

March 14, 1950

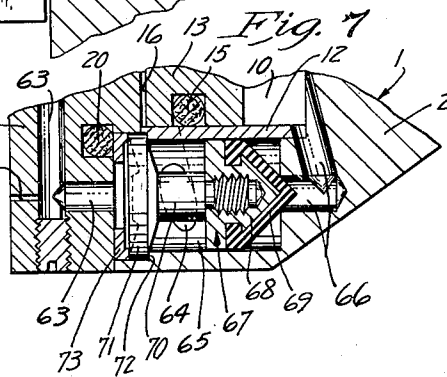
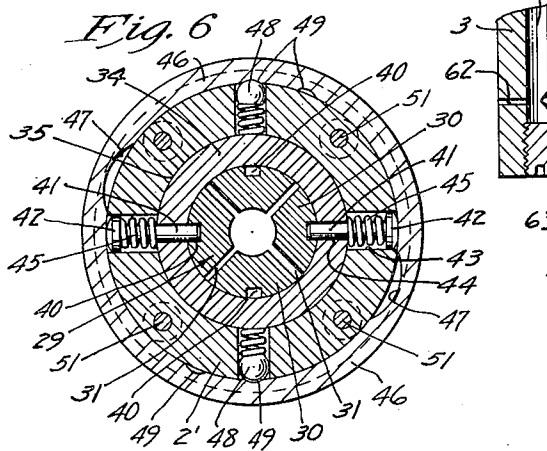
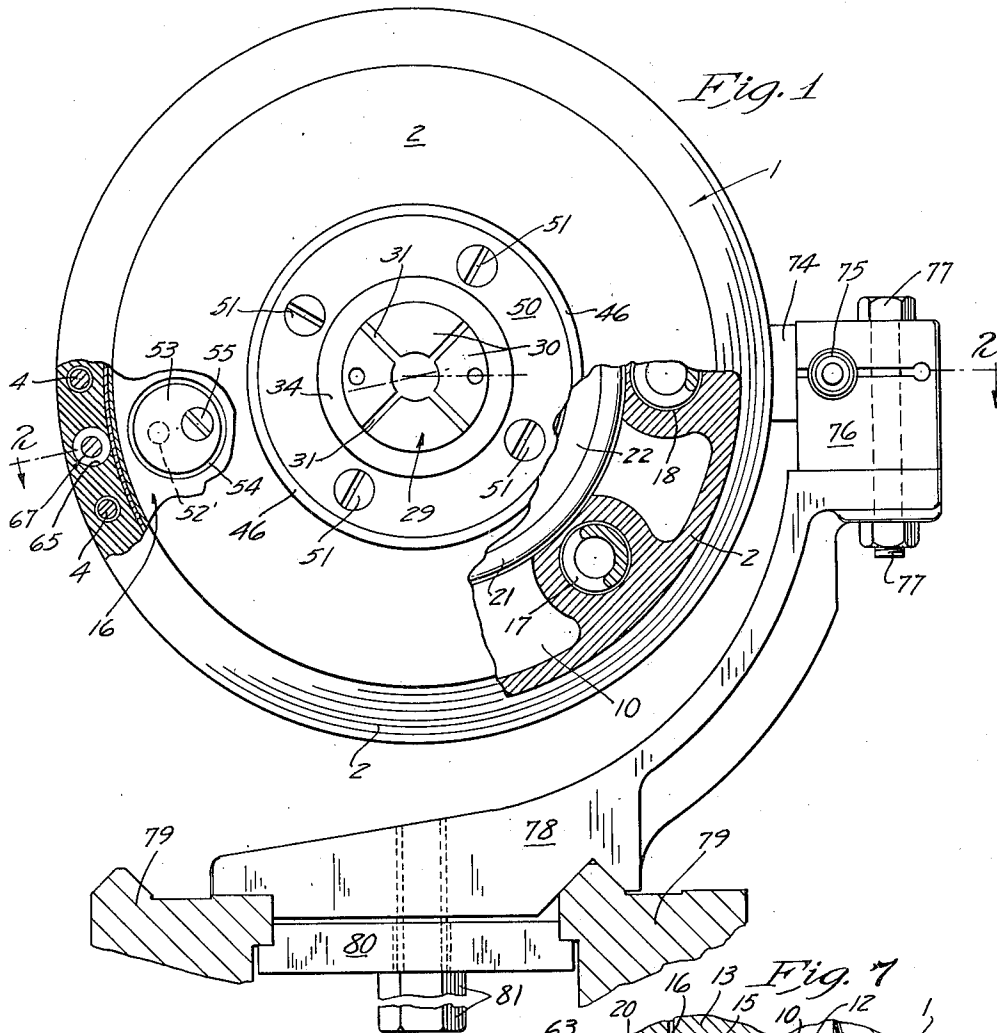
H. J. SADLER ET AL

