Jan. 31, 1950 W. F. SCHROEDER 2,495,869

AIR CYLINDER

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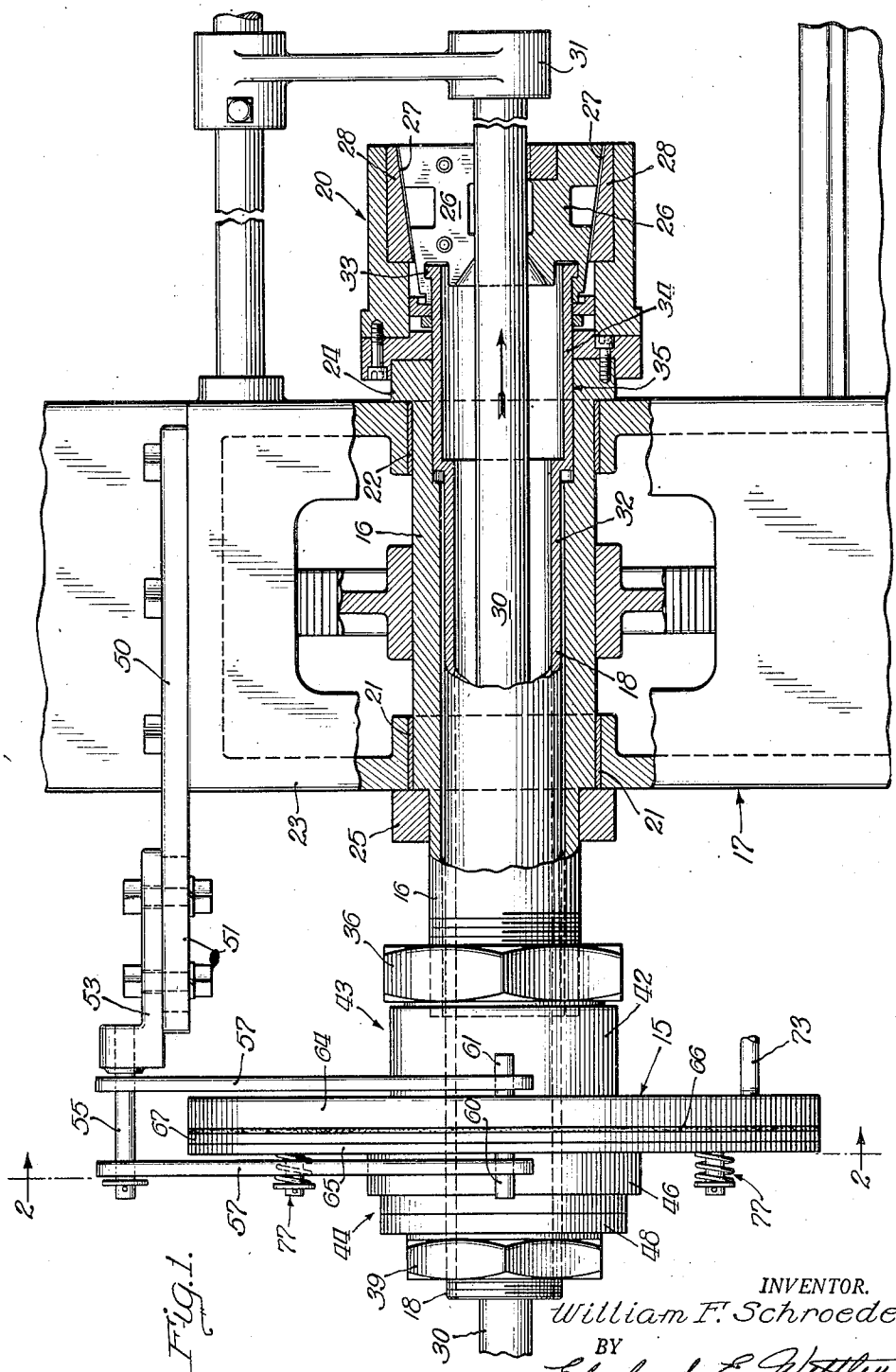

Fig. 1.

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AIR CYLINDER

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Fig. 2.

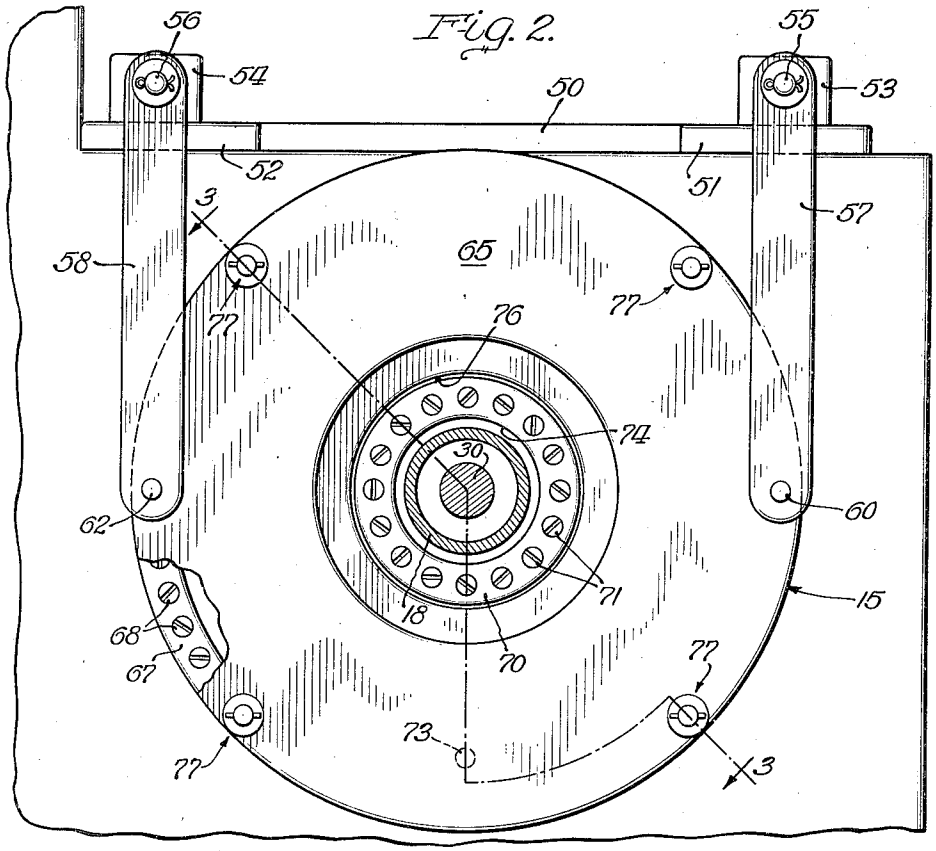
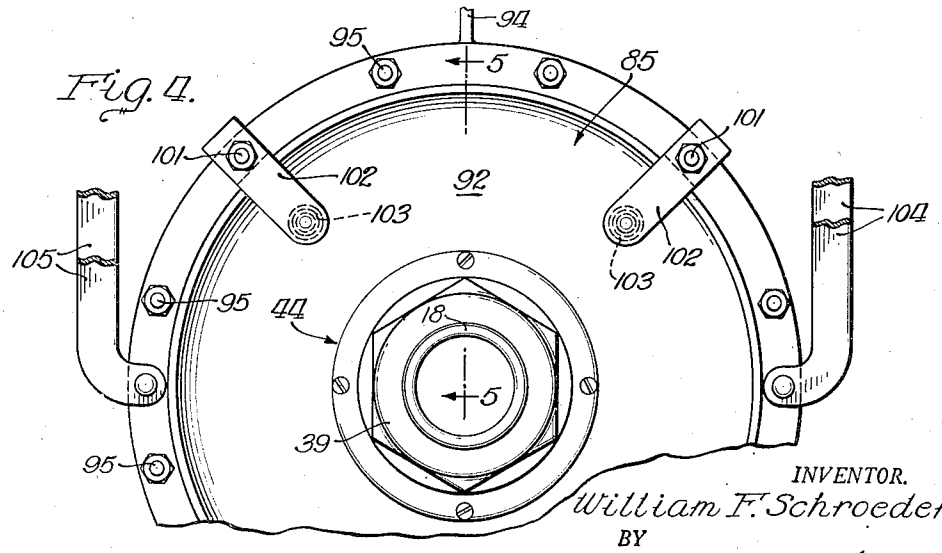


