July 29, 1969 D. W. GRIMES 3,457,840

FORCE APPLICATION DEVICE

Filed June 30, 1967 3 Sheets-Sheet 1

FIG. 1.

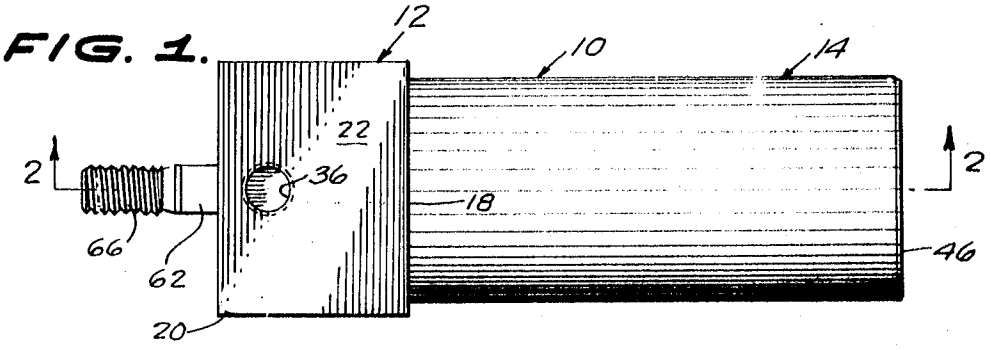


FIG. 2.

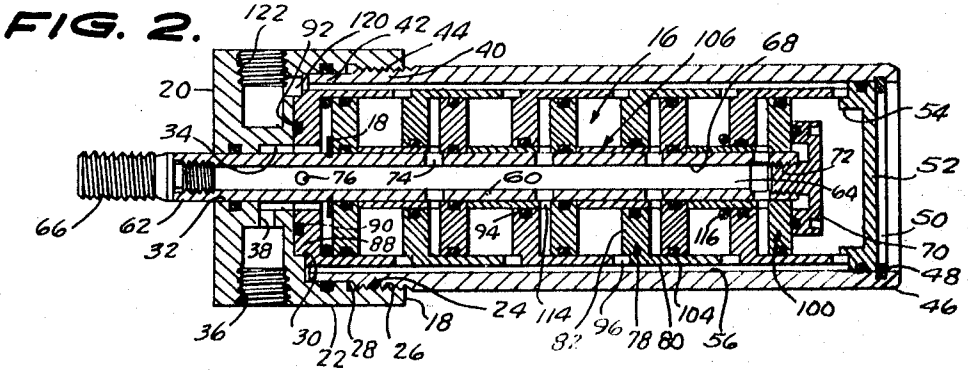


FIG. 5.

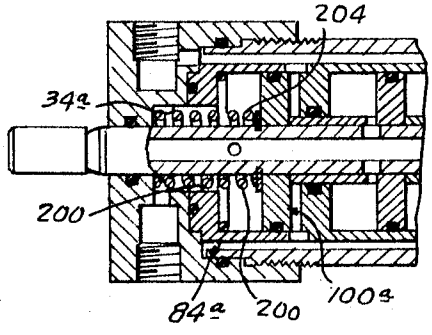


FIG. 6.

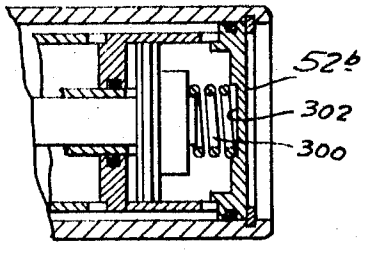
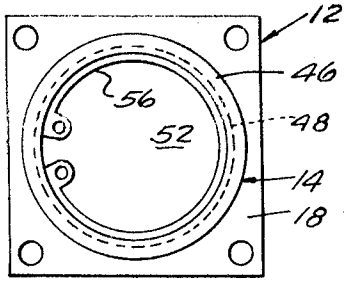


FIG. 3.



