

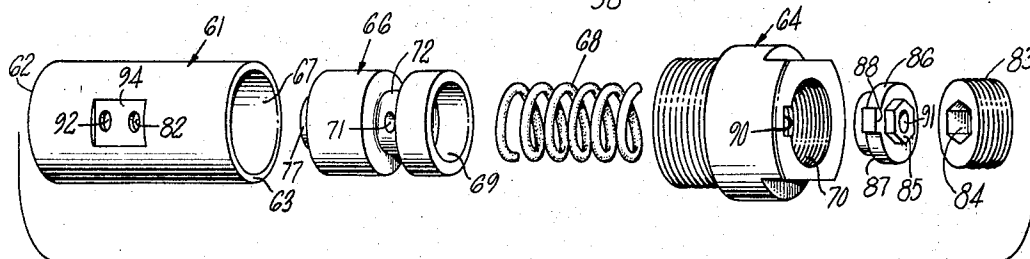
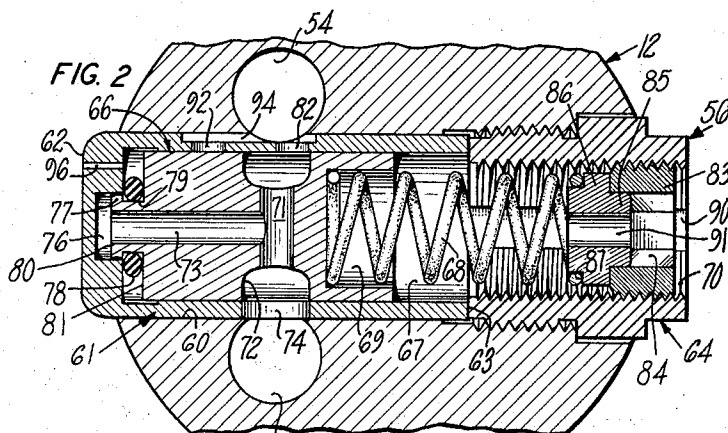
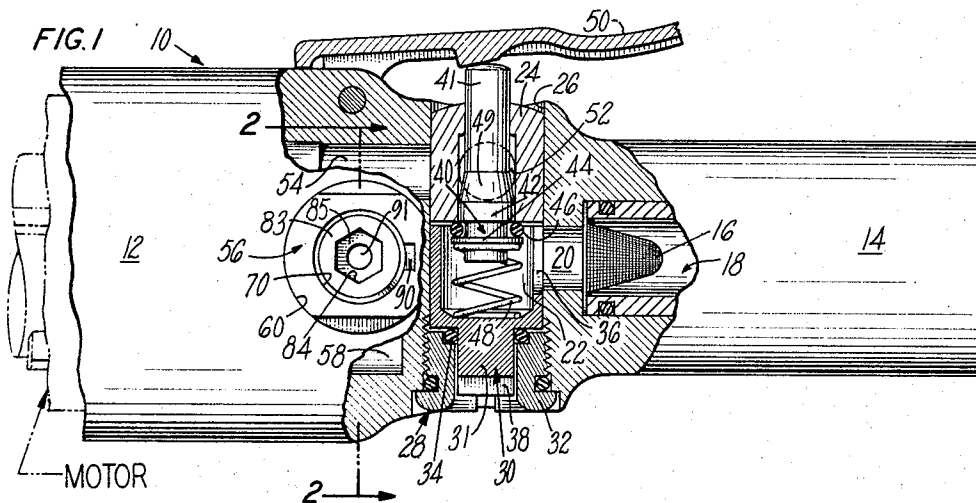
March 19, 1968

H. L. WHITEHOUSE

3,373,824

FLUID OPERATED TOOL

Filed Nov. 24, 1965



INVENTOR.

HUGH L. WHITEHOUSE

BY

Lindsey, Prutzman and Hayes

ATTORNEYS

1

3,373,824

FLUID OPERATED TOOL

Hugh L. Whitehouse, South Euclid, Ohio, assignor to
The Stanley Works, New Britain, Conn., a corporation
of Connecticut

Filed Nov. 24, 1965, Ser. No. 509,576

27 Claims. (Cl. 173-12)

ABSTRACT OF THE DISCLOSURE

Device comprising an air motor, a housing having a supply passageway connected to the motor, a bistable on-off pressure sensitive spool valve movable in the passageway for controlling air flow to the motor and biased toward a normally operative position, passage means for directing back pressure from the motor against the valve urging it into a shut-off position when the motor operating pressure increases beyond a predetermined level, a restriction in the passageway on a supply side of the valve providing an amplified range of air pressures acting on the motor between no load and stall conditions and increasing the sensitivity of the valve, and means responsive to shifting of the valve into a closed position and for maintaining it therein independently of fluid pressure acting on the motor.