Fig. 4.



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AIR CYLINDER

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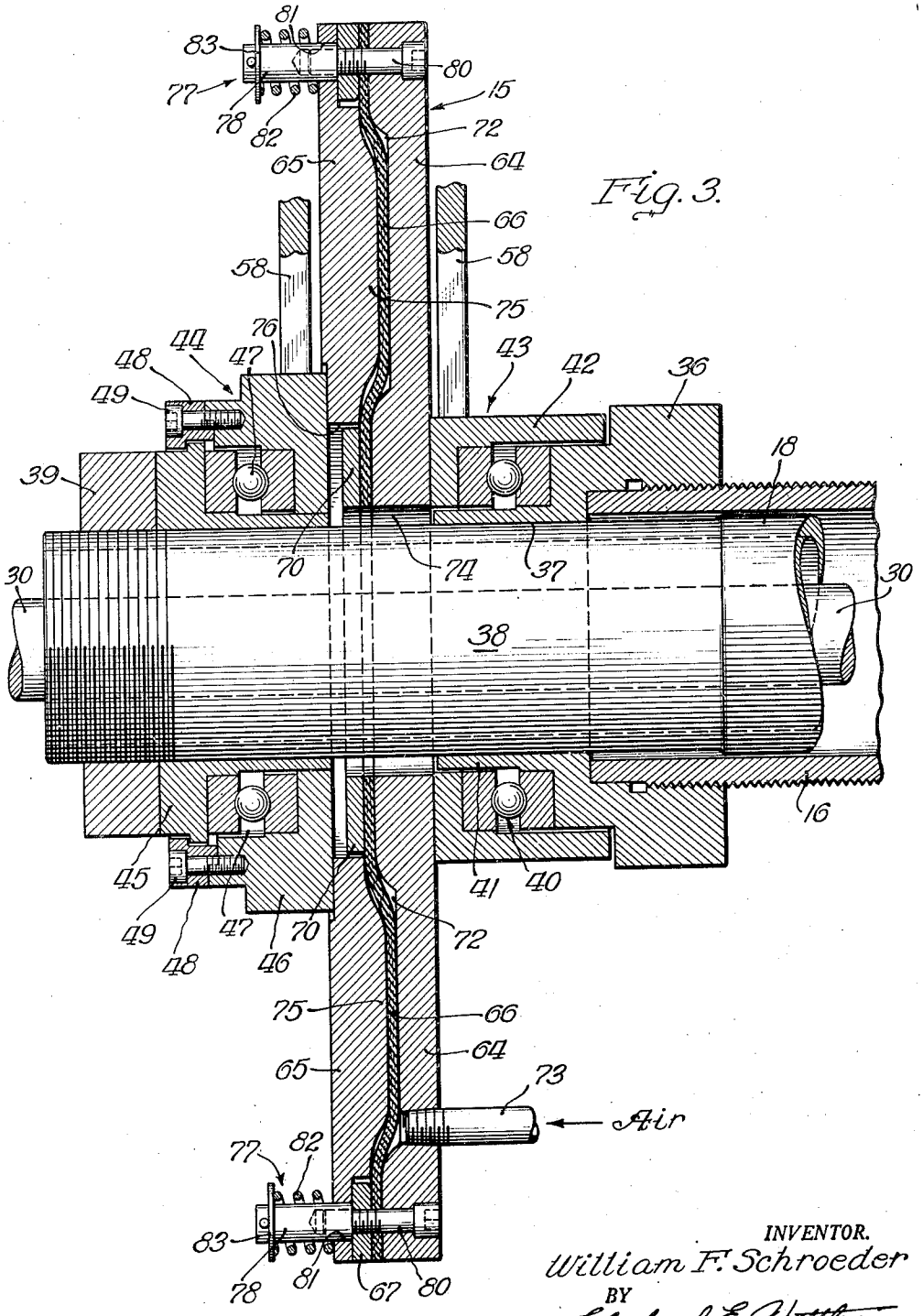

Fig. 3.

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Fig. 5.