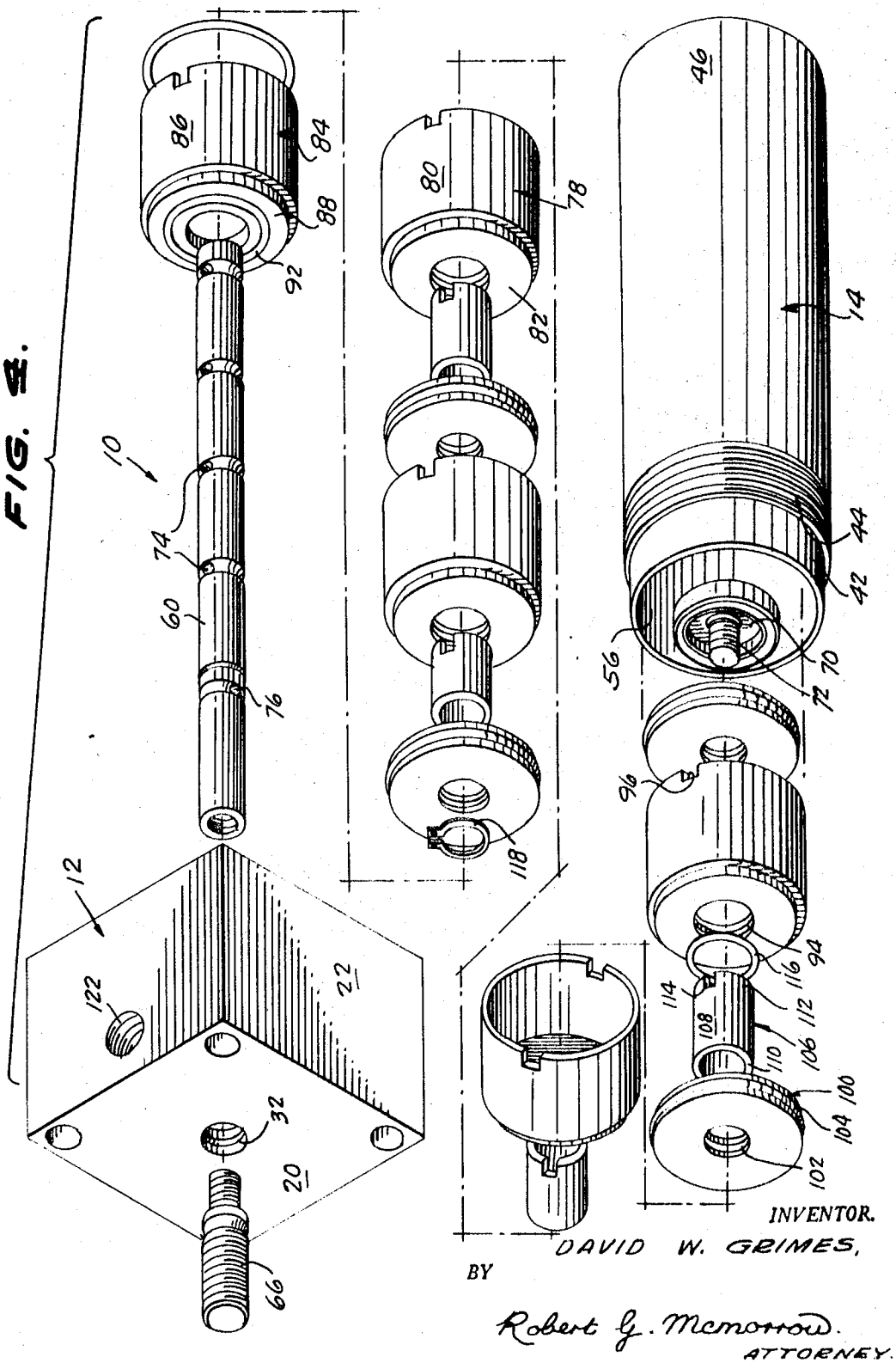
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FORCE APPLICATION DEVICE

Filed June 30, 1967 3 Sheets-Sheet 2

FIG. 4.



