

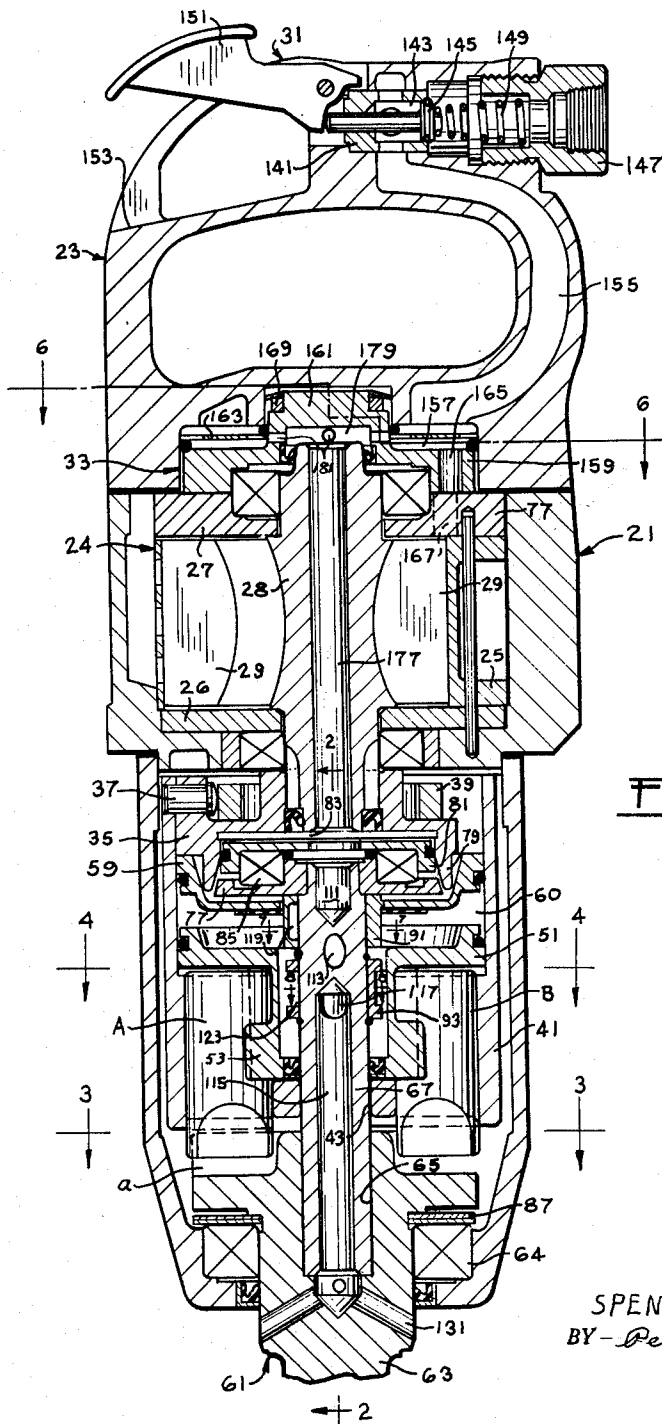
Dec. 18, 1962

S. B. MAURER
ROTARY IMPACT TOOL

3,068,973

Filed July 29, 1960

4 Sheets-Sheet 1



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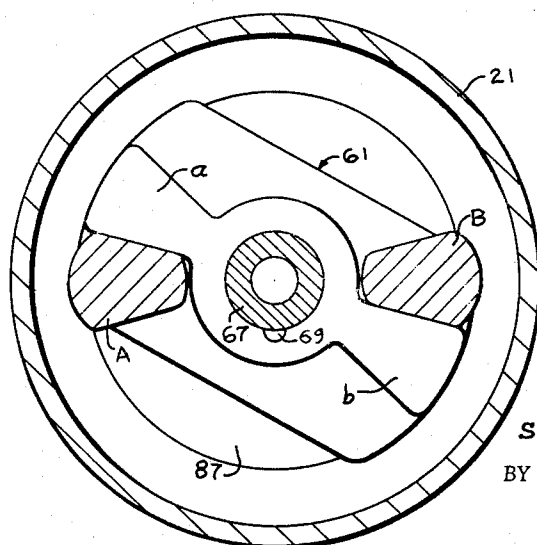
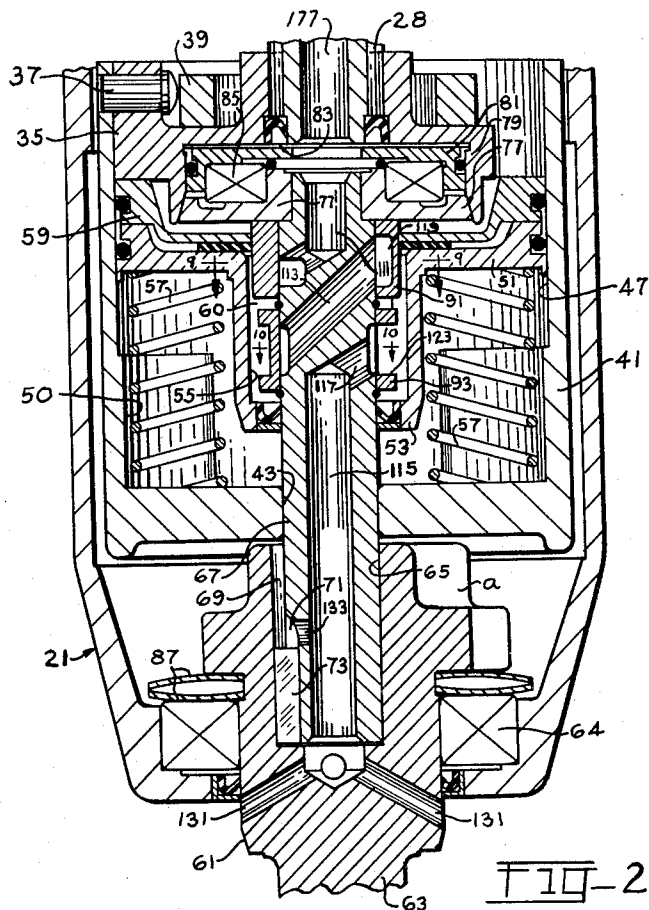
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4 Sheets-Sheet 3

