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3,249,823

ELECTROMAGNETIC ACTUATOR

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*Fig. 1*

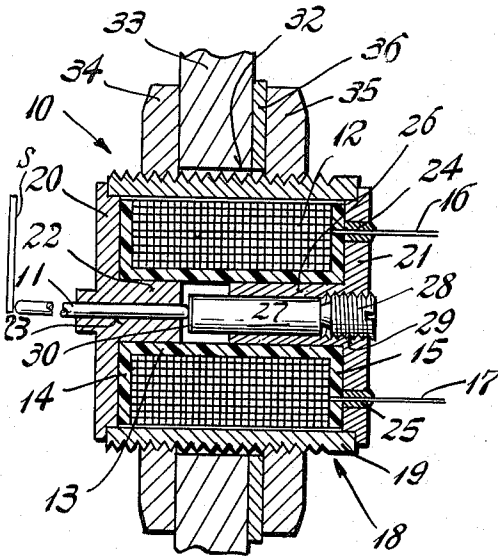


*Fig. 2*

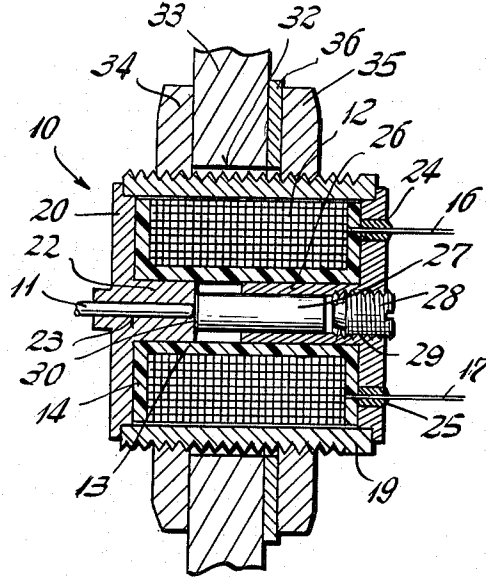


*Fig. 3*

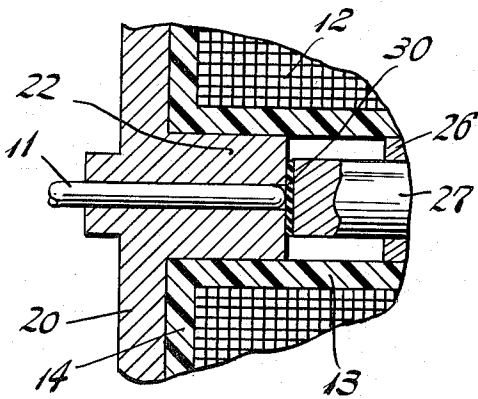
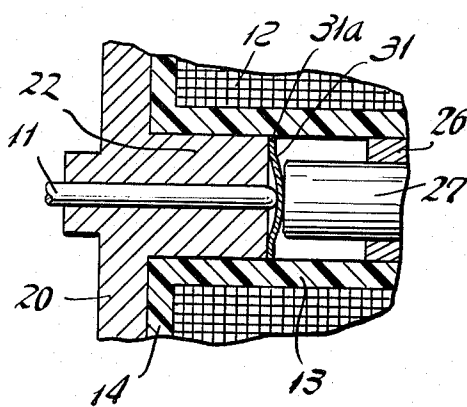


*Fig. 4*



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## ELECTROMAGNETIC ACTUATOR

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9 Claims. (Cl. 317-191)

This invention relates to an electromagnetic actuator for use with an instrumentality having a slidable operator or push rod, said actuator being operable to move the push rod from a predetermined normal position in response to energization thereof.

It is an object of the present invention to provide an electromagnetic actuator which is of simple construction, easy to assemble and which can, with facility, be assembled with an instrumentality having a means therein operated by a sliding operator or push rod, which operator is normally urged to a predetermined position and adapted to be moved therefrom by said actuator for controlling the operation of said instrumentality.

A feature of the invention resides in the novel construction whereby the actuator is self-shielding and establishes a predetermined controlled flux path.

Another feature of the invention resides in the fact that the air gap in the magnetic circuit has a definite relation to the amount of movement of the operator for controlling the instrumentality.

A further feature resides in the provision of adjustable stop means whereby the position of the armature and the establishment of the air gap can be readily accomplished to facilitate the use of the actuator with various instrumentalities.

A still further feature of the invention resides in the construction wherein the armature is completely enclosed within the unit and the unit can be readily hermetically sealed as required.