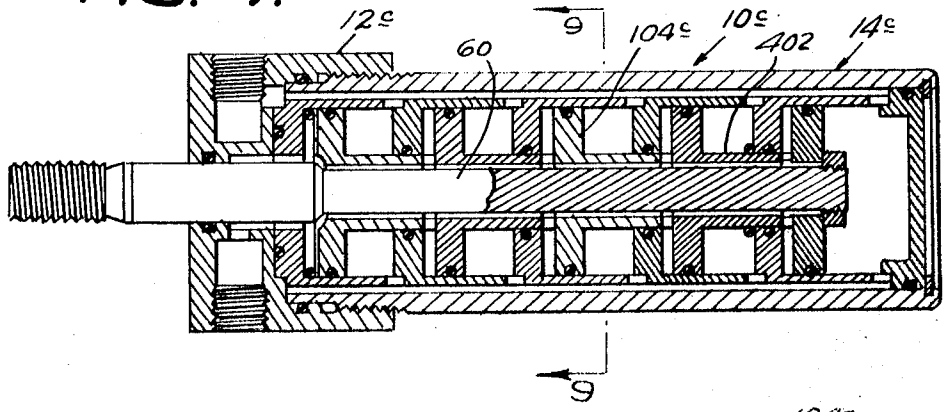
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FORCE APPLICATION DEVICE

Filed June 30, 1967 3 Sheets-Sheet 3

FIG. 7.



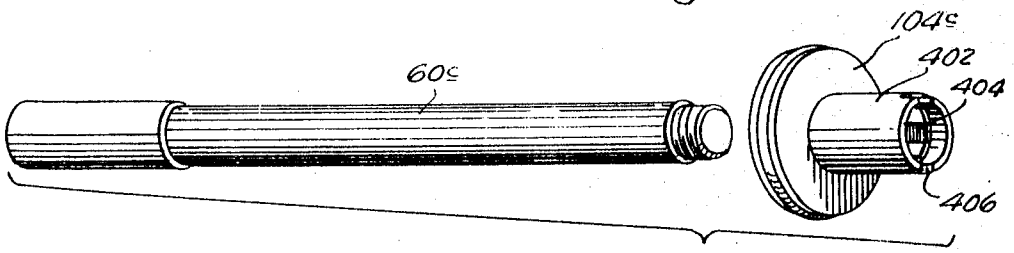


FIG. 8.

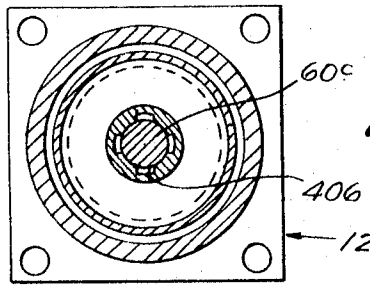


FIG. 9.

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3,457,840

FORCE APPLICATION DEVICE

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Filed June 30, 1967, Ser. No. 650,353
Int. Cl. F01b 1/02, 3/00, 7/04
U.S. Cl. 92—111 10 Claims

ABSTRACT OF THE DISCLOSURE

An air pressure cylinder assembly having a central piston rod with a plurality of coacting pistons and cylinders thereon, the piston rod having pneumatic pressure passage means therein vented between the respective cylinders and pistons, to provide a means of combining the individual force of separate pistons in collective action.

BACKGROUND OF THE INVENTION

Field of the invention

This invention pertains to the application of force through fluid pressure, such as air pressure, and to devices for the application of such force at a given location and for a selected duration.

Description of the prior art

Prior art apparatus conventionally employs a housing with an extensible force application head. This apparatus includes a single chamber housing, and a piston disposed within the housing movable against the force applying head upon the introduction of pressure within the housing. Problems have arisen in connection with the necessary bulk of such apparatus, where the final environment of employment is such that space limitations preclude the use of particularly elongated or unduly wide cylinders.

