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TEMPERATURE COMPENSATING HYDRAULIC CYLINDER

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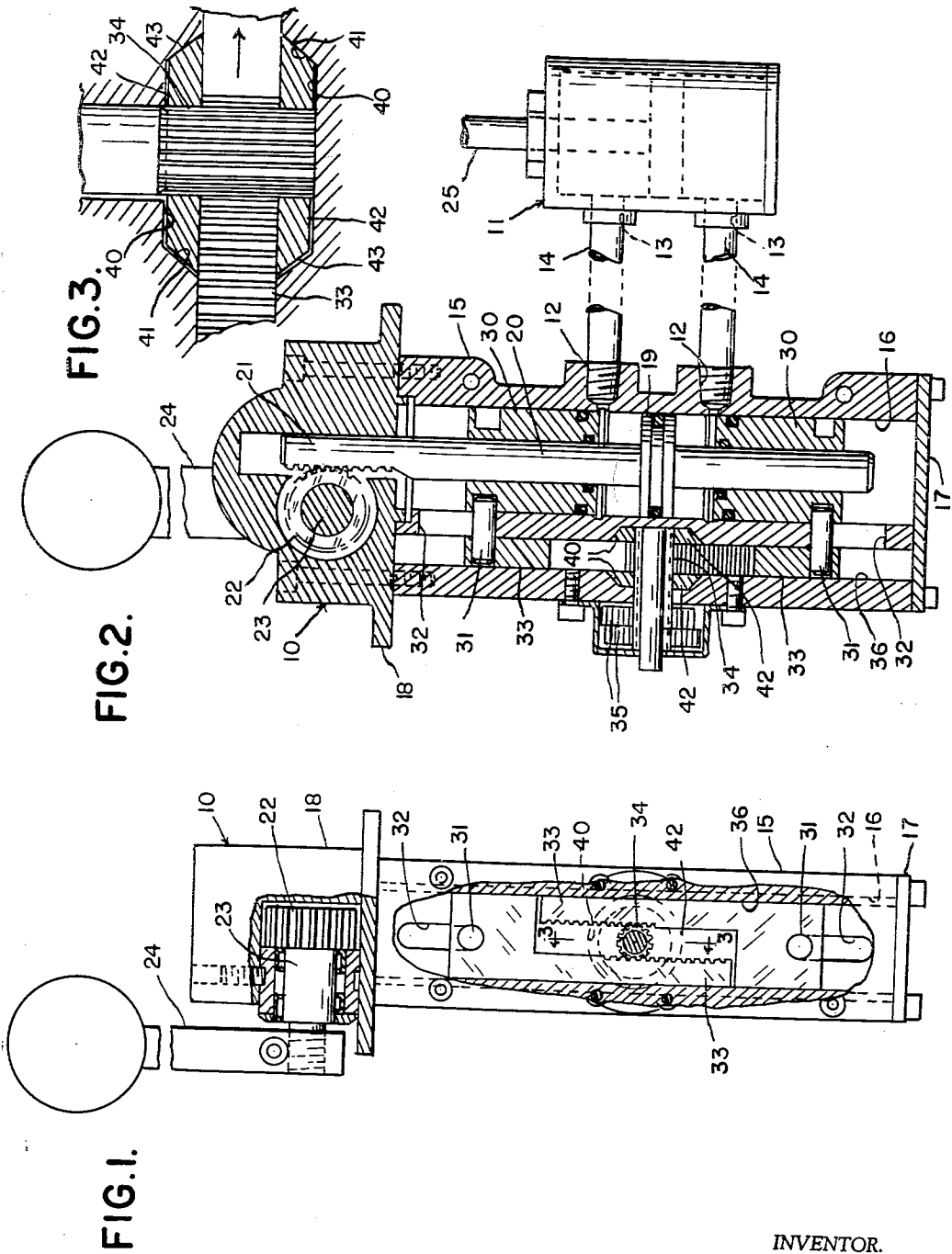


FIG. 1.

FIG. 2.

FIG. 3.

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## TEMPERATURE COMPENSATING HYDRAULIC CYLINDER

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6 Claims. (Cl. 60—54.5)

My invention relates to hydraulic cylinders and more particularly to a temperature compensating cylinder for use in a closed circuit hydraulic system.

In closed circuit hydraulic systems such as a remote control circuit having master and slave cylinder and piston assemblies, a means is required to compensate for changes in the volume of fluid in the system effected by expansion and contraction of the fluid, such a means being operable without affecting the accurate functioning of the system.

An object of the present invention is to improve closed circuit hydraulic systems by providing a simplified temperature compensating device for altering system volume without affecting precise operation of the system.

