

Feb. 25, 1969

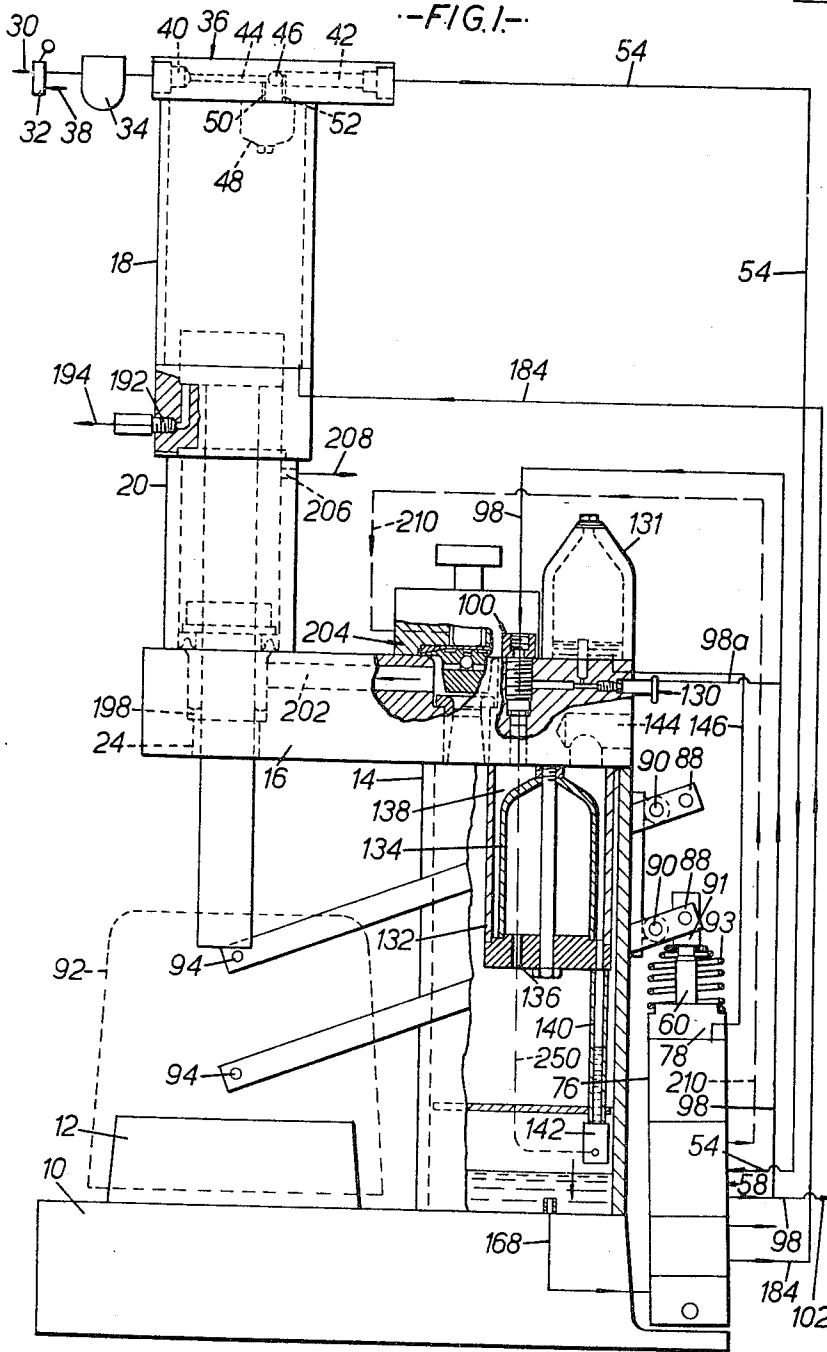
S. STANWORTH

3,429,227

POWER OPERATED TOOLS

Filed May 18, 1966

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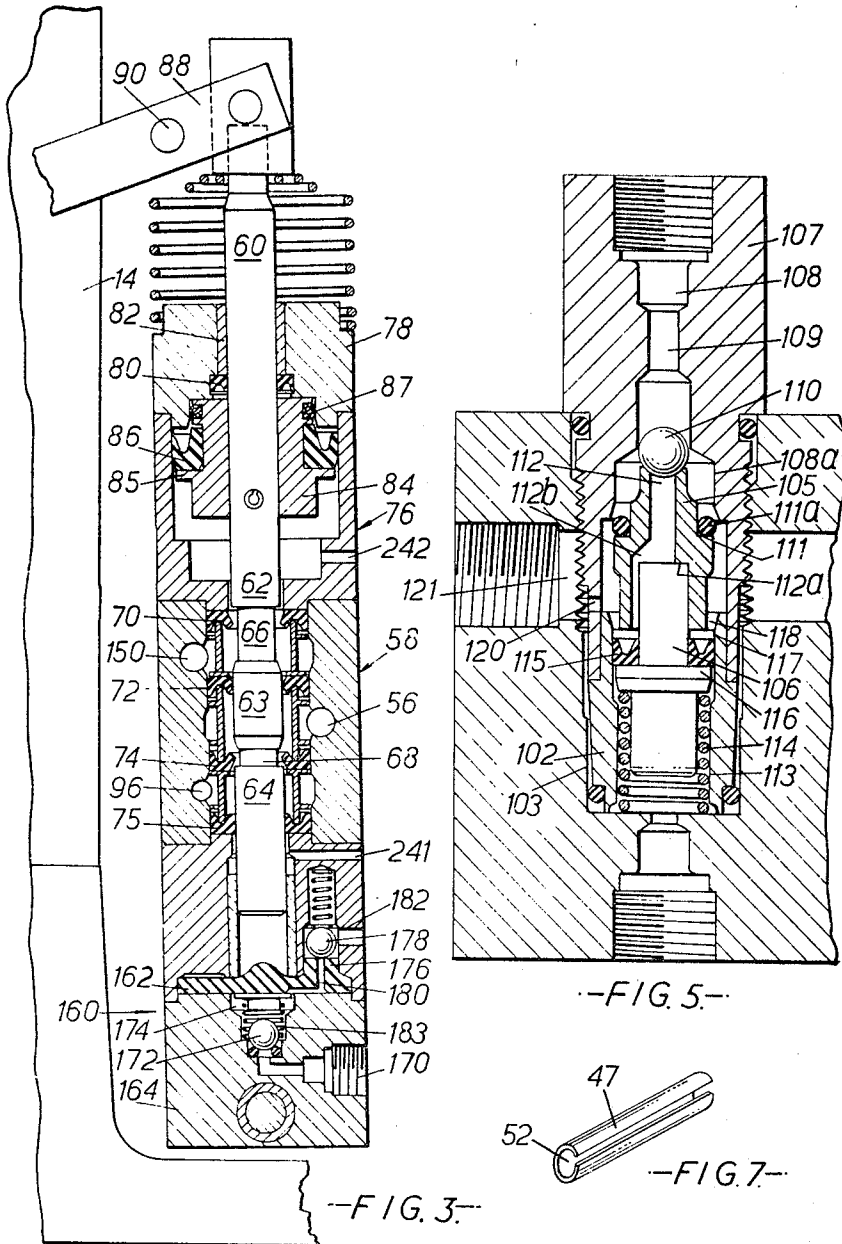
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-FIG. 3-

