

March 12, 1957

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2,784,818

IMPACT TOOL WITH ROTARY POSITION VALVE

Filed March 22, 1955

2 Sheets-Sheet 1

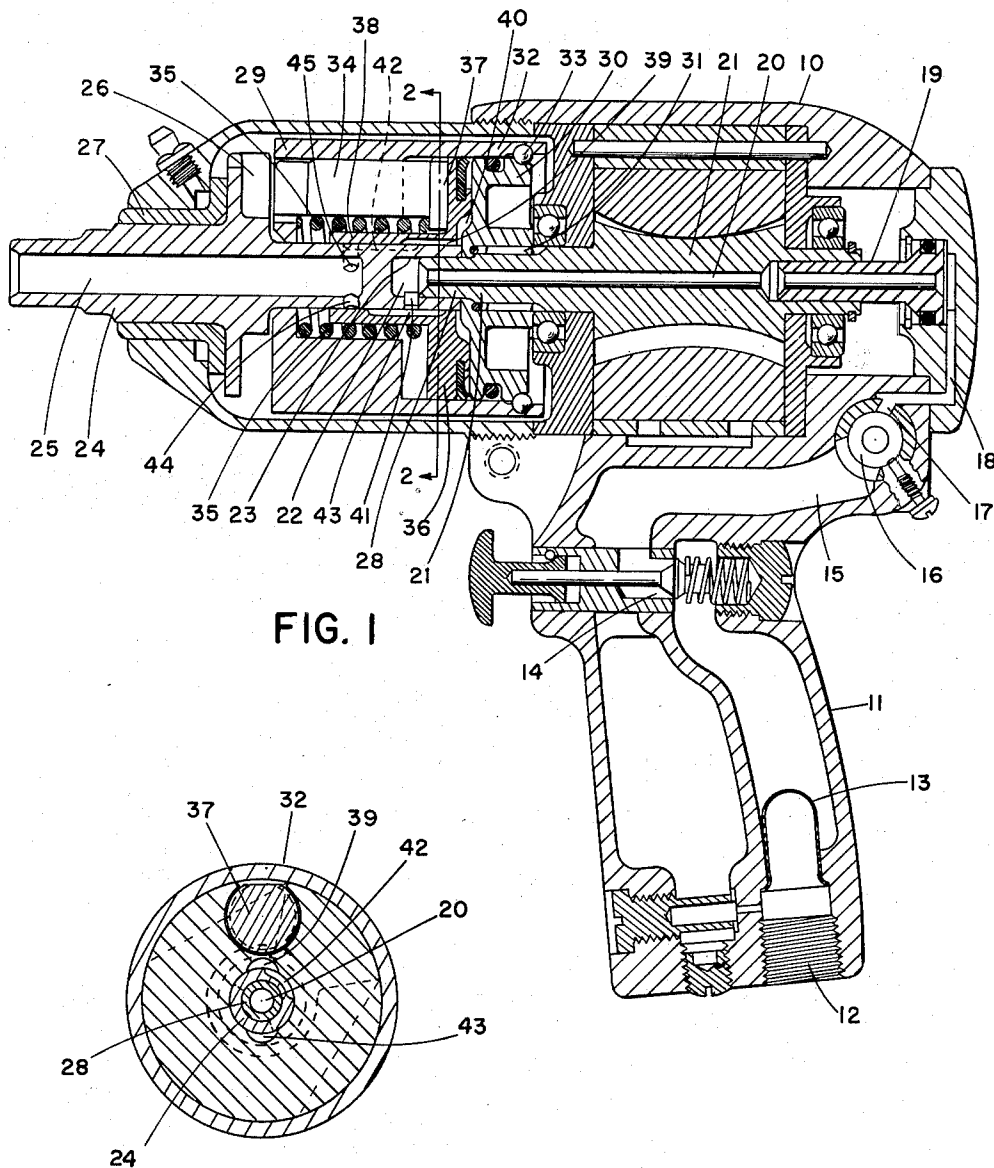


FIG. 1

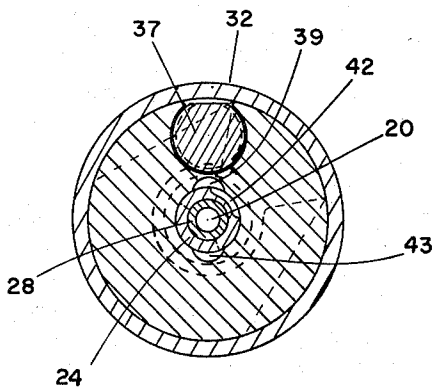


FIG. 2

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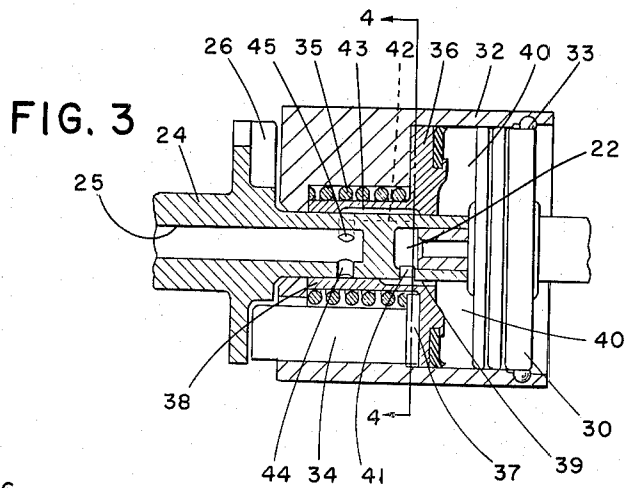


FIG. 3

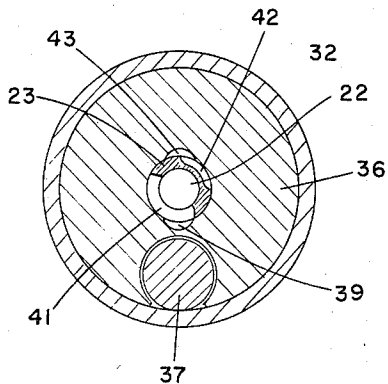


FIG. 4