2,500,383

PNEUMATIC PRESSURE-OPERATED DEVICE

Filed April 3, 1948

2 Sheets-Sheet 1



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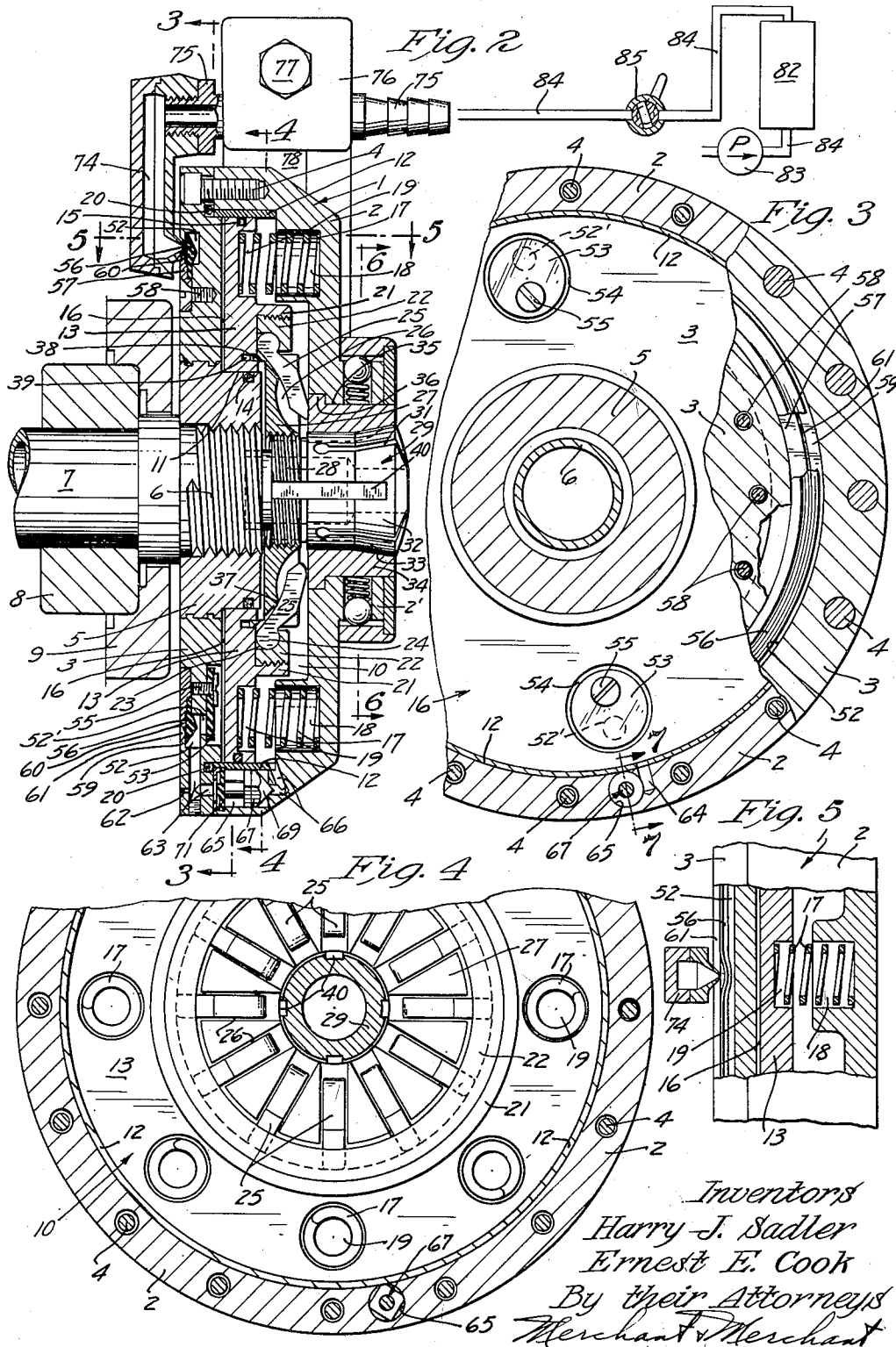
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

