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Parsons et al.

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[54] **APPARATUS FOR ACTUATING A WORK GRIPPING DEVICE**

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[52] **U.S. Cl.** **91/420**; 91/422; 92/106; 279/4

[51] **Int. Cl.**[2] **F15B 11/08**; F15B 13/042

[58] **Field of Search** 91/420, 422, 222; 92/106, 92/111; 279/4

[56] **References Cited**

UNITED STATES PATENTS

3,017,006	1/1962	Dence et al.	92/106 X
3,364,823	1/1968	Benjamin et al.	91/420
3,369,464	2/1968	Blattry	91/420
3,411,415	11/1968	Benjamin et al.	92/420
3,641,875	2/1972	Kodalle	91/420 X
3,748,968	7/1973	Pinto	91/420

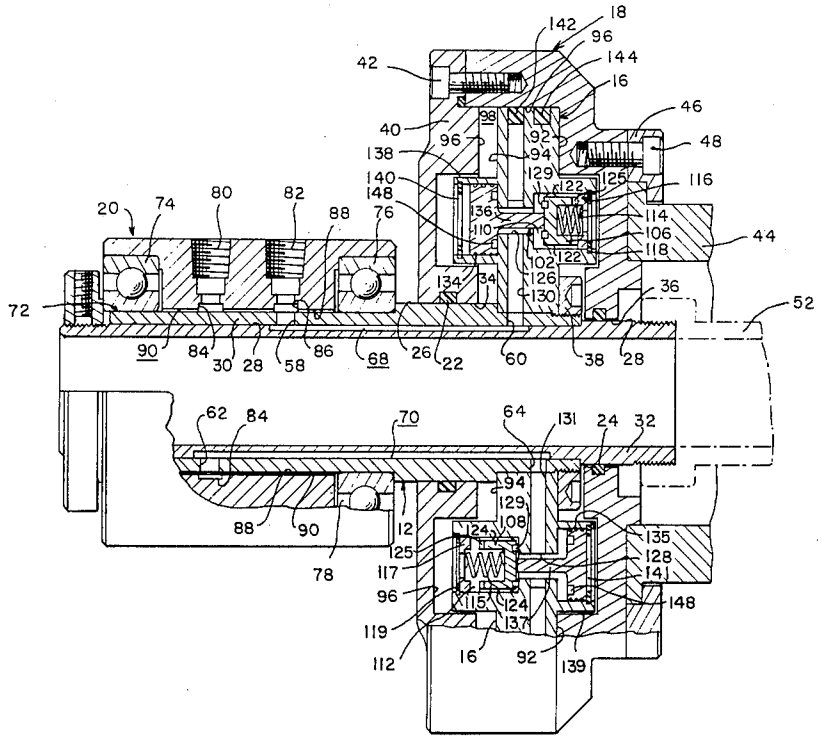
Primary Examiner—Irwin C. Cohen

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[57] **ABSTRACT**

An apparatus for actuating a collet or other chucking devices which includes a rotatable cylinder and double acting piston assembly positioned around a tubular draw member for causing a collet or the like to reciprocate in a lathe spindle. The piston, which is rigidly secured to the drawing member, is provided with a pair of spring-biased, piston operated valves for admitting fluid under pressure to the expansible chambers defined by the piston and the cylinder walls as well as venting the same for the purpose of causing the piston to reciprocate in the cylinder. The valves also include check means for trapping fluid under pressure in either of the chambers should the pressure of the fluid source be reduced. The drawing member generally comprises two concentric tubes, the inner one having a pair of slots in its external surface which cooperate with the internal surface of the outer tube to form a pair of passageways for providing fluid under pressure to the aforementioned expansible chambers.