SUMMARY OF THE INVENTION

This invention relates to pressure cylinders of the type often serving as components in machine tools and relates essentially to a multiple component cylinder which embodies a series of pistons and cylinder assemblies operating from a single pressure supply.

A basic objective of the invention resides in the provision of apparatus in the nature of a pressure cylinder assembly wherein the exterior dimensions of the apparatus are minimized in relation to the available force output. This objective involves the employment of a centralized pressure output source acting on a series of pistons and cylinder means which act in unison to direct a thrust force against an object at a given point. Practical applications of the apparatus include adaptation to clamping functions, gripping elements of tools including hand tools, direct work applications, and the like. The minimization of area permits the application of the cylinder to hand tools such as those used in rivet closing, and the like, and further adaptations of the apparatus permit its employment in embossing and stamping uses.

A related object of the invention is to provide a cylinder of the type indicated which is operable from line pressure as is often available in work locations and which eliminates the need for expensive and cumbersome hydraulic equipment.

By non-complex modification of the basic assembly hereof, the invention provides an air cylinder which may be double acting in function, providing for reversal of the direction of fluid power employment.

Another objective of the invention resides in supplying a device as aforesaid of increased efficiency, providing a proportionally greater amount of thrust in terms of the original power available than conventional, single piston units. In the present invention, the force applied is a function of the area of piston surface contacted by the introduced fluid and its pressure, and the arrangement of the combined force of a plurality of pistons on a common carrier has been found to produce a significantly advanced degree of total applied force.

An advantage of the invention resides in its unitary but modular formation, permitting the design of the unit in terms of its ultimate applied use.

Other and further objects and advantages of the invention will become apparent to those skilled in the art from a consideration of the following specification when read in conjunction with the annexed drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a side elevational view of a force application device constructed and assembled in accordance with the teachings of this invention;

FIGURE 2 is a longitudinal cross sectional view taken substantially on the line 2—2 of FIGURE 1, looking in the direction of the arrows;

FIGURE 3 is an end elevational view;

FIGURE 4 is an enlarged, dis-assembled perspective view of the apparatus;

FIGURE 5 is a fragmentary sectional view of a first modified form of the apparatus;

FIGURE 6 is another sectional view, showing details, and showing a second modified form of the invention;

FIGURE 7 is a view similar to FIGURE 2, showing a third modification;

FIGURE 8 is a dis-assembled perspective view disclosing certain of the components of the assembly of FIGURE 7; and

FIGURE 9 is a sectional view along the line 9—9 of FIGURE 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIGURES 1 through 4 the force application device hereof will be seen to comprise a unitary assembly **10** making up a component employed in clamping or other operations which involve the application of force at a given point or area and for either a substantial duration or an interrupted sequence. The unit **10** includes a header **12** of optional design but here shown as of substantially rectangular, block-like form, a housing **14**, and an operating piston assembly **16**.

The header **12** includes an inner end **18** and an opposite outer end **20** positioned adjacent the point of desired force application. The block making up the header also has a plurality of side walls **22**, the number and disposition of which depend upon design features. The header is formed of any suitable material, such as metal, durable plastic, or the like, and has an enlarged, compound main chamber **24** formed therein. The chamber **24** is internally threaded at its initial side wall section **26** and is thereafter stepped inwardly at **28** and **30** to provide shoulders as disclosed more fully below.

Opening on the chamber **24** at one end on the outer end **20** of the header at a remote location is a longitudinally extending, axially arranged bore **32**. The bore, in the use of the apparatus, is aligned with the selected point of force application, and in FIGURE 2 it is to be noted that the bore includes an enlarged portion **34** adjacent the main chamber.

An inlet port **36**, which may be threaded to receive a hose connection, is formed in the header, preferably opening on one of its side walls. The port **36** communicates, through a passage **38**, with the enlarged portion **34** of the bore, thereby supplying fluid pressure through the inlet to the bore upon the introduction of such pressure into the inlet port. This introduction may be by

means of a typical air pressure supply as found in shops and factories.

