Aug. 27, 1963 F. S. FLICK 3,101,860

MULTIPLE TIE ROD PISTON AND CYLINDER DEVICE

Filed Feb. 2, 1961

FIG. 1

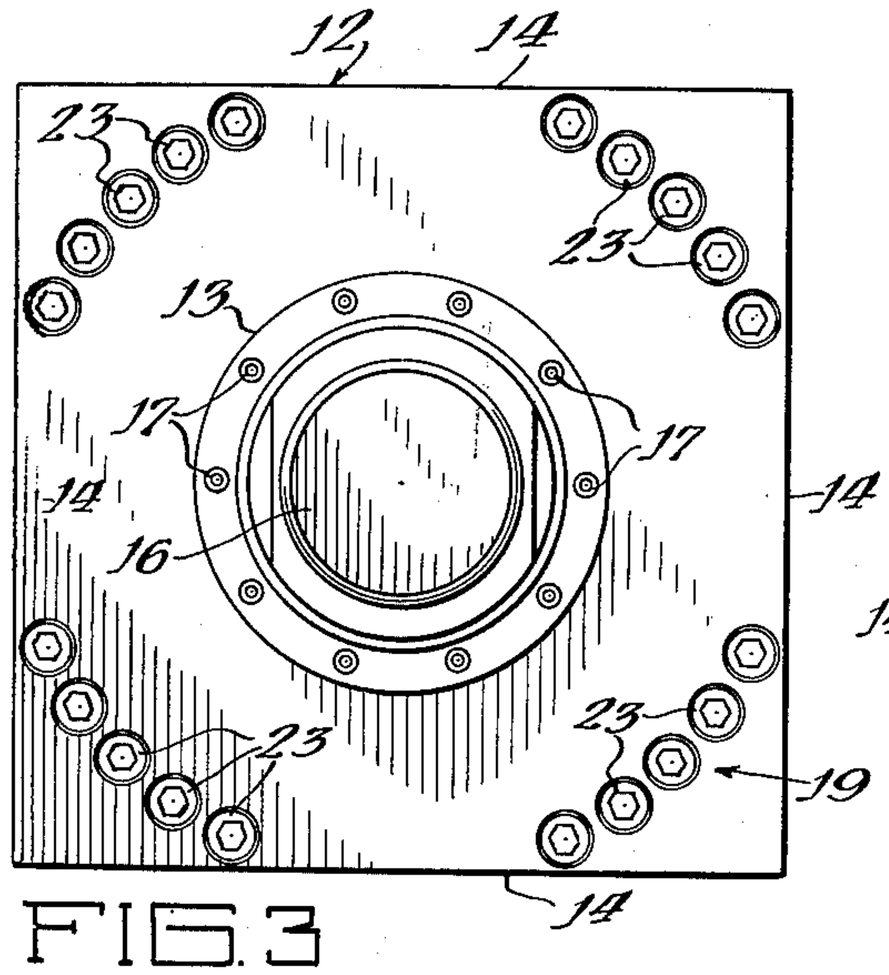

FIG. 2

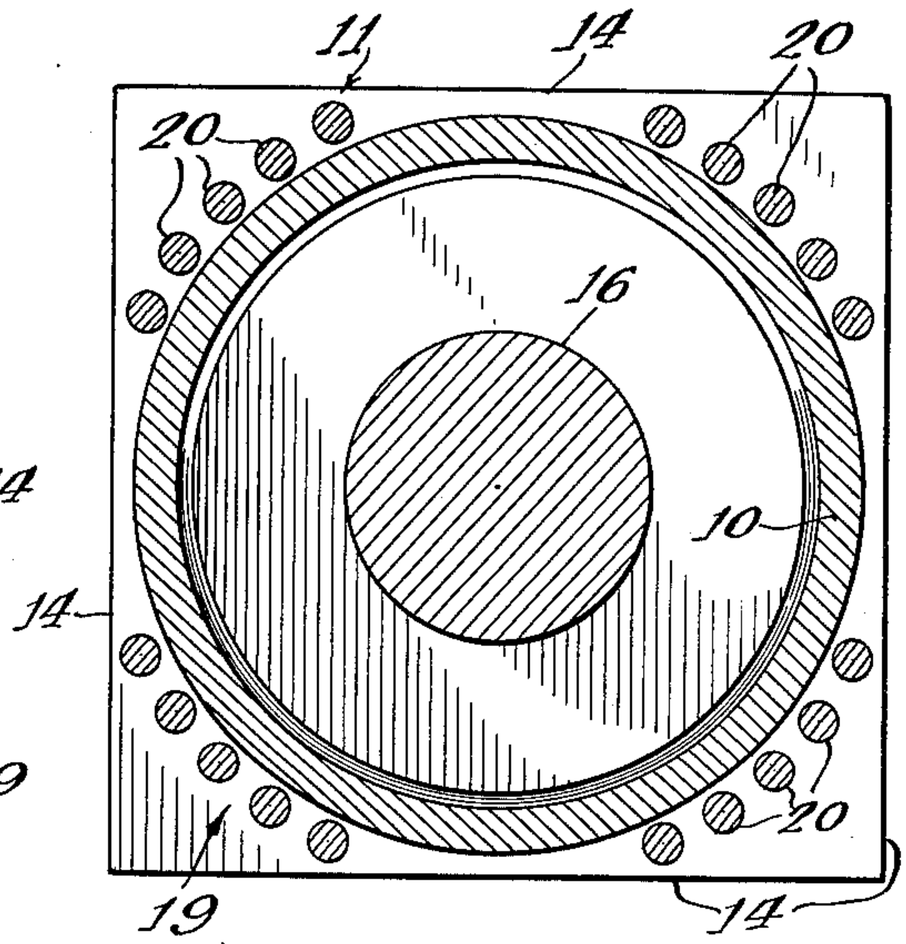

FIG. 3

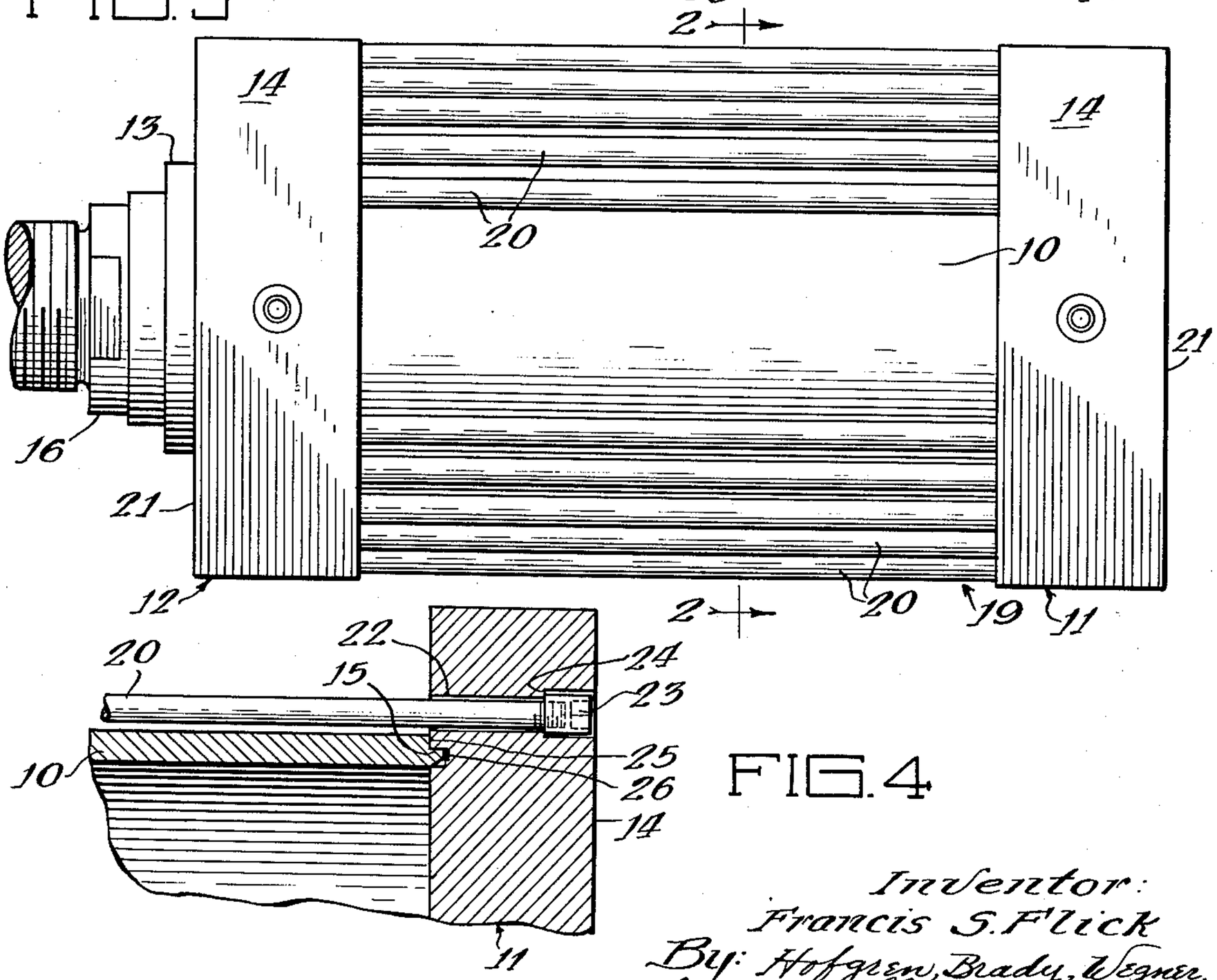

FIG. 4

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MULTIPLE TIE ROD PISTON AND CYLINDER DEVICE

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This invention relates to a piston and cylinder device and more particularly to a large bore cylinder intended for service in installations requiring high pressure hydraulics.

The advantage of making large bore cylinders with tie rods extending between the heads to hold the heads in assembly on the cylinder have been known. It is advantageous to make the heads of the cylinder square in configuration, thus saving space for mounting the cylinder and providing square sides on the heads which may be used with a number of different styles of mounting. In the large bore cylinders, those of 10 to 14 inches, the tie rod sizes have had to be large in order to withstand the tension to which they are subjected at high pressures. Two inch diameter rods were often used in the larger sizes of cylinders. The size of the square heads had to be sufficiently large to accommodate the large tie rods so that the corner areas of the heads would have