9 Claims, 7 Drawing Figures



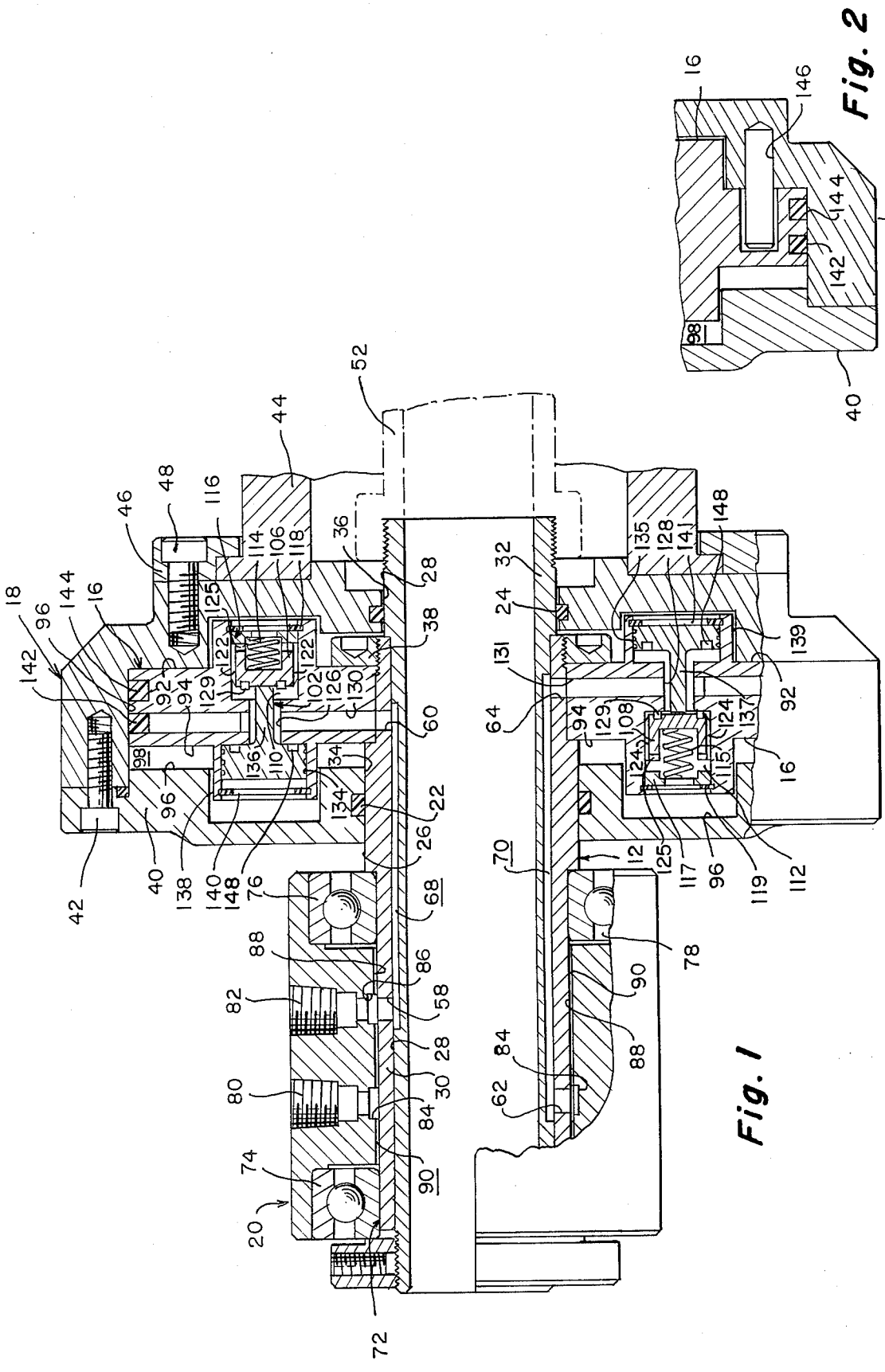

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Fig. 2

Fig. 1

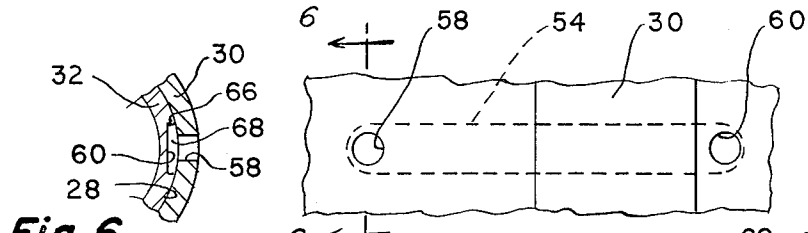


Fig. 4

Fig. 6

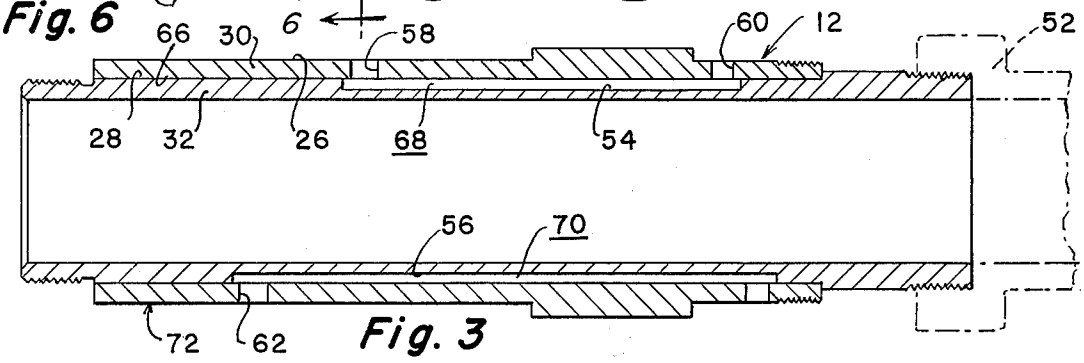


Fig. 3

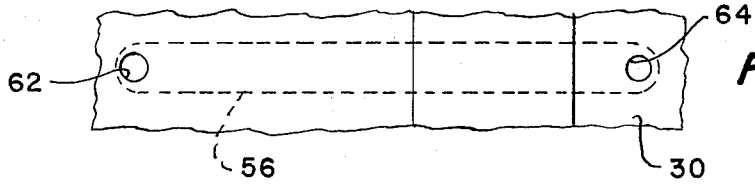
