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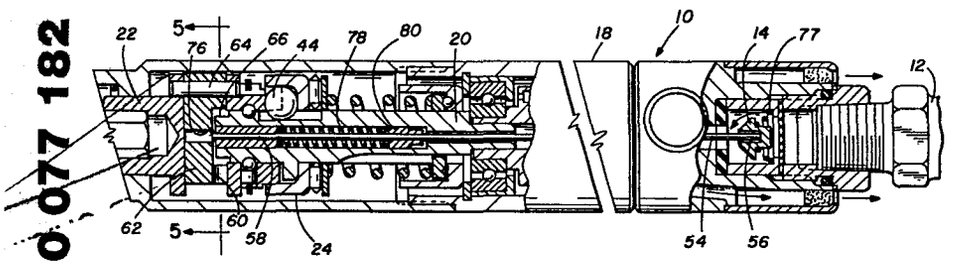
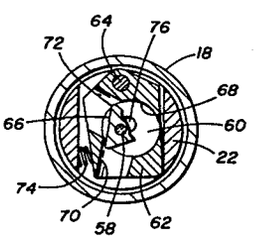
(54) Pneumatically driven apparatus.

(57) A pneumatically driven tool includes a hollow housing (18) in which is located an air motor including a rotatable motor shaft (20) arranged to drive a tool such as a screwdriver, socket wrench via a tool drive shaft (22). A torque-sensitive clutch (24) is located between the tool drive shaft (22) and the motor shaft (20) permitting the motor shaft (20) to move relative to the tool drive shaft (22) when a predetermined torque is encountered. A valve (14) located in the housing (18) between the motor and the air supply source controls the flow of pressurised air to the motor. The valve (14) is controlled by an elongated valve operating member (54) having a first end (56) engaging the valve and having a second end (58). A latch member (62) is pivotally mounted on the tool drive shaft (22) and has a surface (60) thereon that engages the second end (58) of the valve operating member (54). A hole (76) formed in the latch member (62) is sized to receive the end of the elongated valve operating member (54). Normally the hole (76) is not in alignment with the valve operating member (54) and, thus, the valve (14) is held in the open position. Upon relative rotation as previously mentioned, the latch member (62) is cammed to a position so that the hole (76) aligns with the valve operating member (54) permitting the valve (14) to close.





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PNEUMATICALLY DRIVEN APPARATUS

This invention relates to pneumatically driven apparatus, comprising: a hollow housing; an air motor including a rotatable motor shaft located in the housing, the motor being arranged for connection with a source of pressurized air and the apparatus being arranged to drive a tool such as a screwdriver, socket wrench or the like via a tool drive shaft rotatable in the housing; a torque-sensitive clutch between the tool drive shaft and motor shaft permitting the motor shaft to move relative to the tool drive shaft when a predetermined torque occurs; and a valve in the housing between the motor and the air supply source which, when open, permits air to reach the motor.

The valve controls the flow of pressurized air from the source to the pneumatic motor contained within the tool. Apparatus for controlling the opening and closing of such valves has been the subject of much work and several patents for many years.

For example, U.S. patent 2,964,151 illustrates apparatus for controlling the valve. While that apparatus operates satisfactorily, it does have certain drawbacks, such as the imbalance caused by the valve control mechanism. Such imbalance is magnified as a vibration problem unless carefully counterbalanced when used in the high rotational speed tools of present

pneumatic apparatus.