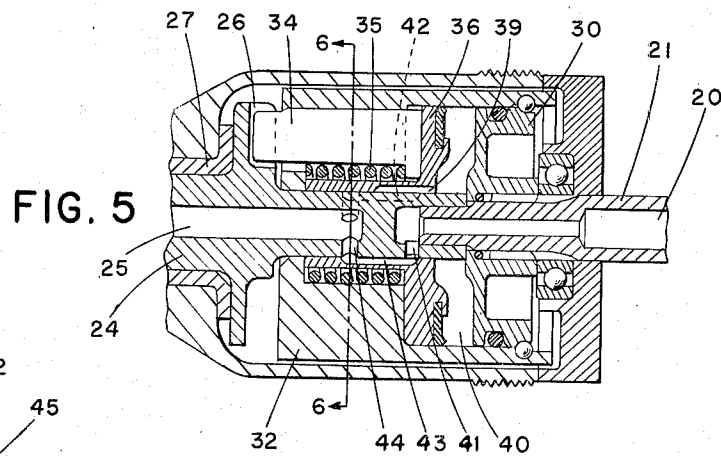


FIG. 5

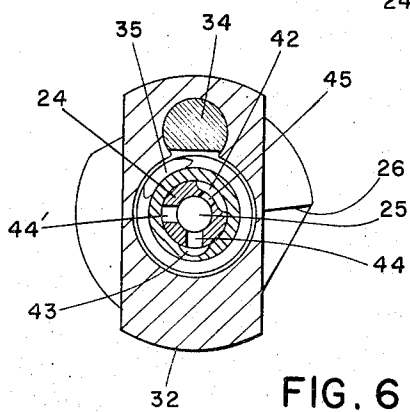


FIG. 6

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2,784,818

IMPACT TOOL WITH ROTARY POSITION VALVE 5

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10 Claims. (Cl. 192—30.5)

This invention pertains to air-operated tools of the impact type such, for example, as pneumatic impact wrenches, screw drivers and the like.

