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AIR PRESSURE ACTUATED WORK HOLDING APPARATUS

Filed April 11, 1960

3 Sheets-Sheet 1

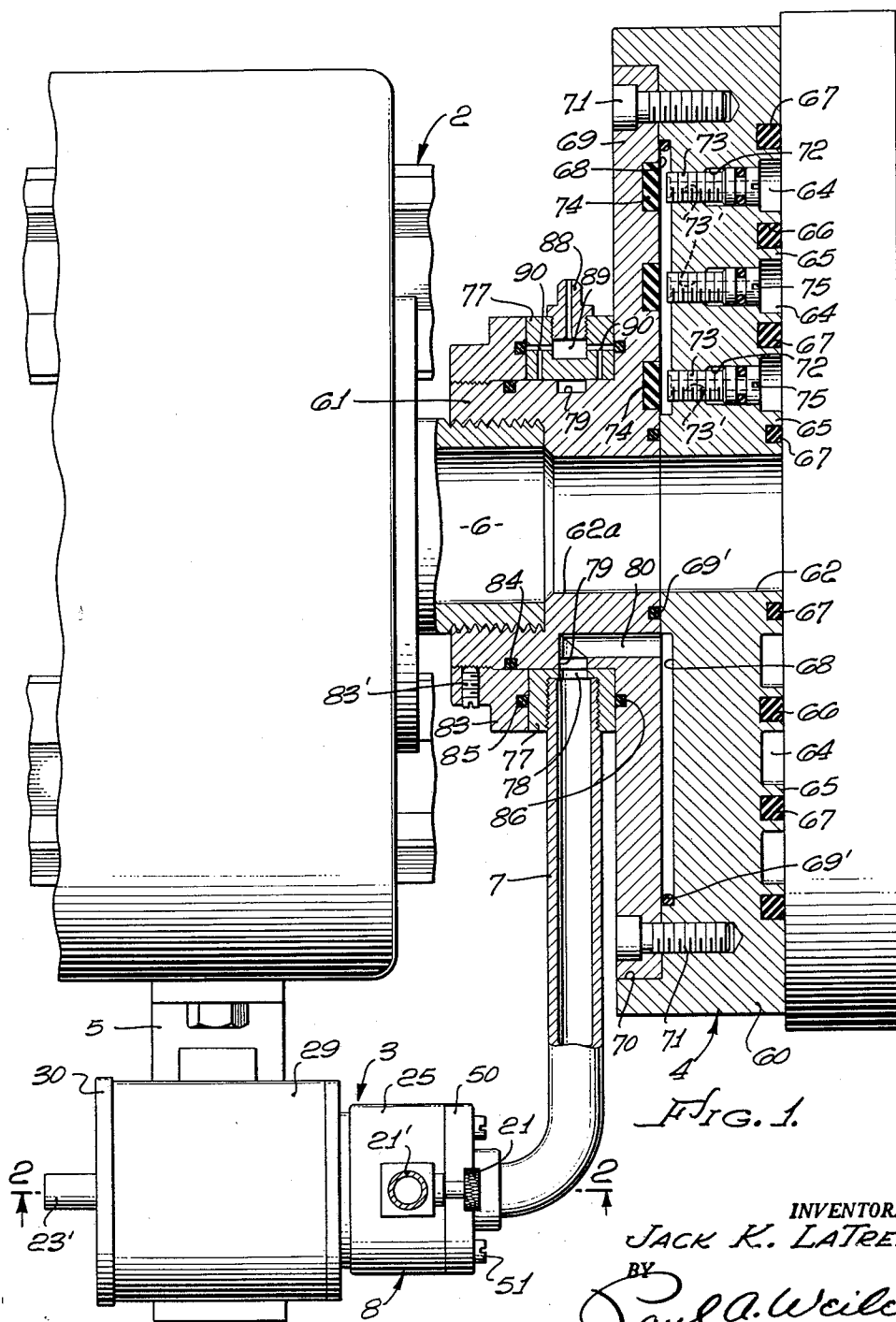


FIG. 1.

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FIG. 2.

