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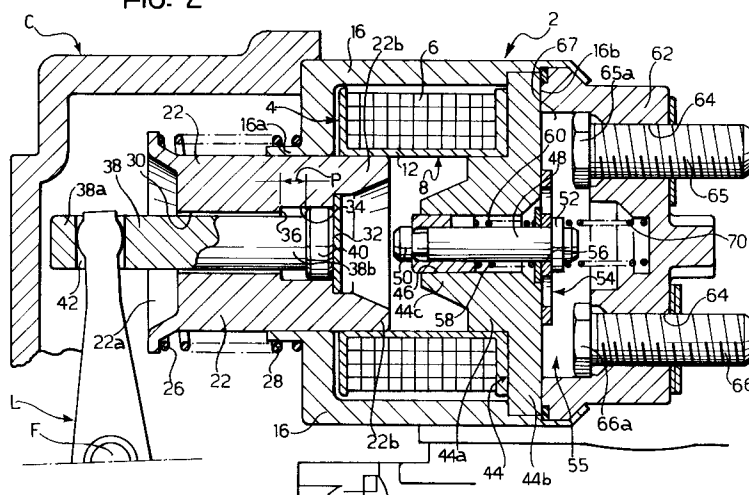
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I-10152 Torino (IT)(54) **Electromagnetic control device for an electric starter motor for internal combustion engines.**

(57) The device comprises an electromagnet (4) with a winding (6) and a movable core (22) with which is associated a return spring (28) which tends to retain the core in a rest position. This core (22) can be moved, by the excitation of the winding (6), towards an operative position in which it closes a switch (55; 54, 65a, 66a) which controls the supply of current to the starter motor. On the opposite side to the switch (55), the core (22) is associated with a control member (38), one end of which can be coupled to a lever

transmission member (L) in order to couple a pinion (120) to a ring gear (122) of the internal combustion engine. This control member (38) is slidably coupled to the movable core (22) with predetermined relative axial clearance (P) between the two such that, when the movable core (22) moves from the rest position into the operative position and vice versa, the core (22) can perform an initial stroke of predetermined length before engaging and entraining the control member (38).

FIG. 2**EP 0 643 411 A1**

The present invention relates to an electromagnetic control device for an electric starter motor for internal combustion engines, comprising an electromagnet having a winding in which is disposed a movable core to which are associated return means tending to retain the core in an axial rest position, and which can be moved, by the excitation of this winding, towards an axial operative position in which it closes a switch which can control the supply of current to the starter motor; on the side opposite the switch, the core is associated with a control member, one end of which can be coupled to a lever transmission member in order to couple a member controlled by the starter motor to a corresponding member of an internal combustion engine.

Such electromagnetic control devices are widely used in vehicles for starting internal combustion engines.

In a known device, the control member is integral with the movable core and has at the free end a wide axial opening in which one end of the lever transmission member is free to pivot with ample clearance. When the movable core is in the rest position, this end of the lever member is located behind the edge of the axial aperture which is turned towards the switch. In this way, as a result of the excitation of the winding, the movable core moves from the rest position towards the switch, performing an initial stroke of predetermined length before engaging and entraining the lever transmission member. In the last portion of the stroke, the movable core closes the contact of the electric switch which supplies the starter motor; the latter starts to rotate, rotating the fly wheel of the internal combustion engine.

Conversely, from the operative position, the end of the lever transmission member is situated behind the edge of the axial opening of the control member which is turned towards the opposite side to the switch. When the winding is de-energised, the movable core is returned by the return means, in the direction opposite the preceding direction, performing an initial stroke of predetermined length, equal to the preceding stroke; before engaging the lever transmission member in order to uncouple the starter motor from the internal combustion engine, the electric switch opens as it is no longer pressed by the movable core, de-energising the starter motor.

The sequence of steps during which the starter motor is not supplied and is uncoupled from the internal combustion engine, as a result of the relative axial clearance between the control member and the lever, is necessary since the drive member controlled by the starter motor (generally a pinion connected by a free wheel to a hub which meshes with a helical gearing on the rotor shaft of the

starter motor), when it transmits torque, is forced to maintain the meshing with the fly wheel of the internal combustion engine since the helical gearing of the shaft faces in the opposite direction to the sense of rotation of the starter motor rotor.

The known device described above has the disadvantage that the need for relative axial clearance between the control member and the lever transmission member increases the size of the control member in the axial direction, with the consequent increase in the size of the electromagnetic device in the same direction.

The object of the invention is to produce an electromagnetic device enabling this disadvantage to be overcome.

According to the invention, this object is achieved by an electromagnetic device of the above-mentioned type, characterized in that the control member is slidably coupled to the movable core with a predetermined relative axial clearance between the two, such that, when the movable core moves from the rest position to the operative position, and vice versa, the core can perform an initial stroke of predetermined length before engaging and entraining the control member.

In this way, the relative axial clearance between the control member and the lever transmission member is obtained inside the movable core and no longer externally thereof. Consequently, the axial size of the control means, and hence the overall axial size of the electromagnetic device, can be reduced.