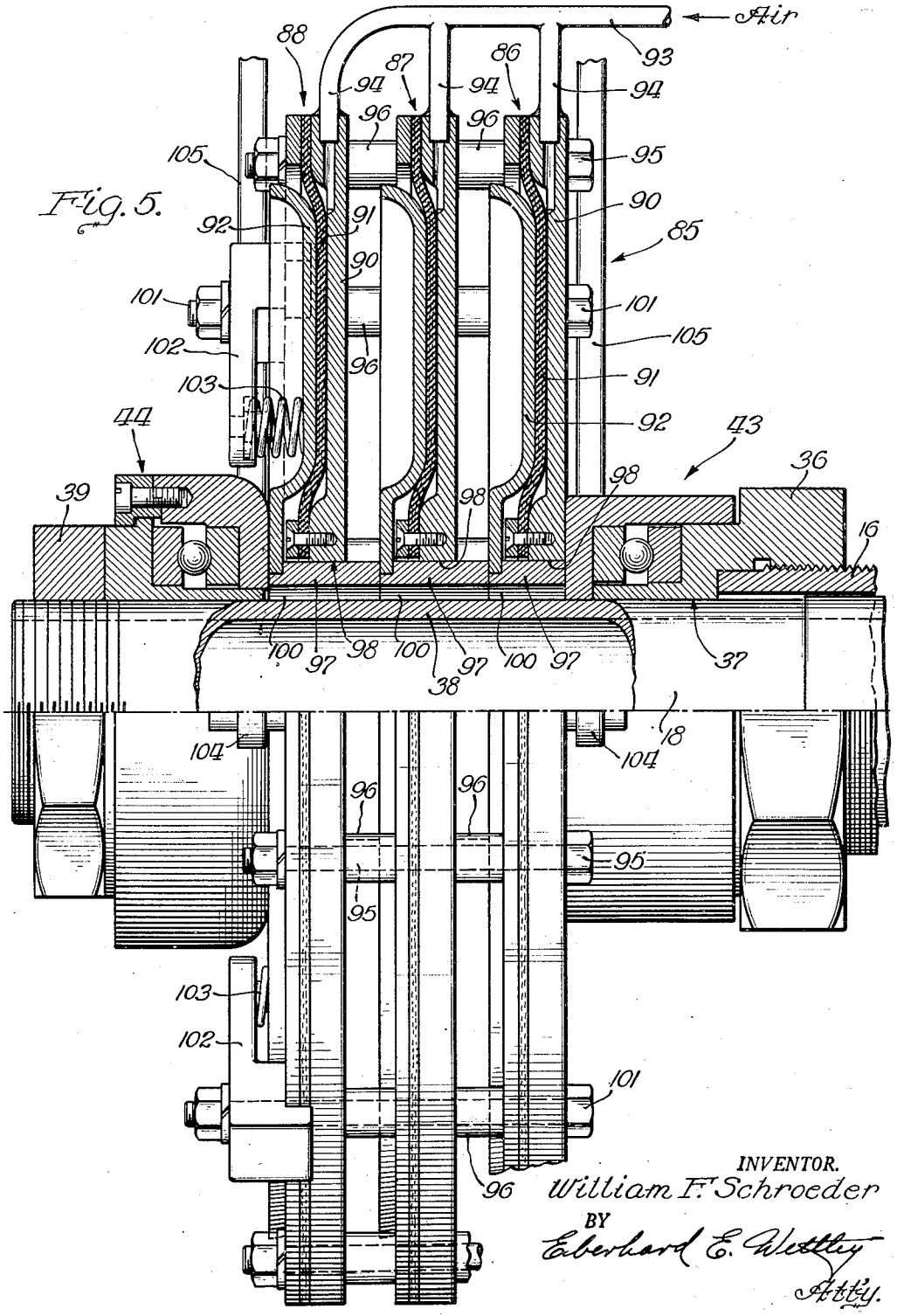

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Fig. 6.

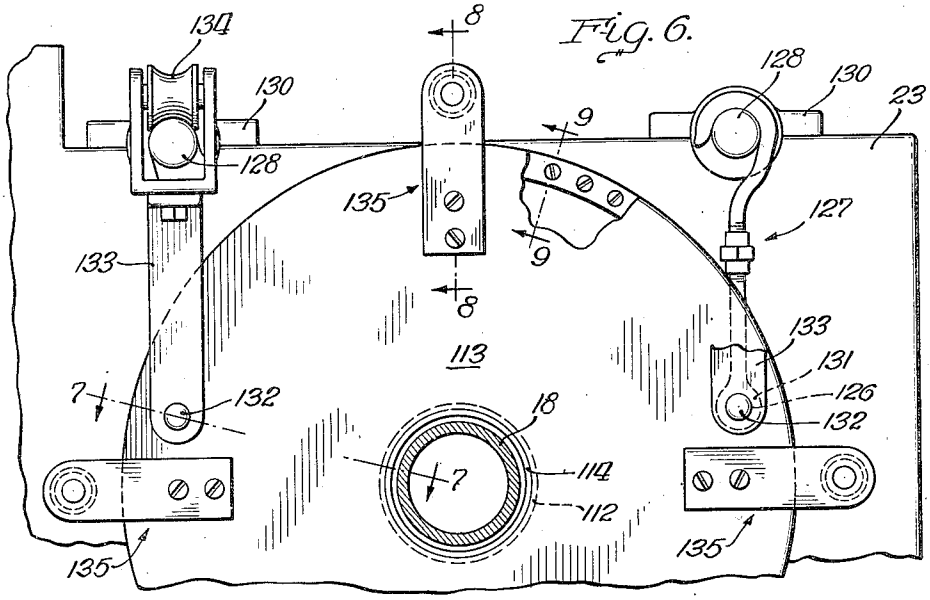

Fig. 13.

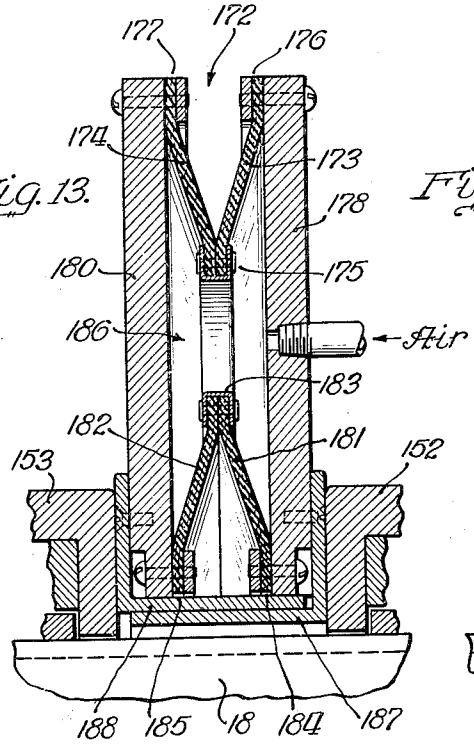

Fig. 14.