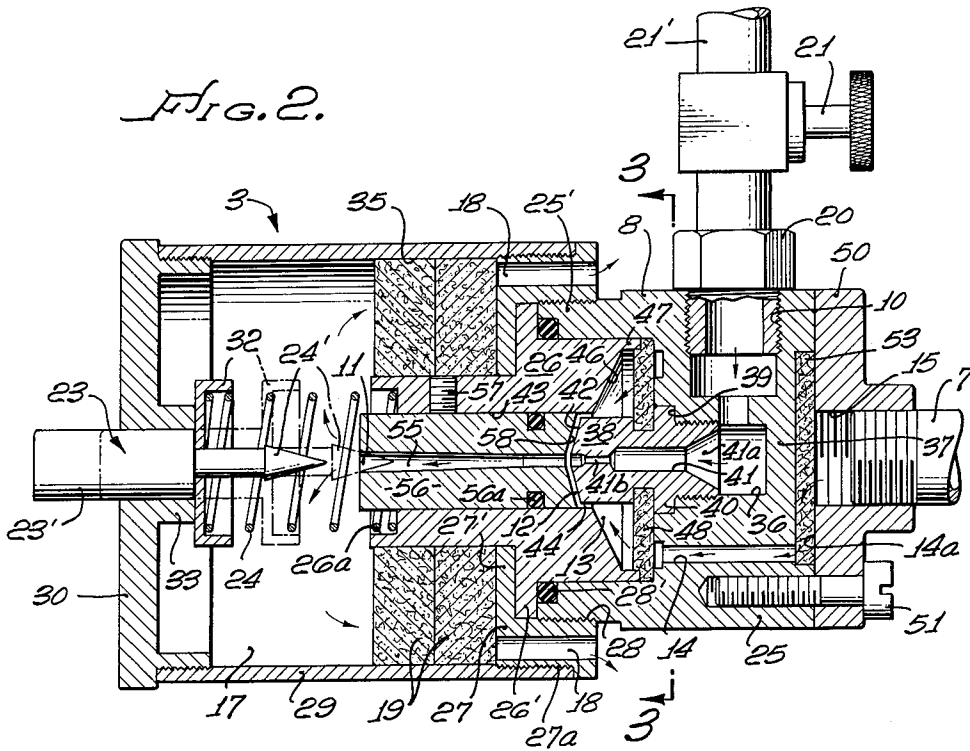


FIG. 4.

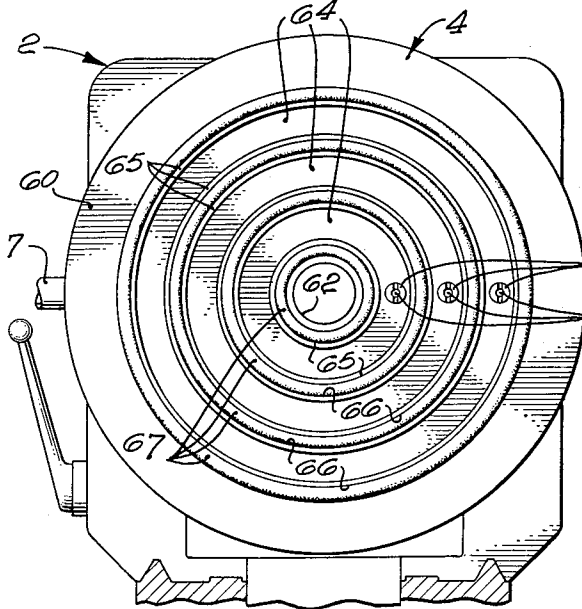
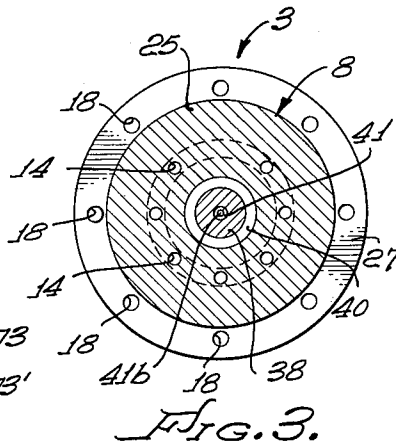


FIG. 3.