The invention will now be described with reference to the appended drawings which illustrate some preferred embodiments thereof, presented solely by way of non-limiting example. In the drawings:

- Figure 1 shows schematically a partial sectional view of a starter motor;
- Figures 2, 3 and 4 are longitudinal sections of an electromagnetic device according to the invention, illustrated in different operating steps;
- Figures 5 and 6 are longitudinal sections of an electromagnetic device according to two variants of embodiment.

In Figure 1, a starter motor conventionally consisting of a casing 102, inside which is arranged the inductor winding 104, and of a rotor 106 substantially comprising a pack of sheets 108, in which are disposed the armature winding, a commutator 110 and a shaft 112, concentric with the casing 102 and secured between two supports C and C' such that it is free to rotate is indicated 100.

The part of the shaft 112 in correspondence with the support C has a helical gearing 114 which engages the hub 116 of a free wheel clutch 118 which can drive a toothed pinion 120.

An electromagnetic control device 2 is associated with the starter motor 100.

When the electromagnetic device 2 is excited, it urges the free wheel 118 towards the ring gear (fly wheel) 122 of an internal combustion engine (not illustrated) and closes a switch which supplies the starter motor; the pinion 120 meshes with the ring gear 122 and rotates it.

The helical gearing is in the opposite direction to the sense of rotation of the rotor 106 and thus in the opposite direction to the rotation of the shaft 112 which is integral therewith, such that, when the pinion 120 transmits torque to the ring gear 122, it tends to "unscrew" the hub 116 from the helical gearing 114 of the shaft 112; the pinion 120 presses against the shoulder 124 and thus maintains the meshing with the ring gear (fly wheel) 122 of the combustion engine.

This situation, which is necessary in the starter phase, is particularly critical in the event of the combustion engine failing to start, since the starter motor continues to be supplied even when the electromagnet (2) is de-energised.

It is then necessary to interrupt the supply to the starter motor in order to enable the electromagnetic device 2 to separate the pinion 120 from the ring gear (fly wheel) 122; in order to satisfy this requirement, predetermined clearance P is imparted to the kinematic sequence comprising the starter device 2, the lever L and the free wheel with hub and pinion (118, 116, 120).

In Figures 2, 3 and 4, the support (at the pinion side) and the electromagnetic control device, generally indicated 2, for the electric starter motor of an internal combustion engine, is indicated C. A lever transmission member L, with its fulcrum at F on the support C, is associated with the electromagnetic device 2.

The electromagnetic device 2 comprises an electromagnet 4 with a winding 6. The winding 6 is housed in a coil 8 comprising a tubular core 12. The tubular casing 16 surrounds the winding 6 and the coil 8. The casing 16 has an end part 16a of reduced diameter, coaxial with and adjacent the tubular core 12 of the coil 8, in which a movable core 22 can slide axially.

The movable core 22 has axially opposite ends indicated 22a and 22b. The end 22a of the movable core 22 is flared and defines externally a widened section 24 defining a shoulder surface 26. A spring 28, interposed between the shoulder surface 26 and the casing 16, is disposed about the core 22.

The movable core 22 has a central axial through-hole 30. Close to the end 22b, the hole 30 leads into an axial cavity 34 of larger diameter which is closed by a transverse disc 32. A shoulder surface 36 is defined in the cavity. A control mem-

ber 38, of which the axially opposite ends are indicated 38a, 38b, can slide axially inside the hole 30 in the cavity 34. At the end 38b, the control member has a head 40, with a widened cross-section, which can slide in the cavity 34 between the shoulder surface 36 and the disc 32. The distance between the shoulder surface 36 and the disc 32, which constitute stop surfaces for the head 40, is larger than the dimensions, in the axial direction of this head, such that the head is axially movable in the cavity 34 with predetermined relative axial clearance, indicated P in the drawings. At the end 38a, the control member 38 has a transverse aperture 42 in which one end of the lever transmission member L is engaged.

Integral with the coil 8 and the casing 16 is a fixed core 44 having a central cylindrical portion 44a engaged in one end of the core 12 of the coil, a ring gear or flange 44b and an end 44c tapered frustoconically and turned towards the movable core 22. The fixed core 44 has an axial through-hole 46 in which a rod 48 can slide axially. The rod 48 comprises respective heads 50 and 52 at both ends.

A metal plate 54, externally of the hole 46, is slidably mounted on the rod 48, which extends through a central aperture 56 therein. The plate 54 acts as the movable contact of a switch generally indicated 55. A helical spring 60, disposed about the rod and tending to force the plate 54 against the head 52, is interposed between the plate 54 and a bush 58 carried by the rod 48.

A cup-shaped element 62 made of electrical insulating material is adjacent the fixed core 44 and is blocked in a turned edge 16b of the casing 16. The base of the element 62 has two parallel holes 64 in which are inserted two screws 65 and 66, the heads 65a and 66a of which extend in the space 67 between the element 62 and the fixed core 44, such that they face the ends of the movable contact 54. The heads 65a and 66a of the screws 65 and 66 act as fixed contacts. The portion of the rod of the screw 65 which is outside the cup element 62 is electrically connected to the battery (not illustrated); the similar portion of the screw 66 is electrically connected to the windings of the starter motor.

A helical spring 70, which, by means of its head 52, urges the movable contact 54 against the fixed core 44, is interposed between the head 52 of the rod 48 and the element 62.