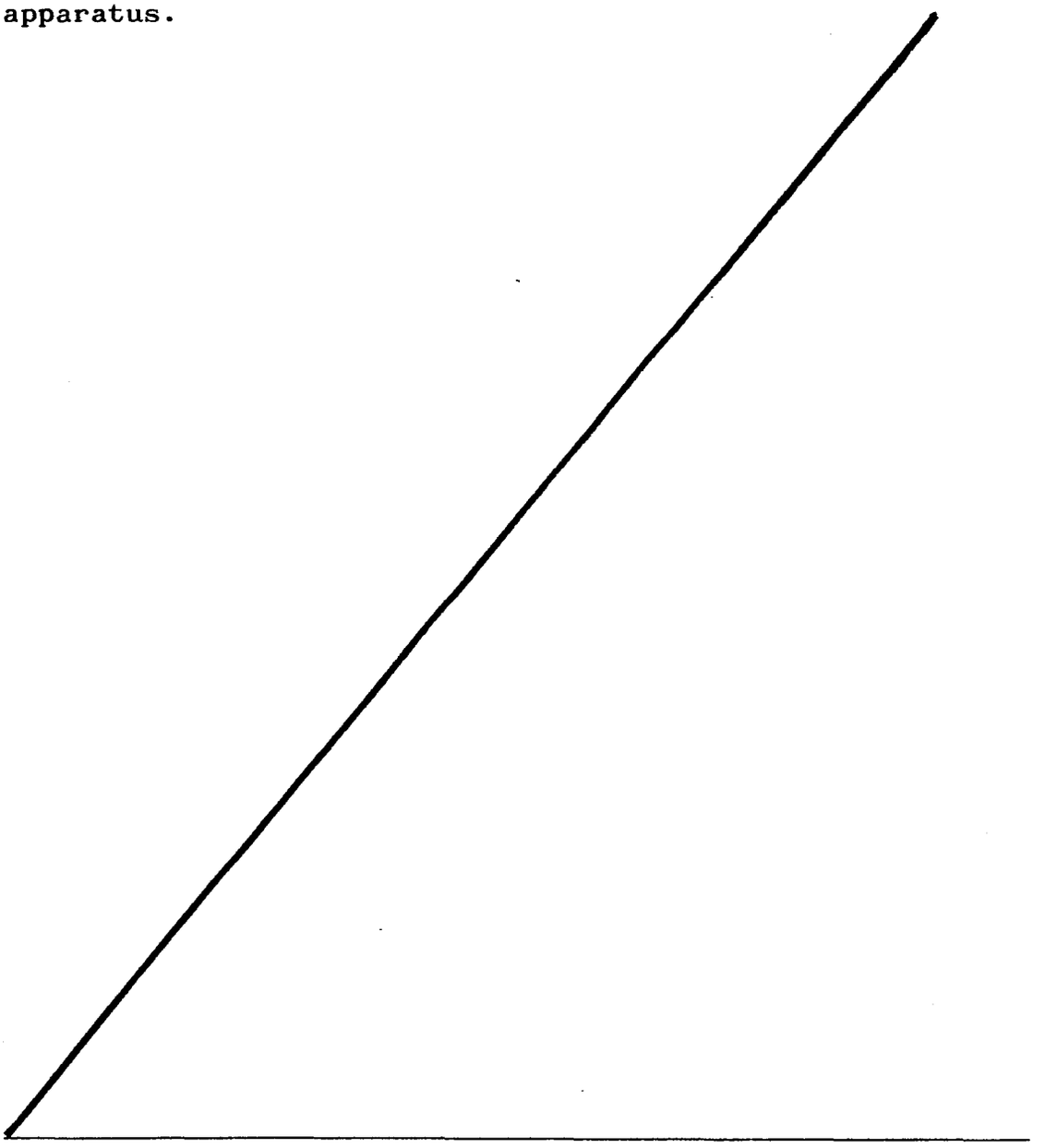
Another example of control apparatus is illustrated in U.S. patent 4,154,308. The control apparatus illustrated therein utilizes a sliding latch member that engages the valve control rod to control the open and closed positions of the valve. The sliding latch member utilizes some of the imbalance by a particular arrangement of a centroid or center of mass of the sliding member to maintain it in the desired position during the rotation of the tool.

An additional problem encountered in the production of pneumatically driven tools is the space limitation imposed on many tools. Desirably, the tools are extremely small and light for ease of handling. Accordingly, the distance that the valve control mechanism can move, and movement is required in some direction or the other to control the valve rod, is extremely limited. Therefore, very little movement in the radial direction is most desirable.