Another object of the invention is to simplify temperature compensation in closed circuit hydraulic systems by providing a cylinder device with interconnected movable cylinder heads having an automatically actuated brake operable when unequal forces are applied.

A further object of the invention is to improve closed circuit hydraulic systems by constructing an improved automatically actuated temperature compensating device operable to expand and contract the volume of the system without effecting the sensitivity thereof.

For a more complete understanding of the invention, reference may be had to the accompanying drawing illustrating a preferred embodiment of the invention in which like reference characters refer to like parts throughout the several views and in which

Fig. 1 is a cross-sectional view of a preferred master cylinder embodying the invention and connected with a preferred closed-circuit hydraulic system.

Fig. 2 is a top view of the cylinder of Fig. 1 partially in section to show the mechanism, and

Fig. 3 is a fragmentary cross-sectional detail view taken substantially on the line 3—3 of Fig. 1.

A preferred remote control type of closed circuit hydraulic system is illustrated as comprising a master cylinder 10, which preferably incorporates the temperature compensating feature, and a slave cylinder 11, the cylinders having outlets 12 and 13 respectively, connected by conduits 14.

The master cylinder 10 comprises preferably a housing 15 having a cylinder bore 16 closed by a plate 17 at one end and a support member 18 at the other. A piston 19 is slidable in the bore 16 intermediate the outlets 12, being mounted on a shaft 20 which has a rack portion 21 at one end for actuation by a gear 22 connected by a shaft 23 to a handle 24. Operation of the piston 19 directs hydraulic fluid through the conduits 14 in one direction or the other to operate a piston assembly 25 in the slave cylinder 11.

A pair of cylinder heads 30, one on each side of the piston 19, are axially slidable in the bore 16 and on the shaft 20. Each head 30 is connected by a pin 31 or other means, operating through a slot 32 in the housing 15, with a rack 33, the two racks being interconnected by means of a medial spline gear 34 to synchronize the

racks 33 and heads 30 for equal movement in opposite directions.

When the hydraulic fluid expands and contracts under the influence of temperature or other changes, the cylinder heads 30 can move in equal opposite directions to alter the total system volume, ensuring that the effect is equal on the two sides of the piston 17 so that the operating conditions in the system are unaffected.

Springs 35 are preferably mounted on the housing 15 and connected with the end of the spline gear 34 such as to urge the racks 33 and cylinder heads 30 inward by rotating the gear 34. The racks 33 slide within a groove 36 provided in the housing 15.

It is essential in the present type of system that operation of the piston 19 putting pressure on one side of the system will in no manner be able to move the cylinder heads 30, so a means must be provided for locking the cylinder heads 30 against movement only when the piston 19 is operated or, in case the cylinder 10 is used as the slave unit, when pressures on opposite sides of the piston 19 are unequal. For this purpose, a pair of circular recesses 40 are provided in the housing 15, each recess 40 having a peripheral edge 41 which is preferably sloped at an angle of about 45 degrees, substantially as shown in Fig. 3.

A pair of brake discs 42 are secured to the splined gear 34, one disposed in each recess 40 and having similarly sloped edges 43. The discs 42 contact the racks 33, and any movement tending to laterally displace the discs 42 will cause the edges 43 of the discs 42 to engage the sloping edges 41 of the recesses 40, producing angular braking friction between the discs 42 and edges 41 and additionally displacing the discs axially inwardly, the discs thus frictionally engaging the racks 33 to lock them against movement. Since the mechanism has fairly close fitting parts, the aforesaid displacements are made possible only by the slight side play present in such mechanisms, as indicated in exaggerated degree in Fig. 3. When the two cylinder heads move under the influence of system expansion and contraction, or when the racks are moved by the gear 34 from the springs 35, no side movement occurs since both cylinder heads tend to move their respective racks 33 the same amount so that the gear 34 will maintain a constant position centrally of the racks and the discs 42, although contacting the recess edges 41 and the racks 33, will apply no braking action since they are not thrust against the sloped edges 41. Thus the ultimate effect of the mechanism is to automatically lock the cylinder heads 30 only at such times that unequal forces are applied thereto, the discs 42 at such times due to the racks tending to move by unequal amounts, being thrust sideways against the edges 41 which cam the discs inward into friction engagement with the racks 33, locking them in position. It should also be noted that I have found the use of the one disc 42 to be about as effective as the two discs shown for locking the racks 33.

Although I have described only one preferred embodiment of my invention, it will be apparent to one skilled in the art to which the invention pertains that various other changes and modifications may be made therein without departing from the spirit of the invention and the scope of the appended claims.