Other features and advantages of the invention will be apparent from the specification and claims when considered in connection with the accompanying drawings in which:

FIGURE 1 shows a sectional view of the actuator with the armature in normally retracted position.

FIG. 2 is a view similar to FIG. 1 showing the armature in actuated position.

FIG. 3 is an enlarged fragmentary view of FIG. 1 showing a buffer layer on the end of the armature.

FIG. 4 is a view similar to FIG. 3 showing another form of buffer layer.

As shown in the drawings, the present invention relates to an electromagnetic actuator 10 for use with an instrumentality, not shown, having a slidable operator or push rod 11 normally urged to a predetermined position by suitable means such as spring S (FIG. 1).

In the preferred form of the invention the actuator comprises a wound coil 12. While the coil may be a coreless, self-sustaining unit, it is herein illustrated as being wound on an insulating spool having a core 13 and end flanges 14, 15 with the terminal leads 16, 17 for the coil carried by and projecting from the flange 15.

A housing 18 of a readily magnetizable material, such as cold roll steel, encloses the coil and provides a self-shielding device having a controlled, predetermined flux path. The housing comprises a casing 19 surrounding the wound coil and end plates 20, 21 secured to the ends of the casing.

The end plate 20 has a bushing 22 projecting into the core 13 to lie within the coil, and has an axial bore 23 to slidably receive the operator 11, as shown in FIG. 1. The operator is preferably formed of non-magnetic material and projects beyond the end of the bushing a pre-

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determined distance as determined by the required movement of the operator to control the instrumentality.

The end plate 21 has insulating bushings 24, 25 secured therein through which the leads 16 and 17 pass and by which the coil may be connected to a suitable source of electrical energy, not shown, as required. The end plate 21 also has a sleeve 26 extending into the core 13 with its end spaced from the end of the bushing and slidably carries an armature 27 of magnetizable material. The armature is in alignment with the end of the operator, as shown in FIG. 1, and preferably has a transverse dimension greater than that of the operator so that its end cooperates with the bushing to form an air gap of great flux density.

In the preferred form of the invention the armature is normally moved to a retracted position by the force of the operator in moving to its predetermined position. As noted in FIGS. 1 and 2, the operator and armature move as one and hence there is no impact on the operator, when the coil is energized, as would be present if this relation did not exist. Therefore, vibration and improper operation of the operator or push rod by the armature, due to impact or vibrations which might be produced by the impact, are avoided.

While the armature and operator could be made as a single unit, it is preferred to make them as separate elements, as illustrated herein, inasmuch as it simplifies the assembly of the device and also permits the actuator unit to be used with various instrumentalities having built-in operators or push rods.

To further facilitate the use of the actuator with various instrumentalities, the housing has a stop 28, preferably of non-magnetic material, threaded in the outer end 29 of the sleeve which is adjustable to locate the armature in said retracted position to provide the required air gap as determined by the distance that the operator must be moved to operate a particular instrumentality with which the actuator is connected. In the illustrated form of the invention the distance through which the operator must be moved is the distance that its end projects beyond the end of the bushing and the stop is adjusted to move the end of the armature into engagement with the operator in said position. This thus establishes an air gap having a predetermined relation to the movement of the operator.

As shown in FIGS. 1 and 3, it is at present preferred to provide the end of the armature facing the bushing with a buffer layer 20 of non-magnetic material. This may be a plastic coating, rubber or other non-magnetic material which will prevent the armature from contacting the end of the bushing when it is actuated. This will prevent any sticking of these elements due to residual magnetism which might be present. Also, it prevents the armature from moving to a point in the flux path at which the maximum counter E.M.F. which may be produced is attained so that said E.M.F., when coupled with the force exerted by the operator is not sufficient to momentarily overcome the force actuating the armature whereby a smooth, vibrationless operation of the operator is provided.

As will be seen from FIGS. 1-3, the housing completely encloses and seals all of the elements of the actuator, i.e., the coil, armature and stop, and thus by sealing the connection of the unit to the instrumentality by any suitable means the device can be hermetically sealed so as to become a part of the instrumentality.

In the form of the invention shown in FIG. 4, the buffer layer comprises a flexible diaphragm 31 of flexible, resilient, non-magnetic material which has its peripheral margin 31a secured to the end of the bushing and extends across the end of the bushing in position to be interposed between the armature and the operator. In

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this type of construction the diaphragm can be applied to the bushing before the housing is assembled and effectively seals the unit and the air gap therein from any danger of contamination which might alter the operation of the device.