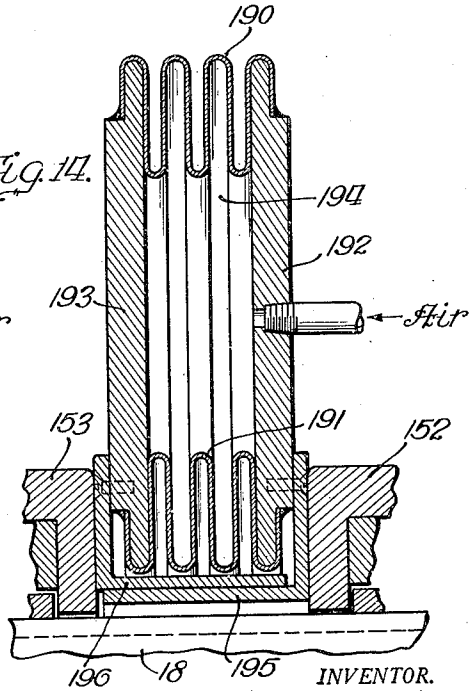

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Fig. 7.

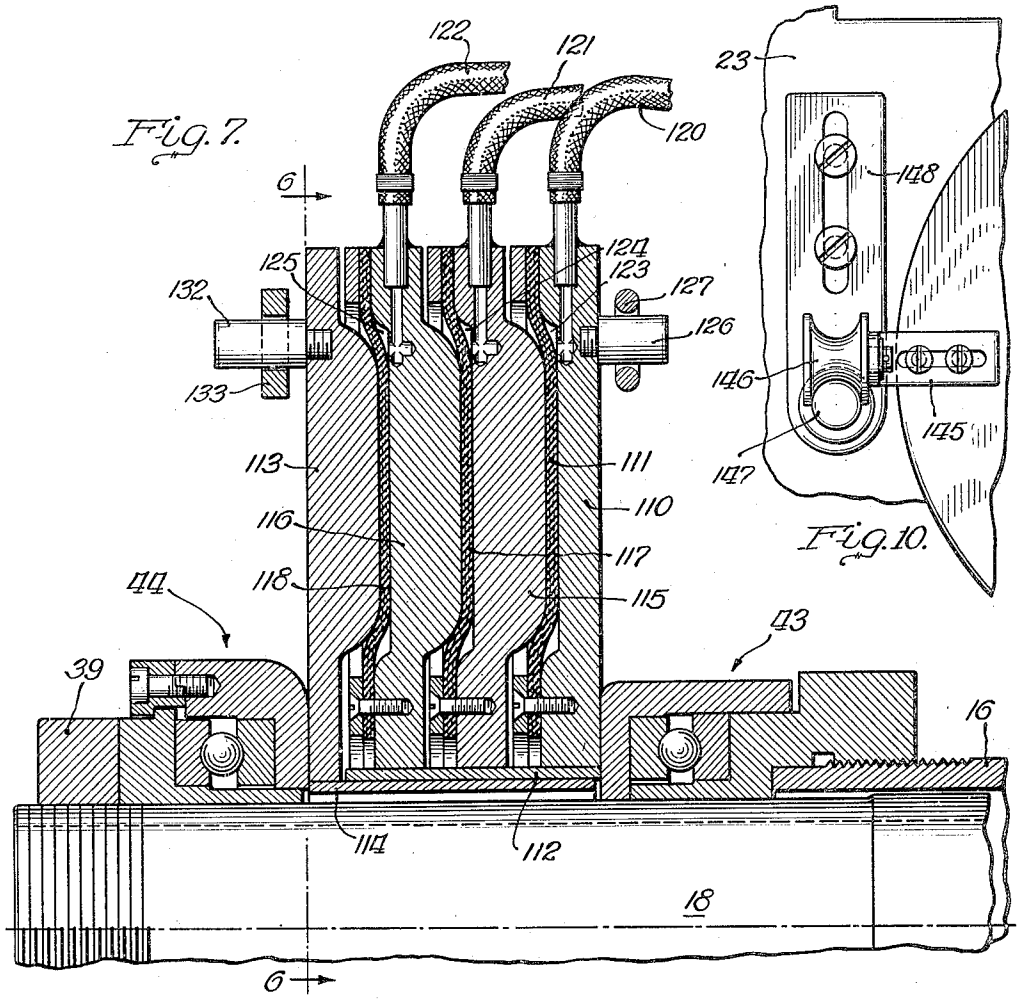


Fig. 10.

Fig. 8.

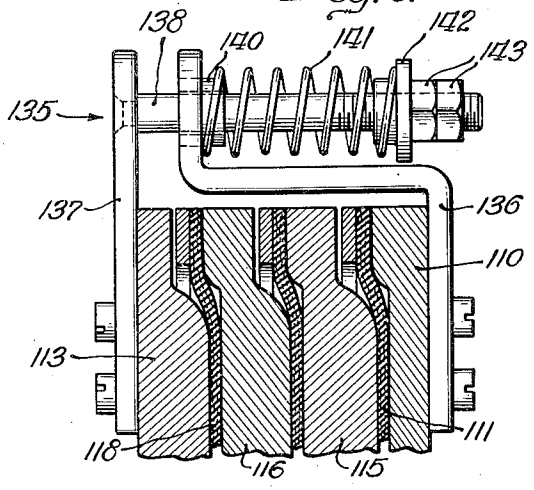
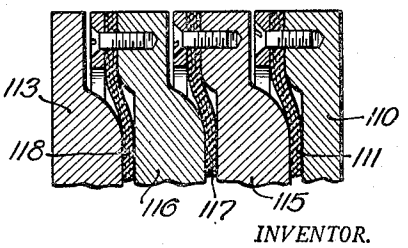


Fig. 9.



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AIR CYLINDER

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Fig. 11.

