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(54) Door operating mechanism.

(57) The invention provides a door operating mechanism which can be mounted on the pivot axis of a door. The mechanism comprises a casing 1 in which is guided axially a piston 4, and actuating member 6 therefor. Coupled to the actuating member is a pivot member 7. A compact construction results where the actuating member and pivot member have complementary helical fingers whereby rotation of the pivot member gives rise to axial movement of the acuating member and piston. The axial movement in one direction causes hydraulic fluid acting on the piston be pressurised which provides a return force acting on the piston. This can be used to return a door to a starting position from which it has been displaced. By having fluid acting on the piston instead of a spring, failure of the fluid system does not give rise to slamming of the door which is the case where the fluid merely serves as a damping medium for movement of the door. The construction renders its self-adaptable to automatic operation.

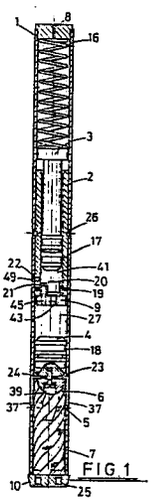

FIG 1

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Description

Door Operating Mechanism

The present invention relates to a door operating mechanism and in particular to a mechanism for controlling the opening or, more especially, the return of a door.

To close a door automatically after opening requires actuating means coupled to a part of the door, which actuating means is energised or charged up on opening of the door and then is released after opening to close the door. It is preferable to control the rate of closing. The known door closing mechanisms use a spring which is compressed on opening of the door by an actuating lever actuated by movement of the door and which acts directly on the spring, whilst the rate of closing is controlled by means of hydraulic fluid acting as a damper. the fluid being forced into a chamber on opening and acting on the actuating means in a direction to oppose closing so that by controlling the return flow of fluid the rate of closing is controlled.

The disdadvantage of such a system because of the direct spring connection is that in the event of hydraulic failure, there is no means of controlling the rate of closure. Consequently the door slams closed. It is an aim of the present invention to overcome this problem.

It is also an aim of the present invention to provide a door closing mechanism which can be easily fitted to a door and which is accommodated within the door so as to avoid unsightly mechanisms projecting from the door, or the need to have relatively awkward floor mounting.

According to the present invention then, there is provided a door operating mechanism comprising a casing accommodating a piston member which is axially movable in a piston chamber against fluid means, a pivot member which is rotatably mounted relative to the casing, and means interconnecting the piston member and the pivot member whereby rotation of the pivot member causes axial movement of the piston member and vice versa, the fluid means serving as return means.

The means interconnecting the piston and pivot members may be a part of the piston member, say as an extension, or separate from, but say connected thereto. We envisage the fluid means acting on the piston member to urge it axially and thereby generate rotation of the pivot member relative to the casing.

In a typical application of the door operating mechanism, the casing is received in a bore in the door on the pivot axis thereof and the pivot member is located non-rotatably relative thereto, say in a recess in the floor. The casing may be part of the door. Opening of the door causes the piston member to be displaced axially by the relative rotation of the casing relative to the pivot member. This axial movement is preferably used to displace hydraulic fluid from the said piston chamber to a second piston chamber to move a second piston therein which is acted on by a spring. This forms in effect an hydraulic accumulator, with pressurised fluid acting on the piston member to provide a force for returning the door/piston member to its starting position.

A particularly advantageous arrangement results when valve means is interposed between the (first) piston chamber and the second piston chamber. It is also advantageous for the area of the second piston chamber to be smaller than that of the first. More preferably, the valve means comprises a check valve allowing relative free flow of fluid from the first chamber to the second chamber whilst inhibiting, indeed preventing, flow in the reverse direction. The valve means also comprises a restricting jet, which serves to allow flow between the first and second chambers, but with restriction, preferably adjustable restriction, and which serves to control the release of pressure from the second chamber to drive the piston member axially and thus return the door to its closed position. By using hydraulic fluid to separate the piston member from the spring means automatic closing of the door does not occur on failure of the hydraulics. Furthermore, a large door closing torque can be generated with only a relatively weak spring by virtue of the hydraulic pressure multiplication which results from having pistons of different areas.

