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PISTON MOLDING CORE

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2 Sheets-Sheet 1

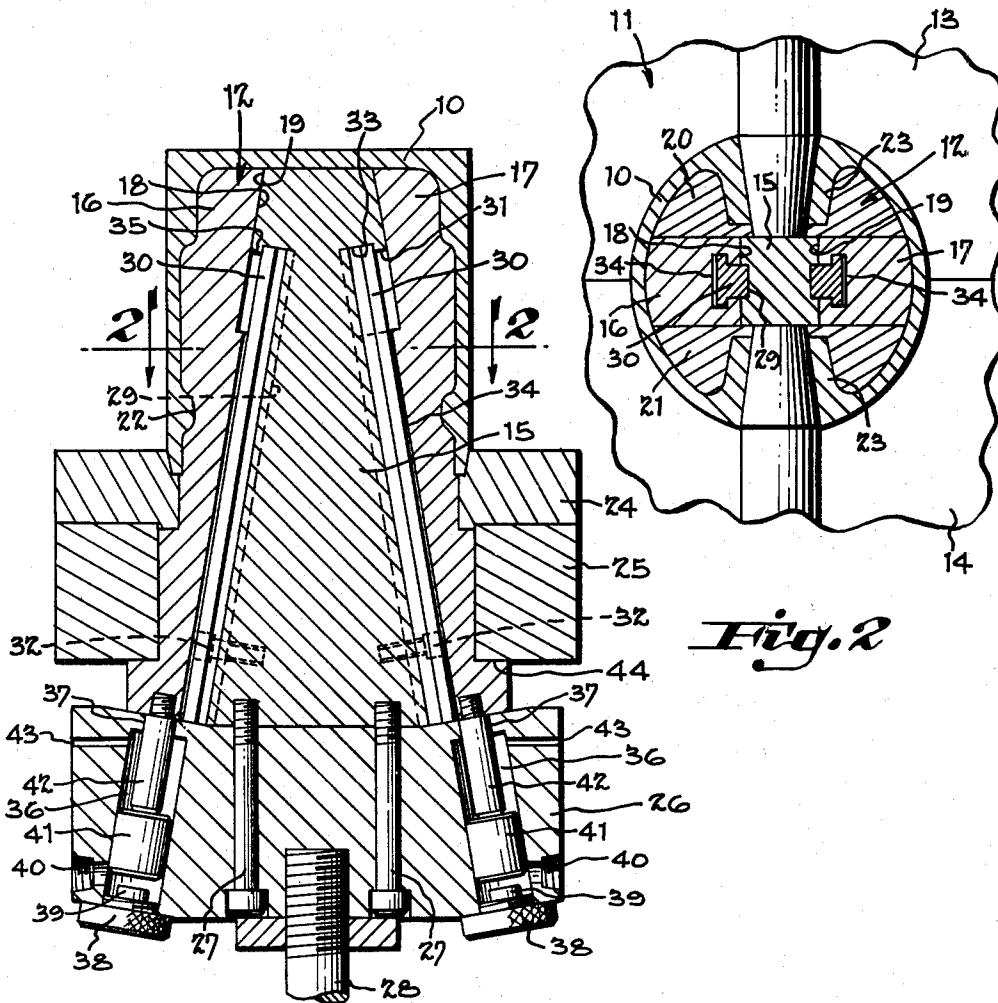


Fig. 1

Fig. 2

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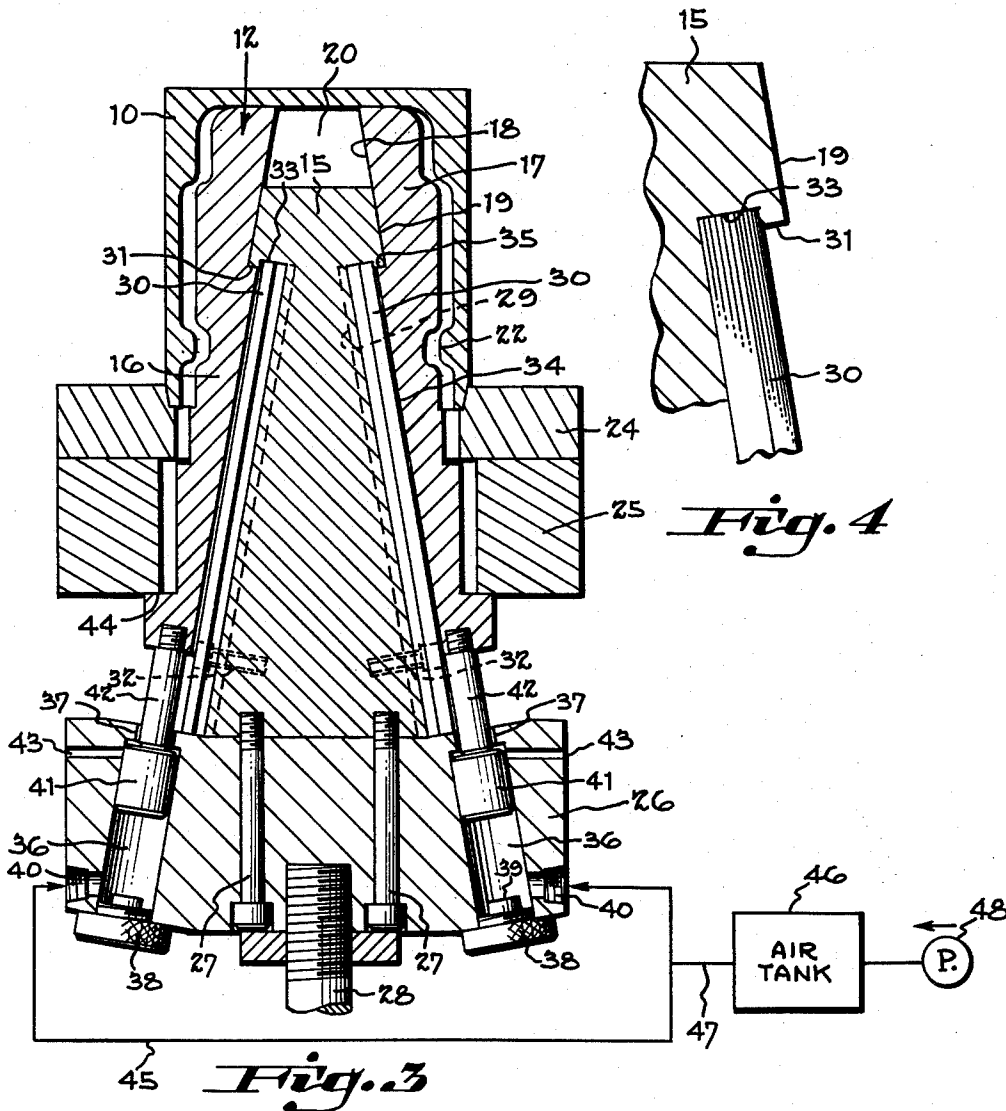
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PISTON MOLDING CORE

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This invention is directed to molding cores and, more particularly, to a core for use in molding pistons for internal combustion engines in which the pistons have an internal annular ledge or ring which prevents a direct withdrawal of the molding core after the piston has been cast.

The pistons in use today have a head and a depending skirt, and are usually cast in an aluminum alloy to save weight. The skirt is generally thin-walled, since it does not carry much load, serving, rather, to align the axis of the load carrying head coincidentally with the axis of the cylinder so that the head cannot twist or become jammed within the cylinder. The pistons are cast and then machined to final dimensions. Inwardly extending annular grooves are machined into the outside of the piston at various stations to receive the piston rings which make the seal with the cylinder wall. In the extra lightweight pistons that are becoming increasingly common in automobile and particularly truck engines, the skirts are so thin walled as to require a build-up in thickness on the inside of the skirt, as for example adjacent to the lower edge of the skirt. This build-up in thickness is below the bosses at the inside of a piston and it can readily be seen that the internal configuration of such a piston requires the use of a somewhat unique molding core rather than a conventional one-piece core, since the wrist pin bosses and the annular ledges prevent the removal of such a core after the piston had been cast.