I claim:

1. In a closed circuit hydraulic system, a hydraulic cylinder having spaced outlets, a piston operable in said cylinder intermediate said outlets, means compensating for changes in the volume of fluid in said hydraulic system effected by expansion and contraction of the fluid and comprising movable cylinder heads in said cylinder, means synchronizing the movement of said cylinder heads for equal opposite movement and comprising a rack element connected with each cylinder head and a gear

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rotatably carried by said cylinder and engaging said racks, and braking means operable to arrest movement of said cylinder head and actuatable in response to a build up of unequal fluid pressures in the cylinder chambers to either side of said piston, said braking means applied to said means synchronizing the movement of said cylinder heads.

2. In a closed circuit hydraulic system, a hydraulic cylinder having spaced outlets, a piston operable in said cylinder intermediate said outlets, means compensating for changes in the volume of fluid in said hydraulic system effected by expansion and contraction of the fluid and comprising movable cylinder heads in said cylinder, means synchronizing the movement of said cylinder heads for equal opposite movement and comprising a rack element connected with each cylinder head and a gear rotatably carried by said cylinder and engaging said racks, and braking means coacting with said gear and said racks and operable to arrest movement of said cylinder heads only when unequal forces act thereon, said braking means comprising a disc element connected with and rotatable with said gear and contacting said racks, said racks being engaged with said gear for opposite synchronizing movement, and means urging said disc element into frictional braking contact with said racks only when the aforesaid forces tend to move said racks in the same direction.

3. In a closed circuit hydraulic system, a hydraulic cylinder having spaced outlets, a piston operable in said cylinder intermediate said outlets, means compensating for changes in the volume of fluid in said hydraulic system effected by expansion and contraction of the fluid and comprising movable cylinder heads in said cylinder, means synchronizing the movement of said cylinder heads for equal opposite movement and comprising a rack element connected with each cylinder head and a gear rotatably carried by said cylinder and engaging said racks, and braking means coacting with said gear and said racks and operable to arrest movement of said cylinder heads only when unequal forces act thereon, said braking means comprising a disc element connected with and rotatable with said gear and contacting said racks, said racks being engaged with said gear for opposite synchronizing movement, and means urging said disc element into frictional braking contact with said racks only when the aforesaid forces tend to move said racks in the same direction, said cylinder having a circular recess adjacent said gear, said recess having a sloped peripheral edge, said disc element disposed in said recess and having a similarly sloped peripheral edge, whereby any movement acting to laterally displace said disc effects friction engagement of the sloped edges of said recess and said disc to produce axial displacement of said disc relative to said recess.

4. In a closed circuit hydraulic system, a hydraulic cylinder having spaced outlets, a piston operable in said cylinder intermediate said outlets, means compensating for changes in the volume of fluid in said hydraulic sys-

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tem effected by expansion and contraction of the fluid and comprising movable cylinder heads on said cylinder, means synchronizing the movement of said cylinder heads for equal opposite movement and comprising a rack element connected with each cylinder head and a gear rotatably carried by said cylinder and engaging said racks, and braking means coacting with said gear and said racks and operable to arrest movement of said cylinder heads only when unequal forces act thereon, said braking means comprising a disc element connected with and rotatable with said gear and contacting said racks, said racks being engaged with said gear for opposite synchronizing movement, and means urging said disc element into frictional braking contact with said racks only when the aforesaid forces tend to move said racks in the same direction, said cylinder having a circular recess adjacent said gear, said recess having a sloped peripheral edge, said disc element disposed in said recess and having a similarly sloped peripheral edge, whereby any movement acting to laterally displace said disc effects friction engagement of the sloped edges of said recess and said disc to produce axial displacement of said disc relative to said recess, the slope of the aforesaid recess and disc edges being approximately 45 degrees with respect to the axis of said disc.

5. In a closed circuit hydraulic system, a hydraulic cylinder having spaced outlets, a piston operable in said cylinder intermediate said outlets, means compensating for changes in the volume of fluid in said hydraulic system effected by expansion and contraction of the fluid and comprising movable cylinder heads in said cylinder, means synchronizing the movement of said cylinder heads for equal opposite movement and comprising a rotatable element, an actuating element connected with each cylinder head and engaged with said rotatable element, said actuating elements and said rotatable element operably coacting to maintain equality of movement of said cylinder heads, and braking means operable to arrest movement of said cylinder head and actuatable in response to a build up of unequal fluid pressures in the cylinder chambers to either side of said piston, said braking means comprising a friction braking element moved into braking engagement with said actuating element in response to forces produced by said unequal pressures in the cylinders tending to move said rotatable element.

6. A closed circuit hydraulic system as set forth in claim 1, wherein said braking means comprises a friction braking element moved into braking engagement with the means synchronizing the movement of the cylinder heads actuated.

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