The housing **14** is preferably of tubular metallic construction and has a first end section **40** with a smooth walled leading portion **42** and a trailing, externally threaded portion **44** engaged with the threaded side wall section **26** of the header. The opposite end **46** of the housing has an inward, peripheral groove **48** therein receiving the snap ring **50** which serves to retain therein a closure means comprising a plate **52**. The plate **52** has an enlarged side section with a peripheral flange **54** spaced inwardly of the smooth inside wall **56** of the housing.

The operating piston assembly **16** comprises an elongated piston rod **60** which has a proximal end section **62** and a distal, interior end **64**. The end **62** projects slidably through the bore **32** of the header and has an outer work element **66** (preferably threaded for connection with other elements) detachably mounted thereon by screw means as shown. The piston rod **60** has a longitudinal passageway **68** therein which is closed at its forward end by the work element **66** and is also closed at its interior end by a piston retaining nut **70** having a central plug stem **72** threadedly seated therein. At spaced intervals the piston rod **60** has lateral outlet vents **74** formed therein in opposite pairs, the rod being reduced in outside diameter at the peripheral location of the respective pairs. In FIGURE 3 it will further be observed that the piston rod has a similar pair of inlet vents **76** formed therein adjacent its end **62** and arranged for fluid communication with the enlarged portion **34** of the bore for reception of air pressure or other fluid pressure into the passageway **68**.

The assembly **16** further comprises a series of cupped cylinder members **78** each having an outer wall **80** and a top wall **82**. The series includes an initial cylinder **84** (see FIGURE 4) with an outer wall **86** substantially identical to the walls **82**, and a top wall **88** with a circular channel **90** having a cushioning ring **92** therein. The initial cylinder abuts one of the shoulders of the chamber wall in a first position and the seal **92** prevents pressure loss in that position. The top walls of the cylinder members each have centrally located openings **94** therein through which the piston rod **60** extends, and has stepped portions about their peripheral edges whereby they are interfitting with one another. Further, the outer walls have spaced slots **96** therein also in opposite pairs. The outside diameter of the outer walls is such that these are spaced inwardly of the interior wall **56** to define an outlet chamber **98** therebetween with fluid transfer occurring through the slots **96**.

A disk-like, annular piston **100**, having a central rod opening **102** therein, is provded for each cylinder member. The pistons are of a diameter to fit closely within the cylinder members and are provided with seals **104** at their side edges. The openings **102** permit mounting of the pistons on the piston rod.

Further included in the piston assembly **16** is a group of generally tubular bushings **106** each having a cylindrical body portion **108** with a top edge **110** and a bottom edge **112**. A pair of slots **114** are formed in diametrically opposite sides of the body portion, opening on the bottom edge **112**. The bushings **106** space the pistons from one another, and as seen in FIGURE 2, the slots **114** are adapted for alignment with the vents **74** and **76** of the piston rod.

A cushion element, in the form of a ring **116**, is disposed about the innermost one of the bushings immediately above the top wall **82** of the corresponding cylinder to prevent damage on maximum inward displacement of the elements.

The innermost cylinder element **78** seats against the closure plate **52** between the flange **54** thereof and the housing wall **56**. The inside portion **100** has a maximum inward travel limited by the retaining nut **70**, and a series of cylinder elements, pistons and bushings is engaged at the opposite end of the rod by a retaining ring **118**.

It will be noted in the drawing that fluid sealing means is provided at the connecting sections of the elements. The seals are of conventional type, and serve to avoid pressure leakage.

With continued reference to FIGURE 2, it is there shown that the outlet chamber **98** is in open communication with a passageway **120** formed in the header **12** and leading to an outlet port **122** for connection with a suitable fitting. While the ports **36** and **122** herein have been characterized as inlet and outlet ports, it is to be noted that these functions are readily reversible, and that the unit may be made to operate in reverse fashion by merely changing the direction of fluid pressure introduction through the medium of an associated slide valve or by other known expedient.