The problem is further complicated by several other factors. The aluminum alloy of which the piston is cast has a high crystallization shrinkage and also a coefficient of expansion and contraction several times that of the cast iron or steel of which the core is almost universally constructed. The poured piston, upon solidifying and cooling, tends to shrink away from the outside mold halves, but also tends to shrink tighter on the core, which may result in the development of hairline cracks in the thin skirt or even freezing of the casting on the core. This demands that the core be removed while the piston is still relatively hot. Furthermore, the production of trucks and automobiles being what it is, the magnitude of the piston casting problem is increased many fold. Obviously, destructible cores are impractical in the mass production of piston castings; and, even if reusable collapsible cores are employed, they must be susceptible of adaptation to automatic operation.

Many attempts have been made to provide an adequate collapsible multi-element core. Such cores commonly have had side sections which acted with a middle section, movable relative thereto, to present the desired surface, the core being removable from the mold piece-by-piece in such a way as to disengage from the wrist pin bosses and the annular ledge.

As the present invention involves several highly commercial improvements over prior automatically operable collapsible molding cores, it is necessary to describe these prior cores in order that the advantages of the present invention may better be comprehended.

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Both prior and present cores are made in five pieces. Two of these pieces constitute side sections, the other three pieces together constituting a middle section. The two side sections are configured to form the wrist pin bosses. Their removal presents no problem once the middle section has been withdrawn, inasmuch as they can be shifted into the space previously occupied by the middle section. The difficult problem, and the one to which this invention is directed, lies in the removal of the middle section past an internal ledge on the piston skirt. In the present instance this is done, following known techniques, by utilizing a middle section having an upwardly tapering wedge or center piece, together with two end pieces commonly called "corner blocks." The corner blocks have inner surfaces conforming to the taper of the center piece and are keyed along these inner surfaces to the center piece so that partial withdrawal of the wedge-shaped center piece cams the corner blocks in toward the center of the piston away from the skirt sufficiently far to clear the internal ledge. Once clearance is established, the corner blocks and the wedge or center piece may be withdrawn completely. After this, the removal of the two side sections presents no difficulty.

In the past, the keying means have comprised a T-shaped keyway slot cut in one or the other of the adjacent corner block and center piece faces, in which slot rides a button-headed machine screw or a similar device which is fastened to the opposite face. One improvement of this invention resides in the provision of long T-shaped keys which ride in cooperative keyways to attach the center piece to the corner blocks and to provide the necessary sliding movability. The prior keying devices, for example, the button-headed screw, were in contact with the keyways only at isolated points and, therefore, were occasionally malfunctioning as they acted as swivels about which the corner blocks could turn or twist. As explained above, the core must be withdrawn from the piston after the metal has solidified, but before the cooling and shrinking piston becomes frozen to the core. At the stage in the cooling of the piston when the core must be withdrawn, the piston thus is quite fragile and, if the corner blocks twist, the piston is deformed. The long keys of the present invention, which extend substantially the full length of the keyways, permit no such twist to occur. The result is an exceedingly smooth-acting camming means which acts positively to impart only a sliding motion to the corner blocks and permits no relative twist.

In addition to the above discussed means to cam the corner blocks in as the center piece is withdrawn, it will be apparent that there must also be provided biasing means to prevent the corner blocks from moving downwardly until they have been cammed inwardly to a point at which they are clear of the newly-cast internal ledges. In other words, initially there must be lost motion between the center piece and the corner blocks so that the corner blocks translate horizontally but not vertically. Downward movement of the corner blocks prior to the point at which they are clear of the ledges will bring pressure to bear on the ledges and tend to crack them off. In the past, such means have resided in the provision of coil springs which bias the corner blocks upwardly. The inherent difficulty in the use of these springs lies in the fact that they must operate at high temperatures which promotes rapid metal fatigue so that the springs must be replaced at regular, frequent intervals. Another of the improvements of the present invention resides in the provision of fluid-actuated biasing means in place of coil springs. This eliminates the fatigue and replacement problem.

The use of any sort of corner block biasing means, be it spring, fluid or otherwise, in conjunction with button-headed screws riding in the keyways, creates a critical

problem of alignment. For, unless the biasing means exerts a force which is exactly in that vertical plane containing the axis of the button screw, a torque will result which will cause the corner blocks to twist about the screw axis, thereby deforming the new-cast piston. Therefore, the biasing means, whatever their nature, have had to be most carefully aligned so as to act on the corner blocks along just the right line of force. The provision of the long T-shaped keys of the present invention obviates the necessity of such critical alignment, since inherently there can be no twist imparted by the long key. The driving rod of the fluid-operated biasing means herein provided thus functions perfectly without the necessity of accurate fitting.