Broadly, there are several different classifications of impact clutches. One of these classifications is the torque-operated, or cam-type, where the disengaging motion of the hammer from the anvil is accomplished by motor torque acting through a cam arrangement. A second classification is the centrifugal type, or speed-responsive clutch, using centrifugal force to accomplish the engaging motion and, usually, a spring for disengaging motion. Another type uses a cam for both motions and involves some inertia forces to aid in the engaging motion. Another classification is the fluid-operated clutch wherein engagement or disengagement, or both, are accomplished by means of fluid pressure forces. In this last classification of impact tools there are, in general, two types of controlling valves which regulate the engaging and disengaging motions. One of these types is the centrifugally operated valve exemplified by Maurer Patent 2,693,867. The other type is a torsionally responsive valve exemplified by Shaff Patent 2,476,632 wherein a resilient diaphragm is used to transmit the motor torque to the hammer and the valve action is dependent upon the degree of twist in the diaphragm.

The ideal valve for controlling a fluid-operated clutch is a two position valve. The first valve position should cause relative engaging motion between the hammer and the anvil, and the second valve position should cause relative disengaging motion. The shift of the valve from one position to the other must be rapid and should occur at a definite point in the cycle of operation in the interest of efficiency and proper timing of the action of the hammer and anvil.

In the tool using a torsionally responsive valve, the shift of the valve from the second position to the first position to produce the engaging motion may be relatively slow and indefinite, and a tool using this type of valve frequently operates only over a narrow range of air pressures.

The device of the present invention embodies a third type of valve to control a fluid-operated clutch. This valve is a rotary position valve wherein the valve action depends upon relative rotary position between the hammer and anvil members.

It is an object of the present invention to provide an impact tool, the operation of which is dependent upon a fixed positional relationship as contrasted to prior art devices wherein the operation was dependent upon either torque or speed of the tool.

A further object of the invention is to provide an impact tool whose operation is consistent over a wide range of fluid pressures.

A further object of the present invention is to provide an impact tool which is effective in operation yet which is simple and inexpensive to make.

Another object of this invention is to provide a tool wherein the air pressure acting on the motor is greatly

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reduced when the hammer element is in contact with the anvil element, thereby to reduce the motor torque and, consequently, the frictional forces existing between the hammer and the anvil which must be overcome to pull the hammer back from the anvil.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in conjunction with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the drawings:

Fig. 1 is a central longitudinal section showing the impact tool of the invention with the hammer and anvil disengaged and before rotation of the motor has started;

Fig. 2 is a transverse sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is a fragmentary sectional view, somewhat similar to Fig. 1, but with the hammer rotated 180 degrees and a portion of it in position to strike the anvil upon further rotation;

Fig. 4 is a transverse sectional view taken along line 4—4 of Fig. 3;

Fig. 5 is a sectional view somewhat similar to Figs. 1 and 3 but showing the tool in its position when a portion of the hammer element strikes the anvil; and

Fig. 6 is a transverse sectional view taken along line 6—6 of Fig. 5.

The illustrative embodiment of the present invention consists of a rotary impact tool which has a fluid pressure driving motor therein adapted for connection with a source of fluid under pressure for operating the motor. A rotatable output shaft is provided having an impact-receiving surface and having a first portion of a rotary position valve. A rotatable hammer assembly is provided, including means defining an impact-delivering surface, driven by the motor for intermittent engagement with means defining an impact-receiving surface to deliver a rotary blow. The hammer assembly includes a second portion of the rotary position valve means. In accordance with one aspect of the invention these first and second portions cooperate with each other to establish valve action as the hammer assembly and the impact receiving surface rotate with respect to each other. In addition, means forming an expansible fluid pressure chamber is provided and force transmitting means exist between at least one of the impact surface means and this fluid pressure chamber to transmit relative engaging motion therebetween when the chamber expands. A conduit connects the source of fluid under pressure to the expansible fluid pressure chamber means to establish a force to expand this chamber. The rotary position valve means is connected to the fluid pressure chamber to automatically control the pressure within the chamber thereby to automatically produce the relative engaging motion.

Another aspect of the present invention lies in the provision in an impact tool of the aforesaid general character of valve means which is open when the impact-delivering surface means is in engagement with the impact-receiving surface or anvil for venting to atmosphere the source of fluid under pressure so as to reduce motor torque, and means are provided for closing the valve when the impact-delivering surface means is free to rotate relative to the anvil.