sufficient metal to receive the tie rods and to withstand the stresses imposed upon the head. Bending stresses in the heads were imposed by the concentrated mass of the large tie rod spacing and the heads were required to be made to resist the loads imposed.

The present invention is an improvement over the former structures and utilizes a plurality of tie rods in place of the former single rod in each corner, the plurality being so located relative to the cylinder and other parts as to provide benefits heretofore unknown. Bending stresses in the heads are reduced, compressive loads upon the cylinder tubing at low pressures more evenly distributed and distinct advantages in manufacture are achieved.

It is the primary object of this invention to provide a new and improved piston and cylinder assembly.

Another object is to provide a large bore cylinder with a plurality of tie rods located relatively close to the cylinder barrel to concentrate the mass of the rods closely adjacent the cylinder so that compression stresses may be distributed more evently to the cylinder wall.

Another object is to provide a novel structure which may reduce bending stresses in the square heads of large bore piston and cylinder devices.

Another object is to provide a novel tie rod structure, for large bore cylinders equipped with square heads, capable of reducing the span between tie rods and the length of the head between the tie rods acting as a beam in resisting stress.

Another object is to provide a novel tie rod structure for large bore cylinders utilizing smaller tie rods which may be assembled properly without the use of special machinery to provide proper tie rod stress.

A further object is to provide such a novel tie rod equipped cylinder in which the tie rod nut structure is capable of resisting higher stresses.

Other objects, features and advantages of the present invention will be apparent from the following description of a preferred embodiment illustrated in the accompanying drawings in which:

FIGURE 1 is an end elevational view of a piston and cylinder device having a relatively large bore and embodying the present invention, the view being taken looking toward the end of the device through which the piston rod reciprocates;

FIGURE 2 is a sectional view of the piston and cylinder device taken substantially as indicated along line 2—2

of FIGURE 3 showing the relative position of the tie rods with respect to the cylinder barrel;

FIGURE 3 is a side elevational view of the piston and cylinder device shown in FIGURES 1 and 2; and

FIGURE 4 is an enlarged fragmentary sectional view of the piston and cylinder device along a plane intersecting one of the tie rods.