More preferably, the pivot member comprises a multi-start helical formation, with helical grooves and ridges extending axially, and which cooperate with complimentary helical fingers of an axially movable member, with the fingers received in the complimentary helical grooves. The movable member serves to actuate the piston member. The movable member is keyed to the casing conveniently by way of pins received in axial slots in the casing, so as to be axially movable but non-rotatable relative thereto. The piston member is connected to the axially movable member. Conveniently, the connection is such as to allow rotation of the piston, primarily to increase seal life, and to allow restricted axial movement therebetween. This gives a slight delay before the closing force starts to effect closure of the door as axial movement of the piston is not immediately transmitted to the axially movable member cooperating with the pivot member.

The described co-operating helical formation and helical fingers are particularly advantageous, because, they enable large surface areas to be achieved, giving minimum wear. The helical members may be of cast metal, but advantageously by making the helical members out of plastics, such as nylon, lubrication can be built in to ensure free action.

Of course, alternative actuating means may be employed using a nut and threaded member, say a multi-start, fast thread. Alternatively, a helical cam track can be provided and a cooperating abutment, say a two start internal cam track with a T-shaped abutment, having respective rollers for cooperating with a respective one of the cam tracks, axial movement being transmitted to the abutment to move the piston, on rotation of the helical cam track.

Alternatively the construction could equally be reserved.

The described construction may be modified in a simple manner to provide additional and/or alternative features which are particularly useful.

Firstly, a hold facility can be easily incorporated by providing means to hold the first piston, but preferably the second piston, in a selected displaced position. Depending on the position selected, the door/piston member can be held anywhere between its starting position and displaced position. This could be equated to closed and open positions of the door. Especially useful is to be able to hold the door open for flow of traffic but allowing closure, say automatically on releasing of the hold device. For example, the holding may be done magnetically, by having a solenoid hold the second piston in a predetermined displaced position. A latch mechanism could be employed to hold the piston in position, with the latch released electro-mechanically.

Secondly, the opening of the door could be controlled indeed prevented from opening, simply by arranging for the position of the check valve to be selectively controlled. If the check valve is held closed, then fluid is prevented from being displaced from the first chamber to the second chamber, thus creating in effect a hydraulic lock within the system. This could be done preferably electro-mechanically by a suitably magnetic solenoid, or otherwise mechanically. Of course, preventing the second piston member from displacement against the spring force could also create such a hydraulic lock giving the same effect.

A further alternative is to have automatic opening and/or closing of the door by connecting a pressurised hydraulic circuit into the piston chamber. The second piston and spring could then be dispensed with and optionally the valve means if this incorporated in the auxiliary hydraulics.

Closing of the door can be achieved by introducing pressurised fluid into the piston chamber and then opening the chamber to a return line to allow fluid out on opening of the door.

Opening and closing could be controlled by providing a double acting piston member.

The present invention will now be described further by way of example only with reference to the accompanying drawings; in which:-

Figure 1 is a sectional view through one embodiment of door return mechanism according to the invention;

Figures 2 and 3 are respectively a side view, partially sectioned, and a sectional view on line CC of the pivot member;

Figures 4, 5 and 6 are respectively a side view, a sectional view on line BB, and sectional view on line AA of a pivot cooperating member;

Figure 7 is a side view of an actuating mechanism arranged for a swing door; and

Figure 8 is a sectional view of an alternative embodiment of actuating mechanism.

The door return mechanism according to the invention comprises a casing 1, which is conveniently a tubular aluminium sleeve, say with a tube wall thickness of 3mm, a piston member 4 received slidably in part of the casing acting as a first piston chamber 27, a pivot member 7 received rotatably in the casing and means interconnecting the pivot member 7 and the piston member 4.