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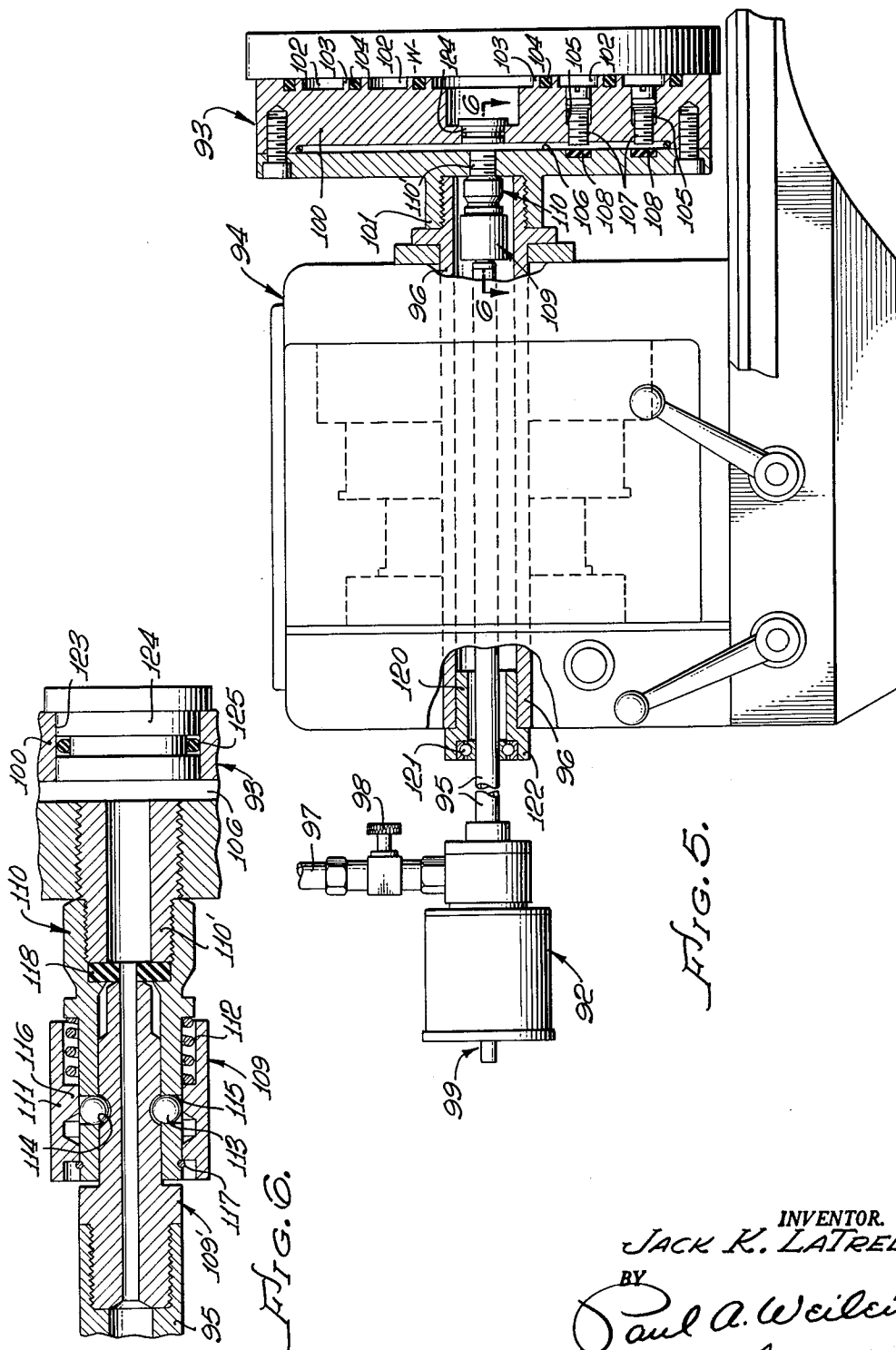
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AIR PRESSURE ACTUATED WORK HOLDING APPARATUS

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3 Sheets-Sheet 3



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AIR PRESSURE ACTUATED WORK HOLDING APPARATUS

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12 Claims. (Cl. 279—3)

This invention relates to air pressure actuated vacuum apparatus, particularly as related to work holding means.

It is the primary object of the present invention to provide a novel vacuum pump and related air pressure operated means for releasably holding work and other objects which heretofore required the use of mechanically operated chucks and similar clamping devices.

It is another object of this invention to provide novel vacuum operated work holding means for use on lathes, drill presses and similar machines, which may be quickly and easily operated to releasably hold work in desired positions subject to machining and treatment, in an advantageous manner not provided for by conventional mechanically actuated chucks and similar holding devices.

It is another object of this invention to provide a novel air pressure actuated vacuum pump which will produce and uniformly maintain a comparatively high vacuum in a particularly efficacious manner in work holding means such as above described or in other means where it is desired to create subatmospheric pressure, and wherein at will, the pump may be operated to produce above atmospheric pressure or subatmospheric pressure of different values in such holding means or other means.

It is another object hereof to provide a novel work holding member which is free from mechanical means for engaging and holding the work, the holding action being effected solely by atmospheric pressure against the exposed surfaces of the work according to the subatmospheric pressure applied through the holding member against the surface of the work abutting the holding member.

A further object of this invention is the provision in apparatus such as described of novel means for controlling the air pressure which operates the vacuum pump to vary the holding action of the holding member, it being possible readily and easily to regulate this action so that the work may be adjusted as desired while being held on the holding member and as readily immovably held thereon under the holding force provided by the apparatus.

An additional object of this invention is to provide work holding apparatus such as described which may be rotated at desired speeds while securely holding the work by reason of the particular construction of the work holding member and the efficient manner in which the vacuum pump cooperates with the work holding member to uniformly maintain an effective negative pressure at one side of the work.

A further object of this invention is the provision of a novel work holding member which is in the form of a disk or plate having sealing means surrounding one or more openings or depressions in which subatmospheric pressures are developed when work bridges the openings or depressions in engagement with the sealing means, there being valve means operable for rendering selected areas of the holding member operable and inoperable as desired best to hold in place work of a particular size or shape.

Yet another object is the provision of a work holding member such as next above described which may be formed with a series of concentric annular grooves or channels in the work engaging face thereof and is provided with valved means operable for selectively communicating the grooves or channels with the vacuum pump for creating the subatmospheric pressures against the work

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whereby atmospheric pressure is effective to hold the work on the holding member. With this arrangement and the control provisions in the vacuum pump, the latter also may be operated to direct air at above atmospheric pressure therefrom to the holding member and against the work for quickly releasing the work, or the holding action may be regulated as desired to prevent adjustment or movement of the work or to permit adjusting movement while the work is held on the holding members.