The figures of the drawings illustrate a relatively large bore hydraulic piston and cylinder device intended for use wtih high pressures. Referring to FIGURES 1–3, the preferred embodiment of the piston and cylinder device comprises a circular cylindrical cylinder barrel 10 with a head at each end closing the barrel. Herein, the heads include a square cap 11 and a similar square head 12. A piston rod 16 reciprocates through the head 12 and is connected to a piston (not shown) within the barrel. The ends of the cylinder barrel fit within circular grooves 15 in each head and are sealed therein as by the use of a flexible sealing material 26. The barrel is provided with a shoulder 25 which engages the head. It is highly advantageous, for reasons well-known in the art, that the heads have a square shape as shown in FIGURE 2. Flat sides 14 on the heads are arranged in a square configuration having opposite flat sides spaced apart only slightly in excess of the outer diameter of the cylinder barrel while still providing sufficient metal in the corners to receive tie rods. The square configuration is larger than a square inscribing the circular end of the cylinder barrel; corner portions of opposite heads are aligned to receive the tie rods extending therebetween and parallel to the centerline of the cylinder barrel. Such heads are preferably formed from ductile steel bar stock thereby providing resistance to shock loads.

A piston within the cylinder barrel is mounted on one end of the piston rod 16 which reciprocally operates through a bushing (not shown) in the head 12 and secured therein by a bushing retainer 13 fastened to the head by cap screws 17 The outer end of the piston rod is threaded for attachment to apparatus which is to be moved. Hydraulic fluid for moving the piston within the cylinder barrel may be admitted to either side of the piston through ports (not shown) in each head. Although the entire piston and cylinder device is herein shown unsupported, suitable mountings may be provided.

For purposes of holding the head on the cylinder barrel, tie rods are secured between corner portions of opposite heads and extend alongside the outer surface of the cylinder barrel. These tie rods are usually prestressed during assemblage to hold the head in compression against the ends of the cylinder barrel under non-working conditions. However, under working conditions, the relatively high internal fluid pressure directed outwardly against the inner side of the heads tends to overcome the initial pre-stress of the tie rods and remove any compression force on the ends of the cylinder barrel. Relatively high internal pressure acting on the heads has a tendency to push the head otuwardly, which is resisted by the opposed tie rods. The pressure creates bending stresses in the span of the head material between the tie rods. In addition, the high internal pressure may cause the cylinder barrel to expand slightly in a radial direction. The tie rods are usually positioned adjacent to or substantially against the outer surface of the cylinder barrel. It is therefore, of great advantage to have a piston and cylinder construction which further reduces the stresses in the heads without sacrificing the advantages gained by use of a square head configuration.

The present invention provides a construction having tie rod clusters, designated 19, arranged in aligned corners of opposite heads. Each cluster of tie rods herein shown comprises five relatively small diameter tie rods which are closely spaced adjacent each other. Other cylinders may

have other numbers of tie rods in each corner from 2 to 6 or more. The rods in each cluster are spaced apart so as to sufficiently act in concert and yet provide adequate space for tie rod nuts therebetween. In FIGURE 2, each cluster is shown to comprise a plurality of straight circular cylindrical tie rods **20** arranged with their centers lying on an arc and extending parallel to the center line of the barrel. The arc is one having its center on the center line of the cylinder barrel. Although the tie rods may be arranged in another manner, it is prefererd to utilize a single arc so that the mass of each cluster may be maintained as close as possible to the outer surface of the cylinder barrel.

As indicated above, the tie rods **20** of each cluster are located closely adjacent to the outer surface of the cylinder barrel. The use of multiple tie rods in clusters instead of a single large tie rod, concentrates the mass of the tie rods close to the cylinder wall so that the tie rods distribute a more even compression stress lengthwise upon the cylinder barrel upon initail assembly. Each of the tie rods is drawn tight between the heads with a predetermined torque so that the tension stress in all the rods is substantially equal. This places a compressive stress in the cylinder barrel.