These improvements and other features of the invention are disclosed in the accompanying drawings in which:

Figure 1 is a diagrammatic longitudinal cross-sectional view taken through the central axis of the core and showing the relative relationships of the center piece and corner blocks to each other and to the piston during casting.

Figure 2 is a diagrammatic cross-sectional view of the piston and mold taken on the line 2—2 of Figure 1, showing the corner blocks cammed out to molding position by the center piece.

Figure 3 is a longitudinal cross-sectional view similar to Figure 1, but showing the relationship of the center piece and corner blocks to each other and to the piston as the center piece is being withdrawn.

Figure 4 is an enlarged fragmentary cross-sectional view showing the method whereby the end of the T-key is attached to the center piece.

As is best shown by Figures 1 and 2, a piston 10 is cast within a mold between an outer mold 11 (Figure 2) and a core 12. The inner surfaces of the outer mold and the outer surface of the core are configured so as to present the desired molding shape. The outer mold is formed conventionally of two mating halves 13—14 (shown diagrammatically only). The inner core consists of a wedge-shaped center piece 15, two opposed corner blocks 16 and 17, having inner faces 18—18 of a taper conforming to that of the wedging faces 19—19 of the center piece 15 with which they mate, and two side sections 20 and 21 which are slidable relative to the three member center section formed by the center piece and the two corner blocks. A piston cast within the mold thus arranged has a head and a thin walled skirt below the head (the piston being cast head up, as is shown in Figure 1). Near the lower edge of the skirt is an internal reinforcing annulus or ledge 22. Above the ledge, on the inside of the skirt, are diametrically opposed wrist pin bosses 23—23. The side sections present cavities within which the bosses are formed. From Figure 2 it is apparent that if the center section is withdrawn, the side sections may be removed into the space thus vacated so that they clear the bosses and they may also be removed from the piston.

Automatic means not shown control the movement of the outer mold halves, mating them when a piston is to be cast and separating them after the case piston has solidified. The mold halves thereby actuated are reciprocable over a horizontal base plate 24. A spacing plate 25 resides below and parallel to the base plate.

The center piece is seated on a transversely extending yoke 26 and is held thereto by means of vertical tie bolts 27—27 extending through the yoke and engaging threaded sockets in the center piece. The yoke 26 is attached by a screw threaded connection to a piston rod 28 below it. The axis of the piston rod is coincidental with the central axis of the piston being molded. The piston rod, following conventional practices, works in a cylinder, not shown, and is automatically operable so as to insert and withdraw the center piece at the correct times during the casting process.

The corner blocks 16—17 are keyed to the center

piece so that withdrawal of the center piece by a downward force exerted on the piston rod cams them in toward each other and away from the annular ledge, in order that they may be removed from the interior of the piston. A shallow slot 29 is milled longitudinally along each of the two slanting wedge faces of the center piece. Seated in each one of these slots is a T-shaped key 30 which runs from a lower point closely adjacent the yoke up to the center piece head which has protruding shoulders 31—31. As shown, the center piece head constitutes substantially less than the upper one-fourth of the center piece. Hence, each key is greater in length than three-fourths of the length of the face of the center piece in which it is seated. Near their lower ends the keys 30 are held in the slots by capscrows 32—32 which extend through the keys into threaded sockets in the center piece, the keys being recessed so as to receive the capscrow heads. An improved method of attaching the upper ends of the keys to the center piece is shown in Figure 4. A transverse groove 33 is milled across the underside of the shoulder, the groove being just wide enough to tightly receive the end of the key. The lip of the shoulder bears on the key to seat and retain it in the groove. The advantage of this method of holding the keys to the inclined faces of the center piece is that the fastening is at the very end of the key and causes no deformity of the key such as intermediately spaced screws might cause. There being no deformation, the key will ride more smoothly in its keyway thereby insuring a more even and continuous camming action. This is important since, as was previously explained, at the stage of casting at which the camming action occurs, the piston is still relatively plastic and would be easily deformed if a jerking or jamming movement occurred in the camming process.