An additional object of this invention is the provision of a work holding member of the character described which is provided with a central opening for registration with the bore of the lathe spindle whereby a part of work may be extended through this opening and into the spindle if this is required, with the holder also operable for holding other parts of the work thereon upon operation of the vacuum pump.

Other objects and advantages of the invention will be hereinafter described or will become apparent to those skilled in the art, and the novel features of the invention will be defined in the appended claims.

Referring to the drawings:

FIG. 1 is a fragmentary plan view partly in section of apparatus embodying the present invention shown as applied to a conventional lathe, only portions of which latter are shown;

FIG. 2 is a sectional view on an enlarged scale taken on the line 2—2 of FIG. 1;

FIG. 3 is a sectional view on a reduced scale taken on the line 3—3 of FIG. 2;

FIG. 4 is a front elevation of a holding member and part of the lathe shown in FIG. 1, on a reduced scale;

FIG. 5 is a fragmentary side elevational and part sectional view of a modified arrangement of apparatus of this invention as embodied in a lathe; and

FIG. 6 is a sectional view taken on the line 6—6 of FIG. 5 on an enlarged scale.

The illustrative embodiment of the invention as shown in FIGS. 1—4 includes vacuum operated apparatus in operative association with a conventional lathe 2, and generally comprising an air jet operated vacuum pump 3 and related work holding member 4. The pump 3 may be mounted on or adjacent the head stock of the lathe 2, for example, by means of a bracket 5 fixed to the head stock. The work holding member 4 is mounted on the tubular spindle 6 of the lathe in place of a conventional chuck, there being a hose or conduit 7 for communicating the vacuum pump 3 with the work holding member 4. Typical work held on the member 4 is designated W.

It is to be understood that the apparatus of this invention may be applied to machines other than here shown, or used in any manner for work holding or article engaging purposes, since it is contemplated that the pump 3 and the work holding member 4 or any member similar thereto which is activated by the pump so that air pressure as here provided becomes the sole medium by which the holding member supports or treats the work under control of the pump are within the scope of this invention regardless of the manner in which these elements are employed for work treating or work holding purposes.

The vacuum pump 3 as shown in FIG. 2, is preferably air pressure operated and generally comprises a sectional body 8 having an inlet 10 for air or other gas under pressure, a jet discharge port 11 and port means 12 between the inlet port 10 and port 11 which, as will be hereinafter described, serves in one operation to produce a vacuum in an annular chamber 13 surrounding the air jet of the pump. A series of ports 14 extending longitudinally in the body 8 communicating the chamber 13 with a chamber 14a having a port 15 to which the hose or conduit 7 is connected so as to lead to the holding

member 4 for operation thereof in response to operation of the pump unit.

Also formed by sections of the body 8 is a chamber 17 into which air or gas is discharged from the discharge port 11 of the pump 3. As here shown, this chamber 17 has a plurality of exhaust ports 18 open to the atmosphere and covered by means of one or more porous members 19 arranged so that the air or gas must pass therethrough to enter the ports 18. The members 19 may be composed of any suitable porous material such as felt or the like and should be selected so as to not cause an excessive back pressure in the chamber 17.

A fitting 20 is connected with the inlet 10 and may be connected with an air or gas pressure supply source, not shown, for supplying air or gas under pressure to operate the pump. A control valve 21 is mounted in an air line 21' connected to the fitting 20 and is manually operable to vary the flow of air or gas to the pump to control the operation thereof. This valve means makes it possible to vary the value of the negative pressure created by the pump to thereby vary the work holding effect of the member 4 as desired.

Another control means is provided for the pump 3 so that at will, it may be changed from a vacuum pump operation to a means for introducing air or gas under pressure to the holding member 4 to effect release of the work from the holding member. As here shown, this control means includes a normally open valve unit 23 in the pressure chamber 17 operable from the exterior of this chamber for closing the jet discharge port 11. Upon release of manual pressure on the stem 23' of the valve unit 23, a spring 24 will return the valve member 24' to its normally open position. When the jet port 11 is closed by the valve member 24', as shown in broken lines in FIG. 2, the air under pressure passes out of the pump through the port means 12 into chamber 13, thence through the port 14, chamber 14a, port 15 and conduit 16 to the work holding member 4 to apply a positive pressure and nullify the holding action of atmospheric pressure on the work and thereby release the work from the member 4. When the valve unit 23 is released and moves to open the port 11, the pump operates to develop a vacuum. With this arrangement it is not necessary to shut off the flow of air to the pump in order to release the work from the holder 4.

More specifically, the pump unit 3 preferably includes a body section 25 which is cylindrical and has its inner end 25' bored to receive an end of another cylindrical body section 26 which latter is held in place by an annular body section 27 threadedly engaged as at 28 with the inner end 25' of the body section 25, there being a flange 27' on the annular section 27 overlying a flange 26' on the section 26. The flange 26' overlies the inner end portion 25' of the section 25, there being a sealing ring 28' between the flange 26' and the end portion 25' to form a seal for the aforementioned annular chamber 13 which, it will now be observed, is advantageously formed between the opposed portions of the body sections 25 and 26.