As best seen in Figures 2 and 3 the pivot member 7 comprises a solid member having a plurality of helical ribs 29 (four in the illustration) extending axially from a base portion 31 and with interposed helical grooves. Alternatively, the helical formation may be in the form of helical fingers. Secured to the base portion across a diameter thereof by countersunk screws 25 is an elongate rib 10, conveniently tapered in a cross-section. The pivot member 7 co-operates engagingly with the inter-connecting means in the form of a member 6 as shown in Figures 3 to 5 which comprises four helical fingers 33 which are shaped to interengage with the helical fingers 29 of the pivot member 7. The member has one or more transverse bores 3 receiving pin means 5 projecting from the outer periphery of the member, and in use, said projecting ends being received in a respective axial grooves 37 in the casing 1. This serves to constrain the member in the casing allowing axial movement, but no rotation.

It will be readily understood that by virtue of said interengaging helical ribs and fingers 29, 33, relative rotation between the pivot member 7 and the casing 1 will give rise to axial movement of the member 6. The construction is analogous with a multi-start thread and co-operating nut. In practice the member 6 is connectible with the piston member 4 so that axial movement of the latter is transmitted to the former and vice versa. Conveniently, the connection is "lose" by means of a screw 23 whose head is received in a bore 39 in the member 6 and whose shank passes through a clearance bore in the member, and into threaded engagement with a bore in the piston member. A thrust washer 24 is interposed between the member 6 and piston member 4. With the piston contacting the end face of the member 6 via the thrust washer, the head of the set screw 23 is clear of the bottom of the bore 39 by a distance of the order of 1mm.

The afore described connection with the piston member 4 is such as to allow rotation of the piston and to compensate for any axial misalignment of the member 6 so that the piston runs true in the bore of the casing. This gives good seal life. The piston member 4 is conveniently cylindrical with a plurality of grooves accommodating seals 18. The lose connection also gives rise to a delay action.

The piston member 4, member 6 and pivot member 7 are each preferably made of plastics, conveniently by moulding. A nylon or polypropylene with self lubricating properties are conveniently employed. The large surface area reduces wear and spreads the loading.

The above described means for converting rotary movement to axial movement is to be preferred, but alternative constructions are possible.

The piston member 4 is movable in the aforementioned piston chamber 27 which accommodates hydraulic fluid and which chamber is in communication with a second chamber 41 having disposed

slidably therein a second piston 3. Movement of fluid from the first chamber 27 to the second chamber 41 causes the second piston to be displaced against the force of a spring 16 which takes its abutment between a rear face of the piston 3 and an end wall 8 of the casing 1. The second chamber 41 is conveniently formed within a sleeve member 2 which is received in the casing and located thereto by screws 26 passing through the casing. Conveniently the sleeve is made of aluminium. The diameter of the second chamber and hence that of the second piston, is less then that of the first piston. There is thus a pressure magnification between the two chambers. This is particularly advantageous because it allows a weaker spring to be used than would otherwise be the case. This reduces space requirements, as well as making the door easier to open for a given available return force. The second piston 3 is sealed in the bore of the second chamber by seals 17.

Interposed between the first and second chambers is valve means comprising a plate 9 threaded into the end of the sleeve 2 and incorporating a check valve 20 and a restricting valve 21. In the illustration, the valves are associated with separate through bores 43, 45 in the valve plate. The check valve 20 allows hydraulic fluid to pass from the first chamber to the second chamber relatively unhindered whilst flow in the reverse direction is prevented (i.e. checked). The check valve can take the form of a simple ball valve engaging against a tapered seat, with or without spring biasing.

The restricting valve 21 controls the flow of fluid from the second chamber to the first. In a particularly simple and convenient form it comprises a threaded screw received in a threaded bore of the valve plate with provisions for leakage of fluid past the threads. A given screw will have a predetermined resistance and adjustment of the restriction can be achieved by changing the screw or the length threaded into the bore.

An O ring seal 19 seals the sleeve 2 relative to the casing to prevent fluid entering between the two. A bleed screw 22 is conveniently provided for bleeding the fluid chamber. This is conveniently disposed in the sleeve 2 and opens into the second chamber, and accessible through an aperture 49 in the wall of the casing 1.

