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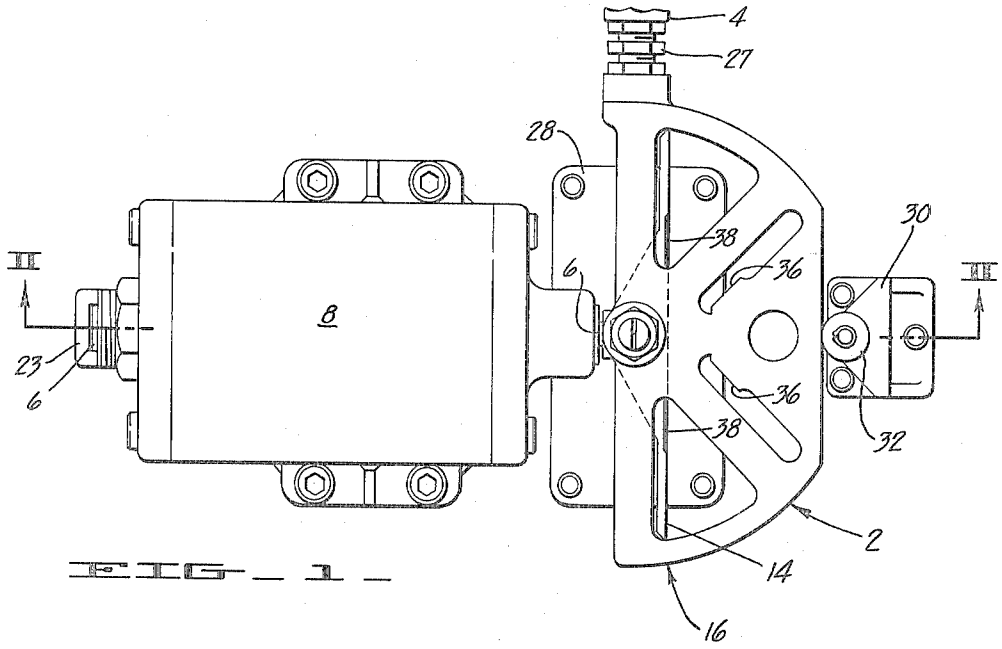


FIG. 1

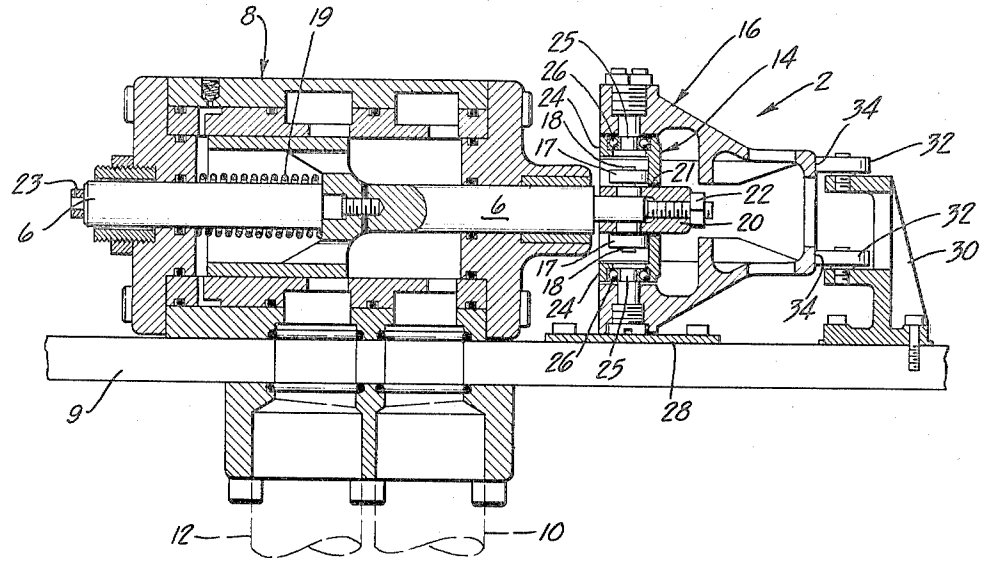


FIG. 2

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PIVOTAL CAM PLATE MECHANISM

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5 Claims. (Cl. 74—110)

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This invention, which relates to driving connections and more particularly to cam mechanisms for converting bi-directional input motions into unidirectional output motions, may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

In making certain driving connections, it sometimes becomes necessary to provide a linkage capable of converting a longitudinally bi-directional motion produced by a driving member into a unidirectional motion in a direction that is transverse to this longitudinal drive. More specifically, the linkage requirement may be one in which the driven member always is to be moved only to one side of a neutral position even though the driving member producing this motion is moved on both sides of that neutral position.

