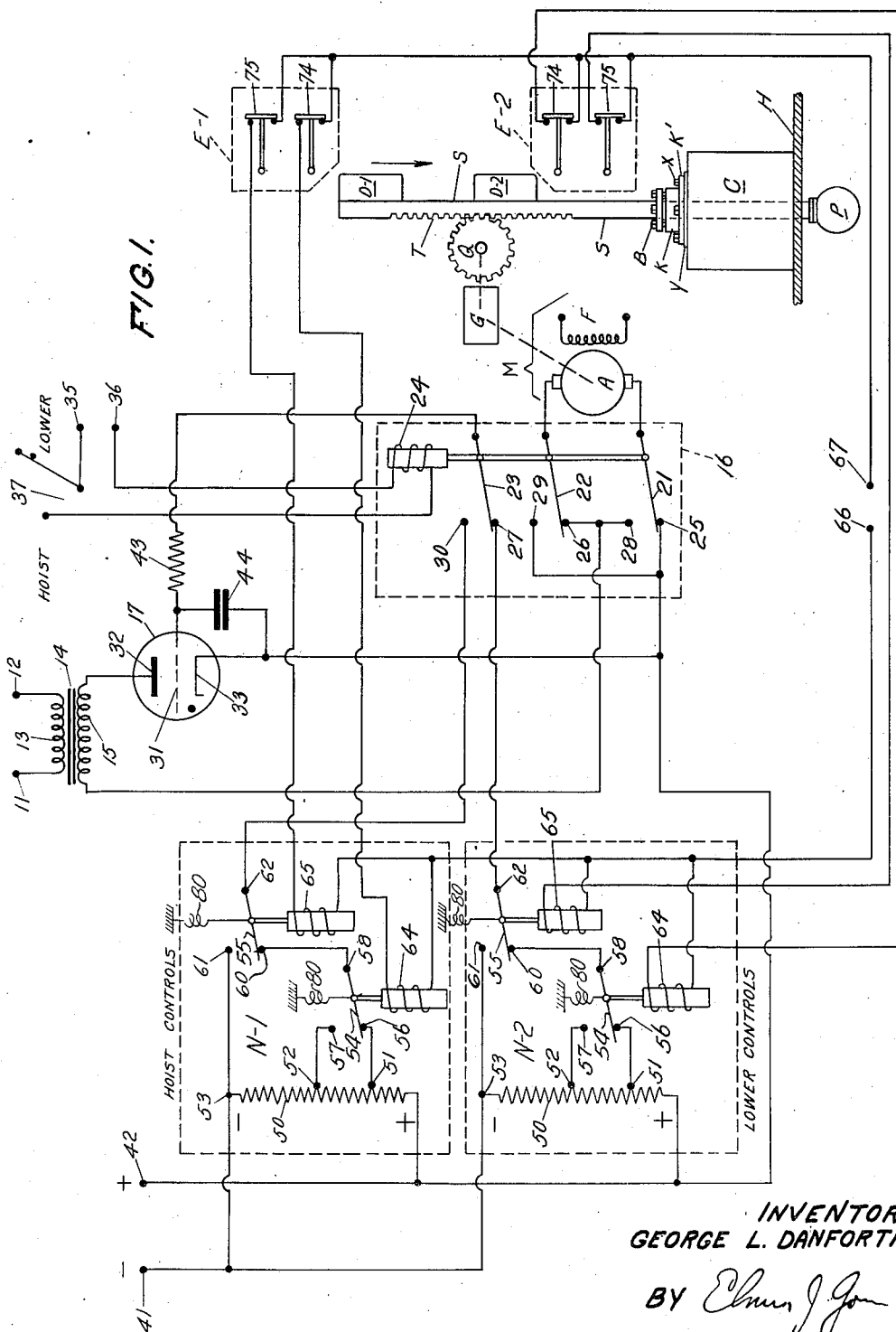
G. L. DANFORTH

2,469,594

HOIST-LOWER CONTROL

Filed July 26, 1947

2 Sheets-Sheet 1



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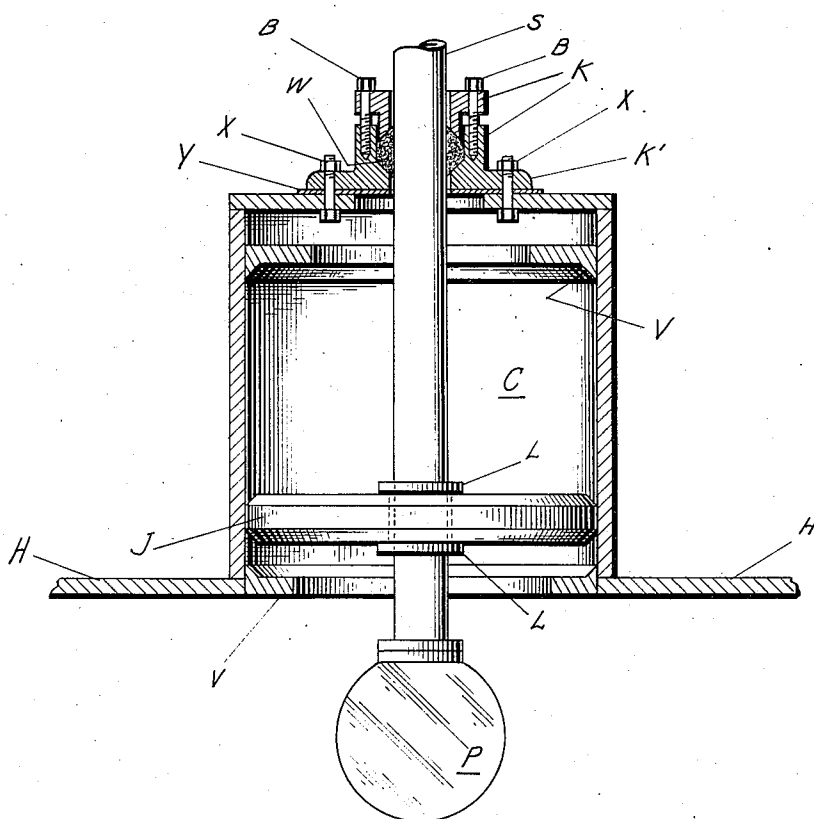
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2 Sheets-Sheet 2

FIG. 2.



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UNITED STATES PATENT OFFICE

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HOIST-LOWER CONTROL

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6 Claims. (Cl. 318—282)

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This invention relates to means for operating a device which must be extended into or retracted from a fluid medium. Such devices have been commonly used in underwater sound communication where a sound projector is extended into the water from a vessel. The vessel may be a submarine, or a surface vessel, or the projector may be on some overboard apparatus into which it is retracted when not in use.

Such sound projectors are usually large and heavy. They must often be extended a number of feet into the water, and the extension and retraction must also be done rapidly and in such a manner that no mechanism is injured or damaged. The mechanism, when retracted within the vessel, usually is seated in a so-called sea chest through which a shaft extends into the vessel. A watertight packing surrounds the shaft and when the projector is retracted, or extended to its furthest position, a flange surrounding the shaft comes to rest on a limit collar for the purpose of properly supporting the shaft and thus aiding in providing a watertight seal.

While it is desirable to extend and retract the apparatus quickly, it is also desirable to seat the apparatus in its extreme positions carefully and slowly. In the prior art this has usually been done by shutting off the power through the driving motor a little before the projector reaches its final position and permitting the shaft to coast until the final position has been reached. Since it is difficult to cut the power as accurately as desired, sometimes the motor drives the projector hard against its seat and provides a substantial and perhaps damaging impact between a limiting collar and the flange. If, on the other hand, the motor is turned off too early the gear may not seat sufficiently tightly for best storage or efficient use.

In accordance with the present invention, means are employed to reduce the speed of the motor when it is desired to seat the apparatus in its limiting positions. This, in the present invention, may be accomplished in a particular manner without the use of control rheostats by operating the motor through a gaseous conduction tube in which the firing portion of the electrical power cycle may be controlled or selected. The speed of the motor may be reduced near the limits of travel of the projector and shaft by causing current to flow through the gaseous conduction tube during a comparatively shorter portion of the electrical power cycle so that not only will the motor creep along at slow speeds but the average power will be less, although the ability

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to seat the sound projection gear in a limit position will be just as effective.

