Aug. 20, 1968 D. M. SKELTON ET AL 3,397,620

FLUID ACTUATOR WITH ANNULAR PISTON LOCKING MEANS

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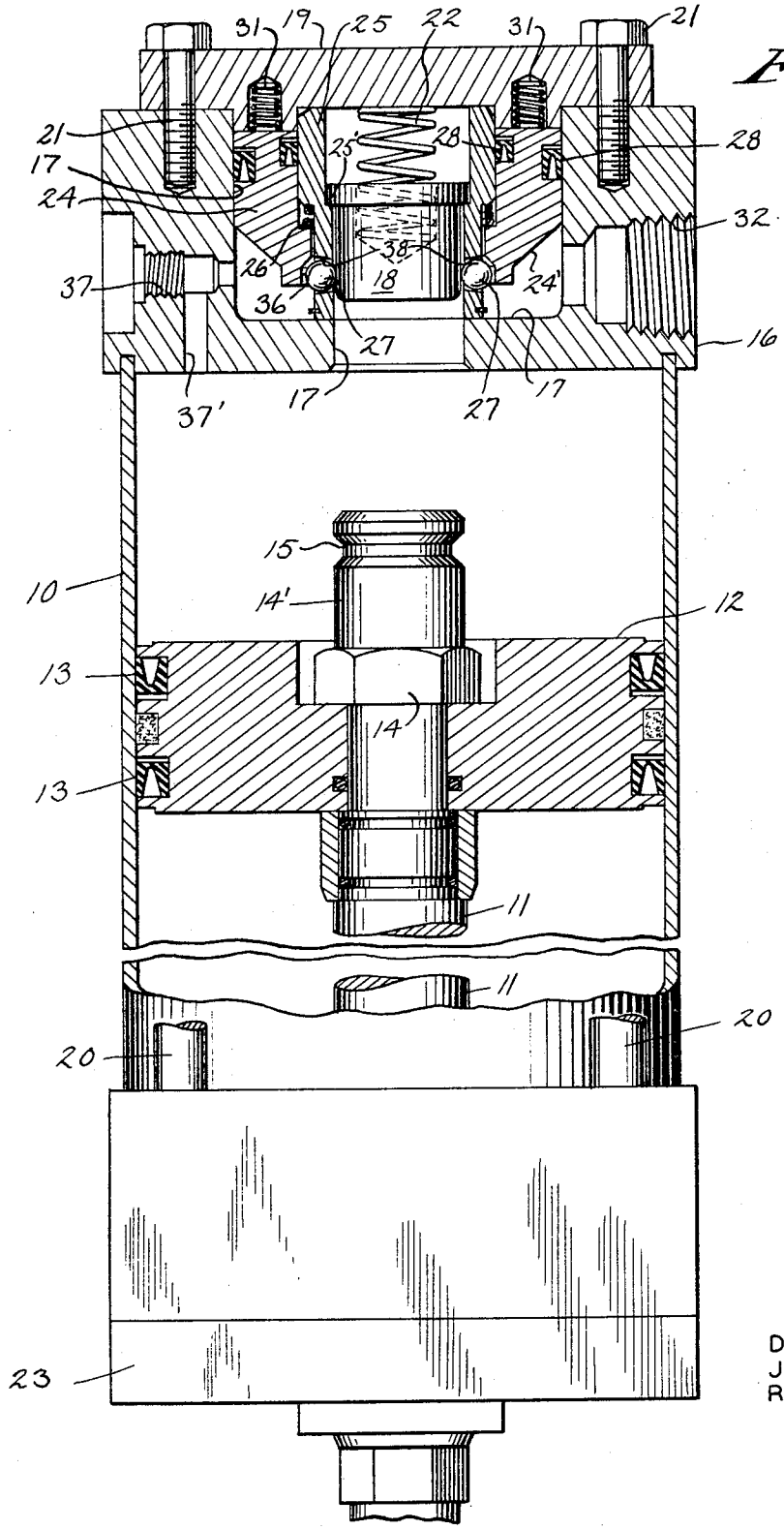
Fig. 1