Thus, by way of example, the flow ratio controller in the error channel of a pressure demand servomechanism usually requires a metering valve in the hydraulic by-pass circuit and 4-way valve-metering valve unit in the hydraulic load circuit. The bypass metering valve stem movement that controls the valve port area is produced through a mechanical driving connection or linkage with the 4-way valve-load metering valve unit. The 4-way valve-load metering valve unit accomplishes its opening and closing movements on either side of a neutral position in response to increasing and decreasing servomechanism error signals in the positive and negative directions. Consequently the valves of this unit have what can be called bi-directional movement (movement to either side) from this neutral position. However, the by-pass metering valve accomplishes its closing and opening movements only to one side of its neutral position in response to increasing and decreasing servomechanism error signals in the positive and negative directions. Consequently, this valve should have what can be called unidirectional movement (movement to one side) from this neutral position.

The requirement then is to convert the bi-directional movement of the driving member (4-way valve-load metering valve) into a unidirectional movement in the driven member (by-pass metering valve) and, one of the better known linkages for accomplishing this conversion is the so-called V-block cam mechanism. In making such a linkage the V-block cam plate may be secured for reciprocation with the valve stem of the 4-way valve-load metering valve unit, while the usual cam follower is mounted on the by-pass metering valve stem, and, with such a coupling, it should be clear that, if the neutral position of the by-pass metering valve is one in which the valve stem follower contacts the notch of the V-block, then bi-directional reciprocation of the block will effect linear displacements of the follower and its valve stem in amounts proportionate to the bi-directional displacements but to one side only of the neutral position.

Although such V-blocks are fully effective insofar as producing the desired action, they nevertheless are undesirable in many installations due to the fact that, if the

block is moved rapidly through center position, there is created a very sudden change in direction of the follower as it passes through the notch of the V and continued movements of this type result in such high acceleration forces that early fatigue failures of the mechanisms frequently are experienced. In installations where continuous operation without the opportunity for constant maintenance is mandatory, such fatigue failures are intolerable and other expedients must be devised. For example, one possible expedient would be the rounding or curving of the V-notch, but such a modification has the obvious ill-effect of sacrificing functional precision since the desired relation between input and output motion then is altered under all conditions of operation. In the metering valve problem stated earlier, another possible solution could be the use of a two-valve system in place of the single bypass metering valve, and, although this duplicatory procedure might be operable, it is objectionable because of its space requirements and also its need for precise duplication if the input and output relation is to be exact. Other proposals have been made but, so far as is presently known, the various attempts to reproduce the V-block cam action have resulted in unduly complicated arrangements which are most impractical for many purposes.

As will be recognized, the above-described use of the V-block cam mechanisms and their equivalents to control a by-pass metering valve is only one of the many possible instances in which the V-block action is desirable. In the same manner, there are many other instances or possibilities for use of the invention about to be described.

As to the present invention, one of its primary objects is to provide a cam mechanism capable of reproducing the action of the described V-block cam mechanism and also capable of prolongating its operational life by the relative elimination of fatigue failures produced by acceleration shocks.

Another object is to accomplish a precise reproduction of the action of the V-block cam mechanism in a simple manner capable of being performed by a small compact apparatus.

These and other objects will be apparent from the detailed description and accompanying drawings.

In the present invention these objectives are accomplished basically by the use of pivotal member in place of the V-block, this member being a pivotally mounted cam plate upon which a cam follower is brought to bear in such a manner that reciprocation of the plate transversely of the follower causes the plate to pivot about its axis. Further, in the preferred form, the plate is centrally pivoted and the pivotal action is controlled by stops to the extent that successive swings in opposite rotational directions about the axis automatically reproduces the angular relationship of the legs of the V-block. In such an arrangement, the reciprocating cam plate may be connected to the bi-directional input so as to constitute the driving member, while the cam follower may be carried by a valve stem which then becomes a driven output member capable of operating a uni-directional valve, or the like. Most suitably, the follower is a roller and, also, the cam plate is pivotally mounted on a carriage provided with a tracking surface engaging thrust bearings. It also is desirable in order to provide a precise linear relationship between the displacements of the cam plate and the follower to assure that the radius of the roller follower and the pivotal radius of the cam plate are made equal.