The keys ride in T-shaped keyways 34—34 which are milled into the faces 18 of the corner blocks 16—17. As will be explained presently, the keyways terminate at shoulders 35—35 which present abutments to the shoulders 31—31 on the center piece 15.

Angulated cylinders 36—36 are bored upward into the yoke 26 at its opposite ends. Smaller bores 37—37 coaxial with the cylinders, extend through the cylinder heads. The lower ends of the cylinders are plugged with caps 38—38 which have stops 39—39 on their upper faces. Through inlets 40—40 closely adjacent the caps the cylinders are connected to a high pressure air supply, not shown. Free pistons 41—41 ride in the cylinders. Biasing rods 42—42 project angularly from the bottom faces of the corner blocks and extend into the cylinders passing loosely through the holes at the upper ends of the cylinders. Bleed off holes 43—43 vent the upper ends of the cylinders above the pistons to the atmosphere. The axes of the biasing rods are approximately coincidental with those of their respective cylinders and make approximately the same angles with the vertical as do the adjacent slanting faces of the center piece and corner blocks, as is readily seen from Figure 1.

When air under pressure is admitted through the inlets into the cylinders beneath the pistons it exerts forces on the bottom faces of the pistons, causing them to move upwardly in their respective cylinders, so that the upper faces of the pistons come to bear against the lower ends of the biasing rods, thereby transmitting through them an upward biasing force to the corner blocks from which the biasing rods depend. Upward movement of the corner blocks is limited by the spacer plate 25 the edges of which arrest lateral shoulders 44—44 formed on the corner blocks. Thus, the cylinders and biasing rods act together to keep the shoulders 44—44 bearing against the spacing plate regardless of the vertical position of the center piece and yoke within the limits to be described. The stops 39 on the cylinder caps 38 space the pistons from the caps and above the bore inlets so that air pressure is always exerted on the lower faces of the pistons.

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The bleed off holes vent the chambers above the pistons to atmosphere so that under no circumstances can air pressure build up above the pistons locking them against the caps.

Since the provision of long keys rather than button screws to track in the keyways eliminates the twisting problem above referred to, the lines along which the biasing forces act are not critical, so long, of course, as they are generally upward. In other words, even if the lines of force are not exactly in the vertical plane of symmetry of the keys, the resultant torque still will not cause the corner pieces to twist relative to the center piece, since the long keys prevent them from doing so. Simply from a design standpoint it is advantageous that the pistons act on the bias rods along lines parallel to the planes of the wedge faces rather than skew to them, for otherwise the bias rods would slip sideways over the pistons when the center piece is moved. This accounts for the angulation of the bias rods and cylinders. Furthermore, since the alignment is not critical, the biasing rods may fit loosely in the holes in the cylinders above the pistons. Previously these holes and rods have had to be precisely positioned and angulated for proper alignment.

The schematic diagram which is superimposed upon Figure 3 illustrates the preferred means of supplying the cylinders 36—36 with air under pressure. In the instance shown, an air line 45 is connected to both of the inlets 40—40. Air under pressure from an air tank 46 enters the line 45 through a connector line 47. The air tank is supplied periodically by means such as a pump 48 to maintain a pressure in the air tank which is at some constant level sufficient to insure that the two corner blocks 16—16 are prevented from moving down during the initial downward movement of the center piece 15. The biasing force of the air pressure within the cylinders is simply overcome by the much greater force acting upon the piston rod 28 when the movement of the center piece is in the opposite direction relative to the corner blocks. Under these circumstances, the air simply backs up in the line 45. In an installation, a number of molding units may be employed in one machine. Hence the line 45, under these conditions, would constitute a manifold common to all inlets.

Figure 1 shows the core in casting position. The corner blocks 16—17 are in their uppermost attitude in which the shoulders 44—44 bear against the spacer plate 25. Thus positioned, the corner blocks 16—17, center piece 15 and side sections 20—21 together present the desired internal molding surface.

Immediately after the piston has been poured and solidifies it shrinks away from the outside mold halves, so that their removal presents no problem. The center piece is now withdrawn.

