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DETACHABLY GANGED VARIABLE CAPACITY CYLINDER CONSTRUCTION

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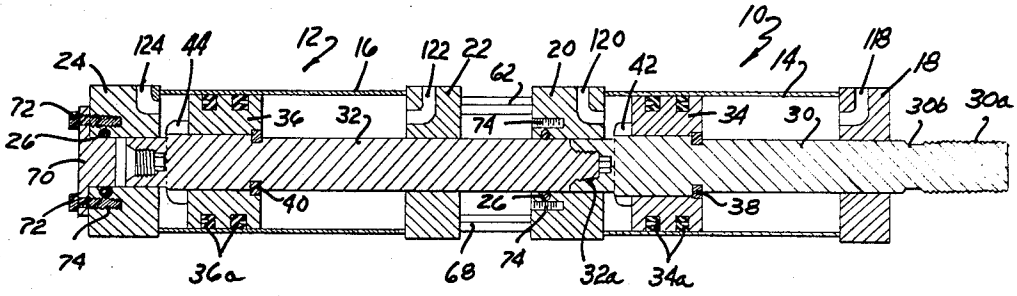


FIG. 2.

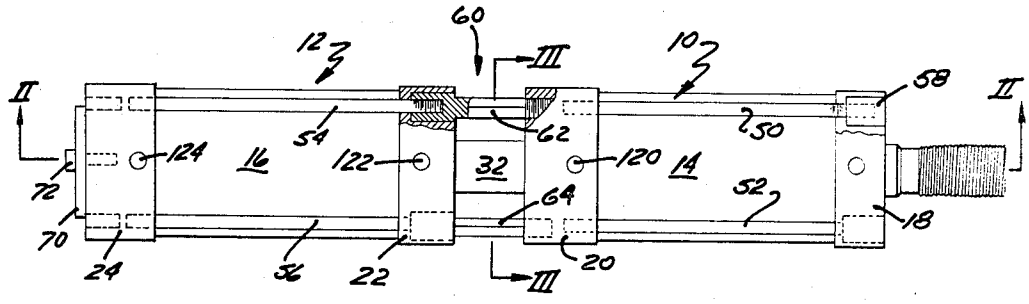


FIG. 1

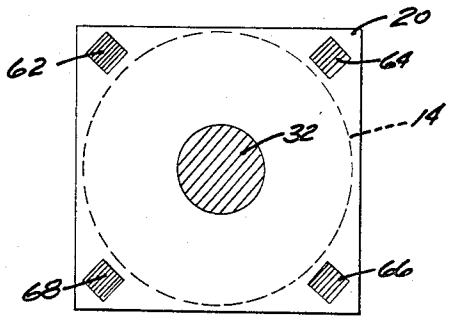


FIG. 3.

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DETACHABLY GANGED VARIABLE CAPACITY CYLINDER CONSTRUCTION

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ABSTRACT OF THE DISCLOSURE

A fluid power system comprised of a plural number of individual power cylinders detachably ganged together in an end-to-end aligned manner, wherein the attachment between each end-to-end pair of such cylinders comprises a plurality of stud-like connecting members extending between the adjacent end closure plates of such a pair of cylinders to space such end plates a predetermined distance and rigidly interconnect such pair of cylinders.

This invention relates to pneumatic power systems of the type utilizing cylinders which are actuated by compressed air, and more particularly it relates to a concept for such a system having a variable output capacity, by which an output force may be obtained which is selectable over a very wide range wherein particular force values may far exceed those previously attainable for a single power cylinder of the same physical size as used in the present system.