The present invention is characterised in that there is provided a valve controller for holding the valve open and for releasing the valve to permit closing said valve controller including: an elongate valve operating member in the housing having a first end engaging said valve and having a second end; a latch member in the housing pivotal on the tool drive shaft, said latch member having a surface thereon facing said valve for engaging the second end of said valve operating member, said surface having a hole therein sized to receive the second end of said elongated valve operating member; a portion on said latch member engageable with the motor shaft upon relative movement between the shafts to pivot said latch member from a first position in which said hole is out of alignment with said operating member into a second position in

which said hole is in alignment with said valve operating member permitting said valve operating member to move thereby closing said valve; and, resilient means biasing said latch member toward said first position.

The present invention provides a valve control apparatus for pneumatically driven tools that reduces vibration problems imposed by such apparatus and that will function effectively while requiring a small amount of radial movement of the valve control apparatus.



The invention will be better understood from the following description of a preferred embodiment thereof, given by way of example only, reference being had to the accompanying drawings, wherein:

Fig. 1 is a cross-sectional view of a pneumatic tool incorporating valve control apparatus that is constructed in accordance with the invention.

Fig. 2 is an enlarged cross-sectional view taken generally along the line 2-2 of Fig. 1.

Fig. 3 is an enlarged fragmented view of a portion of the apparatus illustrating a clutch mechanism contained therein in more detail.

Figs. 4A and 4B taken together, provide an enlarged cross-sectional view of a pneumatic tool containing the valve control apparatus that is constructed in accordance with the invention.

Fig. 5 is a transverse cross-sectional view taken generally along the line 5-5 of Fig. 4B.

Fig. 6 is a view similar to Fig. 4B, but illustrating the valve and the valve control apparatus in the closed position of the valve.

Fig. 7 is a transverse cross-sectional view taken generally along the line 7-7 of Fig. 6.

Detailed Description of the Preferred Embodiment

Referring to the drawing, and to Fig. 1 in particular, shown therein and generally designated by the reference character 10, is a pneumatically driven screwdriver. The screwdriver 10 includes a fitting 12 for connection to a supply of air under pressure (not shown).

Air passing through the fitting 12 flows past a flow valve 14, which in Fig. 1 is illustrated in the open position, and then to an air motor 16. From the air motor 16, the air is exhausted to the atmosphere. The screwdriver 10 will, of course, be provided with the necessary flow passageways, ports, etc. to cause the motor 16 to operate when desired, and to rotate in the direction desired.

The valve 14 and air motor 16, as well as other components of the screwdriver 10, are housed in a hollow case or housing 18.

The air motor 16 includes a hollow motor output shaft 20 that is operatively connected to a tool drive shaft 22 by means of a clutch assembly 24. The speed of the shaft 22 is in proportion to the speed of the shaft 20 due to a gear reduction train 26 that is operatively disposed therebetween. The gear reduction train 26 includes a sliding connection (not shown) to permit the train to partially collapse or telescope during operation of the tool 10.

The tool drive shaft 22 drives a screwdriver bit 28 through mating hexagonal surfaces 30 that are on the exterior of screwdriver 28 and in a bore 32 of the shaft 22. A ball detent 34 retains the screwdriver against longitudinal movement in the shaft 22. The blade of the screwdriver 28 extends close to the end of the nose 36 of the tool body 18.

The nose 36 is slideable within the housing 18 and is retained in the position illustrated by a coil spring 38. The nose 36 can move upwardly into the housing 18 to expose the end or blade of the screwdriver 28.

In Figs. 2 and 3 the clutch assembly 24 is shown in more detail. As shown therein, the motor output shaft 20 is rotatable in and relative to the tool drive shaft 22 through a plurality of ball bearings 40 that are disposed therebetween. The tool drive shaft 22 is provided with a plurality of recesses forming ramps 42 in which a plurality of clutch balls 44 are located. The balls 44 are disposed within openings 46 that are located in a flange 48 mounted on the end of the output shaft 20 and are, thus, rotatable with the motor output shaft 20.