The initial downward movement of the center piece 15 causes it to slide relative to the side sections 20—21 from the position shown in Figure 1 to that shown in Figure 3. During this movement the corner blocks are held against downward movement by the upward biasing force applied through the rods 42—42, so that the downward movement of the center piece cams the corner blocks in toward the center of the core until they are at positions such that they will not engage the internal ledges on the piston when moved downwardly. At this point, the shoulders 31—31 on the center piece head come to bear against the abutments, presented by the corner blocks at shoulders 35—35 and, positively engaging them, cause the corner blocks to move vertically down since no further relative sliding movement is possible. The entire center section is thus withdrawn with only the side sections remaining within the newly cast piston. These sections may then be moved away from the newly cast bosses and into the space vacated by the center section, and then removed.

The advantages of the present invention therefore reside in the facts that the fluid operated biasing means

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do not wear out or fatigue, that the alignment of the biasing rods is not critical and that the keying means permits no twisting between the corner blocks and center pieces.

Having described my invention, I claim:

1. In a multi-section piston molding core having a three piece middle section, the improvement in the middle section comprising a center piece having side faces which taper symmetrically upwardly with respect to the vertical central axis of the piece, two corner blocks, each block having a tapered face mating with the tapered face of a side of the center piece, the center piece having downwardly presented shoulders opposite side faces within the upper fourth thereof, an elongated key which is T-shaped in cross section affixed to each of the side faces of the center piece and extending from the shoulder to the bottom of the center piece in the plane of the vertical central axis of the piece, a keyway in each of the mating faces of the corner blocks slidably receiving said keys, the angulation of the mating faces of the center piece and the two corner blocks being such that downward movement of the center piece causes the two corner blocks to move inwardly toward each other, abutments on the corner blocks engageable with said downwardly presented shoulders on the center piece to limit downward movement of the center piece with respect to the two corner blocks, the spacing between the abutments and the shoulders being such as to permit substantial inward movement of the corner blocks prior to engagement of the shoulders with the abutments, and means biasing the corner blocks upwardly with respect to the center piece to hold the corner blocks up during downward movement of the center piece to the abutments, the last named means comprising a yoke secured to the lower end of the center piece and having portions thereof below the corner blocks, each of said yoke portions having a cylinder therein which is generally parallel to a keyway, a rod secured to the lower end of each corner block and extending into a cylinder, and a free piston in each cylinder, whereby application of fluid pressure to the cylinders underneath the pistons drives the pistons upwardly within the cylinders and into contact with the rods therein to force the rods relatively upwardly.

2. The improvement as set forth in claim 1 in which the upper end of each key is engaged in a slot in the underside of a shoulder.

3. In a multi-section piston molding core having a three-piece middle section, the improvement in the middle section comprising a center piece having side faces which taper symmetrically upwardly with respect to the vertical central axis of the piece, two corner blocks, each block having a tapered face mating with the tapered face of a side of the center piece, a pair of outwardly flaring shoulders at the opposite side edges of the center piece adjacent to the upper end thereof, slots along the under sides of the said shoulders, the tapered faces of said center core being configured to provide keyways, elongated keys which are T-shaped in cross section seated within said keyways in each side face of the center piece and extending from the shoulders to the bottom of the center piece adjacent the side faces thereof and the upper end of each of said keys being securely engaged in and by the slots formed in the under sides of said outwardly flaring shoulders.

4. In a multi-section piston molding core having a collapsible three-piece middle section comprising a center piece and two corner blocks, said center piece having opposite side faces which taper symmetrically upwardly with respect to the vertical central axis of the piece, each of said corner blocks having a tapered face mating with a side face of said center piece, the improvement comprising; in combination therewith; means biasing the corner blocks upwardly with respect to the center piece to hold the corner blocks up during the collapsing action of said core in which the center piece is drawn downwardly,

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said means comprising a yoke secured to the lower end of the center piece and having portions thereof below the corner blocks, each of said yoke portions having a cylinder therein which is generally parallel to the tapered face of a corner block, a rod secured to the lower end of each corner block and extending into one of said cylinders, and a free piston in each cylinder below the rod therein, whereby application of fluid pressure to the cylinders underneath the pistons drives the pistons upwardly within the cylinders and into contact with said rods to force the rods relatively upwardly.

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