Figure 1 shows the rest state of the device. In this state, the head 40 of the control member 38 abuts the disc 32 which closes the cavity 30. If, in this position, the winding 6 of the electromagnet 4 is excited, the movable core 22 moves toward the fixed core 44, performing an initial stroke of predetermined length without engaging or entraining

the control member 38. As soon as the shoulder surface 36 of the control member 38 is forced against the head 40, as shown in Figure 2, the movable core 22 entrains on its travel the control member 38 and consequently actuates the lever transmission member L, which advances and couples the toothed pinion 120 of Figure 1 with the ring gear (fly wheel) 122 of the internal combustion engine. The disc 32, which is integral with the movable core 22, engages and forces the rod 48 in correspondence with its head 50, compressing the spring 70 and attaining the operative position in which the movable contact 54 touches and connects the fixed contacts 65a and 66a to one another, in effect closing the switch 55, to enable current to be supplied to the electric starter motor which starts to rotate and drives the internal combustion engine. As the stroke of the movable core 22 and thus of the rod 48 continues, the head 52 separates from the movable contact 54 (Figure 3), loading the spring 60 which exerts a closing, gripping action of the movable contact 54 on the fixed contacts 65a and 66a; the stroke of the rod 48 terminates when the movable core 22 comes into contact with the fixed core 44: in this position, the head 52 of the rod 48 and the movable contact 54 are spaced apart by a length P' (where P' is less than P).

From this state, when the winding 6 is de-energised, the movable core 22 moves towards the rest position by the action of the spring 28. For a predetermined initial stroke P', the return of the movable core 22 occurs simultaneously with the movement of the rod 48 by virtue of the thrust of the springs 60 and 70; for a stroke which is greater than P' and less than P, the switch 55 opens and the starter motor is no longer supplied. In this way, in the initial movement, the movable core 22 should not entrain the control member 38 and the associated lever L. Further, in this step, the supply to the starter motor is suddenly stopped and the latter no longer transmits power to the combustion engine; the pinion 120 (Figure 1), which does not transmit torque to the ring gear (fly wheel) 122, is no longer urged against the shoulder 124 of the helical gearing 114 of the shaft 112, and the uncoupling of the starter motor and the internal combustion engine is easier.

This uncoupling is initiated when the disc 32, integral with the movable core 22, strikes against the head 40 of the control member 38, entraining the latter and consequently actuating the lever transmission member L.

Figure 5 illustrates a variant of embodiment of the invention in which parts which are identical or substantially equivalent to parts in the preceding drawings bear the same reference numbers. In the device in Figure 5, the cavity 30, in the movable

core 22 and turned towards the lever L, is blind and has a base 82. The head 40 of the control member 38 can slide in the cavity 30 between this base 82 and a stop ring 84 secured adjacent the mouth of the cavity 30. The control member 38 extends with radial clearance through this ring 84.

Figure 6 illustrates a variant of the solution shown in Figure 5.

The device illustrated in Figure 6 differs from that illustrated in Figure 5 in that, during the movement of the movable core 22, the control member 38 can assume positions which are not coaxial with the latter.

In the device of Figure 6:

- between its ends 38a and 38b, the control member 38 has concave profiled external surfaces 38c;
- the head 40 has a surface 40b, turned towards the portion 22b of the movable core, which has the form of a spherical cap with an axis coinciding with the axis of the control member 38; the surface 82 of the movable core 22 which contacts the surface 40b is correspondingly spherical;
- the surface 40a of the head 40 with a circular ring, turned towards the portion 22a of the movable core 22, has the form of a portion of sphere;
- the spherical surfaces 40a, 40b are connected by a third, toroidal surface 40c, the radius of which is substantially smaller than that of the surfaces 40a, 40b;
- the stop ring 84, bevelled on the core 22 in the vicinity of the aperture 30, has a trapezoidal section such that its surface 84a turned towards the core 22 touches the outer surface 40a along a circumference comprised between the junction 40c and the portion of the surface 40a which is diametrically more internal, when the head 40 is in contact with this stop ring 84;
- the transverse aperture 42 of the end 38a of the control member 38 is shaped such that it clasps the end 1 of the lever L; in assembly steps, the end 1 of the lever L is releasably inserted in the aperture 42.

The method of operation of the variants shown in Figures 5 and 6 is similar to that of the embodiments described above with reference to Figures 2 to 4.

Naturally, the principle of the invention remaining the same, the features of embodiment and details of description may vary widely with respect to what has been described and illustrated by way of non-limiting example, without departing from the scope of the present invention.