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PNEUMATIC PRESSURE OPERATED DEVICE

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11 Claims. (Cl. 279—4)

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Our invention relates generally to fluid pressure-operated devices and, more particularly, to novel valve mechanism therefor.

The primary object of our invention is the provision of a fluid pressure-operated device or motor including novel means for transferring fluid under pressure between parts relatively movable, one with respect to the other.

A further object of our invention is the provision of a novel fluid nozzle element and co-operating valve element for transfer to fluid under pressure from one thereof to the other thereof.

Still more specifically, an important object of our invention is the provision of a novel chuck or collet closer utilizing our novel valve mechanism and apparatus for transfer of fluid under pressure from a stationary to a relatively movable part thereof, whereby to contract and release said collet.

A still further object of our invention is the provision of a device of the class above-described which includes relatively few movable parts, which is extremely durable in construction, which is inexpensive to manufacture, and which is efficient and trouble-free in operation.

The above and still further objects of our invention will become apparent from the following detailed specification, appended claims, and attached drawings.

Referring to the drawings, wherein like characters indicate like parts throughout the several views:

Fig. 1 is a view in front elevation of a collet chuck built in accordance with our invention and mounted upon a conventional lathe, some parts being broken away and some parts shown in section;

Fig. 2 is a view, partly in horizontal section and partly in diagram, taken substantially on the line 2—2 of Fig. 1 and turned 90° with respect thereto;

Fig. 3 is a fragmentary cross section, taken on the line 3—3 of Fig. 2, with some parts being broken away;

Fig. 4 is a fragmentary cross section, taken substantially on the line 4—4 of Fig. 2;

Fig. 5 is a fragmentary detail in section, taken on the line 5—5 of Fig. 2;

Fig. 6 is a transverse section, taken on the line 6—6 of Fig. 2; and

Fig. 7 is an enlarged fragmentary sectional detail, taken on the line 7—7 of Fig. 3.

Referring with greater particularly to the drawings, the numeral 1 indicates, in its entirety,

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a head or casing having a cup-shaped front wall 2 and a relatively flat rear wall 3 connected to the outer peripheral edge of said front wall 2 by means of machine screws or the like 4. The elements 2 and 3 are preferably made from lightweight material such as aluminum, in order to reduce the weight of the entire device. The rear wall 3 is preferably cast around and secured fast on an annular bushing 5, preferably made from steel or other material of considerably greater hardness than the wall 3. The bushing 5 is internally threaded to engage the threaded end 6 of a hollow rotary spindle 7 which may be rotatively carried by the head of a conventional lathe, screw machine, or the like, not shown. A spacer 8 and a collar 9 perform no particular function with regard to the instant invention, being merely parts of conventional lathe structure.

Elements 1, 2, and 5 cooperate to produce a circular cavity 10 into which axially projects an annular bearing boss portion 11 of the bushing 5. The inner peripheral wall section of the front wall 2 is provided with a sleeve 12 which may be made of suitable bearing material. An annular piston 13 is axially slidably mounted in the cavity 10 with the inner periphery thereof snugly encompassing the bearing boss 11 and the outer periphery thereof slidably engaging the sleeve 12. Annular seals 14 and 15 prevent leakage of fluid under pressure between the piston 13 and the bearing block 11 and sleeve 12 respectively. The piston 13, a portion of the sleeve 12, the rear wall 3, and bearing boss 11 define a pressure chamber 16, the piston 13 being in the nature of a movable wall thereof. The piston 13 is yieldingly biased in one direction (toward a pressure chamber-contracting position) by means of a plurality of circumferentially-spaced coil compression springs 17 seated in aligned pockets 18 and 19 in the front wall 1 and piston 13 respectively. An annular seal 20 is interposed in the connection between the peripheral portion of the front wall 2 and the rear wall 3 to prevent leakage of fluid from the chamber 16 therethrough.