-FIG. 5-

-FIG. 7-

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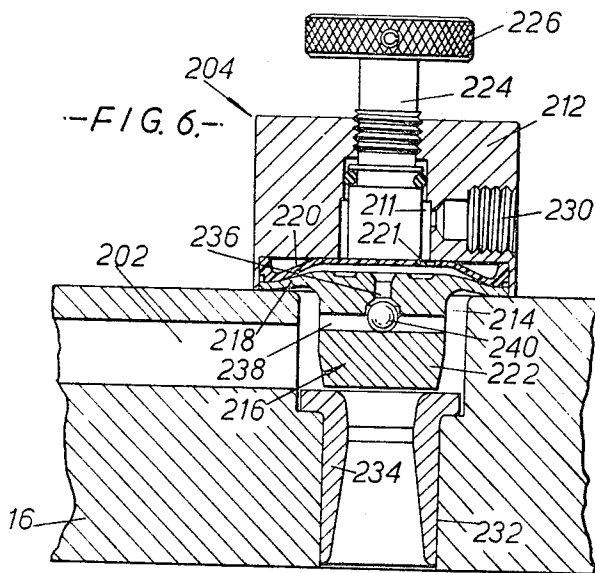
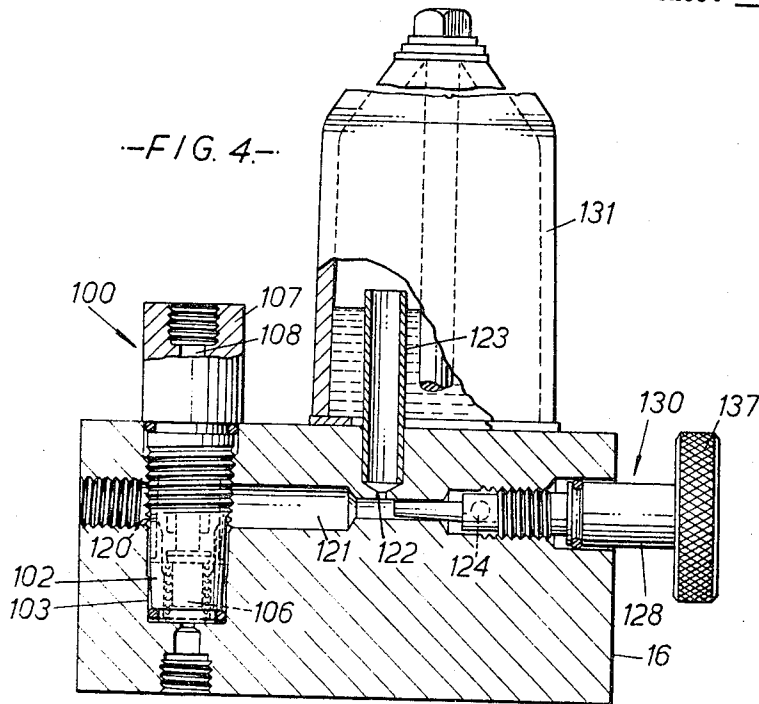
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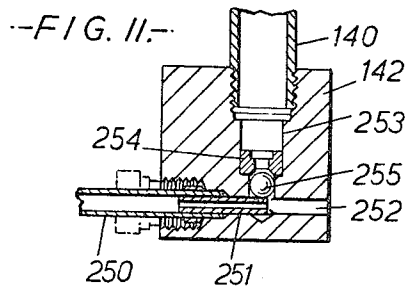
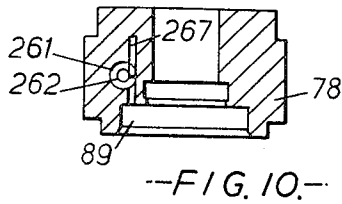
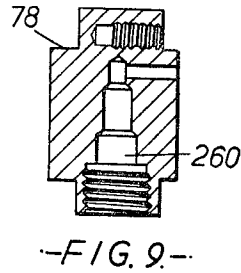
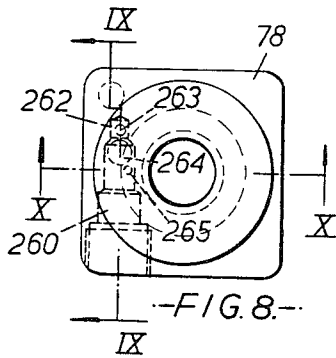
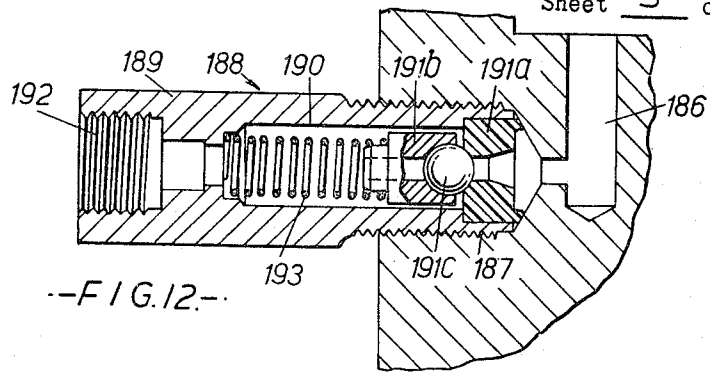
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POWER OPERATED TOOLS