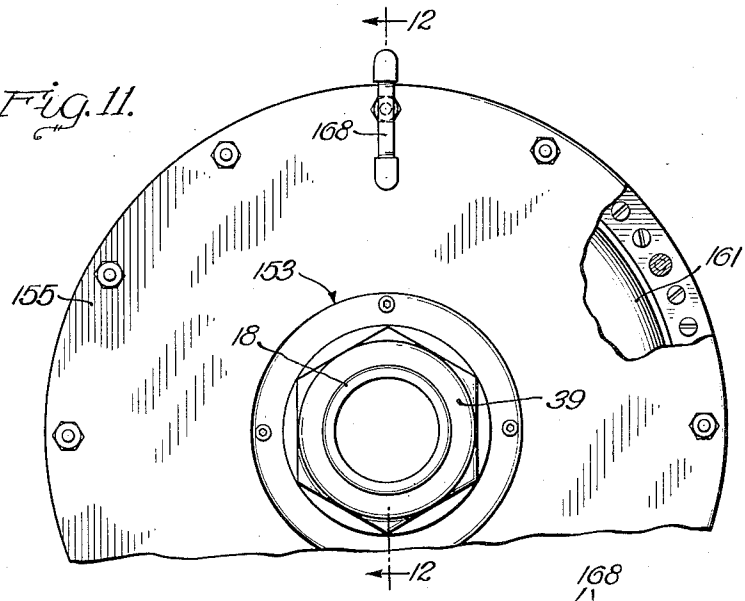
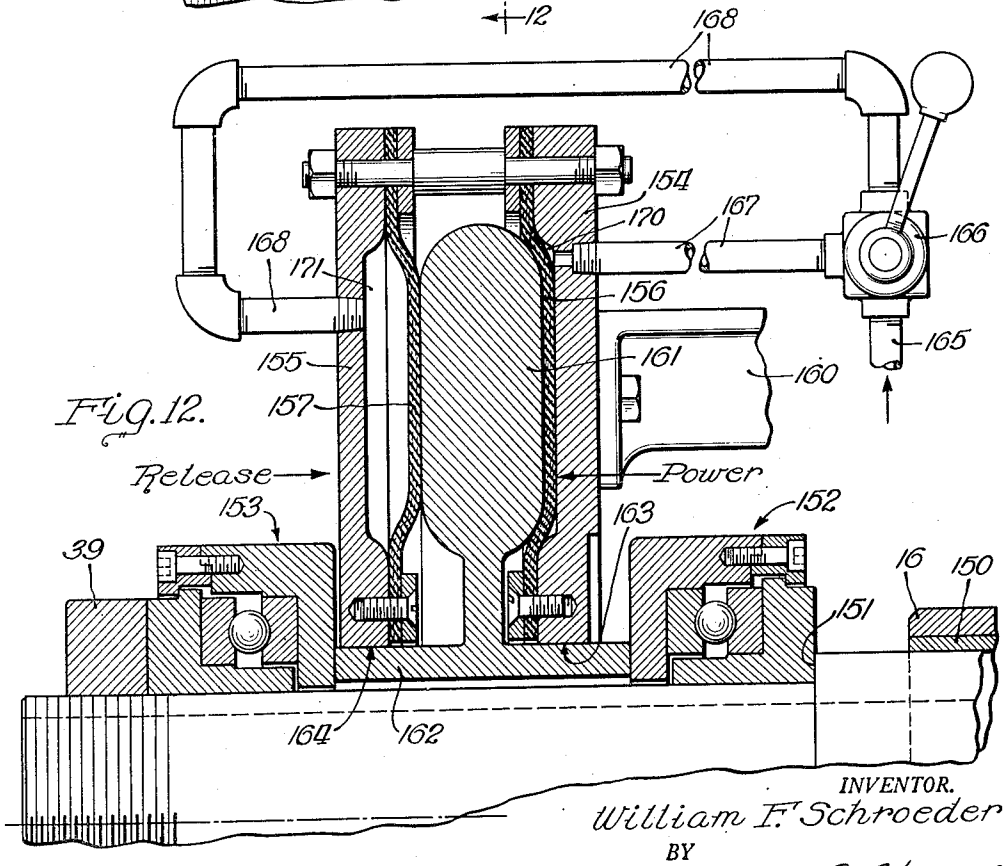


Fig. 12.



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UNITED STATES PATENT OFFICE

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AIR CYLINDER

William F. Schroeder, Chicago, Ill.

Application March 1, 1944, Serial No. 524,830

4 Claims. (Cl. 279—4)

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The invention herein disclosed and described is directed to an improved construction of air cylinder or air operated unit in combination with the operating parts of a standard chuck or a collet chuck so as to place one or the other of the latter in active work or tool holding relation; or to release either at predetermined intervals as the case may be. The air cylinder may be adapted to various purposes for numerous functions, but in order to best describe its use and operation in a workable set up, the same has been more specifically applied to operate the clamping jaws of a conventional collet chuck for the purpose of holding a piece of work at certain intervals to be acted or worked upon in any known manner in a lathe, automatic screw machine or in any type of metal working machine or instrument. In addition, the air cylinder is so arranged and designed as to be particularly applicable for use in connection with a collet chuck of a metal working machine wherein the stock may be axially fed or introduced into the collet chuck without affecting the operation or power efficiency of the air cylinder, the feeding of the stock being unobstructed and unimpaired by the cylinder installation.

With the more general adaptations of the air cylinder given above, some of the main objects of the present air cylinder unit shall be better understood. One of the main objects is to provide a fluid operated mechanism that will cooperate between the rotatable collet parts and the supporting rotatable spindle of the lathe or machine which carries and drives the collet chuck; and wherein such fluid operated mechanism is entirely devoid of fluid seals such as packings, mechanical leakproof accessories, stuffing boxes or like fluid retainers ordinarily utilized to prevent fluid loss between relatively rotating parts and possible pressure drop that may introduce work slippage of the stock within the collet while being worked upon. The maintenance and replacements of such fluid seals has always been a problem, and the only answer to eliminate inefficiency, breakdowns and delays due to the impractical life and faults of such seals is to eliminate using the same. And this has been accomplished with the air cylinder of the present invention.

Obviously, any packing or glands operating between two relatively moving parts are always subjected to considerable wear and the faster the relative speeds of the parts the greater the wear. The generation of heat in such glands or packings further shortens the useful life and efficiency of such fluid seals.

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With the air cylinder of the present invention which actually in its primary conception amounts to an annular expansible diaphragm cylinder, attention is called to the fact that the cylinder and its operating parts are held against rotation and out of contact with the rotatable parts of a metal working machine. This manner of installation is directly contra to the usual air cylinders on the market which do rotate and require the use of various devices or mechanical methods of introducing air from a stationary source into a rotatable cylinder. Naturally these units for feeding air and the cylinders must further incorporate various glands, packings or stuffing boxes or the like to prevent air leakage at the various points of air transfer between relatively moving parts of such assemblies.

Therefore, another main object of this invention is to provide an air cylinder that is stationary with respect to the spindle and collet parts to thereby eliminate all forms of glands or other complicated small tolerance fluid transfer means to introduce fluid from a stationary source to a revolving cylinder mechanism or the like. The disadvantages and corresponding impractical arrangements that must be resorted to in valving or feeding fluid from a stationary source into a revolving unit, or vice versa are self-evident. Such arrangements include devices comparatively costly to manufacture on the basis of the short time that such devices actually remain efficient due to surface wear or to burning out or scoring because of frictionally produced heat.

Further, this design has for an additional object the provision of an air cylinder for the purposes set forth which is actually entirely independent of the rotatable members of the lathe or metal working machine. This resides in the fact that the cylinder is suspended from suitable supporting units and is centrally open to provide more than enough clearance to be substantially axially aligned with the lathe spindle working axis but at the same time spaced annularly out of contact with the spindle and its companion moving parts, referring to the collet chuck parts, etc.