The device operates as follows:-

In use the device is fitted into a bore in the door and is intended to be fitted on the pivot axis of the door. The bore is preferably close fitting so as to serve as reinforcement to the casing, and preferably the part of the door into which it fits comprises an aluminium extrusion. The device is vertical in use with the elongate rib 10 projecting from the bottom edge of the door and received in a location point on the floor or still beneath the door. The casing is secured non-rotatably relative to the door.

Starting from a position with the door closed, the parts will be in the positions illustrated in Figure 1. It will be noted that the pin 5 is above the bottom of the grooves 37 when in the down/closed position. Upon opening of the door the casing will rotate about the pivot member 7 and accordingly, the member 6 and hence the piston 4 will be driven axially upward.

This causes fluid in the first chamber 27 to be displaced into the second chamber 41 by way of the open check valve 20, so that the second piston 3 is displaced upwardly and the spring 16 is compressed. The spring compression force provided by the fluid is magnified hydraulically so that the door feels relatively easy to open. The check valve 20 offers little or no resistance to opening or at least a predetermined resistance.

Once the force holding the door open is removed, then the spring can act to return the fluid from the second chamber 41 to the first chamber 27 and so displace the piston member 4 axially and cause the casing and hence the door to rotate and thereby return to its closed position. The restricting valve limits the flow rate of fluid so that the door closes at the desired rate whilst the check valve closes under reverse flow conditions.

It is envisaged that the above described construction be modified to provide additional and/or alternative features. For example, the check valve can be actuable either adjustable variable to control the permitted rate of opening of the door, or at least to have selective open and closed positions, whereby in the closed position the door is prevented from being opened by the presence of an hydraulic lock within the first chamber. This would be done electro-magnetically or mechanically, with a switch positioned on the door adjacent the mechanism or disposed remotely.

A further possibility is to have a hold facility whereby the door can be held in an open position or any selected intermediate position. This can be done by electro-magnetic means, incorporating a solenoid to hold up the second piston until a release signal is received. Alternatively the restricting valve could further incorporate serially a check valve, electro-magnetically operated, to close the return path selectively.

A still further option is to provide remote power operation of the door, possibly for both opening and closing by having the piston 4 subject selectively to hydraulic fluid pressure from a source. The pressure could be applied to close an open door and/or to hold closed a door by pressurising the piston chamber.

Opening could be catered for by modification of the piston to be double acting with appropriate porting.

The helical actuated mechanism illustrated is of right hand thread configuration and is for use with a door opening in an anticlockwise direction with a clockwise return direction. Where the door is to open in the clockwise direction, a left hand thread configuration is required for the pivot member 7 and the interconnecting member 6. Alternatively, the same right handed configuration could be employed if it is positioned at the top edge of the door rather than the bottom, i.e. if the mechanism is inverted.

Where it is required to accommodate a double opening direction, for example in the case of a swing door having a central closed (return) position, and opening in the clockwise and anticlockwise directions, then a modified drive arrangement is required.

One possible arrangement is illustrated in Figure 7 which shows the pivot member 7′ and interconnecting member 6′ in their interengaged return position for the case of a double acting (swing) door. The length of both the members 6′ and 7′ is increased by approximately 25 mm (or an amount equal to the axial displacement of the interconnecting member for the desired opening angle (say 90 degrees). As before the pivot member 7′ is solid with helical ribs 29 defining helical grooves receiving helical fingers 33′ of the interconnecting member 6′.

In the return position, the two members are interengaged by the same amount as previously, but the end 60 of the interconnecting member 6′ is spaced from the base part 72 of the pivot member 7′ by the above mentioned increased amount and the end 70 of the pivot member is likewise spaced by said increased amount from the top end of the interconnecting member 6′.