Further advantages and features of the invention will be apparent from the description of an embodiment thereof that follows, reference being had to the accompanying drawing, wherein

Fig. 1 illustrates in electrical and mechanical scheme a system in accordance with the invention; and

Fig. 2 is an enlarged view of the sea chest and sound projector of Fig. 1, the sea chest being shown in section.

In the drawing, an underwater sound projector-receiver P is shown being lowered from a sea chest C into the water (not shown) beneath the hull H of the vessel in which the apparatus is installed. The projector P is mounted on a shaft S which projects through the top of the sea chest C by way of a watertight seal (Fig. 2) comprising packing material W disposed between the shaft and two pressure collars K, K which surround the shaft and are pressed together by bolts B. One of the collars K has a flange K' by which the collar is fastened to the top of the sea chest C, as by bolts X. A gasket Y is placed between the flange K' and the top of the sea chest to provide a watertight joint. Pressure on the collars K, K effects a watertight seal between the sea chest C and the shaft S. The shaft S must be able readily to move through the packing material W to hoist and lower the projector P, and to that end is ordinarily lubricated with a proper grease (not shown). It will be appreciated that while the packing material W should be compressed sufficiently to keep water out of the vessel, the compression should not be so great as to prevent the shaft S from sliding or turning therein.

Two inwardly bevelled limit collars V, V are provided inside the sea chest C, one at the top and one at the bottom, surrounding the shaft S. A disc-like flange J, bevelled at both peripheral edges, fits simply inside the sea chest C between the two collars V, V, and is rotatably mounted on the shaft S, being retained against longitudinal displacement by a pair of stops L, L. The flange J is firmly seated in one or the other of the limit collars V, V when the projector P is in the fully hoisted or fully lowered position.

A direct-current type, reversible motor M, (Fig. 1) having an armature A and field coil F, which may in a usual manner be separately excited, drives the shaft S to hoist or lower the projector P by way of a rack and pinion gear arrangement having a gear wheel Q in mesh

with rack teeth T on the shaft S. If it is desired, reduction gears G may be interposed between the motor M and gear wheel Q. Two projecting dogs D—1 and D—2 are mounted on the shaft S in spaced apart relation for the purpose of operating hoist and lower limit control switches E—1 and E—2 respectively, as will be explained below.

Power is furnished to the motor M through a pair of power input terminals 11 and 12, to which is connected the primary winding 13 of a power transformer 14. The secondary winding 15 of this transformer is connected to the armature A of the motor M in series with a multi-pole double-throw switch 16 and a gaseous electron discharge rectifier tube 17. The switch 16 has three switch blades 21, 22, and 23, which are ganged together and operated simultaneously by a relay coil 24. When the coil 24 is deenergized, the switch blades are closed on their lower contacts 25, 26, and 27 respectively, as shown in the drawing, and when the coil 24 is energized, the blades move together into contact with their upper contacts 28, 29, and 30 respectively. The first two switch blades 21 and 22 are connected to the armature A of the motor M, and the third switch blade 23 is connected to the control grid 31 of the rectifier tube 17. The upper contact 28 of the first switch blade 21 and the lower contact 26 of the second switch blade 22 are joined together and connected to one end of the secondary winding 15 of the power transformer 14. The other end of this secondary winding 15 is connected to the anode 32 of the discharge tube 17. The lower contact 25 of the first switch blade 21 and the upper contact 29 of the second switch blade 22 are joined together and connected to the cathode 33 of the rectifier tube 17. The first two switch blades 21 and 22 of the switch 16 are thus operated as a double-pole double-throw reversing switch for the motor M, while the rectifier tube 17 is operated as a current regulator or speed control for the motor, as will be explained below. The relay coil 24 of the switch 16 is energized through a pair of input terminals 35 and 36, to which the coil is connected in series with a single-pole single-throw, or "on-off" type hoist-lower switch 37, shown in the "off" position. When this switch 37 is in the "off" position, the motor M is operated to lower the projector P, and when this switch is closed, the motor M hoists the projector P into the sea chest C.