Another object of this air unit is to provide certain anti-friction mechanisms so arranged as to be interposed between the stationary air cylinder and the rotating spindle and collet chuck operating draw tube, respectively, to reduce rotational friction between the relatively movable members to a minimum while in operation.

Various other features are also incorporated in

certain disclosed and described modifications of the preferred form of device to demonstrate the flexibility of use and application of the fundamental principles embodied in the air cylinder unit of this invention. Such modifications together with further advantages and merits of the air cylinder will hereinafter be emphasized in the following detailed description directed to the disclosures in the accompanying drawings.

In the drawings:

Fig. 1 is a general side elevational view of the stock feeding end of a lathe to illustrate a preferred manner of installation of the preferred form of air cylinder, certain parts being broken away and in section to show the spindle and collet chuck details;

Fig. 2 is a sectional face view of the air cylinder in Fig. 1 as taken substantially along the line 2—2 in Fig. 1;

Fig. 3 is an axial sectional view through the air cylinder as viewed substantially along the line 3—3 in Fig. 2;

Fig. 4 is a view, similar to Fig. 2, of a modified form of air cylinder shown in elevation;

Fig. 5 is a side view of the air cylinder of Fig. 4, part of which is in section as taken substantially along the line 5—5 of Fig. 4;

Fig. 6 is an elevational face view of another modified construction of air cylinder, also viewed from the stock feed end of the lathe as are Figs. 2 and 3, and substantially along the line 6—6 of Fig. 7;

Fig. 7 is a fragmentary sectional view of the modification in Fig. 6 as taken along the line 7—7 in Fig. 6;

Figs. 8 and 9 are sectional views as taken along the line 8—8 and 9—9, respectively, in Fig. 6, to illustrate certain details of construction;

Fig. 10 is a modified arrangement for the suspension of the air cylinders in floating relation to the rotatable lathe members;

Fig. 11 illustrates a face view of still another embodiment of air cylinder of a double acting construction;

Fig. 12 is a sectional view of the Fig. 11 cylinder as taken substantially along the line 11—11 in Fig. 12; and

Figs. 13 and 14 are sectional details to illustrate certain additional substitutional constructions that may be utilized in carrying out the principles of this invention to accomplish the result desired.

Referring now to Figs. 1, 2 and 3 showing the preferred construction of air cylinder 15, such cylinder is preferably supported or suspended substantially in coaxial relationship to the spindle 16 of a lathe 17 and the draw tube 18 of a collet chuck 20. Spindle 16 is supported for rotation in bearings 21 and 22 in the lathe head 23 and held against axial movement by the flange 24 and appropriate means such as a collar 25 secured thereto. Collet 20 is of a conventional design having work holding jaws 26 coacting with the conical internal surface 27 of the collet ring 28. The stock or work 30 is fed by appropriate equipment from the left in Fig. 1, between the collet jaws 26 up against a work stop such as 31. The collet jaws 26 are moved axially by means of a collet tube 32 having an annular flange 33 connected with the jaws 26 of the collet 20 as shown in Fig. 1. Tube 32 is slidably supported at the end 34 within the spindle 16 at 35.

Referring to Fig. 3, the end of the spindle 16 is threaded to receive a threaded bearing collar 36 which may be in the form of a nut which is internally bored at 37 to slidably receive and

support the end 38 of the draw tube 18 of the collet 20. Collar 36 supports a thrust bearing 40 upon the reduced end 41 and a cupped abutment housing 42 is mounted on the bearing 40 and coacts with collar 36 to protect and house bearing 40. The structure including collar 36, bearing 41 and housing 42 all constitute the anti-friction means, indicated by 43, which is directly mounted upon the end of the rotatable spindle 16.

Similar anti-friction means 44 is connected with the terminal end 38 of the draw tube 18 and disposed in spaced relation to the anti-friction means 43. Means 44 comprises a flanged supporting ring 45 and a cupped collar 46 confining and supporting the thrust ball bearing 47 therebetween, said ring and collar being held together by the locking ring 48 through screws 49 as clearly illustrated in Fig. 3. A nut 39 is threaded upon the end of the draw tube 18 to hold the bearing 44 in place upon said tube.

The expansible assembly comprising the air cylinder 15, see Figs. 1 and 3, is interposed between the two anti-friction means or units 43 and 44 and is supported in floating relation to the spindle 16 and draw tube 18 in pendulum fashion to permit axial movement of the air cylinder parts or transverse movement thereof as the case may be. The air cylinder 15 can be supported in any number of ways, but, as shown in Fig. 1, a bracket 50 in the form of a plate is suitably bolted to the lathe head 23 and has projections 51 and 52 extending outwardly to adjustably receive the brackets 53 and 54, see Figs. 1 and 2. Brackets 53 and 54 carry stub rods 55 and 56, respectively, to pivotally support pairs of links 57—57 and 58—58, respectively. Links 57—57 are pivotally connected with stub pins 60 and 61 secured to opposite parts of the air cylinder 15, while links 58—58 connect with similar pins one of which shows at 62 in Fig. 2.

The entire suspension of the air cylinder 15 as just described permits self-alignment of the cylinder unit within the space between the two anti-friction bearings 43 and 44 axially of the spindle-draw tube assembly through the looseness of the links with their connected parts, and transverse movement is also possible because of the pivotal connections of the link ends in the manner shown in Figs. 1, 2 and 3.

The air cylinder 15 comprises chiefly two annular plates or discs 64 and 65 having an annular diaphragm 66 therebetween and arranged to move the plates apart under fluid pressure. Diaphragm 66 is secured to plate 64 at its outer periphery by means of a ring 67 through screws 68, while the central open portion of the diaphragm is similarly secured to plate 64 by means of ring 70 and the screws 71, see Figs. 2 and 3. Plate 64 may be considered as the diaphragm plate and has an annular recess 72 in the face thereof to form an air receiving cavity that may be supplied with fluid under pressure through a suitable pipe line 73. Plate 64 has an axial opening 74 aligned with the diaphragm opening and the inner peripheral edge of ring 70 of such a size as to provide adequate clearance between the air cylinder unit 15 and the external circumference of draw tube 18 to avoid all frictional contact therebetween.