INVENTORS
D. M. SKELTON
J. E. SCHULTZ
R. A. BEWALDA, JR

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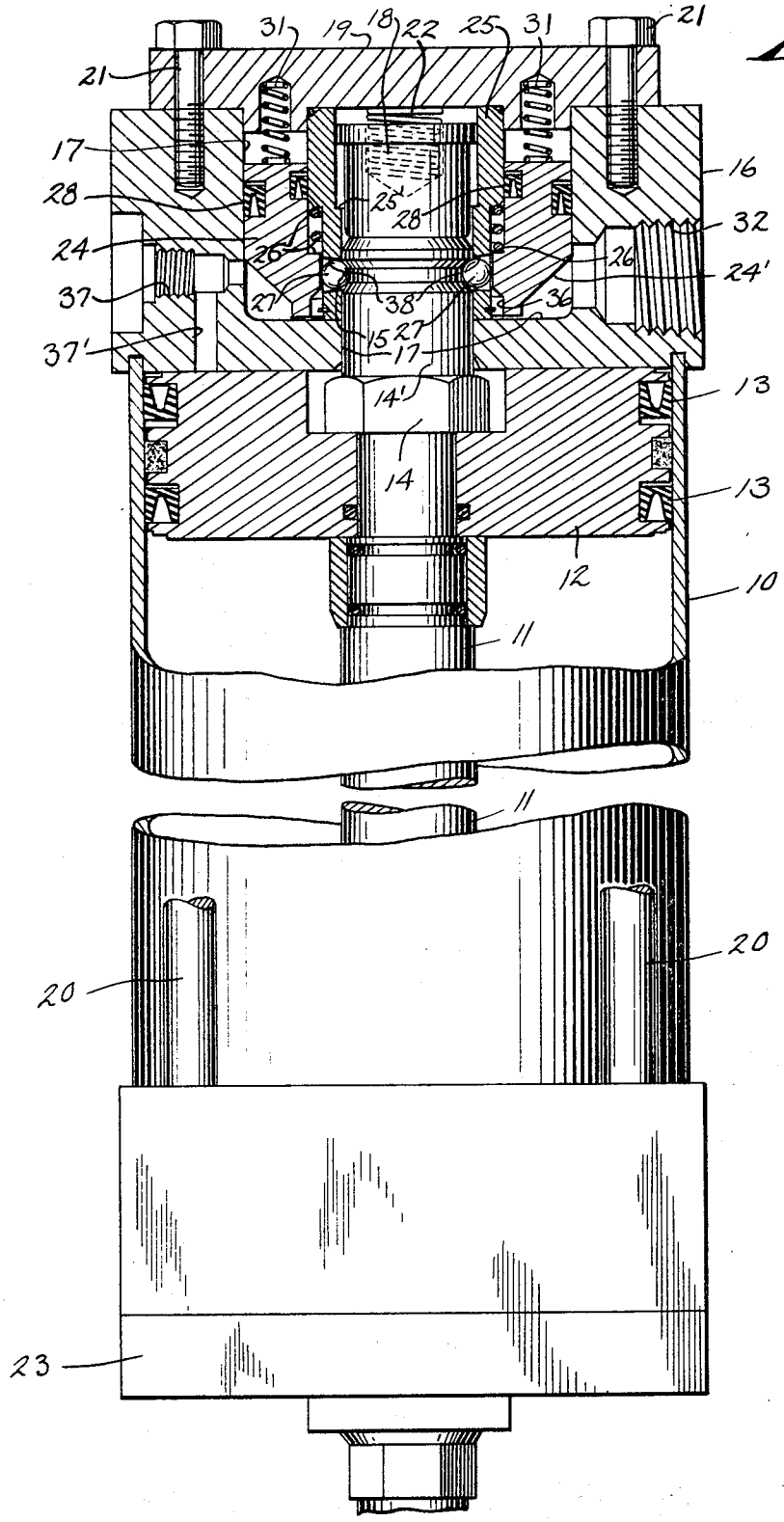
Fig. 2



INVENTORS
D. M. SKELTON
J. E. SCHULTZ
R. A. BEWALDA, JR

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FLUID ACTUATOR WITH ANNULAR PISTON LOCKING MEANS

Darold M. Skelton, Brookfield, John E. Schultz, South Milwaukee, and Robert A. Bewalda, Jr., Cudahy, Wis., assignors, by mesne assignments, to Milwaukee Cylinder Corporation, Cudahy, Wis., a corporation of Wisconsin

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ABSTRACT OF THE DISCLOSURE

A pneumatic or hydraulically actuated cylinder and piston unit having piston locking means including a singular, annular piston located in the head of the cylinder, which piston is fluid-actuated for urging locking means into engagement with the piston of the cylinder.