Stephen Stanworth, 34 Reedley Road,
Burnley, England

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U.S. Cl. 91—38

9 Claims

Int. Cl. F15b 21/02, 15/17; F01b 7/18

ABSTRACT OF THE DISCLOSURE

A pneumatically operated power tool including a cylinder with a constant pressure operated differential piston for a working stroke and an external fluid cylinder and piston device for a return stroke. An air cushion for the differential piston, a quick opening valve for the external fluid cylinder, and a time delay device are also provided.

This invention relates to pneumatically operated power tools of the kind wherein the tool has a rectilinear motion. Press tools and punches are examples of this kind of tool since they have an operating shaft to which the actual forming tool is attached, the shaft being adapted to move axially.

Modern conditions demand that the tool shall operate as quickly as possible, and there are some operations which must be carried out at high speed. The introduction of high speed, however, brings its own problems, notably that of cushioning the high kinetic energy at the end of the stroke of the tool. The present invention is an attempt to deal with this particular problem.

Known pneumatically operated rectilinear motion tools have a piston which is acted upon by an air under pressure, the piston forming a seal with its cylinder (which of course creates friction and tends to reduce the speed of operation of the tool). In order to operate the tool it is necessary to allow any air on the underside of the piston to flow to exhaust. Sometimes, there are throttling arrangements which come into effect on the exhaust towards the end of the operative movement of the piston, in order to slow down the piston at the end of its movement.

According to this invention a pneumatically operated power tool having rectilinear motion of the tool has an operating member working within a cylinder and connected outside the cylinder to the toolholder and is characterised in that the operating member has unequal areas within the cylinder upon which areas the air acts to operate the tool, and means are provided external to the cylinder to oppose the differential force applied within the cylinder in order to move the tool to its initial (non-operative) position.

Because the operating force is obtained from the unequal areas of the operating member, the pressure of the air within the cylinder can remain substantially constant. This means that it is not necessary to exhaust the air on the underside of the piston, and this in itself is an advantage because it simplifies the construction.

It is preferred to arrange the operating member and the cylinder in such a manner that some air is trapped in a cavity of reduced volume as the operating member nears the end of its operative stroke. This in itself is a known feature of some pneumatic and hydraulic arrangements, but its effectiveness is much reduced where the air has to be exhausted, because only low-pressure air is trapped. The advantage of the present invention is that the trapped air has substantially the same pressure as the operating pressure, and consequently it provides an effective cushion, even over a very short distance. Another advantage of using the high pressure air for cushioning is that the

manufacturing tolerances on the bore of the cavity and the part of the operating member which enters that cavity, can be wider than would be permissible if only low pressure air was available for cushioning. The reason for this is that the high pressure air cannot leak as quickly through the clearance between the cavity and the operating member as can low pressure air. By the term "high pressure" is meant pressure greater than atmospheric (e.g. 30-2000 lbs./square inch).

In the preferred arrangement, the external force which opposes the pneumatic pressure acting on the operating member is provided by a fluid cylinder and piston device, there being means for rapidly exhausting this cylinder on one side of the piston to allow the operative force of the pneumatic cylinder to become effective. The fluid cylinder and piston device may itself be pneumatically operated, and the rapid exhaust may be provided for by means of a known quick-opening valve.

As an alternative to known quick opening valves, the invention provides a novel form of dual purpose valve which incorporates a relatively slow supply in one direction but a very rapid exhaust in the opposite direction. According to a feature of this invention a valve comprises a member adapted for flexing to seal a large exhaust outlet and having an internal passage incorporating a non-return valve to allow fluid under pressure to flow via the passage to an outlet port, but to prevent return flow, so that if the pressure supply is reduced or exhausted, the valve member will return to its original position and permit communication between the outlet port and the large exhaust port.

Preferably the invention is applied to an automatic tool and incorporates a timer which can be adjusted to regulate the speed of operation of the tool.

One construction of an automatic power press incorporating the invention will now be described by way of example only, with reference to the accompanying drawings in which:

FIGURE 1 is a general arrangement of the press partly in section, showing the pneumatic connections diagrammatically,

FIGURE 2 is a section to a larger scale through a pressure cylinder and the upper end of a resetting cylinder,

FIGURE 3 is a section through a valve assembly,

FIGURE 4 is a detail sectional view showing a timer arrangement,

FIGURE 5 is a detail sectional view to a larger scale of part of the timer drawn in FIGURE 4,

FIGURE 6 is a detail sectional view of a quick release valve,

FIGURE 7 is a perspective view of a spring pin used in the pressure cylinder head,

FIGURE 8 is a plan view of a cylinder cap,

FIGURE 9 is a section on the line IX—IX in FIGURE 8,

FIGURE 10 is a section on the line X—X in FIGURE 8,

FIGURE 11 is a section through an oil ejector and non-return valve, and

FIGURE 12 is a section through an oil return valve.