The pressure chamber 17 is formed by a cylindrical shell 29 which at its inner end is threaded on or otherwise suitably secured to the annular body section 27. A flanged cap member 30 is threaded into the outer end of the shell 29 and supports the valve unit 23.

The normally open valve unit 23 has its stem 23' slidable through an opening 31 in the cap 30, there being a spring keeper 32 on the stem 23' to engage with a boss 33 on the cap to limit outward movement of the stem. The spring 24 is confined between this keeper and an annular groove 26a in the outer end of the body section 26 so as to hold the valve member 25 away from the jet discharge port 11.

The annular porous members 19 are preferably formed of felt or other suitable material and are frictionally retained in an annular space 35 formed between the reduced outer end of the body section 26 and the wall of the cylin-

dric shell 29. The innermost of the members 19 engages the annular body member 27 and flange 27' and covers the circular series of exhaust ports 18 formed in the body section 27.

The inlet 10 is provided in the body section 25 so as to open on one side thereof, the inner end of the inlet also opening into an axial bore 36 in this body section 25. The bore 36 is closed by a wall 37 at the outer end of the body section and the other end of the bore 36 is threaded.

A jet nozzle member 38 threadedly engages in the bore 36 which is counterbored to form a shoulder 39 on which rests a flange 40 of the nozzle 38. The nozzle 38 has a through passage 41 extending axially thereof, this passage having a flared intake end 41a and a reduced throat 41b to create the desired venturi action or suction at the port 12 due to increased air velocity and reduced pressure in the venturi throat 41b. The venturi passage expands as indicated by the flaring passage 55 extending through an exhaust tube 56 which is disposed in the bore 43 of body section 26, retained in place by set screw 57 or other suitable means, and sealed as by an O-ring 56a. Preferably, in order to maintain turbulence at a minimum with consequent constancy of the suction effect, the discharge end of the venturi throat 41b is the same diameter as the inlet to flaring passage 55.

The inner end of exhaust tube 56 is concave as at 58, and is spaced from the conical end 42 of nozzle 38 to define the annular port 12, and the port 12 may be varied or adjusted by axial adjustment of exhaust tube 56 upon loosening of set screw 57.

The inner end of an axial bore 43 through the body section 26 receives the inner conical end 42 of the nozzle 38 so as to define an annular passage or port 44 between the opposed cylindrical surfaces of the nozzle and the wall of the bore 43, this passage leading into the annular chamber 13.

The inner end of the body section 26 is formed with a concave face 46 bordered by a cylindrical edge portion 47. The face 46 is opposed to and spaced outwardly from the body section 25 to form the annular chamber 13, there being a felt or similar porous screen member 48 of annular form confined between the adjacent end of the body section 25 and the cylindrical edge portion 47 of the body section 26. The screen member 48 is interposed between the circular series of ports 14 in the body section 26 and the chamber 13. The port 15 is provided in a closure plate 50 held by screw fastenings 51 against the body section 26 which latter has a recess therein forming the chamber 14a from which lead the ports 14 and the port 15, there being a felt or other type screen disk 53 in the chamber 14a for covering the ports 14 to exclude dust and similar foreign matter from entering the pump unit.

The work holding member 4 as here shown, comprises a disk-like body 60 having a tubular hub 61 adapted to be threaded onto the lathe spindle 6 in the manner of a conventional chuck. A central opening 62 in the body 60 is aligned with the bore 62a of the hub 61 and the bore of spindle 6 so that portions of the work held on the body 60 may be disposed in these bores.

The work engaging face of the disk-like body 60 of the holding member 4 is provided with a series of concentric grooves 64 and ribs 65, the ribs having small grooves 66 therein for reception of sealing rings 67. These sealing rings are disposed to form seals with the work when the latter is placed against the member 4 so that the grooves 64 will form annular chambers in which subatmospheric pressures are produced.

The back of the disk-like body 60 of the member 4 is provided with an annular chamber 68 closed by a back plate 69 and sealed by sealing rings 69'. The plate 69 is secured within a recess 70 in the body 60 by means of fastenings 71. Ports 72 in the body 60 communicate the chamber 68 with the grooves 64, there being a tubular valve member 73 axially screw threadedly adjustable in each port 72 between positions opening and closing the ports. Each valve 73 is adapted to seat against a com-

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pressible seat 74 countersunk in the back plate 69, the bore 73' through the valve being closed when the valve is seated and opened when the valve is unseated. A slot 75 for reception of a screw driver is provided in the outer end of each valve member 73 to facilitate opening and closing adjustment thereof.