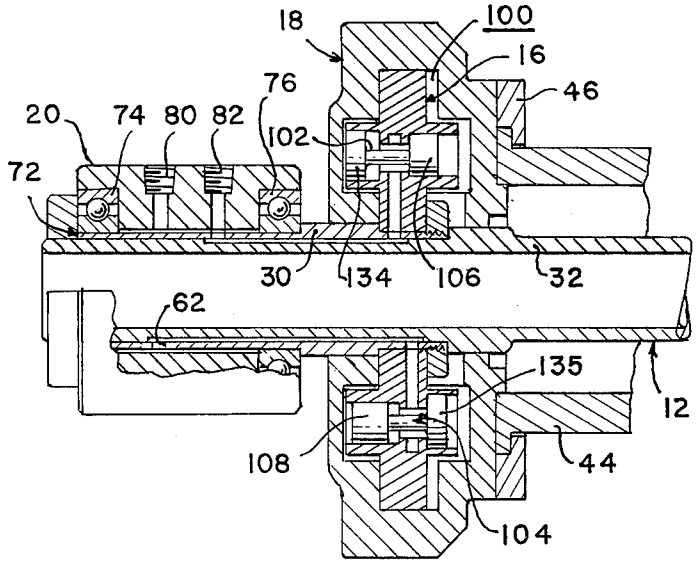


Fig. 5



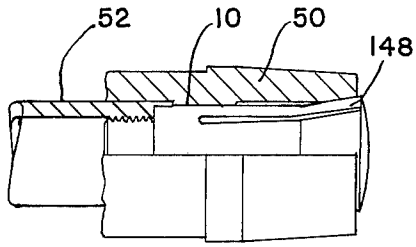


Fig. 7

APPARATUS FOR ACTUATING A WORK GRIPPING DEVICE

BACKGROUND OF THE INVENTION

This invention relates generally to apparatus for opening and closing collets or other chucking devices.