The press is intended for automatic operation, so that once it is set in motion it will reciprocate its press tool continuously until stopped. As shown in FIGURE 1, there is a cast metal base 10 having an upstanding portion 12 onto which is fixed the bottom tool or die and a column 14 which acts as an oil reservoir (as well be hereinafter described) and also supports a header block 16. A combined pressure cylinder 18 and resetting cylinder 20 unit (see also FIGURE 2) is supported above the header block 16, and a ram 22 projects from this unit through a bearing 24 in the header block. The ram 22

carries a chuck for the press tool in operation, but is illustrated in FIGURE 1 without the chuck. It will be appreciated however, that the press operates by vertical reciprocation of the ram 22.

The press is pneumatically operated, and may be connected either to a high pressure air supply or to its own air compressor. The air supply is led via a pipe 30 through a master valve 32 and a filter 34 to a cylinder head cap 36. The master valve 32 is manually operable and when in the "on" position it allows the air under pressure to flow freely through the supply pipe 30. When the valve 32 is turned into the "off" position it shuts off the air flow via the pipe 30, and allows air to escape from the press to an exhaust outlet 38, so that the press can be "drained" of its air pressure.

Within the cap 36, there are inlet and outlet bores 40 and 42 interconnected by a restricted bore 44, formed with a chamfered portion 43 where it joins the outlet bore 42, to receive a ball 46 retained by a pin 47, so providing a simple non-return valve. A porous bronze oil filter 48 may be provided within the upper end of the pressure cylinder 18, because, as will become apparent, the air used in the pneumatic operation of the press carries a dispersion of oil for lubrication purposes, and a filter such as 48 controls the amount of oil carried by the air leaving the cylinder 18. Within the space enclosed by the filter 48 are two small bore holes 50 and 52 leading respectively from the inside of the cylinder 18 to the inlet bore 40 and the outlet bore 42. The pin 47 is shown in detail in FIGURE 7, and is substantially C-shaped in cross-section with a narrow longitudinal slot along one side. The space inside this hollow rolled pin provides the port 52 and since the slot is never completely closed when the pin is driven into its hole, the provision of this port is guaranteed. It will be seen that the pin 47 acts in a dual capacity both as a retaining pin for the ball 46 and as a port. The provision of the two small bores 50 and 52 allows air under pressure (at all times during which air is being supplied to the machine) to flow into the cylinder 18, and it also allows some air to by-pass the non-return valve 46 when the machine is exhausted. It will be appreciated however, that during the operating cycle the only substantial flow of air into or out of the cylinder 18 occurs during the downward working stroke of the ram 22, and when the ram is moved back into its neutral or non-operative position, and that in each of these cases the pressure in the cylinder 18 will only vary slightly from that at the inlet port 40. Only when the machine is exhausted does the pressure in the cylinder 18 exceed the pressure at the inlet port to a substantial degree.

From the outlet port 42 a pipe 54 leads to an air inlet port 56 in a valve 58. The latter is a multiple valve having an axially displaceable rod-like valve member 60 which has lands 62, 63 and 64 and necks 66 and 68 which cooperate in turn with air seals 70, 72, 74 and 75. Such valves are well known and they operate on the general principle that when a land engages in one of the seals, it closes an air passage through the bore of that seal, but when a neck extends through a seal it opens the air passage.

Above the valve 58 there is a short cylinder 76 fixed to the valve block and closed at its upper end by a cap 78. The rod-like valve member 60 extends through the cylinder 76 and out through a seal 80 and a slide bearing 82 in the cap. Within the cylinder 76, a piston 84 is fixed on the valve member 60. The piston 84 has an annular lip 85 which is a clearance fit within the cylinder, and which supports a cup washer 86 which makes sealing engagement with the bore of the cylinder.

Above the cup washer 86, the piston carries a sealing ring 87 which makes sealing engagement with a shallow bore 89 formed in the cap 78 (see also FIGURE 10) when the valve member 60 is in its fully raised position.

This piston 84 provides the operating member for the valve 58.

Above the cylinder 76, the upper end of the member 60 is pivotally attached to one end of a guard operating lever 88. There are two such levers each of which is pivoted at 90 on a bracket projecting from the column 14. A guard 92 made of plastics material is provided to prevent the operative's hand from being pushed under the descending tool, but this guard has to be raised when the tool is raised to allow the workpiece to be removed, and a fresh workpiece to be inserted. Each of the levers 88 is forked to embrace the guard, and there are pivotal connections 94 where the forked ends of the levers are attached to the guard. The arrangement of the two levers 88 provides a lifting motion for the guard when the member 60 is pulled downwardly. It will be noted that the levers 88 are fulcrumed very near to the operating force end, so that the weight of the guard 92 is sufficient to cause it to drop under gravity. To assist in moving the guard 92 to its lowered position, a light compression spring 93 is fitted between the cap 78 and a block 91 on the top end of the valve member 60, this spring urging the valve member upwards. It will be noted that the spring 93 besides having helical coils also has a spiral coil at its top, so that it also acts as a guard to prevent operatives trapping their fingers under the reciprocating block 91.

It will be observed that the valve 58 is shown in FIGURE 3 with the guard in the "down" position. In this position, the compressed air supply communicates via the port 56 and the bore of the seal 74 (which is then open) with an outlet 96. From this outlet a pipe 98 leads to a timer unit in the header block 16. If a swarf blower is required on the machine, a branch pipe 102 leads from the pipe 98, so that air under pressure is available through the pipe 102 to operate a swarf-blower valve (not shown).