The operation of the invention is believed to be made apparent by the foregoing description of structure. Air pressure from a supply is introduced through the inlet port **36** and enters the piston rod passageway **68** through the inlet vents **76**, and also enters the area in advance of the initial cylinder wall **88** through the enlarged portion **34** of the header bore. The pressurized air passes through the aligned opening **74** of the piston rod and the slot **114** of the bushings. The air then exerts an expansive force between the pistons and cylinders with the result that the piston rod is driven forward. This forward positioning continues so long as pressure is maintained. Expended air is expelled through the slots **96** to the chamber **98**, passageway **120** and port **122**.

In FIGURE 5, an arrangement is shown wherein a spring **200** extends through the enlarged portion **34***a* of the bore and to a special opening **202** in the leading cylinder member **84***a*. The spring **200** seats at its inner end **204** against an initial piston **100***a*. FIGURE 6 shows a spring **300** seated at one end in a groove **302** in the closure **52***b* of a third form of the invention. The springs function to constantly urge the piston rod in either an extended or retracted position, thus to reverse the position of the piston rod without the necessity for the introduction of fluid pressure in the alternate direction.

FIGURES 7 through 9 disclose a modification of the means for introduction of fluid pressure. In these views of the drawings, elements similar to those heretofore described have corresponding reference characters applied thereto, the letter *c* being appended for distinction. The central piston rod **60***c* will be seen in the drawing to be of reduced diameter and of substantially solid construction. The cylinder elements **78***c* have side walls **80***c*, top walls **82***c*, and are otherwise similar to the cylinder elements heretofore described. The pistons **104***c* additionally include an interior sleeve **402** replacing the bushing elements employed in the first forms of the invention. The sleeve **402** has longitudinal recesses or slots **404** therein and is arranged to coincide with the opening **94***c*. The slots **404** collectively provide air passageways exteriorly of the piston rod. In FIGURE 8, it will be observed that the sleeve **402** is counterbored at **406** to provide an annular duct about the interior of the sleeve. The sleeve is slotted at **408** for distribution of the fluid pressure between the respective cylinders and pistons.

Thus, this form of the invention provides a unitary arrangement of the bushing and piston and one which is readily assembled. In addition, the piston rod is strengthened by virtue of its solid formation.

As will readily occur to those skilled in the art, the sleeve may optionally have a smooth interior, with a series of splines on the piston rod providing the longitudinal air passageways.

I claim:

1. A device for the application of force comprising:

a substantially rectangular header including an inner end, an opposite outer end, and side walls;

a compound main chamber formed within said header and opening on said inner end, the main chamber

having a plurality of stepped interior shoulders;
said header having a longitudinally extending, axially arranged bore therein and having an enlarged portion adjacent the main chamber;
an air pressure inlet port formed within said header and opening on one of its side walls and on the enlarged portion of the bore, an outlet port carried by said header and opening on another of its side walls;
a substantially hollow housing, having an open end and an opposite end with a sealingly engaged closure seat thereon, said housing being secured to said header with the open end disposed within the main chamber and abutting one of the shoulders in sealing engagement therewith;
an elongated piston rod slideably engaged in and extending through the bore of the header at a force applying end thereof, fluid supply means carried by said piston rod and forming a longitudinal fluid passageway, means for fluid coupling said piston rod fluid supply means to said air pressure inlet port;
a series of cup shaped cylinders, each including an outer wall and an end wall, the end wall having a centrally located opening for receiving said piston rod, substantially discoidal piston means slideably disposed on the piston rod and including integral, tubular spacers for separating the piston from the end wall of respective cylinders, openings carried by said tubular spacers overlying said supplying piston rod;
said cylinder outer walls being spaced inwardly from the housing to define an upper chamber communicating with the outlet port of the header; and
means for retaining the cylinders in fixed position within said housing and said piston and spacer fixed to said movable piston rod.