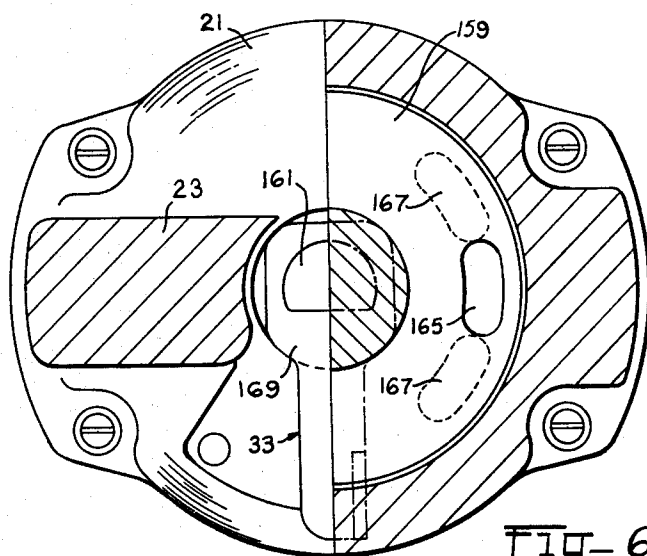


FIG-6

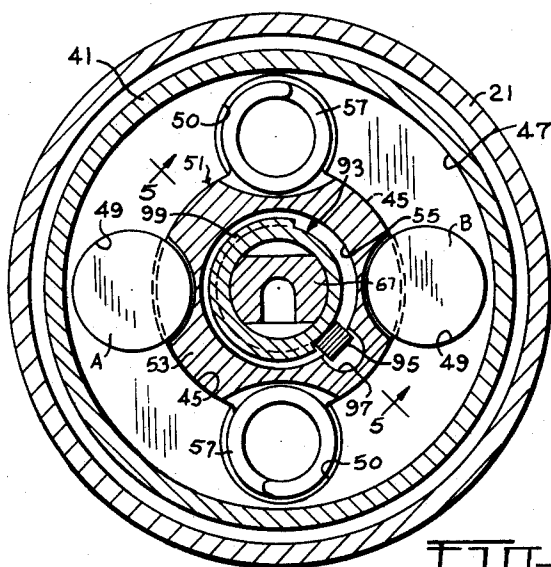


FIG-4

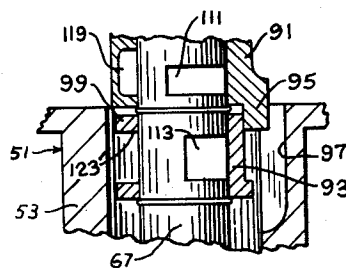


FIG-5

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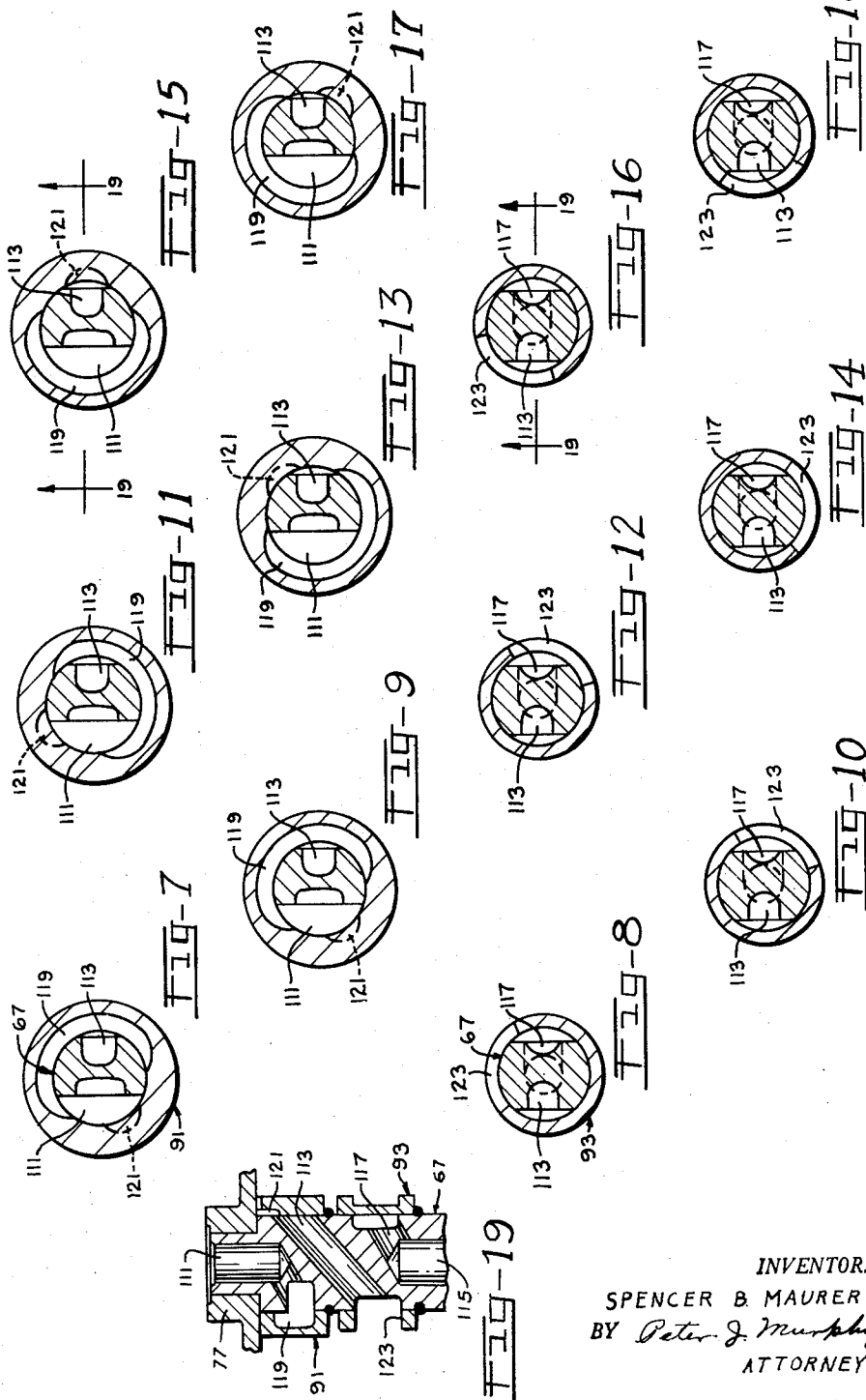
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4 Sheets-Sheet 4