Plate 65 of the air cylinder 15 acts in the capacity of a follower having an annular protuberance 75 on the face thereof adjacent the diaphragm 66 and also has a relatively large central opening 76 therein to clear ring 70 and also draw tube 18. The protuberance 75 on plate 65 and the recess 72 in plate 64 together coact with the

diaphragm 66 to permit greater axial separation between the plates under the action of fluid pressure from pipe 73. A plurality of spring units 77, as in Figs. 2 and 3, provide a means for moving plates or discs 64 and 65 together and to thereby collapse the diaphragm into the position shown in Fig. 3. Each spring unit is made to replace one of the screws 68 and comprises an internally threaded pin 78 which tightens upon the end of a screw 80 and against ring 67, pin 78 fitting through an opening 81 in plate 65 while a spring 82 is confined between the secured washer 83 on the pin 78 and the plate 65. Thus springs 82 act to normally hold the plates 64 and 65 as shown in Fig. 3 or urge them into this position when separated by the diaphragm.

When the air cylinder parts are in the position shown in Figs. 1 and 3, the draw tube 18 is given the necessary freedom and play to release the collet jaws 26 and to permit freedom of passage of the stock 30 axially between the jaws 26. However, when air is introduced through pipe 73 into recess 72, the diaphragm will tend to invert itself to move plates 64 and 65 apart. Under these conditions, plate 64 reacts against the anti-friction unit 43 and obviously against spindle 16 while plate 65 reacts against the anti-friction means 44 carried upon the collet draw tube 18. Since the spindle 16 and its associated bearing 43 do not move axially, the bearing 44 and draw tube 18 are urged outwardly away from the cylinder end of the spindle to cause the collet jaws 26 to move radially inwardly to grasp and hold the stock 30 which may then be worked upon in the customary manner to produce fabricated articles therefrom.

Referring now to Figs. 4 and 5, the principles of the invention have been embodied in a modified arrangement of air cylinder unit 85 to obtain greater collet gripping power with the same line fluid pressures. Here the device incorporates a multiple construction having a plurality of units similar to the Fig. 3 air cylinder and indicated in Fig. 5 by 86, 87 and 88, respectively. Each unit has a diaphragm plate 90, diaphragm 91 and follower plates 92, and fluid under pressure is introduced through a pipe line 93, and branches 94 into each of the units 86, 87 and 88 in the manner shown in Fig. 5.

In this construction the plates 90 are all secured together and in axially aligned relationship by the bolts 95 and spacer bushings 96, and plate 90 of unit 86 abuts the face of bearing 43 of the spindle 16. Each of the plates 92 is connected with spacing sleeves 97 slidably supported in the central openings 98 in the diaphragm plates 90. Therefore, with the bolts 95 and spacers 96 holding the plates 90 and with the latter slidably carrying the sleeves 97 and the follower plates 92, the sleeve openings indicated at 100 are maintained in aligned relationship for the purpose of providing sufficient clearance between the fluid power means or air cylinder 85 and the draw tube 18.

By introducing fluid through pipe 93, the total surface pressure of the diaphragm 91 will act collectively through the follower plates 92 and their bushings 97 to move the bearing 44 and its connected draw tube 18 to the left in Fig. 5. This multiple unit is provided with brackets 102 secured by longer bolts 101, similar to bolts 95, so as to confine springs 103 between the brackets and the plate 92 of unit 88 for the purpose of returning the cylinder parts to normal position when rendered inactive. The reaction of springs 103 upon the face of plate 92 in unit 88 is transmitted to the other follower plates 92 through the sleeves 97 as is clearly apparent from Fig. 5. This multiple power unit 85 is also suspended from the lathe or other support adjacent thereto by links 104—104 and 105—105 as best illustrated in Figs. 4 and 5.

With the above described construction greater force is transmitted to the draw tube although the total possible movement of the tube is substantially the same as the air cylinder in Figs. 1, 2 and 3.

Referring now to Figs. 6, 7, 8 and 9, another modified construction is disclosed also embodying the same general principles of the air cylinder in the first form but so arranged as to be in multiple succession as in the Fig. 5 construction with the exception that the units are made to act in series to obtain greater movement of the draw tube 18 relative to the spindle 16.

In this construction as best illustrated in Fig. 7, 110 represents one plate which carries a diaphragm 111 and has a sleeve 112 secured centrally thereto encircling the draw tube 18. Plate 110 abuts bearing 43 on spindle 16. Another plate 113 acts as the follower in this case abutting bearing 44 and having sleeve 114 secured to the central opening therein to slidably telescope into sleeve 112 to keep the cylinder parts in alignment when being actuated relatively to each other during operation. Intermediate plates 115 and 116 are sandwiched between plates 110 and 113 and each of the former act as both diaphragm and follower plates carrying the diaphragms 117 and 118 respectively. The intermediate plates 115 and 116 ride on sleeve 112 whereby all the plates are kept in axial alignment and the telescoping sleeves are of such internal diameters as to clear draw tube 18 as shown in Fig. 7.

Individual flexible fluid tubes 120, 121 and 122 supply air or other fluid into the annular cylinder chambers 123, 124, and 125 of plates 110, 115 and 116, respectively, and preferably from the same power source to equalize the separation between adjacent plates. The Fig. 7 unit may be suspended in any suitable manner, but one preferred way is illustrated in Figs. 6 and 7. Plate 110 remains in its position during operation so pins 126 are connected therewith and an adjustable hook link 127 can be hooked over rods or shafts 128 carried in brackets 130 secured to the lathe head 23 and the links are provided with an eye 131 to slip over a pin 126.

Plate 113 is provided with pins 132 each to be engaged by a hanger 133 carrying an overhead wheel 134 to ride upon rods 128 with the movement of the leading plate 113, see Figs. 6 and 7. The multiple series operated air unit is therefore suspended in floating relation to the draw tube 18 and the parts of such unit are free to separate and come together during the operation of the device.

In the latter construction of air cylinder the parts are urged into inoperative nested relation by means of a plurality of spring assemblies such as indicated by 135 in Figs. 6 and 8. Brackets 136 and 137 are secured to plates 110 and 113, respectively, with threaded studs 138 secured to brackets 137 for slidably projecting through sleeves 140 carried by brackets 136. Springs 141 are interposed between brackets 136 encircling sleeves 140 and the spring holder 142 adjustably carried upon pins 138 by the fastening nuts 143. With this arrangement the pressure upon the nested plates can be varied to suit conditions.

In Fig. 10 a modified construction of carrier is

disclosed for supporting an air cylinder in spaced relation axially with respect to the draw tube. Here brackets such as 145 are connected to the front and back plates to adjustably carry wheels 146 for horizontal adjustment. Also, rods or shafts 147 are adjustably carried by brackets 148 fastened to the lathe head 23 for vertically positioning rods 147. With these vertically and horizontally adjustable means and the wheel and rod combination, movement is permitted by the air cylinder plates and the form of suspension allows prepositioning of the cylinder with respect to the draw tube 18.