A ball housing 50 encompasses the balls 44 and prevents the balls from becoming dislodged from the openings 46. An output shaft 20 carries a spring biasing the balls 44 into the recesses adjacent to the ramps 42 formed in the tool drive shaft 22. Thus, so long as the balls 44 do not run up and over the ramps 42, the tool drive shaft 22 is operatively connected to the motor output shaft 20. The ramps 42,

balls 44, flange 48 and related parts constitute the clutch assembly 24.

The tool drive shaft 22 is driven by the motor output shaft 20 through the clutch assembly 24. In the event that the tool drive shaft 22 stops while the motor output shaft 20 continues to rotate, and assuming that sufficient torque is available, the balls 44 ride up the ramps 42 and over into the next ramp 42 thus permitting rotation of the motor output shaft 20 relative to the tool drive shaft 22. At this time, the air supply to the motor 16 is shut off by closing the valve 14 as will be described.

It can be seen in Fig. 4B that the valve 14 is in the open position and air can flow thereby to the air motor 16. The valve 14 is retained in the open position by a valve control rod 54, which has one end 56 in engagement with the valve 14, and the other end 58 in engagement with a surface 60 on a pivotal latch member 62. It should be realized that in order to hold the valve 14 open, it is necessary to retain the tool drive shaft 22 displaced to the right as seen in Figs. 4A and B by engagement of the screwdriver bit 28 with the threaded fastener.

The latch member 62 is pivotally mounted on the right end (as seen in Fig. 4B) of the tool drive shaft 22 by pivot pin 64. As shown in Fig. 5, the end 66 of the motor output shaft 20, is triangular in configuration and is disposed in a recess 68 which forms the surface 60 in the latch member 62. The recess 68 is configured so that the end 66 can rotate therein.

The latch member 62 includes a protuberance or cam surface 70 that projects outwardly toward the recess 68 so that it is engageable with the apexes or lobes 72 formed on the triangular end 66 of the motor output shaft 20. A compression spring 74 is located so that one end is in engagement with the tool drive shaft 22 and the opposite end is in engagement with the latch member 62 so that the spring 74 biases the latch member 62 into a position where the cam surface 70 can engage the lobes 72 on the motor output shaft 20 in the event that relative rotation between the motor output shaft 20 and the tool drive shaft 22 occurs.

It will also be noted that a hole 76 extends through the latch member 62. The hole 76 is sized to receive the end 58 of the valve control rod 54 and, when the hole 76 and the valve control rod 54 are in alignment, the rod 54 can move thereinto.

As previously mentioned with relation to Figs. 4A, 4B and 5, the valve control rod 54 retains the valve 14 in the open position since the end 58 of the control rod 54 is in engagement with the surface 60. The flow of fluid past the valve 14 tends to urge the valve 14, which is normally closed, toward the closed position and such hydraulic force is aided by a spring 77 that is disposed between the tool body 18 and the valve 14. The closing of the valve 14 is prevented by the engagement of the end 58 with the surface 60.

As mentioned, the motor output shaft 20 is hollow and the control rod 54 extends therethrough. A flange 80 is attached to the valve control rod 54, so that a coil spring 78 encircling the rod 54 acts on the motor output shaft 20 to urge the clutch assembly 24 and tool drive shaft 22 relatively away from the valve 14 so that the control rod 54 is disposed in the interior of the shaft 20. When this occurs, the latch member 62 pivots into the latched position shown in Fig. 5

Operation of the Preferred Embodiment

As previously mentioned, the valve 14 is normally closed preventing pressurized fluid from reaching the air motor 16. When the screwdriver bit 28 is engaged with the threaded fastener and pressure placed on the tool 10, the bit 28, tool drive shaft 22 and motor output shaft 20 move relatively into the housing 18 telescoping the gear train 26 and by virtue of engagement of the end of the control rod 54 with the latch member 62, by forcing the valve 14 off its seat and permitting fluid flow to the air motor 16.