The piston 13 is provided with an axially forwardly-projecting annular flange 21, which is internally-threaded to receive an externally-threaded collar which is provided with a plurality of circumferentially-spaced inwardly-opening cup-shaped pockets 23 which snugly receive the ball-like radially outer ends 24 of radially-projecting lever arms 25. The lever arms 25 are disposed within radial channels 26 in an annular

ring 27, which is internally-threaded to receive the threaded end 28 of a collet 29, having a plurality of jaws 30 formed by slotting the collet 29 axially, as indicated at 31, in the conventional manner. The collet 29 is provided with a tapered peripheral outer face 32 which is adapted to be engaged by a corresponding tapered portion 33 of an annular contraction ring 34 axially slidable on the outer peripheral surface of the collet 29 and in an opening or bore 35. Forward movement of the contraction ring 34 is lifted by engagement of a circumferential flange 36 with a shoulder in the front wall 2 formed by a counterbore therein.

The bottoms of the channels adjacent the outer ends 26 in the annular ring 27 are each provided with a projecting fulcrum-forming edge or shoulder 37 which is adapted to engage the intermediate portion of its respective lever arm 25. As shown in Fig. 2, the radially inner ends of the lever arms 25 abut the inner end of the contraction ring 34. Centering of the collet 29 with respect to the piston 13 is insured by the seating of an annular flange 38 on the ring 27 within an annular groove 39 in the piston 13.

From the above, it should be obvious that movement of the piston 13, against the bias of the springs 17, axially in the direction of the collet 29, or from the left to the right with respect to Fig. 2, removes the axial thrust imparted by the radially inner ends of lever arms 25 upon the contraction ring 34. Removal of axial pressure against the contraction ring 34 allows the same to slide axially from the right to the left with respect to Fig. 2, thereby releasing the grip of the several jaws 30 upon the stock or workpiece contained therein but not shown. Movement of the piston 13 in a direction from the right to the left with respect to Fig. 2 under bias of the springs 17, on the other hand, causes the radial lever arms 25 to engage the edges or shoulders 37, whereby to produce an axial thrust of the inner ends of the arms 25 against the contraction ring 34 in a direction to contract the jaws 30 of the collet 29.

The collet 29 is provided with a plurality, as shown four, of circumferentially-spaced keyways 40, and which are adapted to slidably seat the inner ends of diametrically-opposed pins 41. The pins 41 are provided with head portions 42 which are slidable in radial bores 43 in the central portion of the front wall 2. The pins 41 extend radially through diametrically-opposed radial passages 44 in the contraction ring 34 and are biased in a radially outward direction by means of coil compression springs 45 (see particularly Fig. 6). It will be seen particularly by reference to Fig. 2, that the bores 43 are located outwardly of the main body portion of the front wall 2 in an axially projecting hub portion 2' thereof. A ring or collar 46 encompasses and is rotatably slidable on the outer periphery of the hub 2' and is provided with a pair of diametrically-opposed recesses 47 that are adapted to receive, under rotary movements of the collar 46, the heads 42 of the pins 41. The pins 41 are of such a length, that when the heads 42 thereof are contained within the recesses 47 the inner ends 41 are spring pressed radially outwardly of the keyways 40 so that the collet 29 may be rotated with respect to the annular ring 27. Rotation of the collet 29 with respect to the ring 27 due to the threaded engagement therein provides axial adjustment of the collet 29 with respect to the contraction ring 34. When the proper adjustment has been ob-

tained, the ring 46 is rotated to a point where the recesses 47 are circumferentially opposite from the heads 42 so that the pins 41 are moved into opposed keyways 40. The recesses 47 are so shaped that rotation of the ring 46 moves the heads 42 therefrom with a camming action against bias of the springs 45. Accidental rotation of the ring 46 with respect to the hub 2' is prevented by a pair of diametrically-opposed spring pressed bore elements 48 adapted to engage circumferentially-spaced detents 49. The ring 46 at one end engages the outer surface of the wall 2 and is limited in axial movements outwardly of the wall 2 by means of an annular plate 50 which is secured to the outer end of the hub 2' by means of machine screws or the like 51 (see particularly Figs. 1 and 2). The internal and external diameters of the plate 50 are such that the plate 50 does not interfere with free rotating movements of the ring 46 nor free axial movements of the contraction ring 34.