This invention relates to power tools and particularly concerns fluid operated tools such as nut setters, screw drivers and the like.

A principal object of the invention is to provide an improved power tool of the type which is fluid operated and which, during its application, is capable of responding with minimal time delay to provide superior uniformity and reliability of operation.

Another object of the invention is to provide an improved fluid operated tool having notable use, e.g., in precisely setting a workpiece to a desired degree of tightness and which incorporates improved means for preventing premature shut-off of the tool.

A further object of the invention is to provide a fluid operated power tool incorporating an improved torque control which is particularly suited to accurately sense variations in the output force of the tool for automatically shutting off the motive fluid when a predetermined torque is developed.

Another object of the invention is to provide a torque control of the type described having an improved adjustment for selectively varying the maximum torque settings within close limits.

A further object of the invention is to provide an improved power tool which is safer and easier to operate, has low maintenance and fluid consumption requirements and which has a combination of parts of low cost manufacture adapted for economical and convenient assembly.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth, and the scope of the application of which will be indicated in the appended claims.

In the drawing:

FIG. 1 is a fragmentary view, partly in section and partly broken away, of a power tool;

FIG. 2 is an enlarged section view taken along line 2-2 of FIG. 1; and

FIG. 3 is an exploded isometric view, on a reduced scale, illustrating the component parts of a preferred embodiment of a torque control incorporated in the present invention.

Referring now to the drawing in detail, a power tool

2

such as a nut setter, e.g., is fragmentarily shown in FIG. 1 as having an elongated cylindrical housing 10 including a motor housing portion 12 and a handle portion 14 of reduced diameter. It is to be understood that a fluid motor, preferably a conventional rotary vane type air motor, is mounted in the motor housing portion 12 for driving a spindle operatively connected to a work engaging element of the power tool.

Compressed air for driving the motor is supplied through a coupling, not shown, at the rear of the handle portion 14 and flows through a suitable inlet screen 16 in a passageway 18, comprising a series of passages described more specifically below, leading to the motor. An inlet passage 20 of the passageway 18 communicates with a double diameter valve chamber 22 defined by a bushing 24, fixed in one end of a bore 26 extending across housing 10, and by an air regulator 28 closing the other end of the bore 26. The air regulator 28 includes an inner cup-like member 30, forming the larger end of the chamber 22, having a shank portion 31 of reduced diameter received in a hollow plug 32 screwed into the bore 26. Member 30 is retained against unintended movement by means of an O-ring 34 encircling its shank portion 31 and seated on the inner end of the plug 32.

An inlet port 36 formed in the wall of member 30 serves to connect the inlet passage 20 and the chamber 22. The volume of air admitted into the chamber 22 is governed by rotatably adjusting the position of member 30 to vary the effective size of the inlet port, the adjustment being facilitated by a screw driver slot 38 which is easily accessible at the outer end of the shank portion 31. Assuming a load of established value, an operator thus may vary the power of the motor and the spindle speed to suit the application of the tool.

A throttle valve 40 is received in chamber 22 having a stem 41 projecting out through the bushing 24. An inner portion 42 of the throttle valve 40 is enlarged relative to the stem 41 and is provided with an annular flange 44 on one side of which is mounted an annular seal 46, engageable with the inner end of the bushing 24, and the other side seating a compression spring 48 biased between the flange 44 and member 30 to hold the throttle valve 40 in a normally closed position.

As pointed out more specifically below, it is important in tools of this type to effectively minimize the initial pressure surge of air supplied to the motor. For this reason, the throttle valve 40 is provided with a graduated intermediate portion 49 which is tapered from the enlarged inner portion 42 of the throttle valve 40 to its stem 41.

To actuate the motor, a hand lever 50, pivotally supported on the housing 10 and engaging the outer projecting end of the stem 41, is depressed to unseat the throttle valve 40. Air then enters chamber 22 through the inlet port 36 to pass through an outlet port 52 in the bushing 24 communicating with an inlet passage 54 to a normally open shut-off control 56, and then through the control 56 into an outlet passage 58 to the motor. It will be seen that the tapered structure of the throttle valve 40 provides an effective anti-surge control.

Referring now to the preferred embodiment of the shut-off or torque control 56 of the tool, a bore 60 is formed across the housing 10 for receiving a sleeve 61 having an outer closed end 62 at one end of the bore 60 and an open inner end 63 abutting a coaxially aligned hollow plug 64 screwed into the opposite end of the bore 60. The sleeve 61 is rigidly fixed in position by any suitable means.

For automatically shutting off air flow to the motor, a valve plunger or spool 66 is received in a chamber 67, defined by the inner surfaces of the sleeve 61, for reciprocating movement between open and closed posi-

tions respectively at the left and right hand ends of chamber 67 as viewed in FIG. 2. The closed end 62 of the sleeve 61 and the inner end of the plug 64 provide seats for the spool 66 in its open and closed positions. The spool 66 is illustrated as being normally held open in its left-hand position by a coil compression spring 68 having one end bearing against the bottom of a cup-shaped cavity 69 in the spool 66 and its opposite end being seated, as described more specifically below, within a threaded bore 70 extending through the plug 64.