Claims

1. An electromagnetic control device for an electric starter motor for internal combustion engines, comprising an electromagnet (4) having a winding (6) in which is disposed a movable core (22) to which are associated return means (28) tending to maintain the movable core in an axial rest position, and which can be moved by the excitation of this winding (6) towards an axial operative position in which it closes a switch (55; 54, 65a, 66a) which can control the supply of current to the starter motor; on the side opposite the switch (55), the core (22) being associated with a control member (38), one end of which can be coupled to a lever transmission member (L) so as to couple a member controlled by the starter motor to a corresponding member of an internal combustion engine;
characterized in that the control member (38) is slidably coupled to the movable core (22) with predetermined relative axial clearance (P) between the two, such that, when the movable core (22) moves from the rest position into the operative position and vice versa, this core (22) can perform an initial stroke of predetermined length before engaging and entraining the control member (38).
2. An electromagnetic device according to Claim 1 in which the movable core (22), on the side opposite the switch (55; 54, 65a, 66a) has an axial cavity (30, 34) in which the control member (38) is slidably mounted.
3. An electromagnetic device according to Claim 2, in which the portion of the control member (38) which extends in the cavity (34) of the core (22) has a head (40) with a widened transverse section, which can slide in the cavity (34) between two transverse stop surfaces (32, 36; 82, 84), the distance of which is greater than the dimension, in the axial direction, of this head (40), such that the head (40) is axially movable in the cavity with the above-mentioned relative axial clearance (P).
4. A device according to Claim 3, in which the surface (40b) of the head (40) of the control member (38) is a spherical cap having an axis coinciding with the axis of the control member (38).
5. A device according to Claim 4, characterized in that the surface (82) of the cavity (30) facing the head (40) of the control member (38) is a spherical toroidal ring having an axis coinciding with the axis of the control member (38).
6. A device according to Claims 4 and 5, in which the spherical surfaces (40a, 40b) are connected by a toroidal surface (40c) having an axis which coincides with that of the surfaces (40a, 40b).
7. A device according to Claims 4, 5, 6, in which one of the stop surfaces (84) is formed by a stop ring (84) having a trapezoidal section.