The rear wall 3 is formed to provide an annular inlet passage 52 which communicates with the pressure chamber 16 through a pair of diametrically-opposed disc-like check valves 53. The check valves are contained in recesses 54 in the rear wall 3 and are secured by screws or the like 55, whereby to be seated over valve openings 52' communicating with the passage 52 and the pressure chamber 16. The rear wall 3 is channeled adjacent the inlet passage 52 to receive an annular check valve 56 which is held in place by means of a clamping ring 57 which is rigidly secured to the wall 3 by means of a plurality of screws 58. As shown in Fig. 2, the rear wall 3 is provided with a radially inwardly projecting flange 59 which is bevelled at its inner edge and cooperates with a bevelled outer edge 60 of the ring 57 to form an inlet port 61. The annular check valve 56 may be made from any resilient flexible material, but preferably, and as shown, is made from soft rubber or the like and is normally seated against the axially inner ends of the flange 59 and clamping ring 57 whereby to close the inlet port 61. The annular passage 52 communicates with atmosphere exterior of the head 1 through a restricted bleeder orifice 62 and an internal passageway 63.

Air is exhausted from the pressure chamber 16 through a passage 64 leading therefrom into an exhaust valve chamber 65, and from thence through a passage 66 into a cavity 10. From thence, the exhaust air from the pressure chamber 16 is dissipated outwardly from the cavity 10 through the slots 31 in the collet 29. An exhaust valve 67 is provided at one end with a head 68 that is preferably rectangular in cross section and which is cone-shaped at its extreme outer end. The circumferentially-spaced outer end is covered with a sealing cap 69 which, under axial movements of the valve 67, is adapted to seal off one end of the passage 66. The valve 67 is provided with an axially extending reduced shank 70 which terminates at its rear end in a circumferential flange 71 which is preferably made of relatively soft flexible material such as rubber or the like and which is held against axial movement adjacent its peripheral portion by engagement at one side thereof with an annular shoulder 72 formed in the peripheral portion of the wall 2. The flange 71 is held against axial movement in the opposite direction by means of an annular stop collar 73 which abuts the outer peripheral portion of the rear wall 3. It will be seen, particularly by reference to Figs. 2 and 7, that the

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passageway 63 communicates with the end of the chamber 65 opposite the exhaust passage 66, but is sealed against communication with the exhaust passages 64 and 66 by the resilient flange 71. The flange 71, due to its resilient nature, permits axial movement of the valve 67 within the chamber 65 for a purpose which will hereinafter become apparent.

Fluid medium under relatively high pressure, preferably air, is applied to the annular port 61 and against the check valve 56 in a highly concentrated jet by means of a nozzle 74 which is adapted to be located in the path of travel of the annular port 61. A hose coupling 75 has screw-threaded engagement with the nozzle 74 and as shown in Figs. 1 and 2 is clamped in a split block 76 by means of a nut-equipped bolt 77 which also secures the block 76 to a bracket 78. The bracket 78 may be fastened to the machine tool in any number of ways, but as shown in Fig. 1 rests upon a lathe bed 79 and is firmly held thereon by means of a clamp 80 and a clamping screw 81. As shown diagrammatically in Fig. 2, air is supplied to the coupling 75 and nozzle 74 from a pressure tank 82 and a pump or the like 83 through conduit means 84. A valve 85 is interposed in the conduit 84 between the tank 82 and the coupling 75, and may be either automatically or manually controlled.