The amount of power passed by the rectifier tube 17 is controlled by the amount of negative bias furnished to the control grid 31, which bias is furnished from a source of unidirectional bias potential (not shown) by way of two bias potential input terminals 41 and 42, of which the positive-potential terminal 42 is connected to the cathode 33. The bias potential terminals 41 and 42 are connected to two bias control networks, N—1 and N—2, comprising in part the "hoist controls" and the "lower controls" respectively, as shown in dotted line boxes in the drawing. The operation of each network N—1 and N—2 is controlled by the hoist or lower limit control switches E—1 or E—2 respectively. As will be recalled, the "hoist control" switches E—1 are operated by the upper dog D—1 on the projector shaft S, and the "lower control switches" E—2 are operated by the lower dog D—2 on the shaft. The grid 31 is connected to one or the other of the networks N—1 or N—2 by way of the third switch blade 23 of the multi-pole switch 16. The upper contact 30 of this switch blade is connected to the first or "hoist control" network N—1, while

the lower contact 27 is connected to the "lower control" network N—2. Thus when the motor M is being operated to lower the projector P, as shown, the bias potential furnished to the rectifier tube 17 is controlled by the "lower control" network N—2 and its limit control switches E—2. On the other hand, when the hoist-lower control switch 37 is placed on the "hoist" position, to energize the relay coil 24 of the multi-pole switch 16, the motor M is reserved to hoist the projector P, and the bias potential of the rectifier tube 17 is controlled by the "hoist control" network N—1 and the associated limit control switches E—1. A current-limiting resistor 43 is connected in series in the grid circuit, and serves to limit or prevent the flow of grid current as desired. A grid-potential smoothing capacitor 44 is connected from the grid 31 to the cathode 33.

Considering now specifically the "hoist control" network N—1 and the therewith associated "hoist control" switches E—1, the network has a potential divider resistor 50 connected across the bias potential input terminals 41 and 42. This resistor has three taps 51, 52, and 53, at which are available three different potentials for the grid 31. The first tap 51 furnishes a potential that is at most only slightly negative with respect to the cathode 33 potential, so that the rectifier tube 17 operates over a sufficient portion of the conductive half-cycle to operate the motor M at full speed. The second tap 52 furnishes a more negative grid bias potential for reduced motor speed, and the third tap furnishes a still more negative grid bias potential substantially to cut off the tube 17 and stop the motor M. Control of an electric motor like the motor M with an electron tube by varying the grid bias of the tube is described more fully in Patent No. 2,163,632 to H. A. Satterlee.

The bias potential that is to be furnished to the grid 31 is selected by a pair of single-pole double-throw switches 54 and 55. The first switch 54 has its first free terminal 56 connected to the first tap 51, and its second free terminal 57 connected to the second tap 52. The second switch 55 has its first free terminal 60 connected to the blade terminal 58 of the first switch 54, and its second free terminal 61 connected to the third tap 53. The blade terminal 62 of the second switch 55 is connected to the upper free terminal 30 of the third switch blade 23 of the multi-pole switch 16, and through that switch blade 23 to the grid 31 when the hoist-lower switch 37 is in the "hoist" position.

The two bias control switches 54 and 55 are controlled by a pair of relay magnets coils 64 and 65 respectively, each switch being closed on its first free terminal, as shown in the drawing, when the therewith associated coil is energized, and on its second free terminal under the control of a suitable biasing spring 80 or the like when the therewith associated coil is not energized. Energizing current for the relay coils 64 and 65 is furnished by way of a pair of relay power terminals 66 and 67. The first relay coil 64 is connected in series with a first normally closed switch 74 of the "hoist control" limit switches E—1, and through this switch across the relay power terminals 66 and 67. The second relay coil 65 is connected in series with a second normally closed switch 75 of the same "hoist control" switches E—1, and through this switch across the relay power terminals 66 and 67. These two normally closed switches 74 and 75 are

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properly positioned with relation to the upper dog D—1 on the projector shaft S to effect hoist limit control, as will be described below. The relay coils 64 and 65 are both energized when the hoist control switches E—1 are both closed. If desired, the relay power terminals 66 and 67 and the hoist-lower relay power terminals 35 and 36 may be connected to the same power source.