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1

3,068,973

ROTARY IMPACT TOOL

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Filed July 29, 1960, Ser. No. 46,309

13 Claims. (Cl. 192—.096)

This invention relates to an air operated rotary impact tool, adapted for use as a wrench, screwdriver, or the like, and particularly to a reversible, multiple hammer impact tool having a rotary position valve assembly which functions by relative rotary positions between the hammer and anvil members.

In a tool of this type it is desirable to provide multiple hammers, or impact-delivering surfaces, and multiple anvils, or impact-receiving surfaces, for the purpose of providing a balanced arrangement of the tool and also for reducing severe stresses on the impacting members. It is also desirable, in such a tool, to provide for a single impact blow for each revolution of the hammers with respect to the anvils. This permits the hammer assembly to accelerate and attain sufficient momentum between impact blows without the necessity of an excessively powerful motor. Further, it is desirable in a tool of this type to provide for operation in either direction of rotation. Accordingly, it is an object of this invention to provide a multiple hammer and anvil tool to produce a single impact blow for each revolution of the hammer assembly and to provide control means for automatically controlling the tool. Another object of this invention is to provide such a tool which is operable in either direction of rotation.

A further object of this invention is to provide an impact tool, the operation of which is controlled in response to fixed positional relationships between the hammers and the anvils.

A still further object of this invention is to provide an impact tool wherein the hammer assembly is directly coupled to the output shaft until the air pressure has built up sufficiently to assure proper control of the tool by the automatic control mechanism.

The novel features of the invention, as well as additional objects and advantages thereof, will be understood more fully from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a longitudinal sectional view of a tool embodying the present invention, showing the hammers extended and engaging the anvils at the moment of impact.

FIGURE 2 is a partial longitudinal section, as viewed along the line 2—2 of FIGURE 1, showing the tool in condition to retract the hammers.

FIGURE 3 is a transverse section taken along the line 3—3 of FIGURE 1, showing the anvils and hammers.

FIGURE 4 is a transverse section taken along the line 4—4 of FIGURE 1.

FIGURE 5 is a fragmentary section, taken along the line 5—5 of FIGURE 4, showing the driving relation of the hammer piston, the primary valve, and the secondary valve.

FIGURE 6 is a transverse section taken along the line 6—6 of FIGURE 1, showing details of the reversing valve.

FIGURES 7, 9, 11, 13, 15 and 17 are diagrammatic views of the rotary valve assembly showing the relation of the primary valve to the valve shaft at various increments of relative rotation. FIGURE 7 is taken along the line 7—7 of FIGURE 1 and FIGURE 9 is taken along the line 9—9 of FIGURE 2.

FIGURES 8, 10, 12, 14, 16 and 18 are diagrammatic views of the rotary valve assembly showing the relation of the secondary valve to the valve shaft at various increments of relative rotation.

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FIGURE 8 is taken along the line 8—8 of FIGURE 1 and FIGURE 10 is taken along the line 10—10 of FIGURE 2.

FIGURE 19 is a fragmentary longitudinal section through the rotary valve taken along the lines 19—19 of FIGURES 15 and 16.

The illustrative embodiment of the present invention comprises a rotary impact tool driven by a pressure fluid motor. A rotatable output shaft is provided with two radially opposite anvils defining impact-receiving surfaces. A rotatable hammer assembly, driven by the motor, includes two, longitudinally extensible hammers defining impact-delivering surfaces for engagement with respective anvils. The hammers are extended, for engagement with the anvils, and retracted, to clear the anvils, by a piston member within a pressure chamber. The piston member is continuously urged to retract the hammer by springs. A rotary valve assembly includes a valve shaft mounted for rotation with the output shaft, a primary valve rotatably mounted on the valve shaft and rotated with the hammer assembly, and a secondary valve rotatably mounted on the valve shaft and coupled to the primary valve through a rotary lost motion connection.

A manually operable valve directs air to the motor and to the rotary valve assembly. The rotary valve assembly automatically controls the air pressure in the pressure chamber to control hammer movement. The tool provides a single impact blow for each revolution of the hammer assembly with respect to the output shaft, and operates identically in either direction of rotation.

With reference to the drawings, the general structure of the illustrative embodiment is best shown in FIGURES 1 and 2. A tool is enclosed in a housing 21 having an integral handle 23 at its rearward (upper) end. A rotary vane air motor 24, of conventional construction, is enclosed in the rearward end of the housing and includes a cylinder 25, a forward end plate 26, a rearward end plate 27, a rotor 28 and a plurality of sliding vanes 29. A throttle valve assembly 31 is incorporated in the tool handle and a reversing valve assembly 33 is disposed immediately rearwardly of the motor. These valve assemblies will be described in detail subsequently.

A hammer housing 41, mounted for rotation in the housing 21, is generally in the form of a cylindrical member having a small axial bore 43 at its forward end, an intermediate axial bore 45, and a large axial bore 47 at its rearward end. The rotor 27 of the air motor, rotatably mounted in anti-friction bearings, includes an integral, forwardly extending shaft extension which is splined to engage and drive a coupling drive member 35. The drive member 35 is received within the large bore 47 of the hammer housing 41. A plurality of retaining pins 37 pass through radially aligned holes in the drive member and hammer housing to couple these members together. A retainer 39 retains the pins in coupling position.