Thus, with the illustrated right hand helical formation, rotation of the pivot member clockwise by way of the elongate rib 10′ gives rise to movement of the interconnecting member downwardly, in a direction towards the base part 72 and the limit of travel. Downward movement of the pivot member 6 brings with it the piston member 4, secured to the interconnecting member as before, (not illustrated in Figure 7). As before the interconnecting member 6′ is guided for axial movement in the casing of the mechanism, which of course has to be increased in length to accommodate the longer members 6′, 7′. Return of the interconnecting member 6 to its rest position can be achieved using a spring 90 disposed within the fingers 33′ and taking its abutment between the end 70 of the pivot member 7′ and shoulder 64 of the interconnecting member 6′

With the above described mechanisms for dual operating direction, it may be preferably for the piston member 4 to be the same diameter as the second piston member 17 (when provided) to equalise the return closing force.

With the illustrated right hand helical formation, rotation of the pivot member anticlockwise, from the illustrated rest position, gives rise to axial movement of the interconnecting member 6′ in the same manner as described previously and with consequent axial upward movement of the piston member 4. As described previously, the fluid means/accumulator can be employd to achieve damped/controlled return of the door.

It is intended that the above described dual direction (swing type) door operating mechanism be employed with a remotely controlled/sourced fluid operating means for controlling movement of the piston member such that the direct spring return means could be dispensed with.

Figure 8 shows an alternative construction of actuating means, in which the pivot member 7″ comprises a member 80 extending upwardly from a base part 82 rotatably mounted in the casing 1″ of the mechanism at 83. An elongate rib 10″ is provided for locating the pivot member 7″ relative to the floor, frame or fixed part relative to the movement door. An interconnecting means 6″ , is provided constructed essentially as before, namely a two start helical thread as illustrated made up of fingers 33″.

Cooperating with the helcial track of the fingers are rollers 84 mounted on the ends of transverse arms 86 branching from the member 80. The rollers 84 are journalled for rotation on the arms, and roll on the helical cam track surfaces defined by the fingers. A minimum of two rollers are provided, with four being a preferred number, the other two being disposed at right angles to those illustrated in section. The cooperating engagement between the rollers and the cam track gives rise to axial displacement of the interconnecting member 6″ on rotation of the door. The mechanism otherwise operates as described previously for controlled return of the door.

Claims

1. A door operating mechanism comprising a casing (1), a pivot member (7) which is rotatably mounted relative to the casing, characterised in that the casing accommodates a piston member (4) which is axially movable in a piston chamber (27) against fluid means, and the piston member and the pivot member are interconnected whereby rotation of the pivot member causes axial movement of the piston member and vice versa, and wherein the fluid means serves as return means.

2. A mechanism as claimed in claim 1 in which the pivot member comprises a helical formation engaged by cooperating abutment means to drive the piston member directly or indirectly.

3. A mechanism as claimed in claim 2 in which said helical formation comprises multi-start helical grooves and the abutment means comprises complementary helical fingers.

4. A mechanism as claimed in claim 3 in which the helical fingers are part of an axially movable member to which the piston member is coupled.

5. A mechanism as claimed in any one of claims 1 to 4 further comprising a second piston member (3) which is displaced against a spring force by the fluid means on axial movement of said piston member (4) against the fluid means.

6. A mechanism as claimed in claim 5 in which valve means is disposed between first and second piston members (4, 6) to control flow of fluid therebetween.

7. A mechanism as claimed in claim 8 or 9 in which the second piston member (6) is received in a second piston chamber (41) which is of smaller area than that accommodating the first piston member.

8. A mechanism as claimed in any one of the preceding claims in which means is provided for holding the first piston in a selected position.

9. A mechanism as claimed in claim 8 when appendent to claim 6 in which the valve means is selectively openable and closable.

10. A mechanism as claimed in any one of claims 1, 2 or 3 in which a selectively press-

urised hydraulic circuit is connected to the piston chamber (27) to control axial movement of the piston member (4) in at least one direction.

11. A door operating mechanism as claimed in any one of the preceding claims when mounted in a bore in a door on the pivot axis thereof with the pivot member adapted to be located in an abutment.