The "lower control" network N—2 and its limit control switches E—2 perform the same function in a lowering operation as do the "hoist control" network N—1 and limit switches E—1, and are substantially identical thereto in structure. Accordingly, the various parts in the "lower control" network and control switches bear the same reference characters as the corresponding parts in the "hoist control" network and switches. The bias potential output terminal 62 of the "lower control" network N—2 is connected to the lower free terminal 27 of the third or grid circuit switch blade 23 of the multi-polar switch 16. The potential divider resistor 50 of the "lower control" network N—2 is connected to the bias potential input terminals 41 and 42 in parallel with the corresponding resistor 50 of the "hoist control" network N—1. The relay coils 64 and 65 of the "lower control" network are energized in the same fashion and from the same power source as the corresponding coils 64 and 65 of the "hoist control" network N—1.

As shown in the drawing, the system is lowering the projector P. The "lower control" network N—2 is connected to the control grid 31, and the two relay coils 64 and 65 thereof are both energized. The least-negative-bias-potential tap 51 is thereby connected to the grid 31, and the motor M is operating at full speed. The "lower control" switches E—2 are so disposed that at a predetermined point along the path of the shaft S the lower dog D—2 pushes open the first switch 74 and opens the circuit of the first relay magnet coil 64 of the "lower control" network N—2. The first switch 54 then changes position, and connects the second bias potential tap 52 to the control grid 31. A more negative bias potential is now applied to the control grid, and the rectifier tube 17 conducts at a later time in each conductive half cycle of the energizing power than formerly, so that the average power furnished to the motor M is decreased, reducing the motor speed. Lowering of the projector P proceeds now at a reduced speed until the flange J is firmly seated in the lower limit collar V at which time the lower dog D—2 opens the second switch 75 of the "lower" limit control switches E—2. The second relay coil 65 becomes deenergized, and the second switch 55 changes position to connect the third bias potential tap 53, furnishing a cut-off bias potential, to the grid 31, whereupon the motor is stopped. The first switch 74 is maintained open at the same time, the spacing between the dog-contacting arms of the two switches of each set being such that both can be contacted at the same time by the dog in the limit position.

The system is now ready for a hoisting operation, which is initiated by manually changing the position of the hoist-lower switch 37 to the "hoist" position. The multi-polar switch 16 relay coil 24 is then energized, current to the motor M is reversed, and the third switch blade 23 thereof connects the "hoist control" network N—1 to the grid 31. Since the "hoist control" limit switches E—1 are both closed, the motor M proceeds to hoist the projector P at full speed. The upper dog D—1

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controls the "hoist control" limit switches E—1 and network N—1 to first reduce the speed of the motor M and then stop it when the flange J is firmly seated in the upper limit collar V. At the same time the lower dog D—2 moves away from the "lower control" limit switches E—2, permitting them to close, so that immediately after the second switch 75 of the "lower control" switches E—2 has closed, the projector travel may be reversed and the projector again lowered if desired. The hoist-lower control switch 37 maintains control at all times in the travel of the shaft S and projector P, and this travel can be reversed at any time therein; an operator does not have to wait until a limit position has been reached.

Advantages of the system in accordance with the present invention should now be more apparent. In prior systems where power to the hoist-lower motor is cut off just prior to the seating of the projector in its limit position, the projector coasts into a limit position. If the collars K are compressed too much, for example, in order to stop a water leak through the packing material W, friction between the packing material and the shaft S may be so great as to prevent seating of the projector in its limit position. The projector may then not be sufficiently extended for proper use, or not sufficiently retracted for tight seating, in which case a water leak eventually develops due to vibration. On the other hand if power to the motor is left on too long, the projector may be seated with violent force, in which case there may be jamming of the projector in a retracted or an extended position, or damage to the rack and pinion gears or to the flange and limit collars. By the present invention the projector is caused to creep into a limit position, the motor power being sufficiently great to seat the projector against the resistance of a tight packing W, but not great enough to burn out the motor M or jam the driving gears if the second switch 75 of either control switch group E—1 or E—2 should fail to open. These latter switches 75 should be adjusted to open just at the limit point, but no harm is done if they fail to open. Further, failure of one of these limit switches 75 to open has no effect on the reversibility of the hoist-lower operation.