This invention relates to improvements in pistons, and more particularly to a novel mechanism for releasably locking a pneumatic or hydraulically actuated piston in a raised position.

Pneumatic and hydraulic pistons have a number of uses in industry, including the continuous intermittent raising and lowering of machine tools or parts during manufacturing operations, and it is frequently desired to automatically temporarily halt such pistons in a raised position for a predetermined time interval during their operating cycles. The conventional manner of accomplishing this is to maintain a sufficient quantity of air or fluid under pressure in the piston cylinder to keep the piston and its load in a raised position. Unfortunately, however, this creates a strain on the air or hydraulic fluid system, particularly when there is a heavy load on the piston, and is not entirely satisfactory for many applications. Moreover, in the event of a leak or failure in the power system the piston will be accidentally released, which can have disastrous results.

With the above in mind, the principal object of the present invention is to provide a novel automatic and releasable locking mechanism for pneumatic or hydraulic pistons which eliminates the necessity of utilizing air or fluid pressure to maintain the piston in a raised position, thereby facilitating the job of the power equpment and also promoting safety in the event of a leak or failure in the system.

A further object of the present invention is to provide a novel locking mechanism for pneumatic or hydraulic pistons which is simple and reliable in operation.

Still further objects of the present invention are to provide a new and improved piston locking mechanism which is relatively inexpensive in design and construction, which is rugged and durable in use, and which is otherwise particularly well adapted for its intended purpose.

With the above and other objects in view, which other objects and advantages will become apparent hereinafter, the invention comprises the novel locking mechanism for pneumatic or hydraulic pistons described in the following specification, and illustrated in the drawing, and any and all modifications or variations thereof as may come within the spirit of said invention and within the scope of the appended claim.

In the accompanying drawing, wherein there is illustrated one preferred embodiment of the invention, and wherein the same reference numerals designate the same parts in both of the views:

FIG. 1 is a side elevational and sectional view of the improved cylinder and piston assembly showing the piston in a lowered position; and

FIG. 2 is a similar view showing the piston in its raised, locked position.

Referring now more particularly to the drawing, the numeral **10** designates a cylindrical piston housing and the numeral **11** designates a piston rod slidably carried within and projecting from the lower end of said cylinder, said piston rod having an enlarged head **12** on its upper portion which is closely movably fitted within said cylinder. Suitable sealing rings **13** are provided to ensure a tight, leakproof fit between said movable piston head **12** and the inner surface of the cylinder **10**. Said piston head **12** is secured on the upper portion of the piston rod **11** by means of a nut member **14** which is threaded onto the end of said piston rod, and which nut member includes an upwardly-projecting portion **14'** having a beveled annular groove **15** formed therein, the function of which will be hereinafter seen.

In FIG. 1 of the drawing the reciprocable piston rod **11** is shown in a lowered position, and in FIG. 2 said piston is shown in a fully elevated position at the top of its stroke, with the piston head **12** abutting against the end cap **16** on the upper end of the cylinder. Said cap **16** may be clampingly secured on the top of the piston cylinder by means of elongated rods **20** projecting upwardly from the cylinder base **23**, or by other suitable retaining means.

It is to be understood that while the piston and cylinder structure illustrated in the drawing and hereinafter described is designed for use with a pneumatic power system it is also possible to utilize hydraulic fluid power, and the invention is not to be limited in this respect. Similarly, the positioning and mounting arrangement as well as many of the details of construction of the illustrated cylinder and piston assembly may be modified or altered for particular applications, and the invention is not to be confined to a unit identical in all respects to that shown and described herein. It is contemplated, for example, that in lieu of the unique nut member **14–14'** the piston rod **11** could be formed with an integral upward extension having a groove therein similar to the groove **15** in said nut member, as well as numerous other modifications in the illustrated structure.