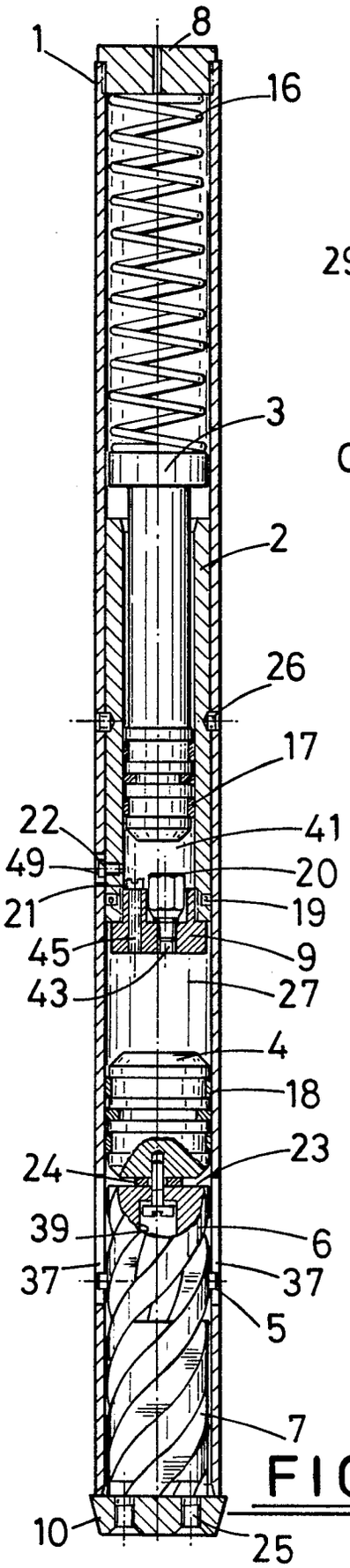


FIG. 1

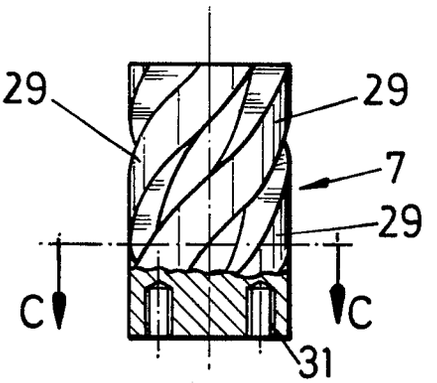


FIG. 2

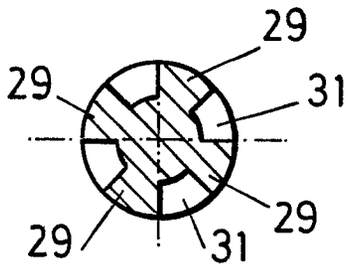


FIG. 3

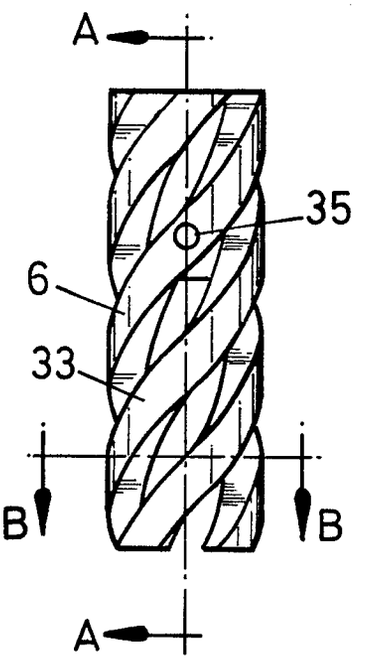


FIG. 4

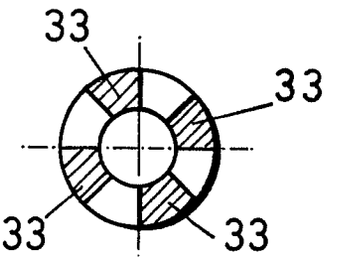


FIG. 5

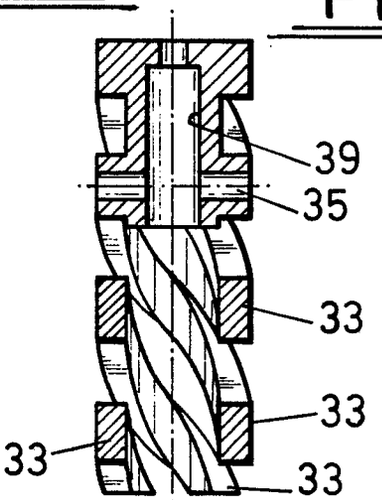
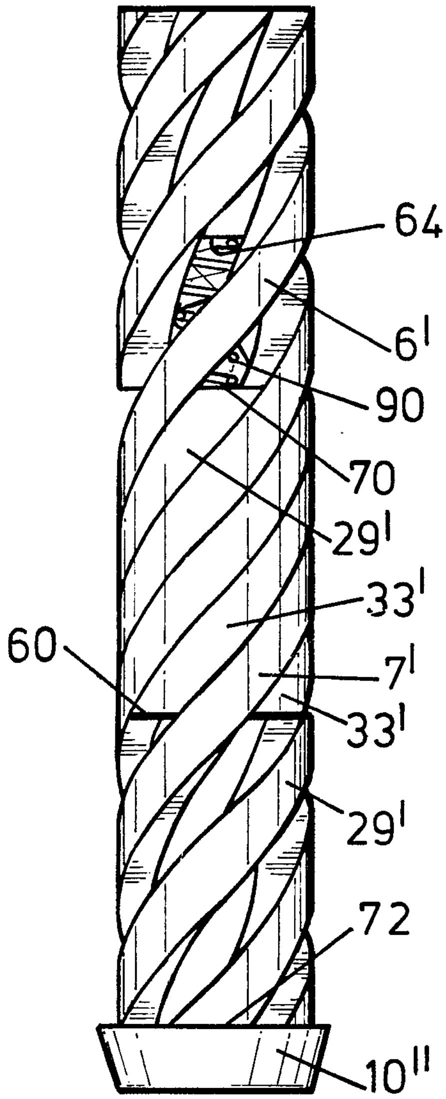