FIG. 1

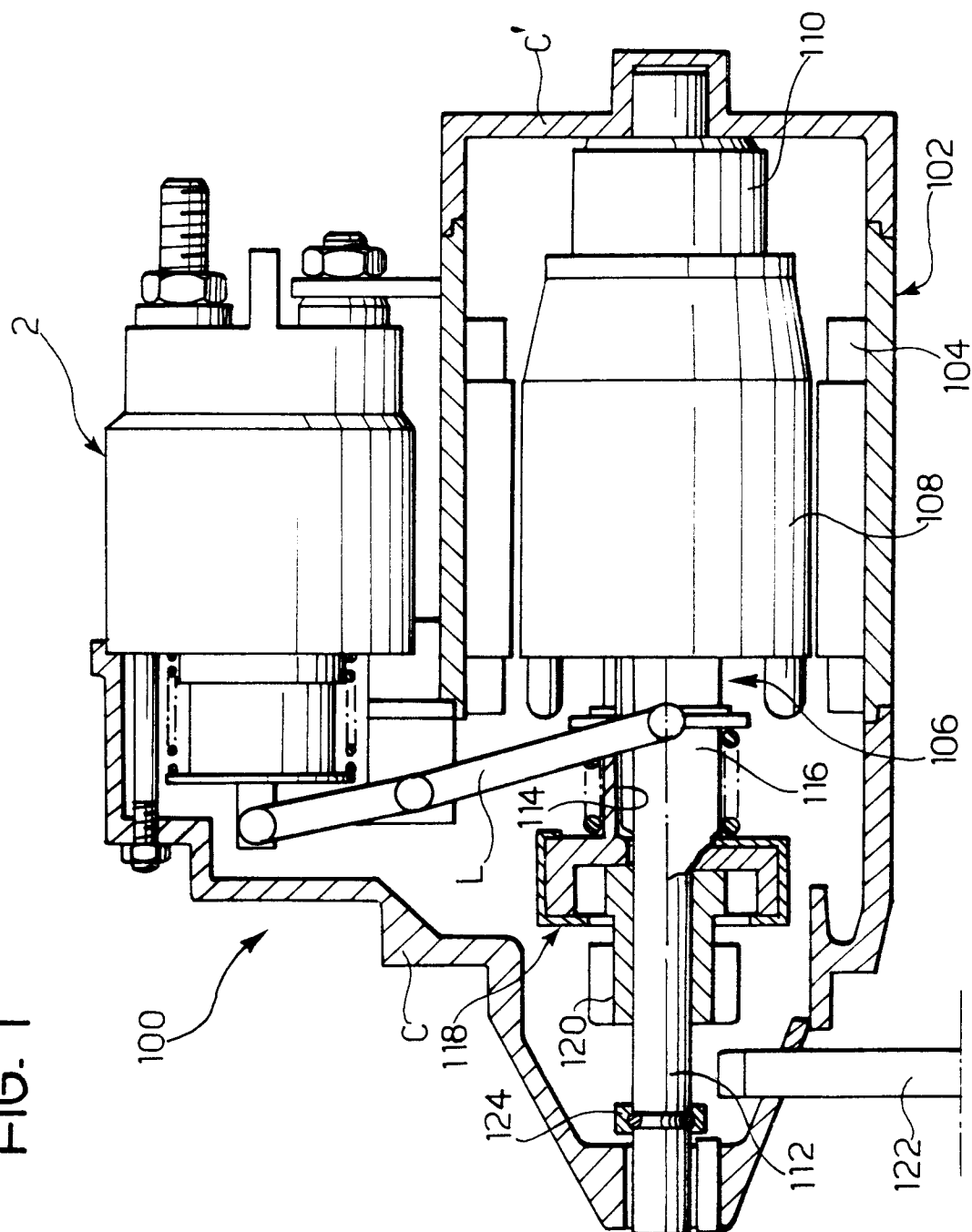


FIG. 2

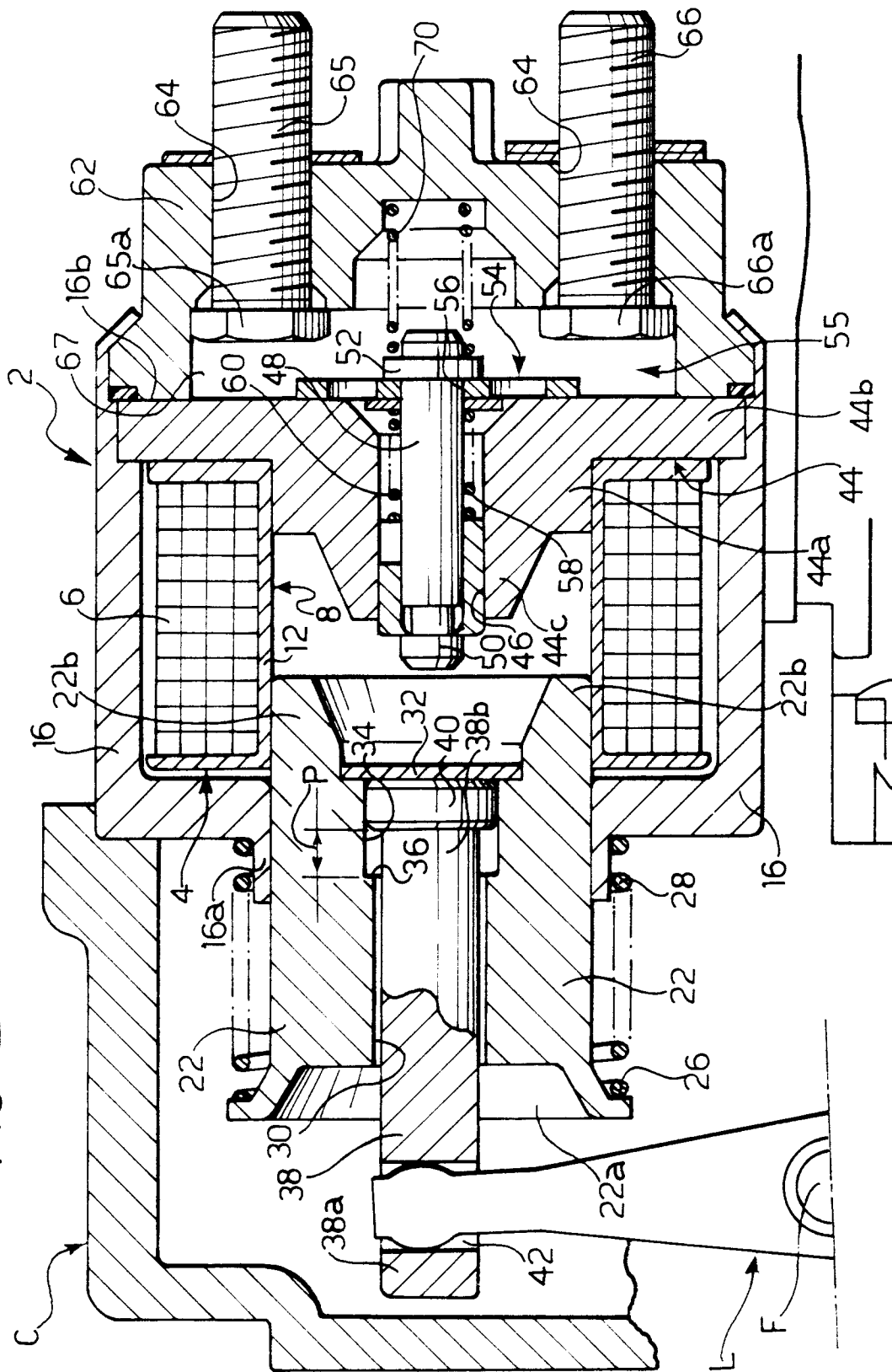


FIG. 3

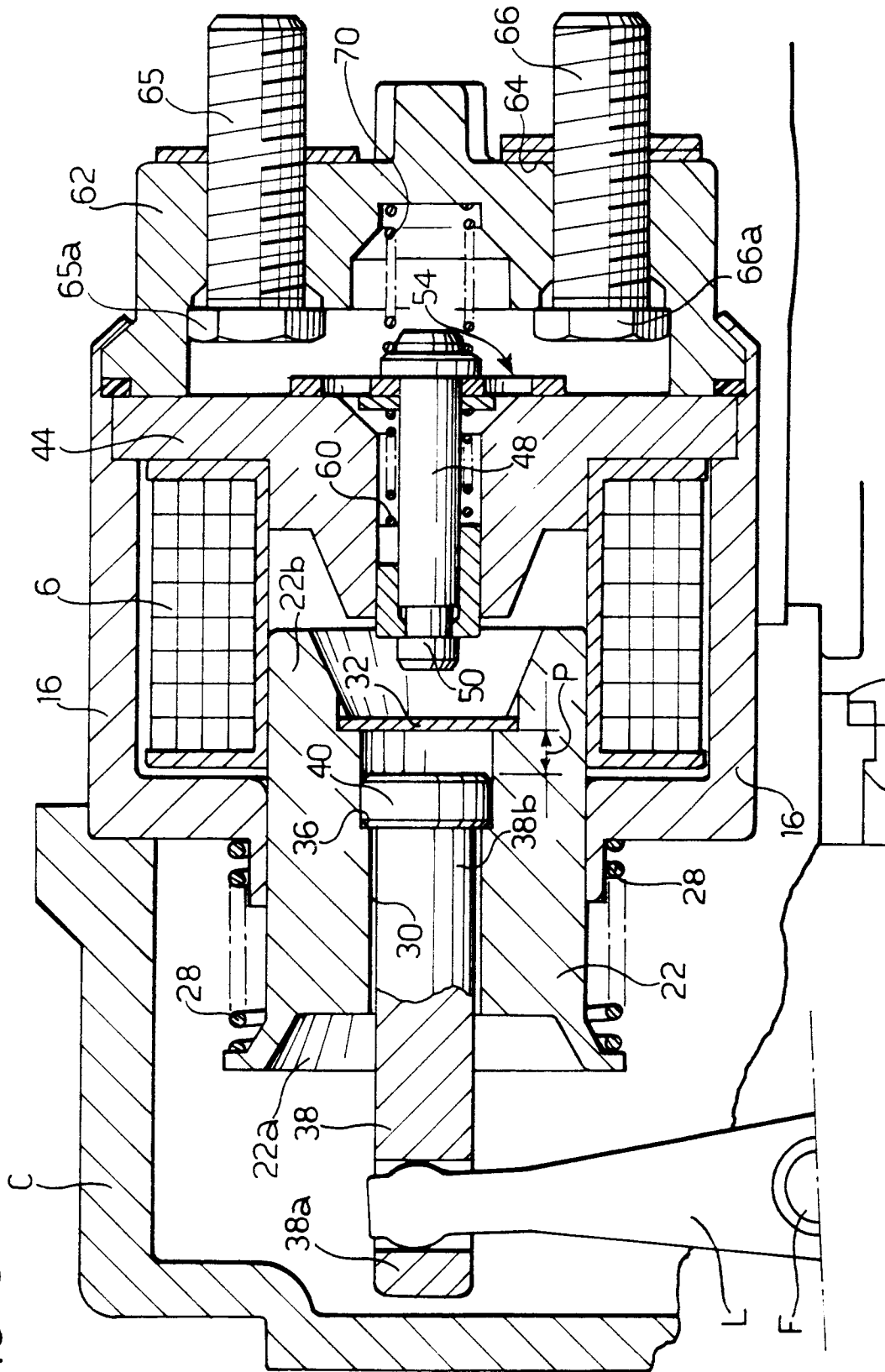


FIG. 4

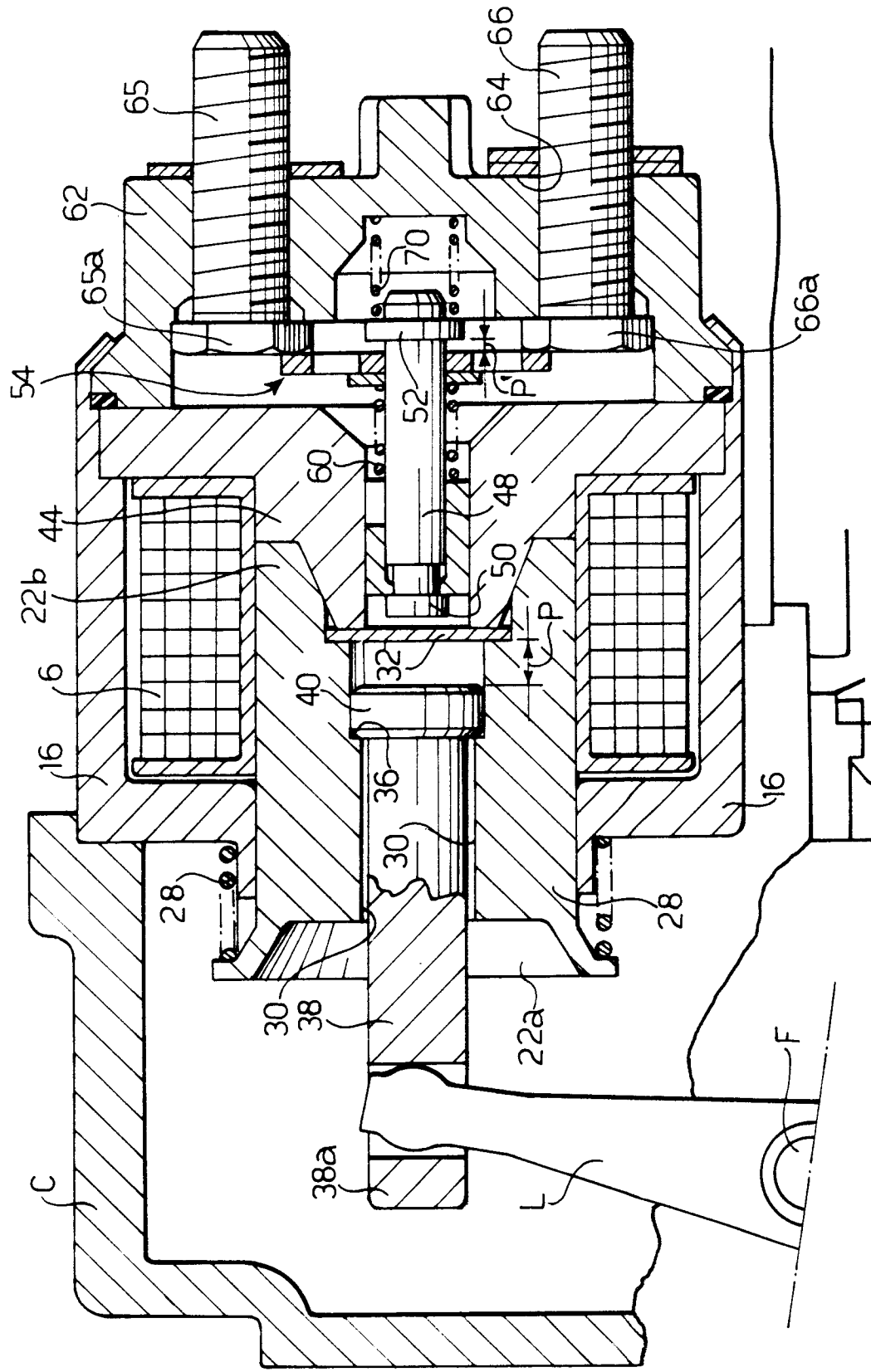


FIG. 5

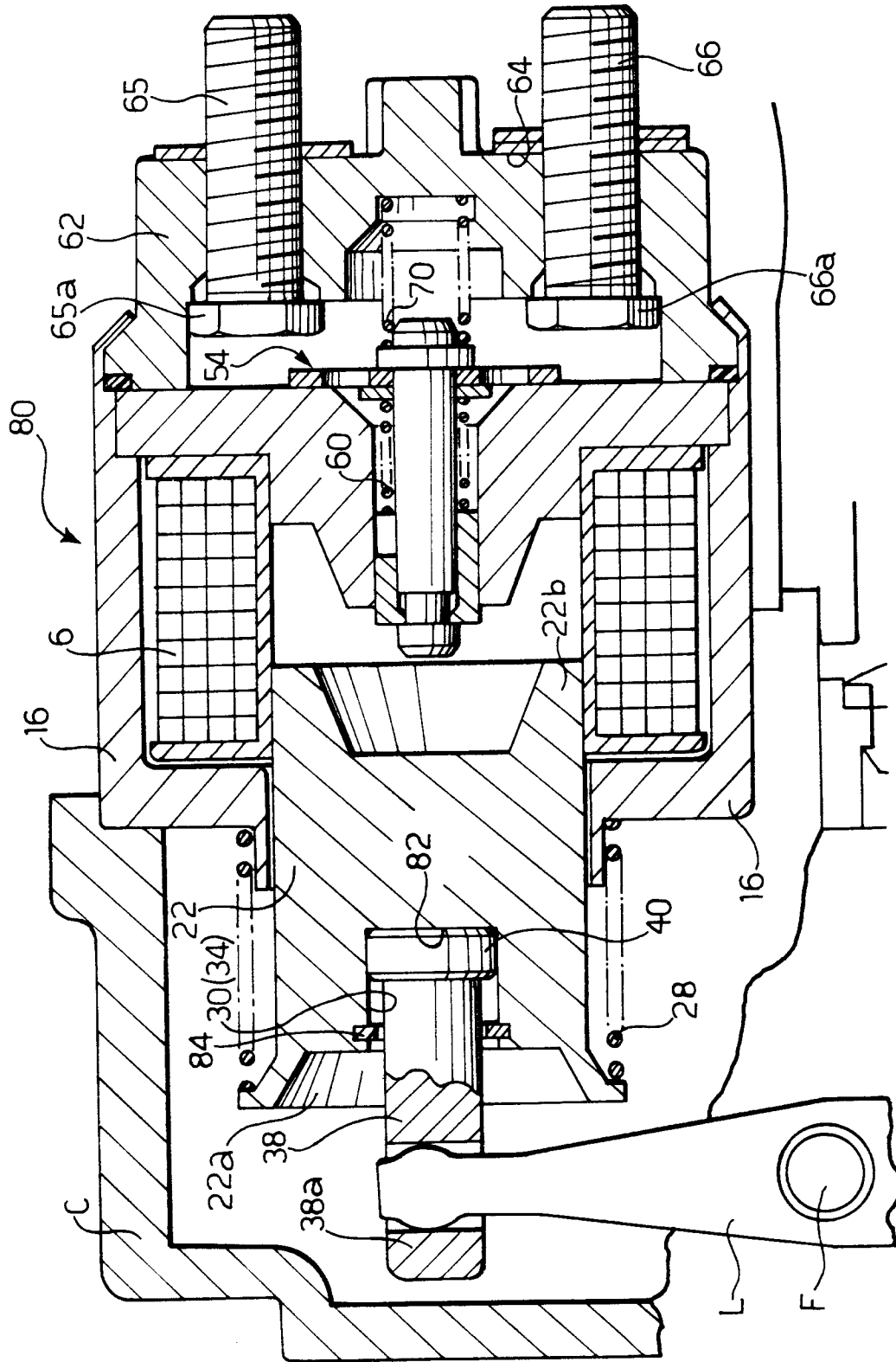