The device can be mounted on a support in any suitable way. In the herein illustrated form of the invention it is mounted in an aperture 32 in a support 33 by means of a pair of clamping nuts 34, 35 threaded on threads formed on the exterior of the casing and located on either side of the support to move into clamping relation with the support. If desired, a resilient lock washer 36 can be employed to securely fasten the unit in place.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

I claim:

1. An electromagnetic actuator for an instrumentality having a slidable operator movable through a predetermined distance, said slidable operator being normally urged to a predetermined position comprising a wound coil adapted to be connected to a source of electrical energy to be energized thereby, and a housing of magnetizable material forming a controlled flux path surrounding said coil comprising an outer casing and a pair of end plates secured thereto and enclosing the coil, one of said end plates having a sleeve extending into said coil and having an armature slidable therein and separate from said slidable operator and the other of said end plates having a bushing extending into the coil adjacent to but spaced from the end of the sleeve and the armature a distance equal to said predetermined distance to form an air gap having a maximum flux density in said flux path, said bushing and end plate having a bore to slidably receive said slidable operator, said slidable operator extending into the air gap a distance equal to the required movement thereof and applying a force to said armature to normally move the armature to a normally retracted position, energization of said coil causing the armature to overcome the force applied by the operator and to move toward said bushing and move the operator from said normal position for said predetermined distance to operate said instrumentality.

2. An electromagnetic actuator for an instrumentality having a slidable operator normally urged to a predetermined position comprising a wound coil adapted to be connected to a source of electrical energy to be energized thereby, a housing of magnetizable material forming a predetermined controlled flux path surrounding said coil comprising an outer casing and a pair of end plates secured thereto and enclosing the coil, one of said end plates having a sleeve extending into said coil and having an armature slidable therein and the other of said end plates having a bushing extending into the coil adjacent to but spaced from the end of the sleeve and the armature to form an air gap in said flux path, said bushing and end plate having a bore to slidably receive said slidable operator, said slidable operator being separate from and engaging the end of the armature with said armature being normally moved to a retracted position by said slidable operator, energization of said coil causing the armature to move toward said bushing and move the operator from said normal position to operate said instrumentality, and means engaging the other end of the armature for locating said armature in said retracted position.

3. An electromagnetic actuator for an instrumentality having a slidable operator of non-magnetic material and normally urged to a predetermined position comprising a wound coil adapted to be connected to a source of electrical energy to be energized thereby, a housing of magnetizable material forming a predetermined controlled flux path surrounding said coil comprising an outer casing and a pair of end plates secured thereto and enclosing the coil, one of said end plates having a

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sleeve extending into said coil and having an armature slidable therein and the other of said end plates having a bushing extending into the coil adjacent the end of the sleeve and the armature to form an air gap in said flux path, said bushing and end plate having a bore to slidably receive said slidable operator, said armature having a transverse dimension greater than said slidable operator and being normally moved to a retracted position with respect to said bushing by a force applied to one end thereof by said slidable operator, a layer of non-magnetic material disposed between the operator and armature and overlying the end of the armature, energization of said coil causing the armature to move toward said bushing and move the operator from said normal position to operate said instrumentality with said layer of non-magnetic material engaging the end of the bushing and preventing contact therewith by said armature, and means engaging the other end of the armature for locating said armature in said retracted position.

4. An electromagnetic actuator for an instrumentality having a slidable operator of non-magnetic material and normally urged to a predetermined position comprising a wound coil adapted to be connected to a source of electrical energy to be energized thereby, a housing of magnetizable material forming a predetermined controlled flux path surrounding said coil comprising an outer casing and a pair of end plates secured thereto and enclosing the coil, one of said end plates having a sleeve extending into said coil and having an armature slidable therein and the other of said end plates having a bushing extending into the coil adjacent to but spaced from the end of the sleeve and armature to form an air gap in said flux path, said bushing and end plate having a bore to slidably receive said slidable operator, a flexible sealing diaphragm of non-magnetic material secured to the bushing and interposed between the end of the bushing and operator and the end of the armature, said slidable operator being separate from the armature and applying a force to said armature, said armature being normally moved to a retracted position with respect to said bushing by the force of said slidable operator, energization of said coil causing the armature to move toward said bushing and move the operator from said normal position to operate said instrumentality, and stop means for locating said armature in said retracted position.