FIG. 6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33I
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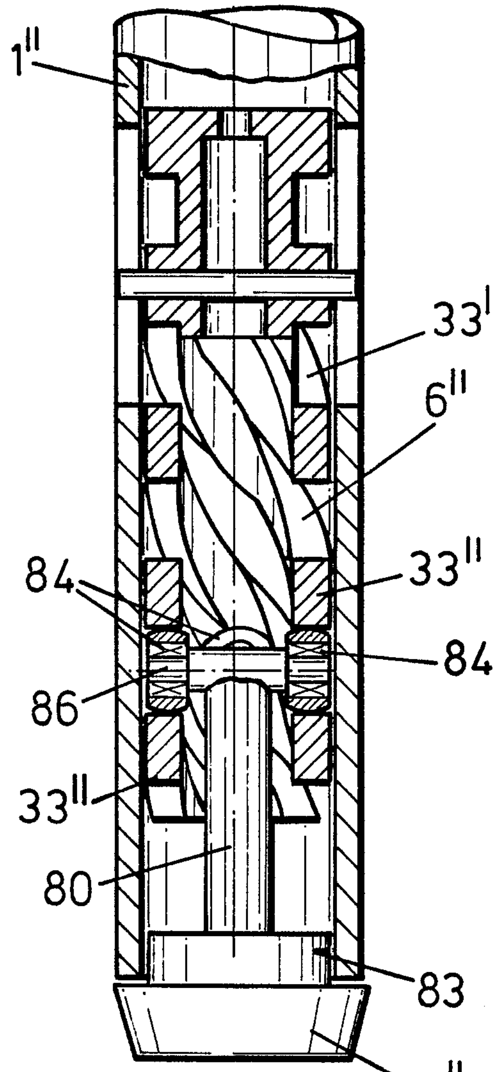
7I
33I
29I
72
10II

FIG.7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84
84
86
33II
80
83
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FIG.8