So that the spool 66 is responsive to variations in the motor operating pressure, which is a function of the output force of the motor, for automatically shutting off air flow to the motor when a predetermined level of torque is reached, passages in communication with the outlet passage 58 are provided for continually directing compressed air against the spool 66 to provide a force in opposition to the spring force when the spool 66 is in its open position.

More specifically, a passage 71 is shown as extending diametrically through a reduced intermediate portion 72 of the spool 66, and another passage 73 extends from passage 71 axially through the left-hand end of the spool to provide internal passage means of generally T-shaped cross section. Passages 71 and 73 are in communication with an outlet port 74 in the sleeve 61 which connects to the outlet passage 58 leading to the motor when the spool 66 is in its open position.

The closed end 62 of the sleeve 61 includes a compartment 76 of circular cross section for receiving an annular extension 77 of reduced diameter in the end of the spool 66 surrounding the axially extending passage 73. The compartment 76 and the extension 77 are dimensioned to provide a preselected clearance between the spool 66 and the closed end 62 of the sleeve 61. This clearance preferably is maintained by an O-ring 78 retained in a groove 79 around extension 77 to provide a tight fluid seal around compartment 76 when the spool 66 is in its open position. Thus, the end of the spool extension 77 provides a pressure sensing surface 80 which is in communication with the outlet passage 58 when the spool is in its open position, the pressure sensing surface 80 being relatively small with respect to the annular end surface 81 of the spool 66 surrounding the extension 77.

Power tools of this type are usually designed to minimize loss in pressure from the full line supply pressure, at the inlet of the handle, to the motor. However, there is always some reduction in pressure. At the inlet to the motor, e.g., orifice sizes are governed by practical limitations, and at free running some pressure reduction occurs because the orifice sizes cannot provide for the theoretical maximum air demand. If the orifice sizes at the inlet to the motor are small, the inherent internal leakage of the tool becomes effective at or near its stall point to reduce the operating air pressure in the motor below the full line supply pressure. Accordingly, such tools are conventionally designed such that the orifice capacity at the inlet to the motor is sufficiently large to allow for stall leakage with an insignificant drop in motor operating pressure. Moreover, by providing for maximum orifice flow capacity, there is only a relatively small increase in the motor operating pressure from free running, through load, to or near stall.

To provide a torque control which is highly sensitive to variations in the output force or torque of the motor as indicated by changes in the static pressure in the outlet passage 58, a drop in the air supply pressure at the inlet to the motor is intentionally created across the spool 66. For this purpose a restrictive inlet port or orifice 82 is formed in the sleeve 61. Assuming that compressed air of relatively constant pressure is utilized to produce an air flow to the motor under variable torque conditions, the restrictive inlet orifice 82 will cause a reduction in air flow to the motor which, when running free, has a relatively large air flow capacity. Since air flow is low and

demand is high, the motor operating pressure is low. As the motor is loaded, its air demand decreases and the motor operating pressure increases. Since the passages 71, 73 and the compartment 76 continually expose the small pressure sensing surface 80 of the spool extension 77 to the motor operating pressure in the outlet passage 58 and since this motor operating pressure is a function of the load on the motor, an automatic pressure actuated shut-off valve is attained which is sensitive to motor load over an amplified range of motor operating pressures. The action of the spool 66 is very fast since a small movement of the spool 66, caused by pressure on the small pressure sensing surface 80, unseats the O-ring 78, and exposes the annular end surface 81 of the spool 66. When end surface 81 is exposed, the force on the left of the spool 66 is suddenly greatly increased, causing the spool 66 to snap into its closed position at the right-hand end of chamber 67 with a minimum of time for motor output force to build up between the time of initial pressure sensing and complete shut-off.

It will be apparent that for a given size air motor and a given minimum air supply pressure, the torque at which shut-off automatically takes place is determined by the force of the spring 68. To preset the shut-off torque at a desired maximum value, an adjustment is provided for precisely varying the spring force exerted on the spool 66. An adjusting screw 83 is threadably received in the outer end of the bore 70 of plug 64. Extending axially through the adjusting screw 83 is a hex socket 84 for receiving a hex head 85 projecting from a circular plate 86 seated against the inner face of the adjusting screw 83 within the bore 70 of plug 64. The plate 86 has an annular shoulder 87 formed on its inner face for seating the spring 68. The spring 68 thus is biased between the spool 66 and the plate 86 to positively maintain the plate 86 securely in contact with the inner face of the adjusting screw 83. The plate 86 is limited to longitudinal movement within the plug 64 by means of a radial projection or tang 88 received in an axial groove 90 formed in the wall of the bore 70. To adjust the spring force exerted on the spool 66, and thus vary the amount of back pressure from the motor required to unseat the spool 66, a hex wrench, not shown, is inserted into the hex socket 84 such that plate 86 is pushed axially inward out of engagement with the adjusting screw 83 which may then be rotated by means of the wrench to provide a predetermined change in shut-off torque. Upon retracting the wrench, the hex head 85 of the plate 86 slips back into the hex socket 84 under the bias of spring 68 to positively lock the adjusting screw 83 in position. The plate 86 is provided with a central bore 91 serving to vent air trapped behind the spool 66 when it is snapped into its closed position.