Means are provided for operatively connecting the conduit 7 with the work holding member 4 so that the vacuum pump 3 is in direct communication with the chamber 68 in the back of the member 4 at all times and is subject to communication with the concentric grooves 64 when the valves 73 are unseated. As here shown, this means comprises an annular member 77 surrounding the hub 61 of the member 4 and provided with an inlet port 78 which communicates with a continuous groove 79 extending circumferentially on the exterior of the hub. The groove 79 communicates with the chamber 68 through a port 80 formed in the hub. One end of the conduit 7 leading from the pump 3, as here shown, is screwed into the inlet port 78 in the annular member 77 thereby communicating the pump with holding member 4.

Any suitable means may be provided to mount the annular member 77 to which the conduit 7 is connected on the hub 61 so that the hub 61 and work holding member 4 may rotate freely relative to the member 77. As here shown, a nut 83 is axially adjustable on the exterior of the hub 61 and confines the annular member 77 between it and the back plate 69 in such a manner that the member 4 and hub 61 thereof may rotate freely relative to the member 77. A set screw 83' holds the nut 83 against movement out of adjusted position. Sealing rings 84, 85 and 86 are arranged to form fluid tight seals around the member 77. A lubricant inlet fitting 88 may be provided on the member 77 for introducing a lubricant in channel 89 and lubricant passages 90 formed in the member 77, whereby free rotation of the holding member 4 relative to the annular member 77 will be assured without undue friction and consequent wear.

As shown in FIG. 1, work designated W in the form of a circular relatively thick member may be securely held on the work engaging face of the work holding member 4 as a result of the negative pressure acting against the inner face of the work and the atmospheric pressure against the exposed faces of the work. It has been found that work of this type or any other type which has a surface adapted to form a seal around the depressions or grooves 64 in the work holding member, when engaged with the sealing rings 67 on the latter, will be securely held, it being possible to rotate the spindle and work at any desired speed while the work is securely and immovably held on the work holding member.

It is important to note that by reason of the flow reversal valve 23 in the pump 3, the operator may depress the stem 23' of the valve and thereby cause air under pressure that has entered the pump to be forced against the face of the work opposite the depressions or grooves in the member 4, whereby the work may be quickly released for removal from the work holding member. An advantage of this is that it is not necessary to shut off the flow of actuating air to the pump in order to release the work from the holding member 4.

Another advantage of the apparatus of this invention is that should it become necessary to adjust the work on the work holding member while the work is held thereon, this readily may be effected by manipulating the valve 21 for reducing the flow of actuating air to the pump and thereby modifying the vacuum so that atmospheric pressure will exert sufficient force to hold the work on the work holding member, yet permit of adjustment of the work relative thereto.

FIG. 5 illustrates a modified form of the invention wherein an air jet operated vacuum pump 92 identical with the vacuum pump 3 shown in FIGS. 1-4 and a

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work holding member 93 of substantially the same construction as the previously described work holder 4, are embodied in a conventional lathe 94 so that the conduit 95 communicating the pump with the work holding member is extended through the hollow spindle 96 of the lathe. With this arrangement the pump 92 is disposed adjacent one end of the spindle 96, whereas the work holding member 93 is mounted on the other end of the spindle. The pump 92 as here shown, is supported on the projecting end of the conduit 96. The conduit 95 is movable axially in the spindle 96 while connected to the pump and the work holding member, such movement being effected in the operation of detaching the holding member as will be hereinafter described.

Air under pressure from a source not shown is supplied to the pump 92 through an intake pipe 97 in which a manually operable valve 98 is operable to control the flow of air into the pump in the same manner as the control valve 21 in the previously described form of the invention. A normally open flow-reversing valve 99 identical with the valve 23 is provided in the pump 92 and is accessible for operation at one end of the pump.

The work holding member 93 as here shown, comprises a disk-like body 100 of circular form having a threaded hub 101 adapted to be screwed onto the lathe spindle 96 in the manner of a conventional chuck. The work engaging face of the member 93 is substantially the same as in the previously described work holding member 4 in that it is provided with a series of concentric grooves 102 and ribs 103, the ribs being provided with sealing rings 104 to engage the work so as to form seals against the work and around the respective grooves.

Ports 105 extend from a chamber 106 in the back of the holding member 93 into the grooves 103, each port being provided with a tubular valve 107 threadedly axially adjustable therein between positions for opening and closing the bore therethrough. A seat 108 is provided in the chamber 106 for each valve 107. The arrangement of the valves 107 makes it possible to render different portions of the work holding face of the member 93 operable and inoperable for creating differential pressures against the work.