With reference to the drawing, there is shown in Fig. 1 an air-driven impact tool which includes a housing 10 with a handle portion 11. Compressed air is admitted through a tapped hole 12 and passes through screen 13 and is admitted to the tool through a manually operable throttle valve assembly 14, a passageway 15 to a reversing valve 16. This valve as shown is of the two-position slide-type. In one position it admits air to effect forward

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operation of the motor, and in the other position it admits air to the motor to produce reverse operation. However, in either position, live air is admitted from the central portion of the valve 16 through a port 17 into passageway 18 in the back cap of the housing 10. The passage 18 communicates with inlet bushing 19 which in turn admits air to a central bore 20 formed in the rotor shaft 21 of the tool's motor. Thus, whenever the tool is running, air is admitted to an axial bore 22 formed at the rear end of control shaft portion 23 of the output shaft 24 of the illustrative tool. An axial bore 25 in the forward end of output shaft 24 serves as an exhaust passage which communicates with atmosphere.

As shown, the anvil of the exemplary tool is formed integrally with the output shaft 24. Thus the shaft 24 is enlarged intermediate its ends, and radially spaced from its axis is formed an impact-receiving surface or anvil 26. The output shaft is journaled at its forward end in a bushing 27 fixed in the housing 10, and is rotatably supported at its rear end on the forward end 28 of rotor shaft 21.

As can best be seen upon reference to Fig. 1 of the drawings, the present impact tool includes a rotary hammer assembly 29, which is interposed between the rotor shaft 21 and the output shaft 24, and which completely surrounds the control shaft portion 23 of the anvil. The impact hammer assembly includes a drive bushing 30 which transmits torsional forces from the rotor shaft 21 through spline teeth 31, to hammer body 32, through the retaining balls 33. The hammer assembly unit further includes an impact pin 34, a disengaging spring 35 and a piston 36. The impact pin 34 is slidably mounted in an eccentrically disposed, longitudinal bore formed in the impact hammer body 32. At its rear end the impact pin 34 is provided with a head 37. The spring 35, which is mounted in a central bore in the hammer body 32, is of the expansion type and engages the head 37 of the impact pin so as to normally urge the impact pin rearwardly toward a disengaged position with respect to the anvil 26.

The piston 36 is provided for effecting forward longitudinal movement of the impact pin 34 with respect to the hammer body 32 so as to project the forward end of the pin into position for engagement with the anvil 26 whereby to deliver hammer blows thereto upon rotation of the hammer's assembly. To the end that the piston 36 and the impact pin are constrained to move together longitudinally with respect to the hammer body 32 and to rotate in unison therewith, the head 37 of the pin engages a recess formed in the forward face of the piston 36, and such engagement is maintained by the normally rearward force of the spring 35 on the pin.

The piston 36 is received in an enlarged bore formed in the rear end of the hammer body 32. The rear end of the bore is closed by the drive bushing 30 so as to form a piston chamber 40. Longitudinal movement of the piston is effected by alternately admitting pressure fluid to the chamber 40 and exhausting the chamber to the atmosphere. In the illustrative tool the piston 36 includes a forwardly projecting sleeve portion 38 which immediately surrounds the control shaft portion 23 of the output shaft 24. Sleeve portion 38 of the piston has a short longitudinal interior groove formed adjacent the rear end thereof to define a control port 39 which is adapted to alternatively supply pressure fluid to or exhaust air from the piston chamber 40. For this purpose the control shaft portion 23 has a supply port 41 and an exhaust port 42 formed therein which are peripherally spaced with respect to each other and are arranged to register with the control port 39 depending upon the relative angular position of the sleeve portion 38 of the piston 36 with respect to the control shaft portion 23 of the output shaft 24. As shown the supply port 41 is a radially disposed port formed adjacent the rear end of the control shaft portion 23 and communicates with the chamber defined by the axial bore 22 in the control shaft portion 23 to which pressure fluid is supplied by way of

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the central passage 20 in the rotor shaft 21 from the source of pressure fluid supply to which the tool is connected as hereinbefore set forth. The exhaust port 42 in the illustrative tool comprises a longitudinally formed groove or slot which is formed in the external surface of the control shaft portion 23. At its forward end the exhaust port 42 communicates with the coaxial exhaust bore 25 formed in the output shaft 24 by way of a port 45. The inner end of the port 42 extends rearwardly sufficiently far to overlap the forward end of the control port 39 so that upon the attainment of the desired relative angular position of the control shaft and piston the two ports 39 and 42 register, thus establishing an exhaust path to the atmosphere for the piston chamber 40.