The hammer housing is provided with four circumferentially spaced bores, aligned parallel with the axis of rotation, which extend forwardly from the large bore 47 and which communicate laterally with the intermediate bore 45. As best shown in FIGS. 1 and 4, two of these bores 49, opposite each other, extend through the forward end of the hammer housing and receive cylindrical hammers A and B. As best shown in FIGS. 2 and 4, the other two bores 50 do not extend through the forward end of the hammer housing. A hammer piston 51, received within the large bore 47 of the hammer housing in sealing relation with the walls thereof by means of an O-ring, includes an axial, forwardly extending cylindrical boss 53 which is received within the intermediate bore 45 of the hammer housing. The hammer piston is pro-

vided with an axial opening 55. The hammers A and B and the boss 53 are provided with complementary notches for coupling these members so that axial movement of the piston imparts corresponding axial movement to the hammers and so that rotational movement of the hammer housing is transmitted through the hammers to the piston. A coil spring 50 is retained in each of the bores 50 to bias the piston 51, and hammers A and B, in a rearward direction. The piston boss 53 is recessed, as shown in FIG. 4, to accommodate the springs 57. A seal plate 59 is received within the large bore 47 of the hammer housing and is positioned immediately forwardly of the drive member 35. This seal plate is sealed with respect to the walls of the large bore by an O-ring and defines, with the bore 47 and the hammer piston 51, an air chamber 60. The seal plate is provided with a central opening.

As best shown in FIGS. 1 and 3, an output shaft 61 includes a radial flange having upwardly extending anvils *a* and *b*, which define oppositely disposed impact receiving surfaces, and a portion which extends through the forward end of the housing and includes a square drive 63 to receive a wrench socket, for example. The output shaft is rotatably mounted in the forward end of the housing by means of a bearing 64. The output shaft is provided with an axial recess 65, extending from its rearward end, within which is received the forward end of a valve shaft 67. The output shaft and valve shaft are provided with mating key grooves 69 and 71, respectively, and are keyed together by a key 73 so that the valve shaft is rotated with the output shaft. The valve shaft extends rearwardly into the clutch body through the small bore 43, through opening 55 of the hammer piston 51, and through the central opening in the seal plate 59. The valve shaft 67 is provided, at its rearward end, with a square which is received in a complementary square opening in a circular clutch plate 77. The periphery of the clutch plate is bevelled to define one element of a cone clutch. The drive member 35 is provided with a forwardly extending annular flange 79 defining a forward facing, cylindrical recess, the inner edge of the flange being bevelled to define the other member of the cone clutch.

A piston 81 is received within the recess in the drive member 35 and is sealed against the walls thereof, by means of an O-ring, to define a chamber 83. An annular anti-friction bearing 85 is mounted between the clutch plate 77 and the piston 81. This bearing serves to support the clutch plate, and hence the upper end of the valve shaft, with respect to the hammer housing 41, through the drive member 35 and the piston 81. Axial movement of the clutch plate 77 is controlled by the piston 81 through the bearing 85; the piston being actuated by air communicating with the chamber 83. Since the clutch plate 77, the valve shaft 67 and the output shaft 61 are coupled together for rotation and axial movement, the axial movement of this assembly is permitted by spring washers 87, disposed between output shaft bearing 64 and the output shaft flange. The spring washers normally bias the cone clutch to engaged condition.

A rotary valve assembly consists of the valve shaft 67, a primary valve 91, and a secondary valve 93, the latter of which comprise rotary sleeve valves mounted over the valve shaft 67 adjacent its rearward end. The secondary valve is axially confined for rotation on the valve shaft by retainer rings. The primary valve is axially confined for rotation with respect to the valve shaft between the secondary valve and the cone clutch plate 77. As best shown in FIGURES 4 and 5, the primary valve includes a radially and forwardly extending dog 95 which is received within a longitudinal slot 97 in the hammer piston 51 to provide rotational coupling between the piston 51 and the primary valve. The slot 97 is sufficiently long to maintain the rotational coupling through the relative axial movements of the piston and primary valve. The secondary valve is provided with radial flanges at

its forward and rearward ends. As best shown in FIGURES 4 and 5, the flange 99, at its rearward end, has a cut-out through a portion of its circumference to receive the dog 95. This cut-out extends through a sufficient angle to provide a rotary lost motion coupling between the primary and secondary valves. The secondary valve is rotated by the primary valve through this coupling; however, at a certain point in the cycle, the secondary valve will float ahead of the primary valve, as will be described. In the rotary valve assembly, then, the valve shaft 67 rotates with the anvils *a* and *b*; the primary valve 91 rotates with the hammers A and B; and the secondary valve 93 is rotated by the primary valve.

As best shown in FIGURE 2, the valve shaft 67 is provided with an axial recess extending forwardly from its rearward end and which communicates with a transverse opening. The transverse opening, in turn, communicates with a transverse groove which opens to a first side of the valve shaft to communicate with the primary valve 91. The above described axial recess, transverse opening and transverse groove define a port 111. A port 113 is defined by a slanted transverse opening which opens to a second side of the valve shaft, opposite from the first side, to communicate with the primary valve, and this port is directed forwardly to a transverse groove which opens to the first side of the valve shaft, to communicate with the secondary valve 93. The valve shaft is provided with an axial recess 115, extending rearwardly from its forward end, which communicates with a transverse recess and transverse groove defining a port 117. The port 117 opens to the second side of the valve shaft to communicate with the secondary valve.

The inner wall of the primary valve is provided with a partial circumferential recess or port 119 which communicates the ports 111 and 113 during certain portions of the operating cycle, as will be described. The primary valve is also provided with a bleed port 121, as best shown in FIGURES 15 and 19, which communicates the port 113 with the interior of the tool housing during a certain portion of the cycle, and hence to atmosphere as will be described. The port 121 is disposed so that it does not communicate with the port 111. The wall of the secondary valve 93 is provided with an opening or port 123, as best shown in FIGURES 16 and 19, to communicate either the port 113 or the port 117 with the chamber 60 defined by the hammer housing 41, the hammer piston 51 and the seal plate 59.