When this occurs, the motor 16 starts to rotate and such rotation is transmitted to the screwdriver bit 28 via the gear train 26, motor output shaft 20, clutch assembly 24 and tool drive shaft 22.

Upon reaching the preset torque, the screwdriver bit 28 and tool drive shaft 22 cease rotating. The clutch balls 44 are driven up the ramps 42 by the continued rotation of the motor output shaft 20. When this occurs, the lobes 72 on the end 66 of the motor output shaft 20 cam the latch member 62 into the unlatched position wherein the control rod 54 is in alignment with the hole 76 in the latch member 62. Upon alignment, the control rod 54 moves, under the influence of the spring 77, and fluid flowing by the valve 14 to close the valve 14 as illustrated in Fig. 6. When the valve 14 closes, air is shut off and the motor 16 stops rotating. So long as the tool 10 is held in engagement with the threaded fastener, the valve 14 cannot be reopened.

To reopen the valve 14, that is, to reset the tool 10 for further operation, it is necessary to remove the tool 10 from the threaded fastener. When this occurs, the coil spring 78 within the motor output shaft 20 displaces the screwdriver bit 28, the tool drive shaft 22 and the motor output shaft 20 toward the nose 36. Such movement continues until the end 58 of the control rod 54 is withdrawn from the hole 76 in the latch member 62. When the end 58 clears the hole 76, the spring 74 pivots the latch member 62 about the pivot pin 64 into the latched position, that is, to the position wherein the hole 76 in the latch member 62 is no longer in alignment with the control rod 54 (See Fig. 5). The valve 14 remains closed, but the end 58 of the control rod 54 is now again resting on the surface 60 of the latch member 62.Thus, the tool 10 is in position to be reopened when the screwdriver bit 28 is engaged with a threaded fastener and force exerted on the tool 10.

From the foregoing detailed description, it will be appreciated that the tool 10 incorporates improved apparatus for controlling the position of the valve 14. It should be appreciated by viewing Figs. 5 and 7 that very little movement of the latch member occurs between the latched and unlatched positions of the control rod 54. Accordingly, such apparatus can be manufactured in very small sizes to fit within the small-high speed, pneumatically driven tools currently being manufactured. Also, it will be noticed that

the apparatus is constructed so that the latch mechanism will be substantially balanced relative to rotational forces, and will therefore create very little vibration in the tool during high speed operation.

Having described but a single embodiment of the invention, it will be understood that the foregoing is presented by way of example only and that many changes and modifications can be made thereto without departing from the spirit or the scope of the invention.

CLAIMS

1. Pneumatically driven apparatus, comprising: a hollow housing; an air motor including a rotatable motor shaft located in the housing, the motor being arranged for connection with a source of pressurized air and the apparatus being arranged to drive a tool such as a screwdriver, socket wrench or the like via a tool drive shaft rotatable in the housing; a torque-sensitive clutch between the tool drive shaft and motor shaft permitting the motor shaft to move relative to the tool drive shaft when a predetermined torque occurs; and a valve in the housing between the motor and the air supply source which, when open, permits air to reach the motor, characterised in that there is provided a valve controller for holding the valve (14) open and for releasing the valve (14) to permit closing, said valve controller including: an elongate valve operating member (54) in the housing (18) having a first end (56) engaging said valve and having a second end (58); a latch member (62) in the housing (18) pivotal on the tool drive shaft (22), said latch member (62) having a surface (60) thereon facing said valve for engaging the second end (58) of said valve operating member (54), said surface having a hole (76) therein sized to receive the second end (58) of said elongated valve operating member (54); a portion (70) on said latch member (62) engageable with the motor shaft (20) upon relative movement between the shafts (20 and 22) to pivot said latch member (62) from a first position (Figure 5) in which said hole (76) is out of alignment with said operating member (54) into a second position (Figure 7) in which said hole (76) is in alignment with said valve operating member (54)

permitting said valve operating member (54) to move thereby closing said valve (14); and, resilient means (74) biasing said latch member (62) toward said first position (Figure 5).