To reduce motor torque after the delivery of a hammer blow, means is provided for venting live pressure fluid to the atmosphere. More particularly, venting of live pressure fluid to the atmosphere occurs subsequent to engagement of the hammer pin 34 with the anvil 26. For this purpose the control portion 23 of the output shaft 24 is provided with a radial vent port 44 which opens into the exhaust passage 25 in the output shaft, and the sleeve portion 38 of the piston 36 is formed with a bypass port 43. The latter port is in the form of a longitudinally disposed internal groove, and a vent port 44 is longitudinally aligned therewith and with the supply port 41. When the piston 36 is in its forward position, wherein the impact pin 34 is in position to engage the anvil 26, communication between the supply chamber 22 and the exhaust passage 25 is established through the ports 41 and 44 by way of the bypass 43, and live pressure fluid is vented to the atmosphere with the result that motor torque is substantially reduced. After the delivery of a blow by the pin 34 to the anvil 26 the spring 35 urges the piston 36 and the pin 34 rearwardly and the bypass port 43 is moved out of registration with the vent port 44 and the latter is closed. Thus, full motor torque is restored for rotation of the hammer assembly 32 to deliver a succeeding blow.

When the throttle 14 is manually opened, live air is supplied to the motor in, say, a forward direction and also to supply chamber 22 at the rear end of the control shaft 23. In Fig. 1 the clutch is shown in the disengaged position before any rotation has taken place. As can be seen in Fig. 2, in such position the control port 39 registers with exhaust port 42 which has accomplished the exhausting of piston chamber 40 allowing the disengagement of the impact pin 34 and anvil 26 to take place by the action of the spring 35. It will also be seen that inlet port 41 registers with by-pass port 43 but, since disengagement has taken place, exhaust port 44 is now closed off from bypass port 43 by a portion of sleeve 38 and motor torque has been restored to full value. As the hammer assembly 29 begins to rotate in a clockwise or forward direction, control port 39 assumes the position shown in Fig. 4 wherein it registers with inlet port 41, thus admitting live air to the piston chamber 40 causing the piston 36 and impact pin 34 to move to the forward positions thereof as shown in Fig. 3. In this position the by-pass port 43 does not register with inlet port 41 and therefore full motor torque is still available. Rotation continues until the impact blow is struck, as shown in Fig. 5. At this point the by-pass port 43 connects inlet port 41 and exhaust port 44 thus allowing live air from the supply conduit 20 to vent directly to atmosphere through axial bore 25 in the output shaft 24. As a result, motor torque is at once substantially reduced, and therefore the frictional forces between the impact-delivering surface of the pin 34 and the impact-receiving surface of the anvil 26, which must be overcome to accomplish disengagement, are also substantially reduced. Further in this relative position of the piston and output shaft the control port 39 now registers with exhaust port 42 thus allowing the air pressure in chamber 40 to be vented to atmosphere and the spring 35 now overcomes

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the above-mentioned frictional forces and moves the piston 36 and the impact pin 34 to the disengaged position as shown in Fig. 1. As best shown in Fig. 6, exhaust port 42 is connected to the central exhaust bore 25 of the forward part of the output shaft 24 by means of drilled port 45. Exhaust port 44 cooperates with the by-pass port 43 in a forward direction and has a counterpart 44' which cooperates with the by-pass port 43 in the reverse direction to perform the same function.

While there have been described what are at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, intended that the appended claims cover all such changes and modifications as fall within the true spirit and scope of the invention as expressed.