Pneumatic power systems utilizing a cylinder having an extendable plunger have long been known and are extensively used in a great diversity of applications, particularly in industrial operations. As is well known, the force with which the plunger member is extended from such a cylinder (or retracted thereinto) is a direct function of the surface area of a piston fixedly secured to the plunger and the pressure of the air admitted into the interior of the cylinder and acting against the piston. Thus, commercially available cylinder members are sold according to their rated output, which in turn has a direct relationship to the physical size of the cylinder, inasmuch as the diameter of the cylinder must of course increase directly with the size of the piston acting therein which produces the force obtainable therefrom. Most industrial facilities have an air compressor and a system of distribution lines as part of their equipment, but practically all such systems produce air under a maximum pressure of from ninety to one hundred p.s.i., since due to the conditions peculiar to air compression it has long been established that relatively complex and expensive special equipment must be used if higher pressures are to be obtained. Thus, when higher levels of output force are required from a power cylinder system, the use of pneumatic cylinders becomes highly limited and often is precluded, due to the unacceptably large size which would be required of a cylinder using the standard air supply mentioned above. While it is possible to switch to hydraulically actuated cylinders to obtain such higher levels of output force, most manufacturing plants and the like do not normally have a system for supplying hydraulic fluids under pressure. Such systems are costly and their added expense is normally unacceptable merely for the exceptional uses which the standard air pressure system cannot accommodate. Consequently, unless a very appreciable and often inordinate increase in cylinder size and weight is not precluded by installation and mounting requirements, as is generally the case, the user who suddenly finds he has a requirement for a high level of output force must either spend the necessary amount for the new and larger cylinder or else entirely forego the desired new operation.

Accordingly, it is a major object of the present invention to provide a pneumatic power system having means for changing the power delivered therefrom at a constant level of actuating air pressure, to either increase or decrease the power obtainable from the system, as may be desired.

A further important object of the invention is to provide a detachably ganged power cylinder construction, in which individual cylinders may readily be added to or removed from the construction to thereby either increase or decrease the net output power provided thereby.

The foregoing major objects of the invention and the advantages provided thereby, together with numerous other objects and advantages equally a part of the invention, will become increasingly apparent to those skilled in the art following a consideration of the ensuing specification and its appended claims, particularly when taken in conjunction with the accompanying drawings illustrating a preferred embodiment thereof.

In the drawings:

FIG. 1 is an overhead plan view of the ganged cylinder construction;

FIG. 2 is a sectional side elevation taken through the plane II—II of FIG. 1; and

FIG. 3 is a sectional end elevation, taken through the plane III—III of FIG. 1.

Briefly stated, the present invention provides a pneumatic power system in which two or more power cylinders are detachably coupled together in an end-to-end relationship, with the individual plunger members of the cylinders in axial alignment and arranged such that the plungers of succeeding cylinders bear directly against and coact with the plunger members of preceding cylinders, such that the net power output from the construction is the sum of the outputs available from each cylinder individually.

Referring now in more detail to the drawings, a ganged cylinder construction is shown for purposes of illustration to be comprised of two pneumatic power cylinders **10** and **12**, together with the structural means by which the two cylinders coact, although it is to be expressly understood that the construction may include any desired specific number of such cylinders, all coupled together in the same manner as the specific pair which is illustrated.

Each of the cylinders **10** and **12** is generally of a known configuration, having a cylindrical sleeve-like body portion **14** and **16**, respectively, and having end closure plates **18** and **20**, and **22** and **24**, respectively. Each such closure plate has an inlet and outlet port **118**, **120**, **122**, or **124**, respectively, formed therein by which pressurized air may communicate pith the interior of the cylindrical sleeves **14** and **16**. Also, cylinders **10** and **12** each have an individual plunger member **30** and **32**, respectively, located therewith, which is extendable outwardly therefrom through the forward end closure plates **18** and **22**, respectively, upon pressure actuation of a piston **34** or **36**, respectively, securely fixed to the plunger members **30** and **32**, as by means of keys **38** and **40** and lock nuts **42** and **44** threaded onto the respective plungers. The pistons **34** and **36** also normally have a desired number of annular seals **34***a* and **36***a*, respectively, which seat in annular grooves formed in the pistons and bear outwardly against the outside surfaces of the sleeves **14** and **16** so that opposite sides of the pistons are effectively sealed from air communication therebetween.

The end closure plates such as **18** and **20** for cylinder **10** and **22** and **24** for cylinder **12** are held in position at the ends of the respective sleeves **14** and **16** by means of four equally spaced tying studs for each such cylinder of which studs **50**, **52**, and **54**, **56** (FIG. 1) are representative. These tying studs are elongate members having threaded ends, and they extend parallel to the longitudinal

axis of each cylinder and lie immediately adjacent the outer surface of the sleeve-like body thereof. The ends of each of the tying studs are threaded into a tapped hole in a corner of each of the said end closure plates, which are square in cross section and thus extend beyond the perimeter of the cylindrical sleeves. The end closure plates **20** and **24** at the rear of each of the cylinders is drilled and tapped to engage the threads at the rearward end of the corresponding tying studs. The end closure plates **18** and **22** at the front of each of the cylinders **10** and **12** is drilled and counterbored to receive an internally-threaded insert member **58** (FIG. 1), into which the forward ends of each of the corresponding tying studs is threaded. Thus, each of the tying studs equally spaced around the periphery of each of the cylinders may be securely tightened into place to draw the end closure plates of that cylinder toward one another and tightly against the ends of the sleeve-like bodies **14** and **16**.