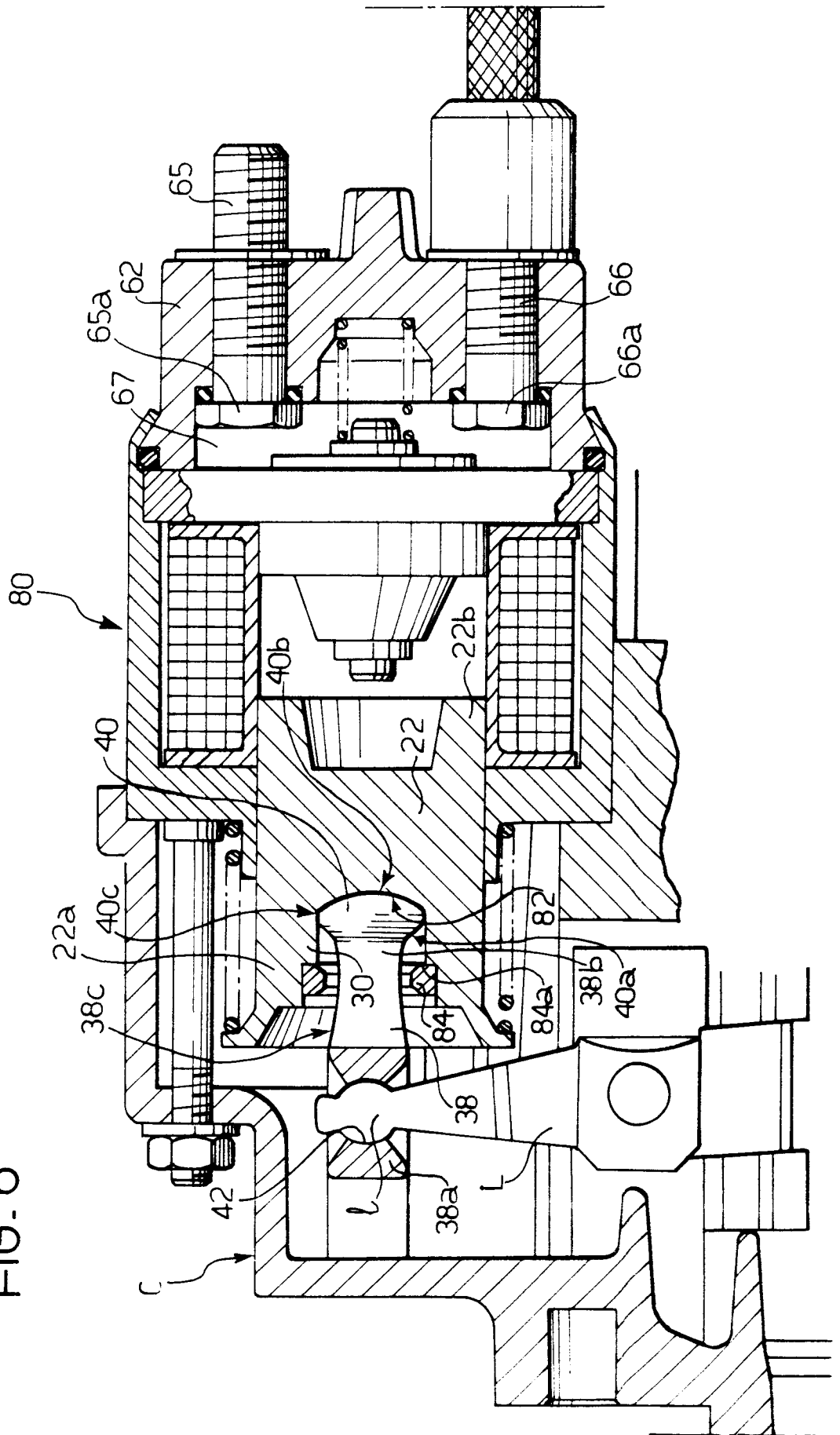


FIG. 6





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EUROPEAN SEARCH REPORT

Application Number
EP 94 11 1691

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	EP-A-0 375 378 (MITSUBISHI DENKI K.K.) * column 6, line 36 - column 7, line 36; figures 2,3A-3D * ---	1	H01H51/06 H01H50/66
Y	FR-A-2 571 783 (SOCIÉTÉ DE PARIS ET DU RHÔNE) * claims; figures 2-4 * ---	1	
A	FR-A-1 548 428 (LUCAS) * page 2, line 1 - line 8 * ---	1	
A	FR-A-2 616 580 (MITSUBISHI DENKI K.K.) * abstract; figures * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H01H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17 October 1994	Examiner Janssens De Vroom, P
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