2. A force application device comprising:
a header carrying separate, reversible fluid pressure inlet and outlet means;
a housing connected to said header;
a movable piston rod carried by said housing and having a force applying end;
fluid pressure transfer means carried by said rod and connected to said fluid pressure inlet means;
cylinder means carried by said housing between said piston rod and said housing to form a fluid passageway between said cylinder means and housing to said outlet means from within said cylinder means; and
piston means carried by said rod for movement within said cylinder means to cause movement of said force applying end of said rod in response to introduction of pressurized fluid either to said piston carried fluid transfer means or said fluid passageway.

3. The invention of claim 2, wherein:
the piston means comprises at least one piston and the cylinder means comprises at least one cylinder, said piston and cylinder being arranged to form a chamber therebetween;
the fluid pressure transfer means of the piston rod includes means for venting pressurized air into the chamber formed between each piston and its cylinder; and
said cylinder further includes means for venting fluid on the opposite side of said piston to said passageway.

4. The invention of claim 2, wherein said fluid pressure transfer means includes:
a spacer between each piston serving to space the pistons apart.

5. The invention of claim 2, wherein:
the fluid transfer means includes longitudinal spline means.

6. The invention of claim 5, wherein:
the means on the piston rod comprises a series of pistons and cylinders including a terminal cylinder limiting movement in one direction of the series; and
the fluid pressure transfer means is vented between each piston and cylinder.

7. The invention of claim 2, including:
a series of pistons and cylinders and a terminal cylinder limiting movement in one direction of the series; and
the fluid pressure transfer means being vented between each piston and cylinder of the series.

8. The invention of claim 7, wherein:
the cylinders each include an outer wall; and
the outer wall of each cylinder is spaced inwardly from the housing to define said fluid passageway.

9. A force applying device comprising:
housing means including separate, reversible fluid pressure inlet and outlet means;
a projecting work element mounted in association with the housing means;
a modular piston assembly, including a plurality of piston elements carried at longitudinally spaced locations operatively connected to the work applying element and coaxially positioned within said housing means;
a plurality of cylinder means carried by said housing means at spaced positions corresponding to said plurality of piston elements;
means including said housing and said individual cylinder elements forming a passageway therebetween to said outlet means; and
fluid transfer means including said piston assembly and said cylinder elements, whereby said work applying element is moved in either of two directions in response to application of fluid pressure to either said fluid pressure inlet means or said fluid pressure outlet means.

10. A device for the application of force at a given point comprising:
a substantially rectangular header having an inner end and an opposite outer end, and having side walls;
the header having a compound main chamber formed therein and opening on said inner end, the main chamber having a plurality of stepped interior shoulders;
the header having a longitudinally extending axially arranged bore therein aligned with said given point of force application, and having an enlarged portion adjacent the main chamber;
the header having an air pressure inlet port formed therein and opening on one of its side walls and on the enlarged portion of the bore, and having an outlet port therein opening on another of the side walls;
a substantially hollow housing, having an open end and an opposite end with a sealingly engaged closure seat thereon, secured to the header with the open end disposed within the main chamber and abutting one of the shoulders in sealing engagement therewith;
an elongated piston rod slidably engaged in and extending through the bore of the header at a force applying end thereof contacting the given point, at its interior end, the piston rod having a longitudinal passageway therein and having an intake vent aligned with the enlarged portion of the header bore;
the piston rod having longitudinally spaced outlet vents therein;
a series of cupped cylinders, each including an outer wall and a top wall, the top wall having centrally located openings therein through which the piston rod extends;
a substantially discoidal piston disposed slidably on the piston rod within the outer wall of each cylinder;
substantially tubular bushings about the piston rod and interposed between each piston, the bushings, in one position, covering the outlet vents of the piston

rod to block air passage and being moved to alternative positions exposing said outlet vents for air passage;

the cylinder outer walls being spaced inwardly from the housing to define an outlet chamber communicating with the outlet port of the header; and

retaining means for the pistons, cylinders and bushings at the interior end of the piston rod and intermediate the ends thereof.

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U.S. Cl. X.R.

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