In forming the detachably ganged power cylinder construction of the present invention, each cylinder which is to be used in the ganged construction is releasably connected or coupled in axial alignment ahead of or behind a corresponding cylinder. Means for accomplishing this is illustrated at **60**. Such means most preferably comprise four stud-like spacing and connecting members **62, 64, 66,** and **68**, which engage and span the distance between corresponding front and rear end closure plates of proximate axially-aligned cylinders, such as for example plates **20** and **22** of cylinders **10** and **12**. The said connecting members preferably have a square or other similar wrench-engageable central cross section. At one end, the connecting members are externally threaded in a typical manner, while at the other end they have an enlarged, internally-threaded head-like portion (FIG. 1) which resembles the insert **58** and which serves a similar function, i.e., to threadedly engage the forward end of the tying studs (such as **54** and **56**) of the particular cylinder being connected behind a given other particular cylinder. It will thus be seen that any given pair of cylinders may be axially coupled together in a fixed and rigid manner with a desired spacing maintained therebetween at all times through the use of the stud-like connecting members **62, 64**, etc.

As previously stated, each of the cylinders such as **10** and **12** have an internal plunger member **30, 32**, respectively. As will be understood, the plunger members are movable within their respective cylinders and extendable forwardly therefrom through a central aperture in the forward end closure plate of each of the cylinders upon fluid actuation thereof, i.e., the supplying of pressurized air through inlet ports such as **120** and **124**, so that the air pressure may act upon the rearward surface of the pistons **34** or **36** secured to each of the plunger members. The outwardly-protruding plunger end extremity of the first cylinder (such as **10**) in a ganged assembly may have a typical conventional form such as is illustrated. This form includes a threaded portion **30***a* by which the plunger may be coupled to an external mechanism and a wrench-engageable hexagonal or other portion **30***b*. The front plunger extremity of each of the other cylinders (such as **12**) in a ganged assembly is different from what is typically found, as are the rearward portions of the plunger members of both cylinders and the rear end closure plates such as **20** and **24** of each (FIG. 2).

That is to say, the front extremity of plunger **32** has a portion **32***a* of reduced diameter which is externally threaded, and the rearward extremities of each of the plunger members **30** and **32** have a recess formed therein which includes an internally-threaded socket portion and a hexagonally-configured blank or void communicating with the said socket and extending forwardly thereof. The threaded socket is arranged to receive and to be threadedly engageable with the projecting end extremity **32***a* of the plunger of the succeeding cylinder in the alignment thereof, and the said hexagonal void is for the purpose of receiving an Allen-type wrench so that the plunger members of the proximately-connected cylinders may be securely joined together. With the plunger members joined in this manner and the cylinders themselves rigidly interconnected by the connecting members **62, 64**, and the like, it will immediately be recognized that a pair of cylinders has been axially connected together in a manner which is both rigid and yet readily releasable, since only a few turns of a wrench are required to separate any given pair of cylinders. While they are so connected, however, it will be clear that fluid actuation of either cylinder will serve to simultaneously extend (re-retract) the securely joined plunger members of all of the cylinders in the ganged assembly thereof.

In order that the interconnected plunger members of the respective cylinders may be joined to operate simultaneously in the aforesaid manner, it is required that, like the end closure plates at the front of each cylinder, the end closure plates at the rear thereof must have a central aperture formed therein, through which the forwardly-projecting end extremity of a given plunger member may extend. This is to be contrasted with the normal construction of power cylinders, in which the rear is usually tightly enclosed to contain the pressurized fluid which actuates the cylinder. The rear closure plates such as **20** and **24** of all cylinders are also formed so that a solid plug such as is seen at **70** may be secured thereto, as by bolts **72**. The plug **70** has a central cylindrical extension which closely interfits within the said plunger aperture and contacts an annular seal **26** located therein. Also, each plug has an enlarged peripheral flange, through which the said bolts may pass to enter appropriate drilled and tapped holes **74** formed in the end closure plates. In this manner, when the desired number of cylinders such as **12** have been added to a first cylinder **10** to form a ganged power cylinder construction having a desired output capacity, the final such cylinder in the axial succession thereof is sealed by inserting and securing a plug **70** to the rear end closure plate thereof.