What is claimed is:

1. In a rotary impact tool having a fluid pressure driving motor adapted for connection to a source of fluid under pressure for operating the same, the combination comprising a rotatable output shaft having means defining an impact receiving surface and having a first portion of a rotary position valve means, a rotatable hammer assembly having means defining an impact delivering surface driven by the motor for intermittent engagement with said impact receiving surface to deliver a rotary blow to said impact receiving surface, said hammer assembly having a second portion of said rotary position valve means, said first and second portions of said valve means cooperating with each other for valve actions as said hammer assembly and said impact receiving surface means rotate with respect to each other, means defining an expandable fluid pressure chamber, transmitting means interposed between at least one of said impact surface means and said chamber means to transmit relative engaging motion between said impact receiving and delivering surface means when said chamber means expands, conduit means for supplying pressure fluid to said fluid pressure chamber to establish a force to expand said chamber means, said rotary position valve means being connected to said fluid pressure chamber to automatically control the pressure within said chamber to automatically produce said relative engaging motion, and means effective upon operation of said valve means to reduce fluid pressure in said chamber for causing disengaging motion between said impact receiving and delivering surface means.

2. A rotary impact tool as set forth in claim 1, further characterized by said impact delivering surface means comprising an impact pin movable axially relative to a massive portion of said hammer assembly and said transmitting means is connected to said impact pin to move said impact pin axially with respect to said massive portion of said hammer assembly.

3. In a rotary impact tool having a fluid pressure driving motor adapted for connected with a source of fluid under pressure for operating the same, the combination comprising a rotatable output shaft having means defining an impact receiving surface, a control shaft axially aligned with said output shaft and extending therefrom, said control shaft having an axial bore therein and having port means extending from said bore to the outside thereof and forming a first portion of a rotary positioned valve means, a rotatable hammer assembly having means defining an impact delivering surface driven by said motor for intermittent engagement with said impact receiving surface to deliver a rotary blow to said impact receiving surface, a portion of said hammer assembly surrounding and being journaled on said control shaft and having port means therein forming a second portion of said rotary positioned valve means, said first and second portions of said valve means being positioned adjacent each other for cooperative valve action as said hammer assembly and said impact receiving surface means rotate with respect to each other, means defining an expandable

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fluid pressure chamber, transmitting means between at least one of said impact surface means and said chamber defining means to produce relative engaging motion between said impact receiving and delivering surface defining means when said chamber means expands, means for supplying fluid under pressure to said chamber to establish a force to expand the same, and means connecting said rotary positioned valve means to said fluid pressure chamber means to automatically control the fluid pressure within said chamber to automatically produce said relative engaging motion, and means effective to produce relative disengaging motion when said rotary positioned valve means is operative to reduce fluid pressure in said chamber.

4. A rotary impact tool as set forth in claim 3, further characterized by said impact delivering surface means comprising an impact pin movable axially relative to a massive portion of said hammer assembly and said transmitting means is connected to said impact pin to move said impact pin axially with respect to said massive portion of said hammer assembly.

5. A rotary impact tool as set forth in claim 3, further characterized by said hammer assembly including an axially movable sleeve surrounding said control shaft and having a by-pass port positioned to cooperate with one of the port means through the axially bored control shaft in timed relation with relative motion between the impact receiving surface means and the rotatable hammer assembly, said one port means communicating with said supply conduit means when the impact delivering surface means is in contact with said impact receiving surface means, and means for connecting said by-pass port to atmosphere only while said impact delivering surface means is in position to engage said impact receiving surface means and is in the immediate vicinity thereof.

6. In a rotary impact tool having a fluid pressure driving motor adapted for connection with a source of fluid under pressure for operating the same, the combination comprising a rotatable output shaft having means defining an impact receiving surface rigid therewith, a control shaft axially aligned with said output shaft, a rotatable hammer assembly including means defining an impact delivering surface driven by said motor for intermittent engagement with said impact receiving surface to deliver a rotary blow to said impact receiving surface, said hammer assembly also including a reciprocable sleeve member surrounding and journaled on said control shaft, means for reciprocating said sleeve member and said impact delivering surface means to cause the impact delivering surface means to engage said impact receiving surface means, said control shaft and said reciprocable sleeve each defining a portion of a valve, said valve portions cooperating to connect said source of fluid under pressure to atmosphere when said impact delivering surface means is in engagement with said impact receiving surface means to reduce motor torque, means for reciprocating said sleeve member and said impact delivering surface means to cause said impact delivering surface means to clear said impact receiving surface means, and means closing said valve means when said impact delivering surface means is reciprocated out of engagement with said impact receiving surface means.