The cylinder cap **16** in the present invention is provided with a transverse central bore **17** designed to receive the upwardly projecting portion **14'** of the piston nut **14** when the piston rod is in its raised position (FIG. 2), said bore being of substantially greater diameter than said nut member. Vertically movably carried within said bore **17** is a plug **18**, and seated within and projecting upwardly from a pocket in said plug is a compression spring **22** which bears against the bottom surface of a plate **19** secured on the outer face of the cap **16** by means of bolts or screws **21**.

Encircling said plug **18** within the cylinder cap bore **17** is a rigid concentric collar **25** having an inwardly projecting lower section adapted to closely surround the lower portion of said plug, and also forming an annular shoulder **25'** against which the enlarged head portion of said plug abuts when said plug is in its lowered position (FIG. 1). Formed in and around said collar **25** is a circumferential ring of closely spaced bores or ports **38**, and movably mounted in each of said ports is a ball **27**, said balls being larger in diameter than the thickness of said collar wall and being designed to protrude either inwardly or outwardly beyond said wall. In FIG. 1 of the drawing said balls **27**, hereinafter referred to as the locking balls, are shown projecting outwardly while in FIG. 2 they are illustrated in a position projecting radially inwardly within the cap bore **17**, the function of which will be hereinafter seen. Said bores or ports **38** are tapered inwardly, as shown, to retain said locking balls therein, and a concentric ring unit **24** closely encircling the collar **25** pre-

vents said balls from escaping laterally outwardly of said collar.

Said ring unit **24** is adapted to move vertically relative to the rigid collar **25** against the action of a spring **26** mounted therebetween, and against the action of a plurality of equispaced springs **31** which bear against the underside of the top plate **19**, said springs functioning to yieldably urge said ring unit **24** downwardly to the lowered position of FIG. 2. Sealing rings **28** provide a leakproof engagement between said movable ring unit **24** and said collar **25**, as well as with the surface of the cap bore **17**. Said ring unit **24** is also provided with a downwardly and inwardly beveled lower exterior face **24'**, and the inner face of said ring is provided with an annular cutout **36** which is designed to accommodate a portion of the locking balls **27** when said ring unit is in the raised position illustrated in FIG. 1, the upper surface of said cutout being beveled as shown.

Formed in the side of the cylinder cap **16** in the present invention is a radial tapped bore **32** which communicates with the central bore **17**, and in the use of the invention an air (or hydraulic fluid) hose is threaded into or otherwise connected to said bore to permit the introduction of air or other fluid under pressure into said cap, there also being suitable exhaust means. Desirably a radial exhaust bore **37** and duct **37'** communicating with the interior of the cylinder **10** are provided, and a needle valve (not shown) or the like is mounted within said bore **37** to control the fluid pressure and to thereby regulate the speed of the reciprocable piston **11** as it approaches the top of its stroke.

In the operation of the illustrated pneumatic piston assembly in a typical manufacturing operation an air inlet line (not shown) leading from a source of air or hydraulic fluid under pressure is connected to the lower portion of the cylinder **10** to provide power means for raising the piston, as is conventional in the art, and suitable release valve and return line means permit the descent of said piston and the load carried thereby. As hereinabove mentioned, the operating cycle can be automatically timed and controlled for the particular machining operation or other intended use of said piston.

In accordance with the present invention, as the piston rod **11** approaches the top of its stroke the upwardly-projecting portion **14'** of the piston nut **14** enters the lower end of the bore **17** in the cylinder cap and engages against the bottom of the movable plug **18**, continued upward travel of said piston and nut pushing said plug **18** upwardly against the pressure of the spring **22**. As said plug **18** moves upwardly to a position above the locking balls **27** said balls are free to shift laterally to an inwardly projecting position (FIG. 2), and when the piston and nut **14** reaches the top of its stroke the groove **15** in said nut is aligned with said balls. Simultaneously, the freedom of said balls **27** to shift laterally inwardly permits the ring unit **24** to move downwardly to the lowered position illustrated in FIG. 2, the aforementioned springs **26** and **31** functioning to urge said ring unit **24** downwardly. The beveled nature of the cutout **36** in said ring unit acts as a wedge to force the locking balls **27** inwardly into the piston groove **15**, and when said ring unit is in its lowered position the vertical inner face thereof bears against said balls **27** and maintains the same in position within said groove. Thus, with said balls **27** projecting into said piston groove **15** the piston is mechanically clamped against vertical movement and the air or fluid in the cylinder **10** can be exhausted, with the attendant advantages hereinabove enumerated.