From the foregoing description of the structural details and the assembly of the present power system, the substantial advantages of such a system will likely be immediately apparent. Firstly, the output capacity of the system is essentially endlessly variable through the simplest and fastest of mechanical adjustments, by which additional cylinders may be added to the construction or removed from it. Thus, instead of having to face a significant and substantial size and weight increase from a power requirement which previously would require a cylinder having a much larger diameter and which would perhaps be capable of producing much more power than is actually needed in any given application, one need now only obtain the exact number of additional cylinder units which are required to produce the desired power output. The additional cylinders are then coupled into an existing power system, which thus maintains the same space requirements as to width or diameter as were previously true. Also, the total weight change effected through the addition of a small number of such sequentially ganged cylinders is likely to be practically negligible when compared to the total weight increase brought about by changing over to a completely different single cylinder that is considerably larger in diameter than the cylinder used previously. Finally, the total ease of making a transition when one is required represents a very significant advantage to the user, which is believed to never have been obtainable previously.

As will be apparent, the operation of the detachably ganged power cylinder construction of the invention is substantially the same as the operation of any individual cylinder, except that the supply of actuating pressurized air must be distributed to each of several like inlet ports such as ports **118** and **122** or ports **120** and **124**, depending upon whether it is desired to initiate plunger extension or plunger retraction. As will be apparent, air distribution in this manner is readily accomplished through

any conventional manifolding system (not specifically shown). This aspect tends to illustrate a further significant advantage of the invention. If power requirements should decrease, a given ganged construction of cylinders built in accordance with the invention need not then be immediately altered by removal of the cylinders whose output is no longer required. Neither is it necessary to have a variable supply for pressurized actuating air. Instead, the inlet ports of the cylinders whose output is not currently needed may simply be shut off or disconnected, so that while such cylinders remain fixedly coupled into the ganged construction and while their interconnected plunger members continue to be moved with those of all of the remaining cylinders, such plungers as receive no pressurized air of course contribute nothing to the effective output of the overall system.

Upon considering the nature of the invention disclosed hereinabove and having perceived the numerous advantages provided thereby, it is quite conceivable that those skilled in the art may devise embodiments of the invention which differ in various details from that which is specifically described herein, or may wish to change certain details of this same structure. Consequently, all such further embodiments and changes in structure as incorporate the concept underlying the invention and are clearly based upon the spirit thereof, are thus to be considered as within the scope of the claims appended herebelow, unless these claims by their language specifically state otherwise.

I claim:

1. A detachably ganged variable capacity power cylinder construction, comprising in combination: a plurality of individual power cylinder members, each having end closure plate means; each of said power cylinders having a movable plunger member extendable therefrom upon actuation of that cylinder; releasable attachment means for mounting said cylinders with their respective plunger members in axial end-to-end alignment such that said cylinders when simultaneously actuated will each extend its plunger member in engagement with portions of the plunger member of the cylinder mounted immediately forwardly thereof, such that the resultant plunger force for the ganged construction is the sum of the forces contributed by each individual cylinder; and said releasable attachment means comprising a plurality of rigid stud-like connecting members rigidly affixed to and extending between the adjacent end closure plate means of each end-to-end pair of power cylinders to space such adjacent closure plates apart a predetermined distance and rigidly interconnect such pair of cylinders.

2. The ganged power cylinder construction of claim 1, wherein each of said stud-like members have a threaded end extremity and are rigidly affixed to said closure plate means at such extremity by a threaded engagement therebetween.

3. The ganged power cylinder construction of claim 1, wherein the end closure plate means of each individual one of said power cylinders include an end plate at each end of such cylinder and elongated tie-bolt elements extending between and interconnecting such end plates, and wherein at least some of said stud-like connecting members have one end attached to a tie-bolt element of one of the power cylinders in an end-to-end pair thereof.

4. The ganged power cylinder construction of claim 3, wherein said attachment of said one end of said stud-like connecting members to said tie-bolt elements comprises a threaded interengagement therebetween.

5. The ganged power cylinder construction of claim 4, wherein said stud-like connecting members have another end and such end is attached to the end plate of the other of the power cylinders in such end-to-end pair thereof by a threaded engagement therebetween.

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