A serious problem with rotating machinery such as lathes having a collet or chuck closed by fluid pressure means occurs when there is an inadvertent drop in the pressure of the working fluid. If there is a reduction in the force which holds the jaws closed, the tool or workpiece may fly off the rotating spindle thereby causing serious injury to the operator.

Benjamin et al, U.S. Pat. No. 3,364,823, Jan. 23, 1968, discloses one solution for the problem by means of an arrangement wherein fluid is trapped in one of the expansible chambers formed by the piston and cylinder walls through the action of a check valve and spool valve combination mounted in the cylinder housing. One drawback to this arrangement is that the placement of the valve means in the cylinder substantially increases the radial dimension and, thus, the rotational inertia of the unit for a piston of given size.

Often in fluid operated work gripping devices of this type, common means for conveying the fluid from the bearing to the expansible chambers are passageways bored in the wall of the draw tube as disclosed in Blattry U.S. Pat. No. 3,369,464. One disadvantage to this design, however, is that the wall thickness of the drawing member must be sufficiently thick to accommodate the passageways. Any increase in the wall thickness and diameter of the drawing tube, necessitates either the use of larger mechanical bearings, or a reduction in the inner diameter of the tube with a resulting limitation on the size of workpiece which can be accommodated thereby.

OBJECTS OF THE INVENTION

It is, therefore, an object of this invention to provide an apparatus for acutating a work gripping device which is capable of maintaining a collet or the like in work gripping position even though the pressure of the working fluid should be reduced.

Another object of this invention is to provide an apparatus for actuating a work gripping device including a fluid operated drawing member having an operating piston with maximum pressure surface area received in a cylinder having minimum radial dimensions.

A further object of this invention is to provide an apparatus for actuating a work gripping device having relatively small rotational inertia.

A further object of this invention is to provide an apparatus for actuating a work gripping device wherein rotational imbalance is minimized.

A still further object of this invention is to provide an apparatus for actuating a work gripping device including a tubular drawing member having a relatively small outer diameter for a given inner diameter.

Still another object of this invention is to provide an apparatus for actuating a work gripping device including a drawing member which may be readily and efficiently manufactured.

SUMMARY OF THE INVENTION

The invention relates to a device for actuating a work gripping collet including a housing adapted to be mounted on a machine tool spindle, a cylinder within the housing, a collet drawing member mounted in the housing for axial movement relative thereto, and a double acting piston slidably received in the cylinder. The piston includes first and second valve assemblies for admitting pressurized fluid to the expansible chambers formed by the piston faces and the inner walls of the cylinder. The valve assemblies also include means for venting one of the chambers when pressurized fluid is introduced into the other as well as check means for trapping fluid in the pressurized chamber should the pressure of the fluid source be reduced. The device further includes a ball bearing joint as well as passageways in the drawing member to convey the pressurized fluid from the bearing joint to the expansible chambers. The drawing member comprises two concentric tubes, the aforementioned passageways being formed by a pair of slots milled in the external surface of the inner tube.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a collet actuating device embodying the present invention with a portion thereof shown in elevation;

FIG. 2 is a fragmentary enlarged sectional view of the collet actuating device illustrated in FIG. 1;

FIG. 3 is a longitudinal sectional view of the drawing member forming a part of the present invention;

FIG. 4 is a fragmentary top plan view of the drawing member illustrated in FIG. 3;

FIG. 5 is a fragmentary bottom plan view of the drawing member illustrated in FIG. 3;

FIG. 6 is a sectional view taken along line 6—6 of FIG. 4, and viewed in the direction of the arrows;

FIG. 7 is a sectional view similar to the view of FIG. 1 illustrating the present invention in relation to a lathe spindle and work gripping collet, the latter being in its closed position.

DETAILED DESCRIPTION OF THE INVENTION SHOWN IN FIGS. 1 THROUGH 7

The device for opening and closing the through hole collet **10** comprises generally a tubular drawing member **12**, a rotatable cylinder **18** positioned around drawing member **12**, a double acting annular piston **16** slidably received in the cylinder **18**, and a ball bearing joint **20**.