5. An electromagnetic actuator for an instrumentality having a slidable operator of non-magnetic material and movable through a predetermined distance, said slidable operator being normally urged to a predetermined position comprising a wound coil adapted to be connected to a source of electrical energy to be energized thereby, a housing of magnetizable material forming a predetermined controlled flux path surrounding said coil comprising an outer casing and a pair of end plates secured thereto and enclosing the coil, one of said end plates having a sleeve extending into said coil and having an armature slidable therein and the other of said end plates having a bushing extending into the coil adjacent to but spaced from the end of the sleeve and the armature to form an air gap in said flux path having a predetermined relation to the movement of said operator, said bushing and end plate having a bore to slidably receive said slidable operator, said armature being normally moved to a retracted position by said slidable operator, energization of said coil causing the armature to move toward said bushing and move the operator from said normal position to operate said instrumentality, and adjustable means comprising a stop of non-magnetic material threaded into the end of the sleeve remote from said bushing for locating said armature in said retracted position and establishing said air gap having a predetermined relation to the movement of said slidable operator through said predetermined distance.

6. An electromagnetic actuator for an instrumentality

having a slidable operator of non-magnetic material and normally urged to a predetermined position comprising a wound coil adapted to be connected to a source of electrical energy to be energized thereby, a housing of magnetizable material forming a predetermined controlled flux path surrounding said coil comprising an outer casing and a pair of end plates secured thereto and enclosing the coil, said casing being cylindrical and having threads on the exterior thereof and having clamping nuts thereon whereby said actuator can be mounted in an opening in a support in predetermined relation to said instrumentality and one of said end plates having a sleeve extending into said coil and having an armature slidable therein and the other of said end plates having a bushing extending into the coil adjacent to but spaced from the end of the sleeve and the armature to form an air gap in said flux path, said bushing and end plate having a bore to slidably receive said slidable operator with said slidable operator projection into the air gap a distance equal to the required movement of the operator, said armature being engaged and normally moved to a retracted position with respect to said bushing by said projecting slidable operator, energization of said coil causing the armature to move toward said bushing and move the operator from said normal position to operate said instrumentality, and adjustable stop means for engaging and locating said armature in contact with said slidable operator in said retracted position.

7. A self-shielding, electromagnetic actuator for an instrumentality having a slidable operator of non-magnetic material and normally urged to a predetermined position comprising a wound coil adapted to be connected to a source of electrical energy to be energized thereby, a housing of magnetizable material forming a predetermined controlled flux path surrounding said coil comprising an outer casing and a pair of end plates secured thereto and enclosing the coil, one of said end plates having a sleeve extending into said coil and having an armature slidable therein and the other of said end plates having a bushing extending into the coil adjacent the end of the sleeve and the armature to form an air gap in said flux path, said bushing and end plate having a bore to slidably receive said slidable operator, said slidable operator being separate from and normally applying a force to one end of said armature to move the armature to a retracted position, a buffer layer of non-magnetic material between said armature and said bushing, energization of said coil causing the armature to move toward said bushing and move the operator from said normal position to operate said instrumentality with said buffer layer preventing engagement of said armature with said bushing, and adjustable non-magnetic means within the housing engaging the other end of the armature for locating said armature in said retracted position.

8. An electromagnetic actuator for an instrumentality having an operator movable through a predetermined dis-

tance for operating an instrumentality and normally urged to a predetermined position, said actuator comprising a wound coil adapted to be connected to a source of electrical energy to be energized thereby, means cooperating with said coil for defining a controlled predetermined flux path therefor, said flux path having a gap therein of predetermined length, an armature movable in said predetermined flux path on the energization of said coil for closing said gap, the gap closing movement of said armature being directly related to the predetermined distance through which said operator is movable, said armature being engaged at one end by said operator and normally held in retracted position thereby and, on said coil being energized, overcoming the force applied by said operator and moving to close said gap in said flux path, whereby said operator is moved from said predetermined position through said predetermined distance and adjustable means engaging the other end of said armature for locating it in said retracted position.

9. An electromagnetic actuator for an instrumentality having an operator movable through a predetermined distance and normally urged to a predetermined position, said actuator comprising a wound coil adapted to be connected to a source of electrical energy to be energized thereby, readily magnetizable means cooperating with said coil for defining a predetermined flux path therearound, said flux path having a gap therein in the area of greatest flux density, an armature movable in said flux path on said coil being energized for closing said gap, one end of said armature being engaged by said operator and normally urged thereby to a retracted position, adjustable means engaging the other end of said armature to stop the armature in said retracted position, the distance said armature moves from retracted position to close said gap defining the length of said gap and being directly related to the distance through which said operator is movable, said armature on said coil being energized overcoming the urging of said operator and moving to close said gap, whereby said operator is moved from said predetermined position through said predetermined distance.

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