While it is believed that the operation of the tool will be apparent from the above description, the following brief summary of operation may be helpful in fully understanding the invention.

The air regulator 28 is adjusted to suitably set the power of the motor and spindle speed in accordance with an established load on the tool. The degree of compression of the spring 68, establishing the amount of air pressure required to unseat the spool 66, is precisely set by means of the hex-lock adjustment. Then as the throttle lever 50 is depressed to actuate the motor and any free movement of the work engaging element is taken up, the torque of the motor builds up in response to an increased load with a resultant build up in pressure thereby slowing down the motor and reducing its air consumption. It will now be apparent that the tapered structure of the throttle valve 40 effectively prevents premature shut-off of the control 56 by minimizing the initial pressure surge of air supplied to the motor.

By virtue of the restrictive inlet orifice 82, the motor operating pressure increases substantially from free running, through load, to or near stall. In view of this amplified range of motor operating pressures, the spool 66

is highly responsive to small pressure differences during the time the load is applied to the output force of the motor. As the preset shut-off torque is approached, the air pressure builds in the outlet passage 58 and in the compartment 76 within the sleeve 61 as communicated through the outlet port 74 and the passages 71, 73. Thus, upon reaching the preset shut-off torque, the pressure acting on the small pressure sensing surface 80 of the spool extension 77 within the compartment 76 reaches its adjusted maximum to overcome the atmospheric pressure and the spring force, and spool 66 shifts slightly to the right out of the compartment 76 to unseat the O-ring 78 and then suddenly snaps into closed position when the large end surface 81 of the spool 66 is exposed to the back pressure from the motor. Further build up in the motor output force is essentially negligible due to the snap action of the spool 66.

As the spool 66 shuts off the passageway, closing the inlet and outlet ports 82 and 74 in sleeve 61, air behind the spool 66 exhausts to atmosphere through the bore 91 in the plate 86 and through the hex socket 84 of the screw 83. A second orifice 92, adjacent the inlet orifice 82, is simultaneously opened to maintain the spool 66 in its closed position, a notch 94 in the sleeve 61 providing a bypass clearance between the inlet passage 54 and the orifice 92. To assure rapid return of the spool 66 when the throttle lever 50 is released for a repeat control cycle, a bleed passage 96 is provided in the closed end 62 of the sleeve 61 to vent air trapped behind the spool 66. The bleed passage 96 also serves to prevent premature shut-off caused by air leakage past the spool 66.

The power tool of the present invention thus provides for automatically limiting the output torque or force of the motor to a predetermined level which may be precisely selected at any point in an amplified sensing range from no load to stall conditions without requiring an operator to exercise any further judgment in determining when the proper shut-off torque is reached. The tool provides almost instantaneous shut-off action for precision application and effectively eliminates premature shut-off. Accordingly, the tool is safe, quick and easy to operate. Since the tool is not required to run down to a stall point, it is not required to operate at maximum torque and the service life of its parts is prolonged. Finally, the maintenance requirements of the tool are minimized and the air required for operating the tool is reduced.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

I claim:

1. A fluid operated tool comprising a fluid motor, a housing, said housing having a passageway for supplying fluid under pressure to said motor, a valve for establishing open and closed fluid flow conditions in said passageway, a bistable on-off pressure sensing control in said passageway of said housing between said motor and said valve for shutting off fluid flow to said motor at a predetermined level of motor output as determined by the fluid pressure acting on said motor, said bistable on-off pressure sensing control when activated to a shut-off position being continuously maintained therein while said valve continues to maintain said open fluid flow condition, and means in said passageway providing a restriction to the flow of fluid to increase the range of fluid pressures acting on said motor between no load and stall conditions thereby to increase the sensitivity of said pressure sensing control.

2. The device of claim 1 wherein said valve is mounted in said housing and includes a valve member received in said passageway, said valve member being movable in said passageway and cooperating with said housing to establish the open and closed fluid flow conditions, said valve mem-

ber having a graduated intermediate portion cooperating with said housing to provide an anti-surge control when said valve member is moved to establish the open fluid flow condition.