Means are provided to connect the conduit 95 with the chamber 106 in the work holding member 93 so that the latter may rotate with the spindle 96 relative to the conduit while maintaining a fluid tight joint of the conduit with the work holding member. As best shown in FIG. 6, this means comprises a quick action coupling 109 consisting of a nipple 109' on the conduit 95 and a socket 110 on the back of the work holding member 93, the socket communicating with the chamber 106 through a tubular fitting 110' threadedly connected to the work holder and the socket 110. A latching sleeve 111 is mounted on the socket 110 so as to be biased by a spring 112 to a position for holding bearing balls 113 in engagement with an annular groove 114 in the nipple. The bearing balls 113 are radially movable in the openings 115, the diameter of these openings permitting the balls to protrude inwardly for engagement in the groove 114 in the nipple without allowing the balls to drop through the openings. When it is desired to disconnect the conduit 95 the hub 101 of the holding member 93 is unscrewed from the spindle 96, the socket unit 110 and sleeve 111 turning with the holding member during the unscrewing operation. As the hub is being unscrewed the conduit 95 is moved axially in the spindle, and when the hub is free of the spindle, access to the coupling 109 may be had by pulling outwardly on the member 91 to slide the conduit 95 out of the spindle sufficiently to reach the coupling. The latching sleeve 111 may now be retracted against the action of the spring 112 so that an annular rib 116 in the sleeve is disposed out of engagement with the bearing balls 113 thereby permitting the socket to be removed from the nipple. A snap ring 117 on the socket limits the outward movement

of the latch sleeve to a position locking the bearing balls in place in the nipple groove 114. The outer end of the nipple abuts a compressible sealing member 118 within the nipple so as to provide a leakproof joint.

When the spindle and work holding member 93 are rotated, the socket 110 with the latch sleeve 111 and bearing balls 113 thereon are rotated freely around the nipple, the bearing balls acting as anti-friction members. It should be noted that the portion of the conduit 95 entering the rear end of the spindle 96 is slidable in a tubular member 120 inserted into the spindle for rotation therewith, there being a ball bearing unit 121 in the enlarged outer end 122 of this tubular member 120 to permit the tubular member and spindle to rotate freely around the conduit 95, also permits free axial movement of the conduit 95 in the spindle. A clean-out opening 123 is provided in the work holding member 93 to afford access to the chamber 106 and related parts, there being a plug 124 having a sealing ring 125 thereon removably positioned in and closing this clean-out opening.

While specific structural details have been shown and described, it should be understood that changes and alterations may be resorted to without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. Air pressure actuated apparatus comprising: an air pump; air pressure applying means for applying sub-atmospheric pressure and above atmospheric pressure to means for holding and releasing work according to said pressures; conduit means connecting said pump with said air pressure applying means; and flow control means embodied in said pump manually operable for controlling the direction of flow of air passing through the pump optionally to create subatmospheric pressure and above atmospheric pressure in said conduit means and said air pressure applying means.

2. Air pressure actuated apparatus comprising: an air pressure operated vacuum pump; air pressure applying means for applying subatmospheric pressures and above atmospheric pressures to means operable to hold and release work according to said pressures; conduit means connecting said vacuum pump with said air pressure applying means; valved intake means for said pump operable to control the flow of air under pressure into said pump; and flow control means embodied in said pump manually operable for controlling the direction of flow of air passing through the pump optionally to operate the pump for creating subatmospheric pressure and above atmospheric pressure in said conduit means and said air pressure applying means.

3. Air pressure actuated apparatus comprising: an air pressure operated vacuum pump; air pressure applying means; conduit means connecting said vacuum pump with said air pressure applying means; valved intake means for said pump operable to control the flow of air under pressure into said pump; flow control means embodied in said pump manually operable for controlling the direction of flow of air passing through the pump from said valved intake means optionally to operate the pump for creating subatmospheric pressure and above atmospheric pressure in said conduit means and said air pressure applying means; and means for connecting said air pressure applying means to a structure in which it is desired to apply said pressures.

4. Air pressure actuated apparatus comprising: an air pressure operated vacuum pump; air pressure applying means having an outlet through which subatmospheric pressure and above atmospheric pressure may be applied to means which will operate in response to said pressures; conduit means connecting said vacuum pump with said air pressure applying means; valved intake means for said pump operable to control the flow of air under pressure into said pump; and flow control means embodied in said pump manually operable for controlling the direc-

tion of flow of air passing through the pump from said valved intake means optionally to actuate said pump for creating subatmospheric pressure and above atmospheric pressure in said conduit means and through said outlet of said air pressure applying means.

5. Air pressure actuated vacuum apparatus comprising: a body having inlet means adapted for connection with a source of air under pressure; means in said body providing a jet pump through which air under pressure is passed from said inlet means; means in said body providing a vacuum chamber surrounding said jet pump; said jet pump having a vacuum port in communication with said chamber; said jet pump having a discharge port; means in said body providing an exhaust chamber into which air is discharged from said discharge port; said body having exhaust ports for venting air from said exhaust chamber; means in said body providing a port which opens exteriorly of the body for connection with means for applying pressure developed by the pump; and passage means in said body communicating said vacuum chamber with said last named port.

6. Air pressure actuated vacuum apparatus comprising: a body having inlet means adapted for connection with a source of air under pressure; means in said body providing a jet pump through which air under pressure is passed from said inlet means; means in said body providing a vacuum chamber surrounding said jet pump; said jet pump having a vacuum port in communication with said chamber; said jet pump having a discharge port; means in said body providing an exhaust chamber into which air is discharged from said discharge port; said body having exhaust ports for venting air from said exhaust chamber; means in said body providing a port which opens exteriorly of the body for connection with means for applying pressure developed by the pump; passage means in said body communicating said vacuum chamber with said last named port; and porous means in said exhaust chamber disposed across said exhaust ports.