7. In a rotary impact tool having a fluid pressure driving motor adapted for connection with a source of fluid under pressure for operating the same, the combination comprising a rotatable output shaft having rigid therewith means defining an impact receiving surface, a control shaft axially aligned with said output shaft and extending away therefrom, said control shaft having an axial bore therein and having a by-pass port extending from said bore to the outside thereof forming a first portion of a rotary positioned by-pass valve means, a rotatable hammer assembly including means defining an impact delivering surface driven by said motor for intermittent engagement with said impact receiving surface to deliver a

rotary blow to said impact receiving surface, said hammer assembly also including a sleeve portion mounted on said control shaft for axial motion with respect to said control shaft and having by-pass port means therein forming a second portion of said rotary positioned by-pass valve means, said first and second portions of said by-pass valve means being disposed in transverse relation to said shaft for periodic cooperative valve action as said hammer assembly and said impact receiving surface means rotate with respect to each other, means defining an expansible fluid pressure chamber, supply conduit means for supplying fluid under pressure to said fluid pressure chamber, means connecting said expansible fluid pressure chamber means to said sleeve portion to move said sleeve axially as said expansible fluid pressure chamber means expands for periodically connecting said supply conduit to the atmosphere, and means conditioned upon expansion of said fluid pressure chamber for disengaging said impact-receiving and impact-delivering surfaces and for moving said sleeve portion to interrupt connection of said supply conduit means with the atmosphere.

8. In a rotary impact tool having a fluid pressure driving motor adapted for connection with a source of pressure fluid for operating the same, the combination comprising an output shaft assembly including an anvil member, a rotatable hammer assembly driven by the motor and including a hammer member movable between an engaging and disengaged positions with respect to said anvil member, means responsive to the application of pressure fluid for moving said hammer member into anvil engaging position, means conditioned during movement of said hammer member into anvil engaging position for moving the same into disengaged position upon interruption of the application of pressure fluid, and valve means interposed between said hammer assembly and said output shaft assembly, said valve means including a pair of elements respectively fixed with respect to said hammer and anvil members for movement relative to each other for controlling the application of pressure fluid to said pressure fluid responsive means.

9. In a rotary impact tool having a fluid pressure driving motor adapted for connection with a source of pressure fluid for operating the same, the combination comprising an output shaft assembly including an anvil member, a rotatable hammer assembly driven by the motor and including a hammer member movable between an engaging and disengaged positions with respect to said anvil member, means responsive to the application of pressure fluid for moving said hammer member into anvil engaging position, means conditioned during movement of said hammer member into anvil engaging position

for moving the same into disengaged position upon interruption of the application of pressure fluid, and valve means interposed between said hammer assembly and said output shaft assembly for controlling the application of pressure fluid to said pressure fluid responsive means, said valve means including an element fixed with respect to said hammer member and a second element fixed with respect to said anvil member for both longitudinal and rotary movement therewith with respect to each other, said elements having one set of ports therein for controlling the supply of pressure fluid to said pressure fluid responsive means upon relative rotary motion therebetween and having a second set of ports therein for controlling the bypassing of pressure fluid upon relative axial movement therebetween.

10. In a rotary impact tool having a drive motor and adapted for connection with a source of pressure fluid for operating the same, the combination comprising an output shaft assembly including an output shaft, an anvil rigid with the shaft, and including a control portion rigid and axially aligned with said output shaft, a rotatable hammer assembly driven by the motor and including a massive body defining a pressure fluid chamber, a piston rotatable with said hammer assembly and reciprocable within said chamber and having a sleeve portion mounted on the control portion of said output shaft, said hammer assembly also including a hammer member longitudinally reciprocable within said body between an anvil engaging position and a disengaged position with respect to said anvil, said hammer assembly further including a spring interposed between said body and said hammer member for maintaining said hammer member in engagement with said piston for movement thereby to its anvil engaging position upon admission of pressure fluid to said chamber, said spring being conditioned during such movement of said piston and hammer member for moving the same to the disengaged position upon interruption of pressure fluid supply to said chamber, said output shaft control portion and said piston sleeve portion having two sets of ports therein for controlling pressure fluid supply, one of said sets of ports cooperating upon relative rotation between said sleeve portion and said shaft control portion to control fluid pressure in said chamber, and the other set of ports cooperating upon relative longitudinal movement of said sleeve portion and said control portion to control pressure fluid bypassing.

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