2. The apparatus of claim 1 characterised in that the motor shaft (20) has a generally triangular cross-section portion (66) providing three lobes (72) that are arranged to engage said latch member (62).

3. The apparatus of claim 2, characterised in that said latch member (62) has a recess (68) in said surface (60) sized to receive the triangular cross-sectional portion (66) of said motor shaft (20) and said portion (70) engageable with the motor shaft (20) includes a cam surface projecting into said recess for engaging one of said lobes (72).

4. The apparatus of claim 3, characterised in that said resilient means (74) comprises a coiled compression spring having one end engaging said latch member (62) and the other end engaging said tool drive shaft (22).

5. The apparatus of claim 4, characterised in that second resilient means (78) are located in said motor shaft (20) for returning said valve operating member (54) to a position wherein said valve is openable.

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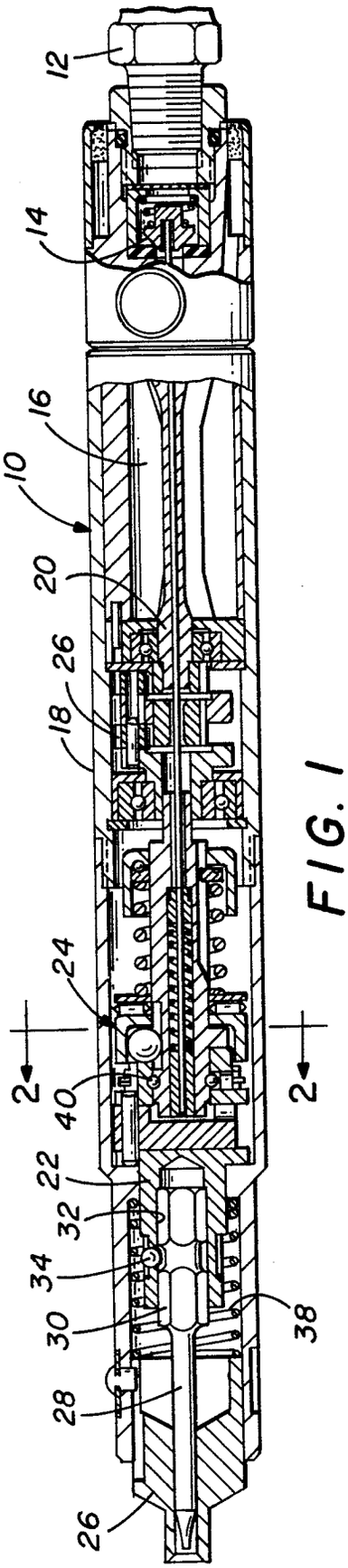