7. Air pressure actuated vacuum apparatus comprising: a body having inlet means adapted for connection with a source of air under pressure; means in said body providing a jet pump through which air under pressure is passed from said inlet means; means in said body providing a vacuum chamber surrounding said jet pump; said jet pump having a vacuum port in communication with said chamber; said vacuum port being uninterrupted circumferentially of said jet pump; said jet pump having a discharge port; means in said body providing an exhaust chamber into which air is discharged from said discharge port; said body having exhaust ports for venting air from said exhaust chamber; means in said body providing a port which opens exteriorly of the body for connection with means for applying air pressure developed by the pump; and passage means in said body communicating said vacuum chamber with said last named port.

8. Air pressure actuated vacuum apparatus comprising: a body having inlet means adapted to be connected with a source of air under pressure; means in said body providing a jet nozzle in communication with said inlet; an exhaust tube mounted in said body in alignment with said jet nozzle and in axially spaced relation thereto to form a vacuum port that is uninterrupted circumferentially of the outlet of said jet nozzle; means in said body providing a vacuum chamber surrounding said jet nozzle and in communication with said vacuum port; and means in said body providing a port leading from said vacuum chamber and which opens exteriorly of the body.

9. Air pressure actuated vacuum apparatus comprising: a body having inlet means adapted to be connected with a source of air under pressure; means in said body providing a jet nozzle in communication with said inlet; an exhaust tube mounted in said body in alignment with said jet nozzle and in axially spaced relation there-

to to form a vacuum port open throughout 360° around the outlet of the jet; means in said body providing a vacuum chamber surrounding said jet nozzle and in communication with said vacuum port; means in said body providing a passage leading from said vacuum chamber and which opens exteriorly of the body; and valve means operable to close said exhaust tube whereby air under positive pressure will be directed through said vacuum port, said vacuum chamber and said passage.

10. Air pressure operated apparatus comprising: a body having inlet means for connection with a source of air under pressure; means in said body providing a jet nozzle in communication with said inlet means; means connected with said body providing an exhaust chamber having an exhaust port which opens to the atmosphere; means in said body providing an exhaust passage for receiving air from said nozzle and discharging the air into said exhaust chamber; means providing a vacuum chamber surrounding said nozzle; said passage forming means being spaced from said nozzle to define around said nozzle a vacuum port which opens into said vacuum chamber; means in said chamber providing a vacuum passage leading from said vacuum chamber and which opens exteriorly of said body; and valve means in said exhaust chamber operable for closing said exhaust passage whereby air under pressure directed from said nozzle will pass through said vacuum port, said vacuum chamber and said vacuum passage.

11. Air pressure operated apparatus comprising: a body having inlet means for connection with a source of air under pressure; means in said body providing a jet nozzle in communication with said inlet means; means connected with said body providing an exhaust chamber having an exhaust port which opens to the atmosphere; means in said body providing an exhaust passage for receiving air from said nozzle and discharging the air into said exhaust chamber; means providing a vacuum chamber surrounding said nozzle; said passage forming means being spaced from said nozzle to define between said passage forming means and said nozzle a vacuum port which opens into said vacuum chamber; means in said chamber providing a vacuum passage leading from said vacuum chamber and which opens exteriorly of said body; valve means in said exhaust chamber operable for closing said exhaust passage whereby air under pressure directed from said nozzle will pass through said vacuum port, said vacuum chamber and said vacuum passage.

ly of said body; valve means in said exhaust chamber operable for closing said exhaust passage whereby air under pressure directed from said nozzle will pass through said vacuum port, said vacuum chamber and said vacuum passage; spring means biasing said valve to open said exhaust passage; and means operable on the exterior of said exhaust chamber for moving said valve to close said exhaust passage.

12. Air pressure operated apparatus comprising: a body having inlet means for connection with a source of air under pressure; means in said body providing a jet nozzle in communication with said inlet means; means connected with said body providing an exhaust chamber having an exhaust port which opens to the atmosphere; means in said body providing an exhaust passage for receiving air from said nozzle and discharging the air into said exhaust chamber; means providing a vacuum chamber surrounding said nozzle; said passage forming means being spaced from said nozzle to define between said passage forming means and said nozzle a vacuum port which opens into said vacuum chamber; means in said chamber providing a vacuum passage leading from said vacuum chamber and which opens exteriorly of said body; valve means movable into a position for opening said exhaust passage as well as into a position for closing said exhaust passage; means biasing said valve means to occupy one of said positions; and means operable from the exterior of said exhaust chamber for moving said valve means into the other of said positions; said valve means when in said position for closing said exhaust passage causing air under pressure to be passed out through said vacuum port, said vacuum chamber and said vacuum passage.

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