Having now described my invention, what I claim is:

1. In a submarine listening apparatus carried and supported at the end of a shaft adapted to be extended through the hull of a vessel into the water, said shaft having limiting positions for retraction into the vessel and extension into the water, electric motor means, a gaseous conduction tube, means supplying power to said motor through said gaseous conduction tube, and switch means automatically operative when said shaft approaches a limiting position for causing said gaseous conduction tube to pass comparatively shorter power pulses while driving the motor in the same direction whereby the shaft creeps slowly to said limiting position.

2. In a submarine listening apparatus carried and supported at the end of a shaft adapted to be extended through the hull of a vessel into the water, said shaft having limiting positions for retraction into the vessel and extension into the water, electric motor means, a gaseous conduction tube having a grid bias control element, means supplying power to said motor through said gaseous conduction tube, and switch means

automatically operative when said shaft reaches the vicinity of a limiting position for controlling said grid element to provide a comparatively higher bias, whereby the tube will pass shorter power pulses and cause the shaft to creep slowly to said limiting position.

3. In a submarine listening apparatus carried and supported at the end of a shaft adapted to be extended through the hull of a vessel into the water, said shaft having limiting positions for retraction into the vessel and extension into the water, electric motor means, a gaseous conduction tube having a grid bias control element, means supplying power to said motor through said gaseous conduction tube, switch means in the circuit of said grid element, and switch control means carried by said shaft positioned to operate said switch means when said shaft reaches the vicinity of a limit position, said switch means controlling said grid element to provide a comparatively higher bias when operated by said switch control means, whereby the tube will pass shorter power pulses and cause the shaft to creep slowly to said limiting position.

4. In a submarine listening apparatus carried and supported at the end of a shaft adapted to be extended through the hull of a vessel into the water, said shaft having limiting positions for retraction into the vessel and extension into the water, electric motor means, a gaseous conduction tube having a grid bias control element, means supplying power to said motor through said gaseous conduction tube, switch means in the circuit of said grid element, switch control means carried by said shaft positioned to operate said switch means when said shaft reaches the vicinity of a limit position, said switch means controlling said grid element to provide a comparatively higher bias when operated by said switch control means, whereby the tube will pass shorter power pulses and cause the shaft to creep slowly to said limiting position, and second switch means in said circuit, disposed to be operated by said switch control means when said shaft is in said limit position, said second switch means controlling said grid element to provide a still higher bias when operated by said switch control means, whereby said motor is deenergized.

5. In a submarine listening apparatus carried

and supported at the end of a shaft adapted to be extended through the hull of a vessel into the water, said shaft having limiting positions for retraction into the vessel and extension into the water, electric motor means, a gaseous conduction tube having a grid bias control element, means supplying power to said motor through said gaseous conduction tube; a source of negative bias potential for said grid, a potential divider connected between said source and the cathode of said tube; a plurality of taps on said potential divider, of which a first tap provides a first bias potential for conditioning said tube for full motor speed, a second tap provides a second bias potential for conditioning said tube for reduced motor speed, and a third tap provides a third bias potential for substantially cutting off said tube; a pair of switch means controlling the connection of said taps to said grid, and normally connecting said first tap to said grid; and switch control means mounted on said shaft and disposed to operate one of said switch means to connect said second tap to said grid in place of said first tap when said shaft approaches the vicinity of a limit position, and to operate the other switch means to connect said third tap to said grid in place of the second tap when said shaft is in said limit position.

6. In an apparatus having a member adapted to be moved between two limiting positions, electric motor means, a gaseous conduction tube, means supplying power to said motor through said gaseous conduction tube, and switch means automatically operative when said member approaches a limiting position for causing said gaseous conduction tube to pass comparatively shorter power pulses while driving the motor in the same direction whereby said motor creeps slowly to said limiting position.

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