The timer unit (see FIGURE 4) comprises a valve assembly 100, a leak-off valve 130 and an oil bottle 131. The valve assembly 100 comprises a lower housing 102 which is pushed into the lower part of a hole 103 formed vertically through the header block to connect into the column 14; upper and lower valve members 105 and 106, and an upper housing 107 which is screwed into the upper end of the hole 103, and which holds the other parts in position.

The upper housing has a bore 108 tapped at the top to receive the connection for the pipe 98, and formed with a constriction 109 engageable on the underside by a rubber ball 110 to provide a non-return valve. The upper valve member 105 is made of plastics material and is freely slidable within the lower end of the bore 108. As shown in FIGURE 5, this member is formed with an upper spigot and a shoulder 111 on which there is seated a rubber O ring 111a, the latter being provided to form a seal with a part 108a of the bore 108 when the member 105 is lifted from the position shown in FIGURE 4. The upper end of the part 108a of the bore is chamfered so that when the member 105 is in its fully raised position, it is possible for air pressure in the upper part of the bore 108 to act on the O ring 111a, and hence on the member 105. The member 105 is itself formed with a bore 112, and at its top end this bore is chamfered to provide an alternative seating for the rubber ball 110.

The lower valve member 106 slides in a compression spring 114 which is a loose fit within a rectangular hole 113 with rounded corners formed in the lower housing 102, whilst its upper end is a tight fit in an enlarged lower portion of the bore 112 of the upper valve member 105. An annular lip 116 is provided on the member 106 and this lip provides an abutment for the upper end of the compression spring 114 (which tends to lift both the valve members away from the position illustrated) and a support for a U seal 115 made of rubber or other resilient and deformable material. A circular hole 117 is formed in the upper end of the lower housing 102, and its

top end is chamfered at 118 to provide a lead for the ring 115 which forms a seal within the hole 117 (when the member 106 is in its lowered position as shown).

Where the bore 112 of the member 105 is reduced, there are four equally spaced lands 112a formed in the bore, so that the top end of the member 106 engages with these lands (as shown) when the members 105 and 106 are assembled. This leaves four narrow passageways 112b through the member 105. In FIGURE 5, the section through the member 105 is taken on two radii at 45° to each other, so that one land 112a and one passageway 112b are illustrated.

When air under pressure is admitted to the bore 108 from the pipe 98, the ball 110 is immediately blown down on to its alternative seat at the upper end of the valve member 105. The bore 112 is then closed, and the air pressure acting on the top end of the member 105 (and on its ring 111a) forces that member downwardly. This forces the lower valve member 106 to move down against the action of the spring 114, and the ring 115 seals in the bore 117, so that air cannot flow out through the lower portion of the hole 113. The air can, however, flow past the member 105, and it travels via a port 120 in the lower part of the housing 107 into a passage 121 in the header block 16.

A small port 122 (see FIGURE 4) leads from the passage 121 into a plastics tube 123 which is fitted into a hole in the header block 16, and which projects upwardly into the oil bottle 131 which is secured to the top of the block 16. A supply of oil is provided in the bottle 131, and this oil supply is constantly replenished during the operation of the machine, because the air entering the bottle via the tube 123 entrains oil, and some of this will be precipitated within the bottle. If the oil level rises too high, the excess oil will drain off down the tube 123 into the passage 121.

The leak-off valve 130 comprises a needle member 128 which has screwed engagement with the header block 16 and there is a knob 137 for adjustment of the needle valve. The needle cooperates with part of the port 121, and on the outlet side of the needle valve there is a port 124, which is connected via a pipe 98a (FIGURE 1 with the pipe 98).

Within the column 14, and suspended from the header block 16, there is an air filter 132 designed to filter oil from the exhaust air. Air can flow into an inner chamber 134 which is made of porous bronze via an inlet port 136. The air can escape through the bronze shell, but most of the oil entrained in the air will collect on the outside wall of the shell and fall into the lower end of an outer chamber 138. From the chamber 138, the oil can drain through a pipe 140 to an oil ejection and non-return valve 142, the construction of which is illustrated in FIGURE 11. A pipe 250 leads from the lower end of the hole 113 in the timer valve 100 to the oil ejector 142 and this pipe 250 terminates within the ejector 142 in a nozzle 251 pointing into a transverse bore 252. The tube 140 is secured in the top end of the ejector 142 and a bore 253 leads from the lower end of the tube 140 into the transverse bore 252. A valve seat 254 is fitted within the bore 253 and a ball 255 is capable of engagement with this seat to prevent air flow from the bore 252 into the tube 140. The valve thereby provided is a non-return valve and the ball 255 cannot escape because it rests on the nozzle 251 in its open position. Normally, the ball is held closed by air pressure within the column 14, but each time there is a shift of air from the valve 100 through the pipe 250, the ball 255 is sucked off its seat and any oil in the pipe 140 is entrained in the air passing out through the bore 252. Oil builds up in the pipe 140 and only when there is a sufficient head of oil to overcome the loading of the non-return valve 255 can this oil flow out into the reservoir constituted by the lower end of the column 14. An outlet port 144 is formed in the header block 16 leading from the inside of the outer chamber

138 of the filter 132 to atmosphere. This provides the exhaust outlet for the pneumatic system.

When air under pressure is supplied via the pipe 98 to the timer unit 100, it operates the valve 100 to the position shown in FIGURES 4 and 5, so that the air can flow to the passage 121 but cannot flow out through the pipe 250. The air therefore begins to flow through the restricted port 122 up into the bottle 131. At the same time, air flows through the pipe 98a and the port 124 to the needle valve 130. Some of this air leaks past the needle valve and is added to the air flowing into the bottle. There is a rapid increase in pressure above the oil in the bottle 131, and the oil is forced to flow via a pipe 146 and a port 260 into the cap 78 at the upper end of the cylinder 76 above the piston 84 (FIGURES 8 and 9).