3. The device of claim 1 wherein said valve includes a valve chamber formed in said housing in communication with said passageway and having an outlet portion of reduced size, a valve member received for movement in said chamber and cooperating therewith to establish the open and closed fluid flow conditions in said passageway, said valve member having a stem received in said outlet portion of said chamber and an end portion of enlarged size for closing off said outlet portion of said chamber to establish the closed fluid flow condition, and said valve member having a graduated intermediate portion tapered from said enlarged end portion to said stem for gradually increasing fluid flow when said valve member is moved to establish the open fluid flow condition.

4. The device of claim 1 wherein said means providing a restriction to the flow of fluid includes an orifice restriction located in said passageway upstream of said pressure sensing control and said motor.

5. A fluid operated tool comprising a housing, a fluid motor in said housing, said housing having a passageway for supplying fluid under pressure to said motor, a valve mounted in said housing for movement in said passageway and cooperating with said housing to establish open and closed fluid flow conditions, a pressure sensing control mounted in said housing between said motor and said valve, said pressure sensing control having a valve member movable in said passageway and cooperating with said housing to establish open and closed flow control positions, biasing means continuously urging said valve member toward the open flow control position, means for directing fluid pressure on the motor side of said valve member against the same to exert a force in opposition to the force of said biasing means, means located in said passageway on the inlet side of said valve member for reducing the motor operating pressure below full line supply pressure at free running of said motor whereby, as load is applied to the output of said motor, the motor operating pressure increases over an amplified range and said valve member automatically shifts to the closed flow control position when the motor operating pressure increases beyond a predetermined level to overcome the force of said biasing means, and means responsive to shifting of said valve member into the closed flow control position and for maintaining it therein while said valve continues to maintain said open fluid flow condition.

6. The device of claim 5 wherein said biasing means is adjustable to establish a preselected force continuously urging said valve member of said pressure sensing control toward the open flow control position.

7. A fluid operated tool comprising a housing, a fluid motor in said housing, said housing having a passageway for supplying fluid under pressure to said motor, a valve mounted in said housing for movement in said passageway and cooperating with said housing to establish open and closed fluid flow conditions, a pressure sensing control mounted in said housing between said motor and said valve, said pressure sensing control having a valve member movable in said passageway and cooperating with said housing to establish open and closed flow control positions, biasing means continuously urging said valve member toward the open flow control position, means for directing fluid pressure on the motor side of said valve member against the same to exert a force in opposition to the force of said biasing means, said fluid directing means including first and second fluid compartments formed between said housing and adjacent portions of said valve member when the latter is in the open flow control position, said first compartment continuously communicating with said passageway on the motor side of said valve member to direct fluid pressure against a portion of said valve member in opposition to the force of

said biasing means when said valve member is in the open flow control position, and means for providing fluid communication between said passageway on the motor side of said valve member and said second compartment after initial movement of said valve member toward the closed flow control position, and means located in said passageway on the inlet side of said valve member for reducing the motor operating pressure below full line supply pressure at free running of said motor whereby, as load is applied to the output of said motor, the motor operating pressure increases over an amplified range and said valve member automatically shifts toward the closed flow control position when the motor operating pressure increases beyond a predetermined level to overcome the force of said biasing means and then snaps into closed flow control position responsive to a sudden increase in pressure force acting on said valve member.

8. A fluid operated tool comprising a housing, a fluid motor in said housing, said housing having a passageway for supplying fluid under pressure to said motor, a bistable on-off valve member movable in said passageway and cooperating with said housing to establish open and closed flow control positions, biasing means continuously urging said valve member toward the open flow control position, means for directing fluid pressure on the motor side of said valve member against the same to exert a force in opposition to the force of said biasing means, means located on the inlet side of said valve member for reducing the motor operating pressure below full line supply pressure at free running of said motor whereby, as load is applied to the output of said motor, the motor operating pressure increases over an amplified range and said valve member automatically shifts to the closed flow control position when the motor operating pressure increases beyond a predetermined level to overcome the force of said biasing means, and means responsive to shifting of said valve member into the closed flow control position and for maintaining it therein independently of the fluid pressure acting on said motor.

9. The device of claim 8 wherein said biasing means is adjustable to establish a preselected force continuously urging said valve member toward the open flow control position.