A plurality of transverse ports 131 communicate the forward end of the output shaft recess 65 with atmosphere at the forward end of the housing 21. The valve shaft recess 115 communicates with the ports 131 to, in turn, communicate the exhaust port 117 with atmosphere. The interior of the tool housing 121 is vented to atmosphere through the key groove 69 in the output shaft and a transverse vent port 133 in the valve shaft which communicates with the valve shaft recess 115.

The throttle valve assembly 31 includes a valve bushing 141 which is mounted in a transverse recess in the tool handle 23. The valve bushing has a stepped bore defining a valve seat and a chamber 143. A valve 145 includes an integral stem which extends through the bushing and guides the valve into engagement with the seat. An inlet bushing 147 is threaded into the handle recess and provides a threaded opening for reception of an airline fitting. A coil spring 149, compressed between the inlet bushing and the valve 145, biases the valve to seated or closed position. A lever 151, pivotally mounted within a slot 153 in the handle, engages the end of the valve stem to unseat or open the valve against the pressure of the spring 149. When the throttle valve is opened, live air passes into the chamber 143 and is directed, through suitable ports, to a passage 155 in a tool handle.

The passage 155 communicates with a chamber 157

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defined by the tool housing and a reversing valve 159 of reversing valve assembly 33. The reversing valve 159 is a rotatable, plate-like member recessed at its forward face and having a rearwardly extending boss 161. A spring washer 163, positioned within the chamber 157, bears against O-rings which seal the chamber 157; and also serves to hold the reversing valve against the rearward end plate 27 of the motor 24. As best shown in FIGURES 1 and 6, the reversing valve has a port 165 which is disposed to align with ports 167 in the motor end plate 27, when the valve is rotated, to effect either forward or reverse drive of the motor. A lever 169 is non-rotatably secured to the boss 161 of the reversing valve for rotating this valve to forward and reverse positions. In FIGURE 6, the valve is shown in a neutral position and may be rotated in either direction from neutral to direct air to the motor 24.

The rotor 28 of the motor is provided with an axial bore 177. The rearward end of the rotor extends into the recess in the reversing valve and is sealed with respect to the recess to define a chamber 179. The chamber 179 is in continuous communication with the chamber 157 through radial ports 181. From the chamber 179, air is directed through the rotor passage 177 to the chamber 83 and to the port 111 of the valve shaft 67.

For a description of the operation of the above described tool, assume that the reversing valve 159 is rotated to drive the motor in a clockwise direction, as viewed from the rearward end of the tool, and that the tool is connected to a suitable air supply. With the throttle valve closed, the assembly of the output shaft 61, the valve shaft 67 and the cone clutch plate 77 is urged rearwardly by the spring washers 87 to engage the cone clutch. This condition is shown in FIG. 2.

When the throttle valve is opened by an operator, the motor immediately starts to rotate and air is immediately directed to the rotary valve assembly. Since the cone clutch is engaged, initially there is no relative rotation between the hammers A and B and the anvils *a* and *b*. At the moment of starting, the relative positions of the rotary valve elements are not known nor are the positions of the hammer with respect to the anvils. If the hammers were permitted to engage the anvils while not fully extended, damage might result to the hammers or anvils. Therefore the cone clutch prevents such relative rotation until the air pressure has built up sufficiently to fully control the hammers through the rotary valve assembly. When sufficient pressure has been built up, air acting on the piston 81 moves the cone clutch plate 77, the valve shaft 67 and the output shaft 61 forward against the pressure of spring washers 87 and the cone clutch is disengaged. The cone clutch remains disengaged until the throttle valve is again closed.

An operating cycle of the tool comprises 360 degrees of rotation of the hammers A and B with respect to the anvils *a* and *b*; and the operating cycle to be described is from one impact of the hammers with the anvils to a succeeding impact. The tool is designed so that the hammer A will always impact against the anvil *a* and the hammer B will always impact against the anvil *b*, in either directions of rotation. The tool provides balanced construction; yet permits 360° of relative rotation between succeeding impacts.

An operating cycle will be described beginning from one impact to a succeeding impact. FIGURES 7 through 18 are diagrammatic views which show the relative positions of the primary and secondary valves 91 and 93 with respect to the valve shaft 67, at several increments of angular rotation. Degrees after impact refer to degrees of rotation of the hammers A and B (hammer assembly) in a clockwise direction with respect to the anvils *a* and *b* (output shaft).

FIGURES 1 and 3 show the condition of the tool at the moment of impact and FIGURES 7 and 8 show the relative positions of the valve shaft and the primary

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and secondary valves at the moment of impact. The primary valve is positioned so that air directed to the port 111 in the valve shaft is directed by the primary valve port 119 to the port 113. Prior to the moment of impact, the secondary valve port 123 had been in communication with the port 113; hence air had been directed into the chamber 60 above the hammer piston 51 to move the piston 51 and hammers A and B forward against the pressure of springs 57. The hammers A and B were then fully extended to impact against the anvils *a* and *b*.

At the moment of impact, as best shown in FIGURE 8, the secondary valve 93 has been rotated just sufficiently to shut off communication between the port 113 and the chamber 60. Simultaneously the secondary valve port 123 has just opened communication between the chamber 60 and exhaust port 117, so that air in the chamber 60 is permitted to exhaust through the port 117, the passage 115, and output shaft ports 131 to atmosphere.