FIG. 1

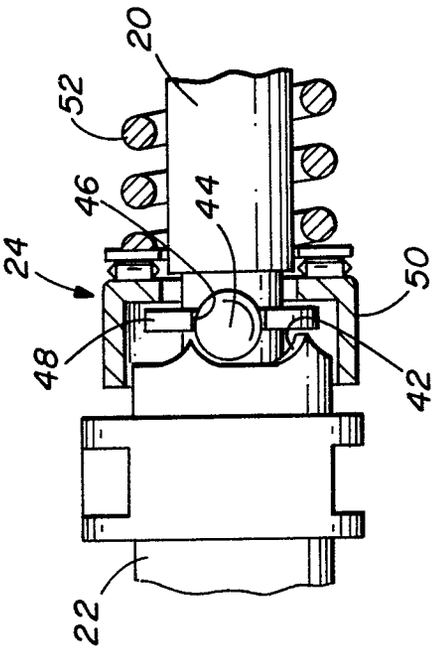

FIG. 3

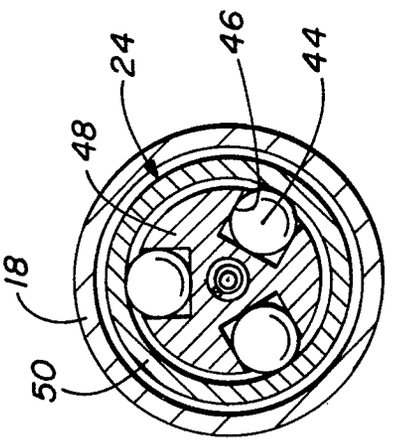

FIG. 2

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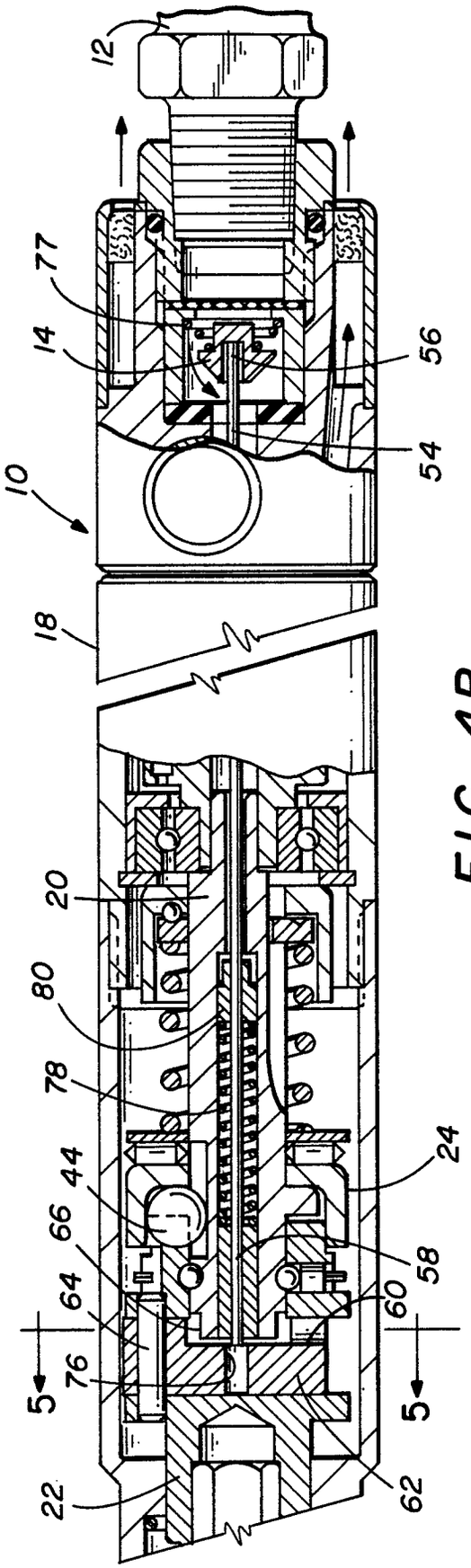