As above pointed out, the check valve 56 normally closes the annular port 61, but due to its flexible and resilient nature is adapted to become unseated and to open the port 61 to communication with the annular passage 52 at localized areas of an extent very slightly larger than the cross sectional area of the jet of fluid projected thereagainst (see particularly Fig. 5). Air admitted to the annular passage 52 passes through the openings 52', unseating the check valves 53, and into the annular pressure chamber 16. Simultaneously, the air under pressure in the passage 52 passes through the passageway 63 and exerts pressure against the flange 71, whereby to move the valve 67 to close exhaust passage 66. The size of the bleeder orifice 62 is such that air escapes therethrough at a much slower rate than it is being projected into the annular passage 52 by means of the nozzle 74, so that pressure is built up within the pressure chamber 16 at a rate sufficient to cause relatively rapid movement of the annular piston 13 in a direction from the left to the right with respect to Fig. 2. As hereinbefore described, such movement of the piston releases pressure of the radial lever arms 25 against the contraction ring 34 and subsequent release of gripping pressure of the collet 29 against a workpiece held therein. Cutting off of the fluid pressure supplied to the nozzle 74, which may be caused by manipulation of the valve 85, allows the annular check valve 56 to seat against the flange 59 and seal the port 61 over its entire circumferential area. This resealing is enhanced by the relatively high fluid pressure within the passage 52. With the cutting off of the fluid supply from the nozzle 74, however, the fluid or air continues to bleed from the orifice 62 and a differential in pressure is formed between the passage 52 and the pressure chamber 16. It will be noted that fluid pressure in the pressure chamber 16 and in the valve chamber 65 is equal due to the connection therebetween of the exhaust passage 64. The consequent differential in pressure in the valve chamber 65 and the annular passage 52 causes the valve 67 to move from the right to the left with respect to Figs. 2 and 7,

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thereby disengaging the sealing cap 69 from the passage 66 and allowing rapid exhaust of fluid from the pressure chamber 16. It will be remembered that the piston 13 is under yielding bias of the several springs 17 to move in a direction to exhaust fluid from the pressure chamber 16 or from the right to the left with respect to Fig. 2, and movement in this direction causes the lever arms 25 to move the contraction ring 34 in a direction to close the jaws 30 of the collet 29.

In operation, it may be assumed that the fluid supply is cut off from the nozzle 74 and that spindle 7 and head 1 are under rotation at operating speed. With the pressure supply cut off, the springs 17 have moved the piston 13 and means carried thereby to close the collet 29 over the workpiece. Opening of the valve 85 allows fluid under pressure to pass through the nozzle 74 in a concentrated highly localized jet which impinges against the annular check valve 56 through the annular port 61, causing the valve 56 to become unseated only at the point of impact of the jet thereagainst. It will be appreciated that this point of impact travels rapidly about the entire periphery of the valve 56 due to its rotation relative to the nozzle 74. In other words, the outer peripheral edge of the valve 56 assumes the position of a ripple or wave (see particularly Fig. 5), which ripple travels continuously about the periphery thereof under rotation of the head as long as the jet of the fluid is applied thereto. Normal seating of the valve 56 against the flange 59 in addition to pressure of the fluid built up within the passage 52 insures the sealing of the annular port 61 at all points about the periphery thereof other than that at which the jet occurs, thus insuring against any leakage of fluid outwardly through the port 61. When sufficient pressure has been built up within the pressure chamber 16, the movable wall element or piston 13 moves in a direction to release the collet 29 from the action of the contraction ring 34. At this point, the workpiece may be removed and another inserted or material fed axially through the spindle 7 and collet 29 for machining thereof. As soon as the material has been properly fed through the collet 29, the valve 85 may be closed, thereby shutting off fluid supply to the nozzle. Bleeding of fluid through the orifice 62 to atmosphere rapidly causes a differential in pressure therefrom between the annular passage 52 and the pressure chamber 16. As hereinbefore described, this differential in pressure allows the exhaust valve to open the passage 66, whereby to allow rapid escape of the air or fluid from the pressure chamber 16 to atmosphere through the cavity 10 under bias of the springs 17 upon the piston or movable wall element 13. Of course, movement of the piston 13 caused by the springs 17 again causes the contraction ring 34 to close the collet 29 upon the workpiece.

Our improved device has been thoroughly tested and found to be extremely efficient and rapid in its operation. In fact, it has been found that our device may be operated entirely automatically by the use of an automatic valve in connection with an automatic screw machine with entirely satisfactory results.

Although the foregoing description is necessarily of detailed character, in order that the invention may be completely set forth, it is to be understood that the specific terminology is not intended to be restrictive or confining, and that various rearrangements of parts and modifications of detail may be resorted to without depart-

ing from the scope or spirit of the invention as herein claimed.