Figs. 11 and 12 portray the use of an air cylinder having means for actuating the collet draw tube in either direction axially of the machine. The construction is for the purpose of positively moving the tube into collet jaw releasing position for freeing the stock and for quick action as a means for eliminating the spring return feature connected with the previously described air cylinders. Very quick release of the work or stock is desirable when higher speed production is sought and also under certain other conditions of operation.

In this arrangement the outer end of the draw tube 18 is journalled in a bushing 150 in spindle 16 and projects outwardly therefrom. A shoulder 151 is provided on the tube to back up bearing 152 while nut 39 is used to position bearing 153 in spaced relation to bearing 152 as shown in Fig. 12. In this construction the bearings 152 and 153 are analogous to bearings 43 and 44 of the other forms with the exception that they are here shown as interchangeable for reasons well apparent to those skilled in the art.

The fluid operated air cylinder in this construction embodies a pair of diaphragm plates 154 and 155 having diaphragms 156 and 157 secured thereto respectively. Shouldered bolts 158 are used to secure plates 154 and 155 together and in alignment and one or more brackets 160 connected with the lathe are fastened to plate 154 to provide the supporting means therefor and to position the air unit with respect to draw tube 18 and the bearings 152 and 153. Disposed between diaphragms 156 and 157 is an annular follower plate 161 having a central sleeve 162 as a part thereof which surrounds the draw tube 18 and also is slidably supported in the openings 163 and 164 in plates 154 and 155 respectively. The opposite ends of sleeve 162 are adapted to abut bearings 152 and 153 to actuate the draw tube when the diaphragms impart motion to plate 161. The bulbous cross-sectional contour of plate 161 is for obtaining greater movement under the nested diaphragm arrangement with the recessed plates 154 and 155 in the same manner as previously described in the Fig. 3 form.

The fluid under pressure is here supplied from its source through pipe 165 to a valve 166 and the latter diverts air through one or the other of the pipe lines 167 or 168 to either chamber 170 or 171. This will cause actuation of the collet tube in either direction to make the collet hold the work or release the same as the case may be.

In the hereinbefore described structures the diaphragm construction and the manner of securing the same has been substantially uniform and has proven satisfactory. Figs. 13 and 14 have been added to suggest modified diaphragms. In Fig. 13 the diaphragm 172 is made up as a bellows having annular flexible rings 173 and 174 suitably joined at 175 and fastened at 176 and 177 to the plates 178 and 180. A second set of annular flexible rings 181 and 182 are joined at 183, and are also secured at 184 and 185 to plates 178 and 180. Thus an annular air cylinder is provided having the enclosed chamber 186 between plates 178 and 180.

In the Fig. 13 construction a pair of telescoping sleeves 187 and 188 are carried by plates 178 and 180 to keep the same aligned during operation. The entire unit may be bodily suspended in any manner as taught by the other embodiments described and disclosed, and the unit is interposed between interchangeable bearings 152 and 153 for power transmission to draw tube 18.

Fig. 14 illustrates the use of annular metal bellows 190 and 191 suitably secured to the outer and inner peripheral edges of plates 192 and 193 as illustrated, establishing the annular air chamber 194. Telescoping sleeves 195 and 196 are secured to plates 192 and 193, respectively, and the entire unit is suspended between bearings 152 and 153. The balance of the structures in Figs. 13 and 14 are otherwise comparable to the details hereinbefore disclosed in Figs. 1, 2 and 3.

Although the various embodiments have all been devised to be adapted more particularly to continuous axial stock feed through a draw tube and collet, the same could readily be used in other collet and chuck arrangements for grasping individual work or stock pieces from the tooling zone of the lathe.

The description has been confined generally to the disclosures in the drawings which illustrate certain preferred applications of the principles of this invention. However, certain changes and variations are anticipated so that the designs submitted are not to be limited to the exact form, construction or combination of parts shown excepting in so far as shall be determined by the breadth and scope of the appended claims.

What I claim is:

1. A fluid operated actuator for imparting relative endwise movement to a pair of coacting rotatable members comprising a first thrust bearing connected with one of said members, a second thrust bearing connected with the other of said members, and an expansible unit disposed between said bearings and surrounding at least one of said members in circumferential spaced relation thereto, whereby said bearings cooperate with said unit to cause said one member to move relatively with respect to said other member when said unit is expanded, said expansible unit comprising a plurality of diaphragm supporting plates, connecting means to hold said plates together, a plurality of movable plates having connecting means to impart movement of each movable plate to each adjacent movable plate, and resilient means to normally maintain said movable plates and diaphragm plates in nested inoperative relation.

2. A fluid operated actuator for imparting relative endwise movement to a pair of coacting rotatable members comprising a first thrust bearing connected with one of said members, a second thrust bearing connected with the other of said members, and an expansible unit disposed between said bearings and surrounding at least one of said members in circumferential spaced relation thereto, whereby said bearings cooperate with said unit to cause said one member to move relatively with respect to said other member when said unit is expanded, said expansible unit comprising a first set of connected plates, a second set of connected plates adapted for movement rel-

ative to said first set of plates, diaphragm members interposed between said two sets of plates to move the same apart, and supporting means connected with one of said sets of plates to hold said expansible unit in self-aligning floating relation between said thrust bearings.

3. A fluid operated actuator for axially shifting a pair of coacting rotatable members relatively to each other comprising a first thrust bearing connected with one of said members, a second thrust bearing connected with the other of said members, and an expansible unit disposed between said bearings and surrounding at least one of said members in circumferential spaced relation thereto, whereby said bearings cooperate with said unit to cause said one member to move relatively with respect to said other member when said unit is expanded, said expansible unit comprising a plurality of relatively movable plate members, diaphragm elements interposed between said plate members to each move the plate members adjacent thereto apart, and guide means connected between the plate members to maintain the same in aligned positions during the movement of said members relative to each other.

4. A fluid operated actuator for axially shifting a pair of coacting rotatable members relatively to each other comprising a first thrust bearing connected with one of said members, a second thrust bearing connected with the other

of said members, and an expansible unit disposed between said bearings and surrounding at least one of said members in circumferential spaced relation thereto, whereby said bearings cooperate with said unit to cause said one member to move relatively with respect to said other member when said unit is expanded, said expansible unit comprising a plurality of relatively movable plates, diaphragms connected between the plates to each react against the plates adjacent thereto, guide means connected between the plates to hold the same aligned during their relative movement with respect to each other, and supporting means connected with certain of said plates to hold the expansible unit in self-aligning floating relation between said thrust bearings.

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