Referring to FIGURE 2, the center of the mass of each separate cluster **19** is located generally equidistantly from the mass of adjacent clusters. The portion of the heads lying between opposite clusters and in line with the center of the cylinder barrel generally represents the longest beam span which must resist the bending stresses imposed on the heads. The portion of the heads lying between the centers of adjacent clusters represents another and somewhat shorter beam span which must be considered. If either one of the beam spans is reduced, the bending stresses will accordingly be reduced and there will be less tendency for the heads to dish outwardly. The use of smaller tie rods grouped in the present cluster configuration enables the beam span to be reduced much more than has heretofore been possible with the use of the single tie rods in each corner of the heads.

Referring to FIGURES 1 and 4, the tie rods in each cluster extend through stepped bores **22** in the heads and are held therein by tie rod nuts **23**. The bores **22** are stepped to provide a larger portion to recieve the tie rod nuts. The stepped bores for receiving the tie rods are arranged on an arc having its center coincident with that of the cylinder barrel and the smaller portion is located almost tangent to the outer surface of the cylinder barrel, as shown in FIGURE 4.

The larger portion of each bore in the heads is of a size to receive the tie rod nut **23** with a close fit. Ordinarily the nut may lay flush with the outer surface of the head.

An annular shoulder **24** is formed between the stepped portions normal to the walls thereof for providing a surface against which the tie rod nut may bear in pre-stressing the tie rods. Each nut is confined closely in its bore in the head greatly increasing the hoop-strength of the nut itself because of the immediate backing up of the nut by the surrounding steel of the head. Each nut has an internal bore at one end to threadably engage the end of a tie rod and an internal drive socket at its opposite end for receiving a suitable manual turning tool. Since the tie rods are of a comparatively smaller diameter than the tie rods heretofore used, there is no need for use of special machinery to provide proper tie rod stress when tightening the nuts as manually operated torque wrenches are adequate.

The tie rods are here shown to be substantially equal in diameter and the same size tie rod may be used on different sizes of cylinders by varyying the number of rods used. Any number of tie rods can be combined to provide a proper cluster for any given cylinder size.

Although the cluster design of the present invention is particularly adapted for square shaped cylinder heads, it is conceivable that such cluster construction can be used with non-square cylinder heads having sufficient space in the corners for receiving the tie rods.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, for some modifications will be obvious to those skilled in the art.

I claim:

1. A piston and cylinder device of relatively large bore, comprising: a circular cylindrical cylinder barrel and a head at each end closing the barrel, said heads having a generally square shape; and a cluster of tie rods in each corner of the heads extending beside the cylinder barrel and holding the heads in assembled relation to the cylinder barrel, each cluster having a plurality of tie rods arranged with their centers each lying on a circle having its center coincident with the center of the cylinder barrel, individual tie rods in each cluster being spaced apart whereby the distance across the head between adjacent tie rods in adjacent clusters is appreciably less than in a piston and cylinder device employing a single tie rod in place of said cluster.

2. A piston and cylinder device of relative large bore, comprising: a circular cylindrical cylinder barrel and a head closing each end of the barrel, tie rods joining the heads and securing the heads upon the cylinder barrel, said tie rods extending beside the cylinder barrel with the center of all the tie rods being equidistant from the center of the cylinder barrel, said tie rods being arranged in clusters generally located at the corners of a square inscribing the circular cylindrical barrel.

3. A piston and cylinder device of relatively large bore, comprising: a circular cylindrical cylinder barrel and a head at each end closing the barrel, said heads having a generally square shape; and a cluster of tie rods in each corner of the heads extending parallel to the center-line of the cylinder barrel and holding the heads in assembled relation to the cylinder barrel, each cluster having a plurality of equal diameter tie rods arranged closely adjacent to each other and with their centers lying on an arc having its center on the center of the cylinder barrel, each said tie rod being contiguous with the outer surface of said cylinder barrel.