We claim:

1. In a fluid pressure-operated device, a rotary head structure defining a pressure chamber and a port through a wall thereof connecting said pressure chamber to atmosphere, an inwardly-opening check valve closing said port, and a non-rotary nozzle for directing a highly concentrated jet of fluid under pressure toward said head and the path of rotary travel of the check valve-equipped port.

2. In a fluid pressure-operated device, a rotary head structure incorporating means for mounting on a rotary shaft, said head structure defining a pressure chamber and a port through a wall thereof connecting the pressure chamber to atmosphere, an inwardly-opening check valve closing said port and having a surface exposed to atmosphere through said port, and a non-rotary nozzle adapted for connection to a source of fluid under pressure and incorporating mounting means adapting it to be positioned to direct a highly concentrated jet of fluid toward the head and the path of travel of the check valve-equipped port, said check valve opening under the impact of the jet when the pressure of the jet against the outer surface of the check valve exceeds the pressure against the inner surface thereof.

3. In a fluid-operated device, a head structure, said head structure defining a pressure chamber and an elongated port through a wall thereof connecting said valve chamber to atmosphere, an inwardly-opening check valve closing said port and having a surface exposed to atmosphere through said port, a nozzle adapted for connection to a source of fluid under pressure and incorporating mounting means adapting it to be positioned to direct a concentrated jet of fluid toward said head and check valve-equipped port, said head and said nozzle being mounted for relative movements one with respect to the other, said check valve closing said port at all points where internal pressure exceeds atmospheric pressure and having sufficient resilience to permit unseating at localized areas of much less extent than the length of the valve port, whereby upon relative movement of said head with respect to said nozzle said valve will be opened only at the constantly changing localized area adjacent said nozzle by the concentrated fluid jet directed by said nozzle against said valve.

4. In a fluid pressure-operated device, a rotary head structure incorporating means for mounting on a rotary shaft, said head structure defining a pressure chamber and an elongated arcuate port through a wall thereof connecting said chamber to atmosphere, an inwardly-opening check valve closing said port and having a surface exposed to atmosphere through said port, and a non-rotary nozzle adapted for connection to a source of fluid under pressure and incorporating mounting means adapting it to be positioned to direct a concentrated jet of fluid toward the head and the path of travel of the check valve-equipped port, said check valve closing said port at all points where internal pressure exceeds atmospheric pressure and having sufficient resilience to permit unseating at localized areas of much less circumferential extent than the circumferential length of the valve port, whereby upon rotation of said head said valve will be opened only at the constantly changing localized area adjacent said nozzle by

the concentrated fluid jet directed by said nozzle against said valve.

5. The structure defined in claim 4 in which said port and said valve are annular in shape and are concentric to the axis of rotation of said head.

6. In a fluid pressure-operated device, a rotary head structure incorporating means for mounting on a rotary shaft, said head structure defining a pressure chamber, an annular port in one wall thereof opening to atmosphere, and an inlet passage connecting said port to said pressure chamber, flexible inwardly-opening annular check valve normally closing said port and having a surface exposed to atmosphere through said port, a non-rotary nozzle adapted for connection to a source of fluid under pressure and incorporating mounting means adapting it to be positioned to direct a highly concentrated jet of fluid toward the head and the exposed surface of the check valve upon rotation of said head, said check valve closing the port at all points where internal pressure exceeds atmospheric pressure and having sufficient resilience to permit unseating at localized areas, whereby upon rotation of said head said valve will be opened only at the constantly changing localized area adjacent said nozzle by the concentrated fluid jet directed by said nozzle against said valve, a check valve in the passage between said first-mentioned check valve and said pressure chamber permitting passage of fluid only from said passage to said chamber, means for creating a differential in fluid pressure between said pressure chamber and said inlet passage, and an exhaust valve for said pressure chamber responsive to differential in fluid pressure between the pressure chamber and said passage.