When it is desired to release the piston **11** air under pressure is introduced into the cylinder cap **16** through the bore **32** and as said air flows into the cap it forcibly engages against the beveled annular face **24'** of the ring unit **24** and urges said ring unit upwardly against the tension of the springs **26, 31**. As said ring unit **24** moves upwardly the annular cutout portion **36** therein is brought

into alignment with the locking balls **27** and said balls are free to shift to an outwardly projecting position, as shown in FIG. 1, the beveled nature of the piston groove wedging said balls outwardly as said piston bears downwardly thereon. Thus the piston **11** is free to descend and commence a new operating cycle.

When the piston and nut **14** move downwardly, as described, the spring-loaded plug **18** follows downwardly therewith and engages against the balls **27** to maintain said balls in their outwardly projecting or retracted position (FIG. 1), thereby ensuring that the locking mechanism is ready for the next upward stroke of the piston.

As hereinabove mentioned, the advantage of the present invention is that it makes it unnecessary to continuously employ air or fluid pressure in the cylinder in order to secure the piston at the top of its stroke, as is required with prior piston assemblies. Not only is said conventional method inefficient and a strain on the power equipment, but in the event of a leak or failure in the system the piston will be accidentally released, which can have serious and even disastrous results.

What we claim is:

1. A piston and cylinder assembly, comprising: an upright cylinder having a base end and a top end; a cap on the top of said cylinder, said cap having a central bore opening in the bottom thereof, and having a fluid inlet bore communicating with said central bore; a rigid, concentric collar mounted within said cap central bore and formnig an annular chamber therewith, said collar having a circumferenital ring of spaced, inwardly tapered ports therethrough; a locking ball mounted in each of said collar member ports, said balls being of a diameter greater than the width of said collar wall and being adapted to project either inwardly or outwardly therebeyond; a vertically movable annular piston slidable in said annular chamber, said annular piston having a downwardly and inwardly beveled outer face and having an annular cutout in its inner face provided with a beveled upper surface, said annular piston being movable from a raised position wherein said cutout is aligned with and adapted to accommodate a portion of said locking balls when the latter are in an outwardly projecting, retracted condition to a lowered position wherein the inner face of said annular piston bears against said balls and maintains the same in an inwardly projecting, locking condition; spring means yieldably urging said annular piston to a lowered position; a vertically movable plug extending downwardly in said cap central bore and closely movably fitted within said collar member, spring means yieldably urging said plug downwardly to a lowered position wherein the side of said plug engages said locking balls and maintains the same in an outwardly projecting, retracted condition, and wherein said balls retain said movable annular piston in its raised position; a reciprocable piston rod mounted coaxially within and extending downwardly from said cylinder, said rod having an enlarged piston head on its upper portion; an extension on said piston rod extending upwardly from said piston head and adapted to be projected upwardly into said cap central bore, and said rod extension having a beveled annular groove formed therein adjacent its upper end adapted to receive said locking balls when said balls are in their inwardly projecting condition; fluid power means for actuating said reciprocable piston rod, whereby as said piston rod approaches the top of its stroke said extension thereon will project into said cap central bore and push said movable plug upwardly therewith until the groove in said piston extension is aligned with said locking balls and the latter are caused to shift laterally by said spring loaded annular piston to a position wherein said balls project into said piston extension groove to mechanically lock said piston rod against downward movement, and with said annular piston in its lowered position; and means for introduc-

ing fluid under pressure into the fluid inlet bore in said cylinder cap to engage against the beveled face of said annular piston to force said annular piston upwardly to a raised position wherein said locking balls are free to shift laterally outwardly to release said piston rod.

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MARTIN P. SCHWADRON, *Primary Examiner.*

I. C. COHEN, *Assistant Examiner.*