10. A fluid operated tool comprising a housing, a fluid motor in said housing, said housing having a passageway for supplying fluid under pressure to said motor, a valve member movable in said passageway and cooperating with said housing to establish open and closed flow control positions, biasing means continuously urging said valve member toward the open flow control position, means for directing fluid pressure on the motor side of said valve member against the same to exert a force in opposition to the force of said biasing means, said fluid directing means including first and second fluid compartments formed between said housing and adjacent portions of said valve member when the latter is in the open flow control position, said first compartment continuously communicating with said passageway on the motor side of said valve member to direct fluid pressure against a portion of said valve member in opposition to the force of said biasing means when said valve member is in the open flow control position, and means for providing fluid communication between said passageway on the motor side of said valve member and said second compartment after the initial movement of said valve member toward the closed flow control position, and means located on the inlet side of said valve member for reducing the motor operating pressure below full line supply pressure at free running of said motor whereby, as load is applied to the output of said motor, the motor operating pressure increases over an amplified range and said valve member automatically shifts toward the closed flow control position when the motor operating pressure increases beyond a predetermined level to overcome the force of said bias-

ing means and then snaps into the closed flow control position in response to a sudden increase in pressure force acting on said valve member.

11. A fluid operated tool comprising a housing, a fluid motor in said housing, said housing having a passageway for supplying fluid under pressure to said motor, a valve member movable in said passageway and cooperating with said housing to establish open and closed flow control positions, said valve member being of generally cylindrical shape and including an extension on one end thereof defining a pressure sensing surface of reduced size, said housing having a complementary recess formed therein for receiving said extension when said valve member is in the open flow control position, means for isolating said pressure sensing surface from the remaining area of said one end of said valve member and for providing a clearance between said pressure sensing surface and said housing when said valve member is in the open flow control position, biasing means continuously urging said valve member toward the open flow control position, means including a passage for directing fluid pressure on the motor side of said valve member against its pressure sensing surface to exert a force in opposition to the force of said biasing means, and means located on the inlet side of said valve member for reducing the motor operating pressure below full line supply pressure at free running of said motor whereby, as load is applied to the output of said motor, the motor operating pressure increases over an amplified range and when the motor operating pressure acting on said pressure sensing surface is increased beyond a predetermined level to automatically shift said valve member against the force of said biasing means, the total end area of said valve member is suddenly exposed to the fluid pressure to snap said valve member into the closed flow control position.

12. A fluid operated tool comprising a housing, a fluid motor in said housing, said housing having a chamber formed therein and a passageway communicating with said chamber for supplying fluid under pressure to said motor, a bistable on-off valve member movable within said chamber and cooperating with said housing to establish an open flow control position at one end of said chamber and a closed flow control position at an opposite end thereof, biasing means continuously urging said valve member toward the open flow control position, a passage communicating said passageway on the motor side of said valve member with said one end of said chamber for directing back pressure from said motor against said valve member to exert a force in opposition to the force of said biasing means, restrictive means in said passageway on the supply side of said valve member for reducing the motor operating pressure at a no load condition of said motor, whereby as load is applied thereto, the range of fluid pressures acting on said motor is increased with a corresponding increase in sensitivity of said valve member for overcoming force of said biasing means to shift said valve member to the closed flow control position responsive to an increase in motor operating pressure beyond a predetermined level, and an additional passage communicating said passageway on the supply side of said valve member with said one end of said chamber for directing fluid under supply pressure against said valve member responsive to its shifting into closed flow control position and for maintaining it therein independently of the fluid pressure acting on said motor.

13. The device of claim 12 wherein said biasing means includes a coil spring engaging said valve member for urging it toward the open flow control position, and an adjustable seat for said coil spring mounted in said housing for selectively setting the spring force biasing said valve member toward the open flow control position.

14. A fluid operated tool comprising a housing, a fluid motor in said housing, said housing having a chamber formed therein and a passageway communicating with said chamber for supplying fluid under pressure to said

motor, a valve member movable within said chamber and cooperating with said housing to establish an open flow control position at one end of said chamber and a closed flow control position at an opposite end thereof, a hollow plug fixed in said housing at said opposite end of said chamber providing a seat for said valve member in the closed flow control position, a coil spring engaging said valve member for continuously biasing it toward the open flow control position, a screw threadably received in said plug, said screw having a hex socket extending axially therethrough, a locking plate interposed between said screw and said coil spring, said locking plate being limited to axial movement relative to said plug, said locking plate having one face providing a seat for said coil spring and its opposite face having a hex head projecting therefrom for locking engagement within said hex socket of said screw whereby the same is rotatably adjustable, upon disengaging said locking plate axially against the bias of said coil spring, to provide a predetermined change in the spring force biasing said valve member toward the open flow control position, a passage communicating said passageway on the motor side of said valve member with said one end of said chamber for directing back pressure from said motor against said valve member to exert a force in opposition to the force of said coil spring, and restrictive means in said passageway on the supply side of said valve member for reducing the motor operating pressure at a no load condition of said motor whereby, as load is applied thereto, the range of fluid pressures acting on said motor is increased with a corresponding increase in sensitivity of said valve member for overcoming force of said coil spring to shift said valve member to the closed flow control position responsive to an increase in motor operating pressure beyond a predetermined level.