FIG. 4B

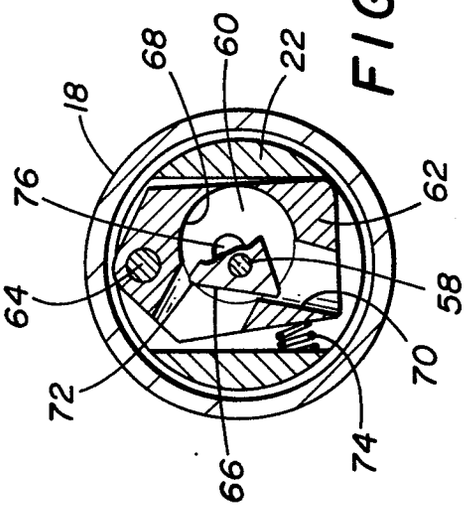

FIG. 5

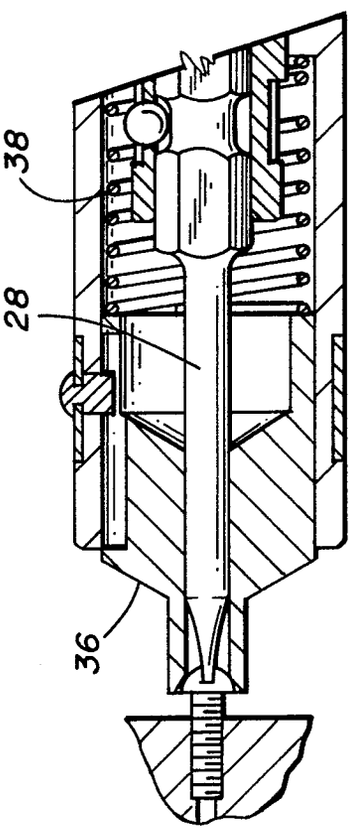

FIG. 4A

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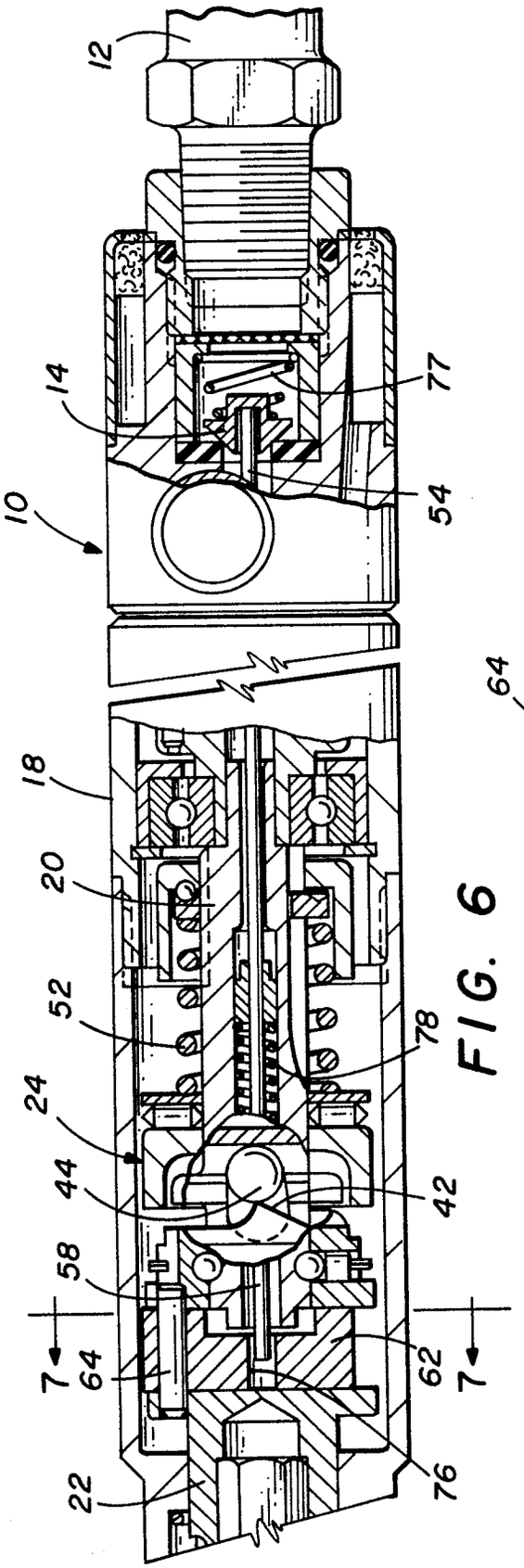

FIG. 6

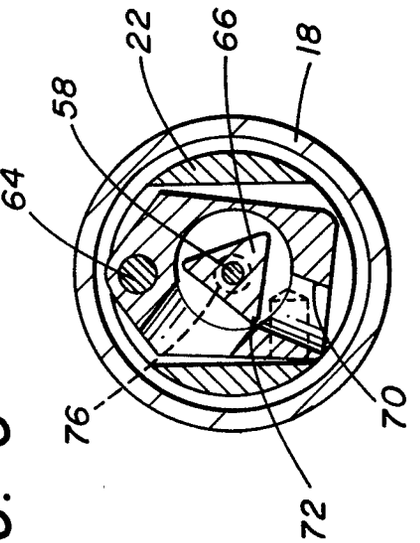

FIG. 7