The drawing member **12** is mounted in cylinder **18** for axial movement relative thereto with seals or gaskets **22** and **24** sealing the interior of cylinder **18** as the external surfaces **26** and **28** of concentric tubular members **30** and **32**, respectively, slide relative to the annular surfaces **34** and **36** of cylinder **18**. The double acting piston **16** is frictionally secured to the drawing member **12** by means of a spanner nut **38** which is threaded on tubular member **30**. Head **40** is secured to cylinder **18** by means of bolts such as **42** while the cylinder **18** is mounted on the lathe spindle sleeve **44** by means of adjusting ring **46** and bolts such as **48**. By these means, the spindle **50**, sleeve **44**, cylinder **18**, piston **16** and drawing member **12** may rotate as a unit about the longitudinal axis of drawing member **12**.

Referring particularly to FIGS. **3** through **6**, the drawing member **12** comprises an inner tubular member **32** threadedly secured to draw tube **52**, and an outer tubular member **30** which is frictionally or otherwise secured to member **32**. The preferred method of accomplishing this is to shrink member **30** over member **32**. A pair of grooves or slots **54** and **56** are milled

in the external surface of inner tubular member **32** and are preferably circumferentially displaced by 180°. Apertures **58** and **60** in member **30** are positioned above slot **54** and apertures **62** and **64** are positioned above slot **56.** Since the internal surface **66** of member **30** tightly engages the external surface **28** of member **32** and is flush therewith, a pair of fluid-tight passageways or conduits **68** and **70** are formed in drawing member **12** and are in open communication with the ports formed by apertures **58, 60, 62,** and **64,** respectively. Because the passageways **68** and **70** are formed by milling the external surface of an inner tube **32** rather than by drilling a longitudinal passage in the wall of the drawing member **12,** the fluid conduits **68** and **70** so formed may have a relatively large cross-sectional area without requiring an increase in the overall wall thickness of the drawing member **12.**

The rear portion **72** of drawing member **12** supports ball bearing joint **20** containing bearings **74** and **76.** A fluid, such as air, is introduced under pressure through stationary hoses at inlets **80** or **82** to the longitudinally displaced annular passageways **84** or **86** formed in the internal surface **88** of member **20.** A portion of external surface **26** of member **30** conforms generally to the internal surface **88** of member **20** but the outer diameter of the former is slightly less than the inner diameter of the latter thereby forming a small annular gap **90** which may be of the order of 0.0005 inches wide. When a fluid under pressure is introduced into gap **90** through inlets **80** or **82** and their respective passageways **84** or **86,** a very small and harmless leakage can take place through it.

Piston **16** is provided with opposite faces **92** and **94** which cooperate with the internal walls **96** of cylinder **18** to form two expansible chambers **98** (FIG. 1) and **100** (FIG. 7). Valve assemblies **102** and **104** are mounted in piston **16** for reciprocating movement in a direction parallel to the axis of rotation of the cylinder, piston and drawing member assembly. Valves **102** and **104** include check valves **106** and **108** positioned in chambers **110** and **112.** The check valves **106, 108** are biased to their closed position by springs **114** and **115** supported by annular retainers **116** and **117** positioned by lock rings **118** and **119.** O-rings **129** provide a seal when the valves **106** and **108** are seated. The check valves **106** and **108** are each provided with radial ribs **122** and **124,** respectively, and connecting slots **125** in the faces between which fluid may flow when the valves are unseated. The ribs **122, 124** also serve to support the check valves **106, 108.** Fluid may be introduced into chamber **98** from passageway **70** through aperture **64** into the passageway **131** formed in piston **16,** through the annular passageway **128** and then around check valve **108** in the channels or openings formed between the radially extending ribs **124** and slots **125** in the faces. Fluid under pressure may be introduced to expansible chamber **100** from passageway **68** through aperture **60** into piston passageway **130,** through annular passageway **126** and then around check valve **106** through the channels or spaces formed by ribs **122** and slots **125** in the faces.