7. In a fluid pressure-operated device, a rotary head structure incorporating means for mounting on a rotary shaft, said head structure defining a pressure chamber, an annular port in one wall thereof opening to atmosphere, and an inlet passage connecting said port to said pressure chamber, a flexible inwardly-opening annular check valve normally closing said port and having a surface exposed to atmosphere through said port, a non-rotary nozzle adapted for connection to a source of fluid under pressure and incorporating mounting means adapting it to be positioned to direct a highly concentrated jet of fluid toward the head and the exposed surface of the check valve upon rotation of said head, said check valve closing the port at all points where internal pressure exceeds atmospheric pressure and having sufficient resilience to permit unseating at localized areas, whereby upon rotation of said head said valve will be opened only at the constantly changing localized area adjacent said nozzle by the concentrated fluid jet directed by said nozzle against said valve, a check valve in the passage between said first-mentioned check valve and said pressure chamber permitting passage of fluid only from said passage to said chamber, means for creating a differential in fluid pressure between said pressure chamber and said inlet passage, said means including a bleeder orifice connecting said inlet passage to atmosphere, said head having an exhaust passage connecting said pressure chamber with atmosphere, and an exhaust valve in said exhaust passage responsive to differential in fluid pressure between said pressure chamber and said inlet passage to exhaust fluid from said pressure chamber when the pressure in said inlet passage

is less than the pressure within said pressure chamber.

8. In a device of the class described, a collet and a collet closer, said collet closer comprising a rotary head structure incorporating means for mounting on a rotary shaft, said head structure defining a pressure chamber and a port through a wall thereof connecting the pressure chamber to atmosphere, an inwardly-opening check valve closing said port and having a surface exposed to atmosphere through said port, a non-rotary nozzle adapted for connection to a source of fluid under pressure and incorporating mounting means adapting it to be positioned to direct a highly concentrated jet of fluid against the exposed surface of said valve upon rotation of the head, said check valve opening under the impact of the jet when the pressure of the jet against the outer surface of the check valve exceeds the pressure against the inner surface thereof, one of the walls of said pressure chamber being movable with respect to the others thereof, a contraction ring mounted concentrically on said collet for axial sliding movements and adapted to contract and release the jaws thereof under said sliding movements, and means operatively connecting the movable wall of said pressure chamber with said contraction ring.

9. In a device of the class described, a collet having a tapered peripheral outer face, and closer mechanism for said collet, said closer mechanism comprising a head structure incorporating means for mounting on a rotary shaft, said head structure defining a pressure chamber, an annular port in one wall thereof opening to atmosphere, and a passage connecting said port to said pressure chamber, a flexible inwardly-opening annular check valve normally closing said port and having a surface exposed to atmosphere through said port, a non-rotary nozzle adapted for connection to a source of fluid under pressure and incorporating mounting means adapting it to be positioned to direct a highly concentrated jet of fluid toward the head and the exposed surface of the check valve, said check valve closing the port at all points where internal pressure exceeds atmospheric pressure and having sufficient resilience to permit unseating at localized areas, whereby upon rotation of said head said valve will be opened only at the constantly changing localized area adjacent said nozzle by the concentrated fluid jet directed by said nozzle against said valve, one of the walls of said pressure chamber being movable with respect to the others thereof, a contraction ring axially slidably mounted on said collet and having a tapered

portion engageable with the tapered peripheral outer surface of said collet, whereby to contract the jaws of said collet and release the same upon axial movements of said contraction ring with respect to said collet, and means operatively connecting said contraction ring with the movable wall of said pressure chamber.

10. The structure defined in claim 9 in which said head is provided with an exhaust passage connecting said pressure chamber with atmosphere and a restricted bleeder orifice connecting said inlet passage with atmosphere, and in further combination with an exhaust valve in said fluid pressure between the pressure chamber and said inlet passage.

11. In a fluid pressure-operated device, a rotary head structure incorporating means for mounting on a rotary shaft, said head structure defining a pressure chamber and an elongated arcuate port through a wall thereof connecting the pressure chamber to atmosphere, an inwardly-opening check valve closing said port and having a surface exposed to atmosphere through said port, a non-rotary nozzle adapted for connection to a source of fluid under pressure and incorporating mounting means adapting it to be positioned to direct a highly concentrated jet of fluid toward the head and the exposed surface of said valve, said check valve opening under the impact of the jet when the pressure of the jet against the outer surface thereof exceeds the pressure against the inner surface thereof, one of the walls of said pressure chamber being movable with respect to the others thereof, means biasing said movable wall in one direction, and means for controlling the flow of fluid through said nozzle and said valve, whereby to move said movable wall against the bias applied thereto, said port and valve being angular in shape and concentric with the axis of rotation of said head.

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