The bore 260 has a reduced portion 261 and a further reduced portion 262. A port 263 leads from the portion 262 into the cylinder 76 above the cup seal 86 on the piston 84 (FIGURE 3). At the shoulder between the two portions 261 and 262 there is a chamfer, and a ball 264 seats on this chamfer to form a non-return valve. A port 265 leads from the portion 261 into the shallow bore 89 of the cap 78. A retaining peg 267 is fitted into the body of the cap 78 to retain the ball 264.

When oil under pressure flows from the bottle 131 into the bore 260, the ball 264 closes the passage through the portion 262, and the oil has to flow through the small port 265 into the shallow bore 89. Therefore the oil pressure only acts on a reduced diameter of the piston 84 to produce initial movement of the operating member 60 downwardly. Eventually, the piston moves completely out of the bore 89, and the oil pressure is then able to act on the full diameter of the piston. On the return stroke, the ball 264 moves off its seat and oil can flow through both the ports 265 and 263, so that the return stroke can be more rapid than the downstroke.

In moving downwardly, the operating member 60 lifts the guard 92 clear of the upstanding portion 12, and also changing the position of the valve member relative to the seals 70, 72, 74 and 75. Air on the underside of the piston 84 can escape via a port 242. As a result, the passage through the seal 74 is blocked, and air under pressure from the supply can no longer flow to the timer 100. Moreover a passage is opened through the seal 75 and air under pressure on the top side of the timer and at the large end of the needle valve 130 can escape to exhaust via an exhaust port 241. Instead, the air from the inlet 56 flows through the seal 72 and out of the valve 58 via a port 150.

When the air supply to the timer is cut-off and exhausted, the air in the valve 100 flows through the bore 112 of the member 105, and lifts the ball 110 on to its top seat, so preventing return flow of air past the ball 110 through the pipe 98. Both valve members 105 and 106 remain depressed, and air commences to leak off through the valve 130, via the port 124, pipe 98a, pipe 98 and exhaust port 241.

Eventually, the pressure drops sufficiently to allow the spring 114 to push the members 105 and 106 upwards, and this then allows air to escape into the column 14 via the corners of the square hole 113, the lower end of the bore 103, pipe 250 and the oil ejector 142. This causes a sudden release of pressure, which will have the effect of allowing the piston 84 to rise in its cylinder 76, forcing oil back into the bottle 131. It will be appreciated that the time delay between the cutting off of the air supply to the timer 100 and the opening of the valve 115 can be controlled by opening or closing the leak off valve 130. This time delay controls the speed of operation of the machine cycle.

Turning now to the tool carrying ram 22, it is desirable that the operative downstroke of the ram (which should commence when the guard 92 has almost reached its bot-

tom position) should be as rapid as possible, subject to certain practical limitations.

The practical limitations are introduced by the design characteristics of the machine; such as the ability of the parts of the machine to stand up to the stress and wear. But the chief limitation on high operative speed at the present time is the necessity to check the shaft (with all its attached parts), or to put it in other words, to absorb the kinetic energy of moving parts at the end of the operative stroke, particularly when the machine has not performed any work.

On the other hand, the speed of the upstroke (or return stroke) is not so important, since this is merely a resetting movement, and in any case, the time cycle of the machine is more likely to be limited by the speed with which articles can be placed on, and removed from, the machine than by the time taken to reset the tool.

The upper end of the ram 22 projects into the pressure cylinder 18 (through a substantially air-tight bearing 152) and a metal piston 154 is fixed on to this end of the ram, the piston being therefore completely within the cylinder 18.

The piston 154 is of considerably smaller diameter than the bore of the cylinder 18, but in the block 156 which provides the lower end wall of the cylinder 18 there is a recess 158 into which the piston 154 is a close fit. The arrangement of the piston on the ram 22 is such that it only enters the recess 158 as the shaft is nearing the end of its operative stroke. FIGURE 1 shows the ram 22 in its lowest position where the piston 154 completely fills the cavity 158. Although the piston is a close fit within the cavity, the manufacturing tolerances need not be very tight.

Oil is normally supplied to the interior of the cylinder 18. For this purpose, a pump 160 is provided at the lower end of the valve 58. A rubber diaphragm 162 is nipped between the body of the valve 58 and a pump housing 164, and this diaphragm is sealed on its opposite faces near to its periphery, but is free to vibrate at the centre. An oil supply pipe 168 leads from the lower end of the reservoir in the column 14 to an inlet port 170 in the housing 164, and a non-return valve 172 is provided between the port 170 and a cavity 174 beneath the diaphragm 162. At one side, the diaphragm is formed with a protuberance 176 on the top of which there engages a spring loaded ball 178, and cored at 180 to provide a communication between the cavity 174 and an outlet port 182. From this latter port, an oil pipe 184 leads into the base of the pressure cylinder 18. At each downstroke of the member 60, its lower end presses the centre of the diaphragm 162 downwardly and this has the effect of squeezing oil in the cavity 174 out through the non-return valve 178 into the pipe 184 and thence into the cylinder 18. When the diaphragm is released it returns to its former position due to the action of a spring 183 on the underside of the diaphragm and since this produces a suction effect in the cavity 174, the valve 172 opens to allow more oil to be sucked into the cavity. The pump 160 therefore provides a means of supplying a limited quantity of oil into the cylinder 18 for lubrication.