Valve actuating pistons **134, 135** having stems **136** and **137** are received in annular cylinders **138** and **139** respectively and retained by lock rings **140,** and **141.** O-rings **148** provide a seal when pistons **134** and **135** are seated. The expansible chambers **98** and **100** are sealed from each other by means of compression seals **142** and **144** as well as pistons **134** and **135,** the latter being snugly received in cylinders **138** and **139.** The piston **16** is held against rotation relative to cylinder **18** by means of a pin **146** (see FIG. 2).

OPERATION

To close collet **10** by drawing it rearwardly in spindle **50** thereby closing its work gripping jaws **148,** a fluid under pressure is introduced at inlet **82,** through passageways **86, 58, 68, 60, 130** and **126,** and around check valve **106** to expansible chamber **100.** The increased pressure in chamber **100** will force piston **135** to the left thereby unseating check valve **108** and venting chamber **98** through passageways **128, 131, 64, 70, 62, 84,** and **80.** At the same time, piston **16** will be forced to the left carrying drawing member **12** with it thereby drawing collet **10** within spindle **50.** This action will cause the work gripping jaws **148** to close. Since valve **106** is a check valve, should there be an inadvertent loss in fluid pressure at passageway **126,** no fluid can escape from chamber **100** due to the fact that spring **114** will have caused check valve **106** to seat when pressure equilibrium was established. When piston **16** has been moved to its leftmost position, it cannot return unless fluid under pressure is introduced into chamber **98** in a manner which will now be described.

Should it be desired to open collet **10** by moving the drawing member **12** to the right, fluid under pressure is introduced at inlet **80** and inlet **82** is vented. The fluid under pressure flows through passageways **84, 62, 70, 64, 131,** and **128,** around check valve **108** and into expansible chamber **98.** The increased pressure in chamber **98** forces piston **134** to the right causing stem **136** to unseat valve **106** thereby venting chamber **100** through passageways **126, 130, 60, 68, 58,** and **86.** At the same time, piston **16** is forced to the right and check valve **108** will close when pressure equilibrium has been reached, thereby trapping the pressurized fluid in chamber **98** until such time as fluid under pressure is introduced to inlet **82.**

The same fluid which operates the collet closing mechanism just described is admitted to the annular gap **90** between the non-rotating support member **20** and the rotating drawing member **12** through which a very small and harmless leakage takes place. Under conditions where collet **10** is closed, the fluid under pressure is admitted through inlet **82** and vented through inlet **80** by any appropriate means such as a four-way valve.

The unitary assembly of spindle **50,** collet **10,** drawing member **12,** piston **16** and cylinder **18** may be rotated by any appropriate means well known in the art.

While this invention has been described as having a preferred design, it will be understood that it is capable of further modification. This application is, therefore, intended to cover any variations, uses and/or adaptations of the invention following the general principles of this invention and including such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and as may be applied to the essential features hereinbefore set forth and fall within the scope of this invention or the limits of the appended claims.

What is claimed is:

1. A device for actuating a work gripping collet comprising:

a. a cylinder adapted to be mounted to a machine tool spindle,

b. a tubular through hole collet drawing member being mounted within said cylinder for axial movement relative thereto,
c. annular piston means slideably received in said cylinder and including means for axially moving said member relative to said cylinder,
d. said drawing member passing through said piston means,
e. said piston means having a first pressure face cooperating with one end of said cylinder to form a first expansible chamber and having a second pressure face cooperating with the other end of said cylinder to form a second expansible chamber,
f. said piston means including first valve means for admitting fluid under pressure to said first chamber, said first valve means being entirely supported by said piston means and movable therewith,
g. said first valve means extending through said piston and forming a portion of said first and second pressure faces,
h. said piston means including second valve means for admitting fluid under pressure to said second chamber, said second valve means being entirely supported by said piston means and movable therewith,
i. said second valve means extending through said piston and forming a portion of said first and second pressure faces,
j. said first valve means including means for venting said first chamber when fluid under pressure is admitted to said second chamber and said second valve means including means for venting said second chamber when fluid under pressure is admitted to said first chamber,
k. means for alternatively connecting a source of fluid under pressure to said first and second chambers through said first and second valve means, respectively,
l. said first valve means including means for trapping fluid in said first chamber when the pressure of the source of fluid under pressure is reduced while said first chamber is connected to the source of fluid under pressure,
m. said piston means, cylinder and drawing member being mounted for unitary rotation,
n. said first and second valve means being mounted in said piston means radially outward of the axis of rotation of said piston means, cylinder and drawing member for movement relative thereto in a direction parallel to said axis of rotation, and
o. each of said first and second valve means including a pressure responsive valve piston having a face thereof forming said pressure face portion.