At the moment of impact the hammer assembly is abruptly stopped, stalling the motor, and the hammer assembly may rebound. It is necessary to retract the hammers immediately to clear the anvils so that the motor may again rotate the hammer assembly and build up momentum for the succeeding impact and to prevent a secondary impact after rebound. For this reason, air must be exhausted rapidly from the chamber 60 to permit the springs 57 to retract the hammer piston. To accomplish this the secondary valve floats forward with respect to the primary valve, due to its angular momentum, to fully communicate the chamber 60 with the port 117. This condition is shown particularly in FIGURES 9 and 10 wherein the secondary valve is rotated about 100° ahead of the primary valve. This relative rotation of the secondary valve with respect to the primary valve is permitted by the lost motion coupling described above. As a result of this floating feature, the chamber 60 cannot be recharged with live air due to rebound of the hammer assembly and the primary valve.

FIGURES 11 and 12 show the positions of the primary and secondary valves at 90° after impact. Air is still directed to the port 113 by the primary valve. The secondary valve is in the same position as that shown in FIGURE 10, since the primary valve has not yet caught up with the secondary valve. The port 113 is still closed to the chamber 60.

FIGURES 13 and 14 illustrate the relative valve positions at 170° after impact. Air is still directed to the port 113 by the primary valve; however, communication between the ports 111 and 113 is about to be closed by the primary valve. The secondary valve is about to close communication between the chamber 60 and the exhaust port 117 and is about to open communication between the chamber 60 and the port 113.

During the cycle up to this point, since the chamber 60 has been continuously open to exhaust and has been closed to live air, the hammers A and B should remain retracted. It may be possible that, due to leakage of air, the hammers had been extended sufficiently to engage the anvils. If that has occurred at this point in the cycle, the hammer A is about to engage the anvil *b* and the hammer B is about to engage the anvil *a*. With the hammers locked in this position, the tool could no longer function; and since the chamber 60 is closed to live air and is about to be closed to exhaust, the hammers would remain locked. In order to prevent or correct this condition, the vent port 121 in the primary valve is now communicating with the port 113 to provide an air bleed from the chamber 60 into the tool housing. The means by which the tool housing is vented to atmosphere has been described. This bleed, then permits the hammers to be disengaged from the anvils so that the tool may resume normal operation.

FIGURES 15, 16 and 19 show the relative positions of

the control valve elements at 210° after impact, and particularly show the vent port 121 and the manner in which it bleeds the chamber 60. The primary valve has shut off the port 113 from live air. The secondary valve port 123 communicates the port 113 and the chamber 60 to maintain communication of the chamber 60 with the vent port 121.

FIGURES 17 and 18 show the positions of the valve elements at 250° after impact. The primary valve port 119 is just beginning to again communicate the ports 111 and 113 to direct live air to the chamber 60. Communication between the port 113 and the vent ports 121 is about to be closed. The chamber 60, then, is about to be closed to all exhaust and the pressure will build up in the chamber 60 to move the piston 51 and hammers forwardly. From this point to 360° after impact, (FIGURES 7 and 8) the chamber 60 is communicated with live air and the hammers A and B are fully extended and positioned for the succeeding impact.

The above described vent port 121 serves to prevent or automatically correct malfunction of the tool. It is not likely that the tool will malfunction during normal operation in one direction of rotation. However, due to the lost motion coupling between the primary and secondary valves, it is not known what the relative positions of these valves are when the tool is started. Hence, when the tool is started the rotary valve elements may be positioned to direct air to the chamber 60 at the wrong time with respect to an operating cycle. Particularly, this may occur when the tool is reversed. The rotary valve is designed to function identically in either direction of rotation. However, due to the lost motion coupling, the valve elements may not be positioned properly when the tool is started in a reverse direction. The vent port 121 then functions to permit the rotary valve to automatically orient itself for proper control of the tool.

A feature of this invention is the provision of the floating secondary valve which floats ahead of the primary valve at the moment of impact to rapidly and fully communicate the chamber 60 with atmosphere. This prevents a secondary glancing blow of the hammers against the anvils which may damage these members.

Another feature of this invention is the provision of a bleed in the rotary valve assembly to exhaust the chamber 60 in the event that the hammer should be locked against the wrong anvils upon starting or reversing the tool.

Still another feature of the invention is the provision of a direct coupling between the hammer assembly and the output shaft which is effective to prevent impact engagement of the hammer and anvils until the air pressure at the rotary valve assembly is sufficiently high to properly control the hammers. This also prevents damage to the impacting members which may occur if the hammers are not fully extended.

What is claimed is:

1. A rotary impact tool comprising a pressure fluid driving motor; an impact-receiving assembly, defining a rotatable output shaft, having a radially disposed impact-receiving member; an impact-delivering assembly, rotatably driven by said driving motor, having a radially disposed impact delivering member; a rotary valve assembly including a valve shaft mounted for rotation with one of said impacting assemblies, a primary valve rotatably mounted on said valve shaft and rotatable with the other of said impacting assemblies, and a secondary valve rotatably mounted on said valve shaft and coupled to said primary valve for rotation thereby through a rotary lost motion connection; manually operable valve means for communicating said motor and said rotary valve assembly with a source of pressure fluid; means defining an expansible pressure fluid chamber in one of said impacting assemblies; transmitting means interposed between said chamber and the associated impacting member, in said one impacting assembly to transmit longitudinal

tudinal motion to said member; said rotary valve assembly being connected to said chamber to automatically control the pressure within said chamber to produce intermittent impact blows of said impact-delivering member on said impact-receiving member; and said secondary valve floating ahead of said primary valve at each of said impact blows to effect rapid disengagement of said impacting members.

2. A rotary impact tool comprising a pressure fluid driving motor; an impact-receiving assembly, defining a rotatable output shaft, having radially and oppositely disposed impact-receiving members; an impact-delivering assembly, rotatably driven by said driving motor, having radially and oppositely disposed impact-delivering members; a rotary valve assembly including a valve shaft mounted for rotation with one of said impacting assemblies, a primary valve rotatably mounted on said valve shaft and rotatable with the other of said impacting assemblies, and a secondary valve rotatably mounted on said valve shaft and coupled to said primary valve for rotation thereby through a rotary lost motion connection; manually operable valve means for communicating said motor and said rotary valve assembly with a source of pressure fluid; means defining an expansible pressure fluid chamber in one of said impacting assemblies; transmitting means interposed between said chamber and the associated impacting members, in said one impacting assembly, to transmit longitudinal motion to said members; said rotary valve assembly being connected to said chamber to automatically control the pressure within said chamber to produce intermittent impact blows of said impact-delivering members on said impact-receiving members; and said secondary valve floating ahead of said primary valve at each of said impact blows to effect rapid disengagement of said impacting members.