The pipe 184 which carries the oil supply to the lower end of the pressure cylinder 18 is connected to a port 159 in the block 156, this port 159 leading to an annular chamber 161 around the ram 22. A sloping port 163 leads from this chamber to a vertical port 165, and a nylon tube 167 projects from the upper end of the port 165 into the lower end of the cylinder 18. The oil level in the cylinder 18 has to be above the top of the tube 167 before oil can flow back to the pump 160, and the tube 167 thus provides a means of regulating the quantity of oil which will remain in the cylinder 18 when the press is stopped (e.g. overnight). Because some oil will always be left in the cylinder 18, the air in that cylinder will contain entrained oil as soon as operation of the press commences.

Since the oil in the cylinder 18 will tend to flow into the cavity 158, it helps to seal the clearance around the

piston 154 as the latter arrives at the lower end of its stroke.

Means have to be provided to prevent an excess amount of oil accumulating in the cylinder 18, and for this purpose there is a vertical oil outlet bore 186 formed in the base 156 of the cylinder.

An internally screwed horizontal port 187 leads into the vertical bore 186, and a detachable spring loaded relief valve 188 is screwed into the port 187. This valve is shown in detail in FIGURE 12.

A metal valve housing 189 has an enlarged bore 190 within which there are two nylon members 191a and 191b with a rubber ball 191c between them. The inner member 191a is nipped between the housing 189 and the end wall of the bore 187, but the outer member 191b is free to move axially in the housing 189, being loaded by a spring 193 towards the inner end. Seats are formed on both members 191a and 191b for the ball, but there are four small grooves in the seat within the member 191b so that even when the ball is seated on that member, there are small passageways past the ball. In the normal position, shown in FIGURE 12, the ball 191c closes the port through the member 191a. Each time the piston 154 arrives in the recess 158, it will force oil under pressure into the port 186, and this will tend to lift the ball 191c off the member 191a. This allows a small quantity of oil to escape at each operation of the tool. The oil can flow around the member 191b and out through a port 192, but if the spring 193 closes its coils to prevent flow of oil through it, some oil can escape via the passageways past the ball 191c. From the port 192, a pipe 194 leads to the oil reservoir in the column 14; of course some air will escape with the oil, but it will only be a minute volume and will not materially affect the pressure within the cylinder 18. When the piston 154 is fully seated in the cavity 158, the pressure on the valve 190 is released and the valve closes.

The upper end of the resetting cylinder 20 is closed by the block 156 and the lower end is closed by part of the header block 16. The ram 22 passes through both ends of the cylinder 20, there being a seal 196 in the block 156 and a seal 198 in the block 16, to prevent escape of air into the upper end or out of the lower end of the cylinder 20.

A conventional sealed piston 200 fixed to the ram 22 works in the resetting cylinder 20. In the header block 16 there is or are a port or ports 202 each of which is connected between the lower end of the cylinder 20 and a two way operating valve 204 (which will be described in greater detail) and at the upper end of the cylinder 20 there is an outlet port 206, which is connected via a pipe or pipes 208 to the interior of the column 14.

When the operating member 60 moves down to lift the guard 92, a passage is opened through the seal 72 (FIGURE 3) to allow the air entering the valve 58 under pressure to flow out through the port 150. A pipe leads from this port to the two way valve 204 to supply air pressure for lifting the piston 200. The valve 204 (see FIGURE 6) has a metal housing 212 which is fitted on top of the header block 16, over a cavity 214 within that block. A moulded rubber valve member 216 has an annular flange 218 which is nipped between the edges of the header block 16 around the upper end of the cavity 214 and an annular plastics sealing disc 220. The main portion 222 of the rubber valve member is suspended from its flange into the cavity 214. A screwed adjusting member 224 provided with a manually operable knob 226 engages in a screwed bore of the housing 212, and its lower end is engageable with the central portion of the disc 220, to limit upward movement of the valve member 216. The pipe 210 leads into a port 230 which is in communication with the topside of the valve member 216, via an annular space 211 around the lower end of the member 224, and a port or ports 221 formed through the disc 220.

A comparatively large bore 232 is provided in the

header block 16, and a venturi type outlet passage 234 is fitted in this bore. Thus there is provided a large air passage from the cavity 214 into the interior of the column 14. The upper end of the passage 234 is very close to the underside of the valve member 216 in the normal open position shown in FIGURE 6. Also there are three spaced apart fingers 235 extending upwardly from the top of the passage 234, to act as guides for the valve member 216.

Within the valve member 216, there are mutually communicating ports 236 and 238, with a non-return ball valve 240 in the port 236. This ball is forced into position by manual pressure through the upper part of the port 236, which can distend to allow the passage of the ball into its housed position.

When air under pressure is applied to the top side of the valve 204, some air will attempt to flow via the ports 236 and 238 and the space between the lower end of the member 216 and the block 16 out through the passage 234. But the air pressure acting on the comparatively large area of the top of the member 216 quickly presses that member down to bring its lower end into sealing engagement with the upper end of the passage 234. With the valve 240 open, the air can flow via the ports 236, 238 and 202 to the underside of the piston 200 in the resetting cylinder 20, and the ram begins to rise. During this upward motion of the ram, air in the upper part of the resetting cylinder 20 is allowed to escape via the port 206 and the pipe 208. Air from the cylinder 18 can escape via the ports 50 and 52 to maintain substantially constant pressure within the cylinder 18.

It will be appreciated that the substantially constant pressure within the pressure cylinder 18 requires the lifting force for resetting the ram to be applied externally of the cylinder 18, and this is the reason for the provision of the resetting cylinder 20.