2. A device for actuating a work gripping collet as in claim **1** and wherein said means for connecting a source of fluid under pressure to said first and second chambers includes first and second longitudinal passageways in said drawing member.

3. a device for actuating a work gripping collet as in claim **1** and wherein:
a. each said valve means includes a first and springbiased, valve piston operated valve.

4. A device for actuating a work gripping collet as in claim **1** and wherein:
a. said means for trapping fluid includes a check valve.

5. A device for actuating a work gripping collet comprising:
a. a cylinder adapted to be mounted to a machine tool spindle,
b. a tubular through hole collet drawing member being mounted within said cylinder for axial movement relative thereto,
c. said drawing member comprising:
a first tubular member having an external surface and including means at one end for securing a work gripping collet thereto,
first and second slots in the external surface of said first tubular member,
a second tubular member having internal and external surfaces and being concentrically positioned around and rigidly secured to said first member,
the internal surface of said second member being flush with the external surface of said first member thereby forming a pair of fluid-tight passageways,
first and second longitudinally displaced apertures in said second member positioned above one of said slots,
third and fourth longitudinally displaced apertures in said second member positioned above the other said slots,
d. annular piston means slideably received in said cylinder and including means for axially moving said member relative to said cylinder.
e. said drawing member passing through said piston means,
f. said piston means having a first pressure face cooperating with one end of said cylinder to form a first expansible chamber and having a second pressure face cooperating with the other end of said cylinder to form a second expansible chamber,
g. said piston means including first valve means for admitting fluid under pressure to said first chamber and second valve means for admitting fluid under pressure to said second chamber,
h. said first and second valve means being entirely supported by said piston means and movable therewith to form a portion of said first and second pressure faces,
i. said first valve means including means for venting said first chamber when fluid under pressure is admitted to said second chamber and said second valve means including means for venting said second chamber when fluid under pressure is admitted to said first chamber, and
j. means for alternatively connecting a source of fluid under pressure to said first and second chambers through said first and second valve means, respectively,
k. said first valve means including means for trapping fluid in said first chamber when the pressure of the source of fluid under pressure is reduced while said first chamber is connected to the source of fluid under pressure,
l. said piston means, cylinder and drawing member being mounted for unitary rotation,
m. said first and second valve means being mounted in said piston means radially outward of the axis of rotation of said piston means, cylinder and drawing member for movement relative thereto in a direction parallel to said axis of rotation.

6. A device for actuating a work gripping collet as in claim **5** and wherein:

a. said piston is provided with first passageway means for connecting one of said fluid-tight passageways to one of said chambers, and

b. said piston is provided with second passageway means for connecting the other of said fluid-tight passageways to the other of said chambers.

7. A device for actuating a work gripping collet as in claim **6** and wherein:

a. said second and fourth apertures are in communication with said passageway means.

8. A device for actuating a work gripping collet as in claim **7** and wherein:

a. said first and third apertures are longitudinally displaced from each other along said second tubular members.

9. A device for actuating a work gripping collet as in claim **5** and including:

a. a sleeve being positioned around said second tubular member and having an internal surface conforming generally to the external surface of said second tubular member but being slightly radially spaced therefrom thereby forming an annular space between the external surface of said second tubular member and the internal surface of said sleeve,

b. means for permitting said tubular members to rotate within said sleeve,

c. said first and second longitudinally displaced grooves in the internal surface of said sleeve being positioned above said first and third apertures at all positions of rotation of said tubular members, and

d. means for connecting each of said grooves to a source of fluid under pressure.

* * * * *