4. A piston and cylinder device of relatively large bore, comprising: a circular cylindrical barrel, a head on each end of the barrel closing the same, each head having flat sides arranged in square configuration with opposite flat sides being spaced apart only slightly in excess of the outer diameter of the cylinder barrel, opposite heads being positioned on the cylinder barrel so as to align said flat sides and having aligned corner portions for reception of tie rods; and a plurality of tie rods in each corner portion of the heads holding said heads on the cylinder barrel, said tie rods extending along the cylinder barrel and being equidistant from the center of the cylinder barrel.

5. A piston and cylinder device of relatively large bore, comprising: a circular cylindrical cylinder barrel and a head at each end closing the barrel, each head having a generally square shape with corner portions on opposite heads in alignment; and a cluster of tie rods extending between each aligned corner portions of said heads and holding the heads in assembled relation to the cylinder barrel, each said cluster having a plurality of tie rods arranged with their centers lying on an arc having its center on the centerline of the cylinder barrel and lying in contiguous relation with the outer surface of said cylinder barrel whereby said tie rods may provide a relatively even compression force on said cylinder barrel, there being a relatively short distance along the head between tie rods in adjacent clusters whereby to reduce bending stresses in said heads.

6. The piston and cylinder device of claim 5, in which the tie rods have nuts bearing against said heads to hold

said rods in predetermined pre-stress tension, said tie rods being of a relatively small diameter whereby said tie rod nuts may be properly assembled on said rods and pre-stressed manually without the use of special machinery to provide said proper pre-stress.

7. A piston and cylinder device of relatively large bore, comprising: a circular cylindrical cylinder barrel and a head on each end of the barrel closing same, said head being of a generally square shape relative to the end of the cylinder barrel and each having two or more stepped bores arranged in a cluster in each corner of said heads with their centerlines lying on an arc having its center on a centerline of the cylinder barrel, said stepped bores of one head being aligned with the stepped bores of the opposite head and extending through said heads in a direction generally parallel to the cylinder barrel, each said stepped bore providing an annular bearing shoulder therein; tie rods extending between said aligned bores holding said head on said cylinder barrel in assembled relationship therewith; and tie rod nuts, one in each stepped bore, secured to the end of said tie rods and bearing against the shoulder in said stepped bore for holding the tie rods in tension between said heads, said nuts and bore having surfaces closely fitted whereby said bores respectively back up said nuts.

8. A piston and cylinder device of relatively large bore, comprising: a circular cylindrical cylinder barrel and a head on each end of the barrel closing same, said head being of generally square shape relative to the ends of the cylinder barrel and each having a plurality of bores arranged in a cluster in each corner of said heads, said stepped bores of one head being aligned with the stepped bores of the opposite head and extending through said heads in a direction generally parallel to the cylinder barrel, each said stepped bore providing an annular bearing shoulder therein, said bores in each cluster being closely adjacent to each other having their centerlines lying on an arc which has its center on the centerline of said cylinder barrel, the circumference of the smaller stepped portion of said bores being generally

tangent to the outer surface of said cylinder barrel; a plurality of tie rod clusters, each cluster having tie rods with opposite ends extending into said stepped bores on opposite heads; and tie rod nuts, one in each stepped bore, threadably engaging the end of said shoulder in the stepped bore for holding the tie rod in tension between said heads, each said tie rod nut having a socket for internal drive and lying fully within said opening to be flush with the outer surface of said heads.

9. A cylinder construction for a piston and cylinder device of relatively large bore, comprising: a circular cylindrical cylinder barrel for receiving a piston; a head closing each end of said cylinder barrel, said heads, each having a generally square shape, approximately inscribing the end of said cylinder barrel and opposite heads having corner portions in alignment, each head having a plurality of stepped bores therethrough providing an annular shoulder in each bore; a cluster of tie rods extending between aligned corner portions of said heads, the center of the mass of the clusters being spaced equidistantly along a circle concentric to said cylinder barrel, each cluster having a plurality of tie rods of equal length and diameter extending into said bores of opposite heads, said tie rods in each cluster being arranged with their centers lying on an arc having its center on the centerline of said cylinder barrel and lying in contiguous relation with the outer surface of said cylinder barrel; and a plurality of tie rod nuts on each end of said tie rods holding said cylinder barrel and heads in assembled relation, said tie rods of each cluster being spaced closely adjacent to each other and contiguous to the outer surface of said cylinder barrel.

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