When pressure on the oil in the oil bottle 131 drops due to opening of the timer valve 100, the guard 92 drops under gravity or spring loading or both and the operating member 60 is raised. This closes the passageway through the seal 72, and cuts off the air supply to the underside of the resetting piston via the valve 204 and allows the air on the top side of the valve 204 to exhaust via the port 150 and an outlet port 242 (see FIGURE 3). The reduction in pressure on the top side of the valve 204 causes the non-return valve 240 to snap closed, and then the air pressure acting on the underside of the flange of the valve member 216 lifts that member and opens the passage 234. Immediately the pressure in the lower end of the resetting cylinder 20 collapses, and since there is an unbalanced downwardly applied pressure on the piston 154, the ram is caused to descend very rapidly on its power stroke.

The valve 204 therefore provides for a relatively slow upstroke of the ram 20, but a very rapid release for the pressure supporting the ram for the downstroke. This valve 204 can be adjusted by means of the screwed member 224, to regulate the setting of the gap between the lower end of the valve member 216 and the top of the passage 234. This setting controls the speed of operation of the ram; by throttling the exhaust from the cylinder 20.

The full cycle of operation of the press is as follows. Starting with both the ram 22 and the guard 92 in the lowered position, there is an air supply established to the timer. The oil pressure from the bottle 131 causes the operating member 60 to descend so lifting the guard 92. As the guard lifts pressure is established through the valve 204 to the underside of the piston 200 and the ram 22 begins to rise. Normally, there is a dwell at the end of the upstroke, and then the rapid release of air through the timer permits the guard to fall which raises the operating member 60 and cuts off the pressure to the valve 204. The latter then opens its quick release passage 234 and the ram 22 is forced down.

The length of the dwell when the ram and guard are

raised can be varied by adjusting the needle valve 128. The more rapid the leakage of air through this valve, the shorter the dwell period. It will be appreciated that this period is preset to allow the operative to place a fresh workpiece in the operative position.

The machine is provided with means for holding the guard fixed in the raised position. When the machine is exhausted of air under pressure with the guard fixed in the raised position, it is necessary to prevent sudden descent of the ram 22 due to air being exhausted from the resetting cylinder more quickly than that from the pressure cylinder. For this reason the ball valve 46 has been provided which ensures that air exhausted from the resetting cylinder must first pass relatively slowly through the pressure cylinder before passing through the small port 50 to exhaust. This slow passage of air is insufficient to close the ball valve 240 and thus the ram 22 will only fall when the air is almost completely exhausted and the energy which it will possess is due entirely to its own weight, and the distance through which it falls.

It is possible to make the pressure cylinder 18 and piston 154 entirely in metal without the use of resilient seals, because even with ordinary manufacturing tolerances on the bore of the cavity 158 and the outside diameter of the piston the air under the piston escapes more slowly owing to its high pressure than if the air was at, or near, atmospheric pressure. This effect is increased by the presence of a dispersion of oil in the air.

Furthermore, the use of high pressure air for cushioning makes it possible to use a shorter cushioning distance than would be required with a conventional (exhausting) system.

In the specific arrangement described above, the upward resetting stroke is provided by means of a pneumatic cylinder. It will be appreciated that the resetting force could be provided by other means (e.g. a purely mechanical device) as long as there is provision for the sudden release of this force.

What I claim and desire to secure by Letters Patent is:

1. A pneumatically operated power tool, comprising a cylinder, a toolholder having rectilinear motion and an operating member working within said cylinder, means connecting said operating member outside the cylinder to the toolholder, the operating member having unequal areas within the cylinder on which air pressure acts differentially for operating the tool on its working stroke, means connecting an air pressure supply directly to the cylinder in such a way that the pressure within the cylinder remains substantially constant despite movement of the operating member into or out of the cylinder, means external to the cylinder to oppose the differential force applied within it in order to move the toolholder to an initial non-operating position, and said cylinder having a cavity within which some air is trapped by the operating member towards the end of its working stroke to cushion the kinetic energy of the operating member and the tool holder.

2. A pneumatically operated power tool as claimed in claim 1, in which said means for opposing the force applied within the cylinder comprises a fluid cylinder and piston device, and means for rapidly exhausting the fluid cylinder to allow the operative force of the pneumatic cylinder to become effective.

3. A pneumatically operated power tool as claimed in claim 1, in which the fluid cylinder is itself pneumatically operated from the same source of air supply as the cylinder and that said means for rapidly exhausting the cylinder comprises a quick opening valve.

4. A pneumatically operated power tool as claimed in claim 3, in which the quick opening valve comprises a member adapted for flexing to seal a large exhaust outlet and having an internal passage incorporating a non-return valve to allow fluid under pressure to flow via the passage to an outlet port and effective to prevent return flow so that if the pressure supply is reduced the valve member

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will return to its original position and permit communication between the outlet port and the large exhaust port.

5 5. A pneumatically operated power tool as claimed in claim 1, comprising means automatically controlling said power tool, and a time delay device holding the tool in an inoperative position.

6. A pneumatically operated power tool as claimed in claim 5, in which said time delay device comprises an exhaust valve operative to close in response to a predetermined applied pressure, a non-return valve arranged to close when a pressure supply is cut-off to trap air under pressure within the valve, an adjustable leak-off valve connected to allow leakage of air from the interior of the valve, whereby the exhaust valve opens when the pressure within the valve is reduced below the predetermined value.

7. A pneumatically operated power tool as claimed in claim 5, in which said means automatically controlling operation of the tool comprises a valve and a hydraulic cylinder operating said valve.

8. A pneumatically operated power tool as claimed in claim 7, in which a reservoir subjected to pneumatic pressure provides the hydraulic fluid.

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9. A pneumatically operated power tool as claimed in claim 1, in which a guard is provided which is adapted to be moved into an operative position before the power stroke of the tool.

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MARTIN P. SCHWADRON, *Primary Examiner.*

I. C. COHEN, *Assistant Examiner.*

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