3. A rotary impact tool as defined in claim 2 including a direct coupling means between said impacting assemblies which is effective to couple said assemblies until the pressure of fluid at said rotary valve assembly has reached a predetermined value.

4. A rotary impact tool comprising a pressure fluid driving motor; a rotatable output shaft having radially and oppositely disposed impact-receiving anvils; a hammer assembly rotatably driven by said driving motor; a pair of radially and oppositely disposed, longitudinally extensible hammers carried in said hammer assembly; a rotary valve assembly including a valve shaft mounted for rotation with said output shaft, a primary valve rotatably mounted on said valve shaft and rotatable with said hammer assembly, and a secondary valve rotatably mounted on said valve shaft and coupled to said primary valve for rotation thereby through a lost motion coupling; manually operable valve means for communicating said motor and said rotary valve assembly with a source of pressure fluid; means defining an expansible pressure fluid chamber in said hammer assembly; transmitting means interposed between said chamber and said hammers to transmit longitudinal motion to said hammers to engage said anvils; said rotary valve assembly being connected to said chamber to automatically control the pressure within said chamber to produce intermittent impact blows of said hammers on said anvils; and said secondary valve floating ahead of said primary valve at each of said impact blows to effect rapid disengagement of said hammers from said anvils.

5. A rotary impact tool as defined in claim 4 including means for directly coupling said hammer assembly and said output shaft effective until the pressure of fluid at said rotary valve assembly has reached a predetermined value.

6. A rotary impact tool comprising a pressure fluid driving motor; an impact-receiving assembly including a rotatable output shaft having a pair of radially and oppositely disposed impact-receiving members; an impact-delivering assembly, rotatably driven by said motor, having

a pair of radially and oppositely disposed impact-delivering members; means defining an expansible chamber in one of said impacting assemblies; transmitting means interposed between said chamber and the associated impacting members, in said one impacting assembly, to transmit motion to extend and retract said members; means in said one impacting assembly continuously urging said transmitting means to retract said members to prevent engagement of said members with counterpart impacting members; a rotary valve assembly comprising a valve shaft mounted for rotation with one of said impacting assemblies, a primary valve rotatably mounted on said valve shaft for rotation with the other of said impacting assemblies, and a secondary valve rotatably mounted on said valve shaft and rotated by said primary valve through a lost motion coupling; manually operable valve means for directing pressure fluid to said motor and to said rotary valve assembly; said primary valve directing pressure fluid to said secondary valve when said impact-delivering members are adjacent to respective impact-receiving members and cutting off pressure fluid from said secondary valve when said impact-delivering members are adjacent to opposite impact-receiving members; said secondary valve communicating said chamber with said primary valve when said impact-delivering members are approaching respective impact-receiving members to extend the associated impacting members prior to impacting; and said secondary valve floating ahead of said primary valve at the moment of impact to fully communicate said chamber with atmosphere to permit retraction of the associated members.

7. A rotary impact tool comprising a pressure fluid driving motor; a rotatable output shaft having a pair of radially and oppositely extending impact-receiving anvils; a hammer assembly rotatably driven by said motor; a pair of extensible hammers, carried in said hammer assembly, disposed radially opposite each other for engagement with respective anvils once during each revolution of said hammer assembly with respect to said output shaft; means defining an expansible chamber in said hammer assembly; transmitting means interposed between said chamber and said hammers to transmit motion to extend and retract said hammers; means in said hammer assembly continuously urging said transmitting means to retract said hammers to prevent engagement of said hammers with said anvils; a rotary valve assembly comprising a valve shaft mounted for rotation with said output shaft, a primary valve rotatably mounted on said valve shaft and rotatable with said hammer assembly, and a secondary valve rotatably mounted on said valve shaft and rotated by said primary valve through a lost motion coupling; manually operable valve means for directing pressure fluid to said motor and to said rotary valve assembly; said primary valve directing pressure fluid to said secondary valve when said hammers are adjacent to respective anvils and cutting off pressure fluid from said secondary valve when said hammers are adjacent to opposite anvils; said secondary valve communicating said chamber with said primary valve when said hammers are approaching respective anvils to extend said hammers prior to impacting; and said secondary valve floating ahead of said primary valve at the moment of impact to fully communicate said chamber with atmosphere to permit rapid retraction of said hammers.

8. A rotary impact tool comprising a pressure fluid driving motor; a rotatable output shaft having a pair of radially and oppositely extending impact receiving anvils; a hammer assembly rotatably driven by said motor; a pair of extensible hammers, carried in said hammer assembly, disposed radially opposite each other for engagement with respective anvils once during each revolution of said hammer assembly with respect to said output shaft; means defining an expansible chamber in said hammer assembly; transmitting means interposed between said chamber and said hammer to transmit motion to extend

and retract said hammers; means in said hammer assembly continuously urging said transmitting means to retract said hammers to prevent engagement of said hammers with said anvils; a rotary valve assembly comprising a valve shaft mounted for rotation with said output shaft, a primary valve rotatably mounted on said valve shaft and rotatable with said hammer assembly, and a secondary valve rotatably mounted on said valve shaft and rotated by said primary valve through a lost motion coupling; manually operable valve means for directing pressure fluid to said motor and to said rotary valve assembly; said primary valve directing pressure fluid to said secondary valve when said hammers are adjacent to respective anvils and cutting off pressure fluid from said secondary valve when said hammers are adjacent to opposite anvils; said secondary valve communicating said chamber with said primary valve when said hammers are approaching respective anvils to extend said hammers prior to impacting; said secondary valve floating ahead of said primary valve at the moment of impact to fully communicate said chamber with atmosphere to permit retraction of said hammers; said primary valve having a bleed port communicating with said secondary valve when said hammers are adjacent to opposite anvils; and said secondary valve communicating said chamber with said bleed port.