15. A fluid operated tool comprising a housing, a fluid motor in said housing, said housing having a passageway for supplying fluid under pressure to said motor, a member fixed in said housing having a chamber therein and an inlet and an outlet communicating said chamber with said passageway, a spool valve reciprocable in said chamber and cooperating with said member to establish an open flow control position at one end of said chamber and a closed flow control position at the opposite end thereof, and biasing means continuously urging said spool valve toward the open flow control position, said inlet and outlet being aligned with a reduced intermediate portion of said spool valve when it is in the open flow control position, said outlet being connected with said one end of said chamber when said spool valve is in the open flow control position for directing back pressure from said motor against said spool valve in opposition to said biasing means to urge said spool valve toward the closed flow control position, and said inlet being of a fixed reduced size relative to said passageway and said spool valve while in open flow control position remaining stationary and providing a uniform restriction of fluid flow to said motor to increase the range of fluid pressures acting on said motor between no load and stall conditions thereby to increase the sensitivity of said spool valve such that an increase in pressure on the motor side thereof beyond a predetermined level overcomes the force of said biasing means and shifts said spool valve to the closed flow control position.

16. The device of claim 15 including a first passage extending laterally of said spool valve through said intermediate portion thereof, and a second passage extending from said first passage axially through one end of said spool valve to form internal passages of generally T-shaped cross section for connecting said outlet to said one end of said chamber when said spool valve is in the open flow control position.

17. A fluid operated tool comprising a housing, a fluid motor in said housing, said housing having a passageway for supplying fluid under pressure to said motor,

a member fixed in said housing having a chamber therein and an inlet and an outlet communicating said chamber with said passageway, a spool valve reciprocable in said chamber and cooperating with said member to establish an open flow control position at one end of said chamber and a closed flow control position at the opposite end thereof, and biasing means continuously urging said spool valve toward the open flow control position, said inlet and outlet being aligned with a reduced intermediate portion of said spool valve when it is in the open flow control position, said intermediate portion of said spool valve including a first passage extending laterally therethrough and a second passage extending from said first passage axially through one end of said spool valve to form internal passages of generally T-shaped cross section for connecting said outlet to said one end of said chamber when said spool valve is in the open flow control position for directing back pressure from said motor against said spool valve in opposition to said biasing means to urge said spool valve toward the closed flow control position, a tubular extension surrounding said second passage on said one end of said spool valve, a complementary recess formed in said one end of said chamber for receiving said extension when said spool valve is in the open flow control position, a fluid seal secured around the outside of said extension for seating engagement against said one end of said chamber when said spool valve is in the open flow control position, said fluid seal providing a preselected clearance between the end of said extension and said chamber and isolating the remaining area of said one end of said spool valve when the same is in the open flow control position, and said inlet being of reduced size relative to said passageway to increase the range of fluid pressures acting on said motor between no load and stall conditions thereby to increase the sensitivity of said spool valve such that an increase in pressure on the motor side thereof beyond a predetermined level overcomes the force of said biasing means and shifts said spool valve to unseat said fluid seal and suddenly expose the total end area of said spool valve to the fluid pressure thereby to snap it into the closed flow control position.

18. A control for a fluid operated tool having a fluid motor and a passageway for supplying fluid under pressure to the motor comprising a housing having a chamber therein and an outlet and an inlet communicating said chamber with a passageway of the tool, a valve member movable in said chamber and cooperating with said housing to establish open and closed flow control positions, biasing means continuously urging said valve member toward the open flow control position, and means providing fluid communication with said outlet for continuously directing fluid under pressure against said valve member in opposition to the force of said biasing means when said valve member is in the open flow control position, and said inlet being of a fixed reduced size relative to said outlet and said valve member while in open flow control position remaining stationary and providing a uniform restriction to the flow of fluid to increase the range of fluid pressures acting on the motor between no load and stall conditions and thereby increase the sensitivity of said valve member to changes in fluid pressure for automatically shutting off fluid flow when the motor operating pressure increases beyond a predetermined level.

19. A control for use in a fluid operated tool having a fluid motor and a passageway for supplying fluid under pressure to the motor comprising a housing having a chamber therein and an outlet and an inlet communicating said chamber with a passageway of the tool, a pressure sensing control movable in said chamber and cooperating with said housing to establish open and closed flow control positions, said chamber having first and second fluid compartments acting on said pressure sensing control, said first compartment continuously communicating with said outlet when said pressure sensing control is in the open

flow control position, and means for providing fluid communication between said outlet and said second compartment after the initial movement of said pressure sensing control, responsive to an increase in fluid pressure, thereby to snap the same into the closed flow control position responsive to a sudden increase in pressure force acting thereon.

20. The device of claim 19 wherein said inlet is of reduced size relative to said outlet to provide a restriction to the flow of fluid to increase the range of fluid pressure acting on the motor between no load and stall conditions thereby to increase the sensitivity of said pressure sensing control.