9. A rotary impact tool comprising a pressure fluid driving motor; an impact-receiving assembly including a rotatable output shaft having a pair of radially and oppositely disposed impact-receiving members; an impact-delivering assembly, rotatably driven by said motor having a pair of radially and oppositely disposed impact-delivering members; means defining an expansible chamber in one of said impacting assemblies; transmitting means interposed between said chamber and the associated impacting members, in said one impacting assembly, to transmit motion to extend and retract said members; means in said one impacting assembly continuously urging said transmitting means to retract said members to prevent engagement of said members with counterpart impacting members; a rotary valve assembly comprising a valve shaft mounted for rotation with one of said impacting assemblies, a primary valve rotatably mounted on said valve shaft and rotatable with the other of said impacting assemblies, and a secondary valve rotatably mounted on said valve shaft in axially spaced relation with said primary valve; means defining rotary lost motion coupling between said primary and said secondary valves; manually operable valve means for directing pressure fluid to said motor and to said rotary valve assembly; said valve shaft including an inlet port communicating with said manual valve means, an exhaust port communicating with atmosphere, and a port connecting said primary and said secondary valves; said primary valve having a port communicating said inlet port and said connecting port at certain rotational positions of said primary valve with respect to said valve shaft; said secondary valve having a control port communicating said chamber with said connecting port during certain relative positions of said valve with respect to said shaft, and connecting said chamber with said exhaust port during certain other relative positions of said valve with respect to said shaft; said ports cooperating to direct pressure fluid to said chamber to extend associated impacting members prior to the impact position of said members with respect to counterpart impacting members; and said secondary valve floating ahead of said primary valve at the moment of impact to fully communicate said chamber with said exhaust port to permit rapid retraction of said impacting members.

10. A rotary impact tool comprising a pressure fluid driving motor; a rotatable output shaft having a pair of radially and oppositely extending impact-receiving anvils; a hammer assembly rotatably driven by said motor; a pair of extensible hammers, carried in said hammer

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assembly, disposed radially opposite each other for engagement with respective anvils once during each revolution of said hammer assembly with respect to said output shaft; means defining an expansible chamber in said hammer assembly; transmitting means interposed between said chamber and said hammers to transmit motion to extend and retract said hammers; means in said hammer assembly continuously urging said transmitting means to retract said hammers to prevent engagement of said hammers with said anvils; a rotary valve assembly comprising a valve shaft mounted for rotation with said output shaft, a primary valve rotatably mounted on said valve shaft and rotatable with said hammer assembly, and a secondary valve rotatably mounted on said valve shaft in axially spaced relation with said primary valve; means defining a rotary lost motion coupling between said primary and said secondary valves; manually operable valve means for directing pressure fluid to said motor and to said rotary valve assembly; said valve shaft including an inlet port communicating with said manual valve means, an exhaust port communicating with atmosphere, and a port connecting said primary and said secondary valves; said primary valve having a port communicating said inlet port and said connecting port at certain rotational positions of said primary valve with respect to said valve shaft; said secondary valve having a control port communicating said chamber with said connecting port during certain relative positions of said valve with respect to said shaft, and connecting said chamber with said exhaust port during certain other relative positions of said valve with respect to said shaft; said ports cooperating to direct pressure fluid to said chamber to extend said hammers prior to the impact position of said hammers with respect to said anvils; and said secondary valve floating ahead of said primary valve at the moment of said impact to fully communicate said chamber with said exhaust port to permit rapid retraction of said hammers.

11. A rotary impact tool as defined in claim 10 wherein said primary valve is provided with a bleed port communicating with said secondary valve through said connecting port; and said secondary valve communicating said chamber with said bleed port.

12. A rotary impact tool comprising a pressure fluid driving motor; an impact-receiving assembly, defining a rotatable output shaft, having a radially disposed impact-receiving member; an impact delivering assembly, rotatably driven by said driving motor, having a radially

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disposed impact-delivering member; a rotary valve assembly including cooperating valve elements rotated, respectively, with each of said impacting assemblies; manually operable valve means for communicating said motor and said rotary valve assembly with a source of pressure fluid; means defining an expansible pressure fluid chamber in one of said impacting assemblies; transmitting means interposed between said chamber and the associated impacting member, in said one impacting assembly to transmit longitudinal motion to said member; said rotary valve assembly being connected to said chamber to automatically control the pressure within said chamber to produce intermittent impact blows of said impact-delivering member on said impact-receiving member; normally engaged clutch means directly coupling said impacting assemblies; and fluid pressure actuated means for disengaging said clutch means when the fluid pressure at said rotary valve assembly reaches a predetermined value sufficient to fully actuate said transmitting means.

13. A rotary impact tool comprising a pressure fluid driving motor; a rotatable output shaft having a radially disposed impact-receiving anvil; a hammer assembly rotatably driven by said driving motor; a radially disposed, longitudinally extensible hammer carried in said hammer assembly; a rotary valve assembly including a valve shaft mounted for rotation with said output shaft, a primary valve rotatably mounted on said valve shaft and rotatable with said hammer assembly, and a secondary valve rotatably mounted on said valve shaft and coupled to said primary valve for rotation thereby through a lost motion coupling; manually operable valve means for communicating said motor and said rotary valve assembly with a source of pressure fluid; means defining an expansible pressure fluid chamber in said hammer assembly; transmitting means interposed between said chamber and said hammer to transmit longitudinal motion to said hammer to engage said anvil; said rotary valve assembly being connected to said chamber to automatically control the pressure within said chamber to produce intermittent impact blows of said hammer on said anvil; and said secondary valve floating ahead of said primary valve at each of said impact blows to effect rapid disengagement of said hammer from said anvil.

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