21. The device of claim 19 including biasing means between said housing and said pressure sensing control for continuously urging the latter into the open flow control position in opposition to the force of the fluid pressure in said first and second compartments.

22. The device of claim 21 wherein said biasing means is adjustable to selectively vary the force thereof opposing the movement of said pressure sensing control under the force of the fluid pressure in said first and second compartments.

23. For use in a fluid operated tool having a fluid motor, a shut off control handle comprising a housing including a fluid supply passageway for supplying fluid under pressure to the motor and a chamber in communication with an intermediate portion of said fluid supply passageway, a pressure sensing spool valve reciprocable in said chamber to establish a closed flow control position shutting off fluid flow to the motor and an open flow control position, said spool valve being biased toward one end of said chamber into normally open flow control position, a hand operated throttle valve mounted in said housing upstream of said spool valve for movement in said fluid supply passageway between an open position and a normally closed position for controlling fluid flow, and fluid communication means including passage means between said one end of said chamber and said fluid supply passageway on a motor side of said spool valve for directing back pressure from the motor urging said spool valve toward its closed flow control position responsive to an increase in motor operating pressure beyond a predetermined level, said fluid communication means further including an inlet port on the supply side of said spool valve for directly communicating said one end of said chamber with said throttle valve when said spool valve is moved into its closed flow control position under the force of motor operating pressure, said spool valve being maintained in a closed flow control position under the force of supply pressure until said throttle valve is moved into its normally closed position, permitting said spool valve to return to its normally open flow control position.

24. The device of claim 23 further including a spring engaging one end of said spool valve and continuously biasing it toward said one end of said chamber into said normally open flow control position, and an adjustable seat mounted in said housing and engaging said spring for selectively setting a compressive spring force continuously biasing said spool valve toward its normally open flow control position.

25. The device of claim 23 wherein said passage means includes first and second passages of generally T-shaped cross section formed in said spool valve, said first passage extending laterally through said spool valve and said second passage extending from said first passage axially through an end of said spool valve to provide an opening confronting said one end of said chamber in continuous communication therewith for connecting said one end of said chamber with said fluid supply passageway on the motor side of said spool valve when it is in its normally open flow control position.

26. For use in a fluid operated tool having a fluid motor, a shut off control handle comprising a housing having a chamber formed therein and a fluid supply passageway for supplying fluid under pressure to the motor, said chamber positioned intermediate said fluid supply passageway and in communication therewith, a pressure sensing spool valve reciprocable in said chamber to establish a closed flow control position shutting off fluid flow to the motor and an open flow control position, a spring engaging one end of said spool valve and continuously biasing it toward one end of said chamber into said open flow control position, fluid communication means between said one end of said chamber and said fluid supply passageway on a motor side of said spool valve, said fluid communication means including internal passage means formed in said spool valve having an opening confronting said one end of said chamber and in continuous communication therewith for directing back pressure from the motor against said spool valve in opposition to the biasing force of said spring to overcome the same and shift said spool valve into said closed flow control position responsive to an increase in motor operating pressure beyond a predetermined level, and additional fluid communication means between said one end of said chamber and said fluid supply passageway on a supply side of said spool valve for directing fluid under supply pressure against said spool valve responsive to its shifting into closed flow control position and for maintaining it therein independently of the fluid pressure acting on said motor.

27. For use in a fluid operated tool having a fluid motor, a shut-off control handle comprising a housing having a chamber formed therein and a fluid supply passageway for supplying fluid under pressure to the motor, said chamber positioned intermediate said fluid supply passageway and in communication therewith, a pressure sensing spool valve reciprocable in said chamber to establish a closed flow control position shutting off fluid flow to the motor and an open flow control position, a spring engaging one end of said spool valve and continuously biasing it toward one end of said chamber into said open flow control position, fluid communication means between said one end of said chamber and said fluid supply passageway on a motor side of said spool valve, said fluid communication means including internal passage means formed in said spool valve having an opening confronting said one end of said chamber and in continuous communication therewith for directing back pressure from the motor against said spool valve in opposition to the biasing force of said spring to overcome the same and shift said spool valve into said closed flow control position responsive to an increase in motor operating pressure beyond a predetermined level, and a hand operated throttle valve mounted in said housing on a supply side of said spool valve for movement in said fluid supply passageway between an open position and a normally closed position for controlling fluid flow, said internal passage means in said spool valve being closed off to said fluid supply passageway on the motor side of said spool valve upon movement thereof into its closed flow control position, and said spool valve being maintained in its closed flow control position under the force of supply pressure until said throttle valve is moved into its normally closed position, whereby said spool valve is returned to its open flow control position under the biasing force of said spring.

References Cited

UNITED STATES PATENTS

3,220,526 7/1964 Gattiker.

ERNEST R. PURSER, *Primary Examiner.*