In such a mechanism, it should be rather apparent that not only is the V-block action duplicated but, of equal importance, the action is such that the swing or pivoting imposes a slight delay or lag during the interval that the roller follower moves through center position, such a lag

being beneficial insofar as shock reduction is concerned. Thus, in effect, the action is similar to that which might be accomplished if the V-block were provided with an arcuate notch, although, at the same time, the input-output relationship of the V-block is maintained. It also will be clear that the stops can be varied in accordance with the job to be performed, so that the arrangement can be made to reproduce the actions of V-blocks of varying angles or, in fact, the cam surfaces can be somewhat curved to produce whatever output position characterization may be deemed desirable.

The preferred embodiment of the invention is illustrated in the accompanying drawings of which Fig. 1 is a plan view of the cam mechanism connected to fluid valves, and Fig. 2 a longitudinal section taken along lines II—II of Fig. 1.

Referring to the drawings, the cam mechanism, generally indicated by numeral **2**, is connected at one end to a stem **4** of an input device, such as a valve (not shown), input being transmitted through a coupling to another stem **6** of an output device that may be a by-pass metering valve **8**. The input and output devices, most suitably, are fixed on a support **9** over which the cam mechanism reciprocates and, in the illustrated embodiment, the cam mechanism functions to translate a bi-directional signal input to a uni-directional linear output motion in valve **8** for controlling the by-pass of the fluid between lines **10** and **12**. As previously mentioned, such valves are shown for explanatory purposes only and it should be obvious that the cam mechanism may be used in other servomechanisms, regulators, machine tools, computers, etc.

Considering the cam mechanism in further detail, it may be seen to include an elongate cam plate **14** that is intermediately pivoted on a reciprocable carriage **16**, the pivotal action of the plate being influenced by a cam follower formed, preferably, of a pair of rollers **17** mounted on a valve stem **6** and resiliently urged by spring **19** against plate **14**. These rollers or followers are carried by pins **18** which, in turn, are secured to opposite sides of an alignment block **20**, this block being threaded to stem **6** and also extending through a longitudinal slot **21** in the plate to maintain the rollers in alignment with the cam tracks. The longitudinal position of stem **6** may be adjusted by loosening lock nut **22** and rotating the stem. However, this structure can be simplified by the use of a dog set screw for guiding stem **6**, such a screw making it possible to eliminate the slot in the cam as well as one of the cam followers. In the event the dog set screw is utilized, other suitable mechanical means can be provided to adjust stem **6**. Adjustable stop **23** is provided with a cross bar positioned in the path of the valve stem as a safety precaution to insure that cam plate **14** rotates from one angular position to the other as the mechanism passes through center. Since clearance is at all times provided between stop **23** and the end of stem **6**, the stem will strike the stop only in case cam plate **14** freezes or fails to rotate due, for example, to high bearing sticking resistance. As a further structural feature, it is to be noted that the cam plate is provided medially with spaced lugs or ears **24** extending laterally from the cam track and provided with bearing surfaces for receiving pins **25** and bearings **26** on which the plate as a whole is pivotally supported, the cam plate being positioned between spaced upper and lower carrier sections which form a cam cage. Preferably, cam plate **14** is adjustable through rotation of pins **25** for aligning slot **21** with respect to block **20**.

Carriage **16** is connected to the input device through turnbuckle **27** (Fig. 1), the carriage being reciprocable transversely of output stem **6** and slidable on a shim plate **28** bolted to support **9**. To guide the reciprocable motion of the carriage and take up the transverse thrust arising from the spring-loaded cam followers, a guide bracket **30** is bolted to support **9** and is provided with a pair of spaced rollers **32** slidable along flat upper and lower carrier surfaces **34**. Rollers **32**, most suitably, are axially parallel to and balanced with cam follower rollers **17**.

Cam plate **14** is shown in the drawing as being in its central or neutral position and as there seen the pivotal axis of the cam and the rotational axis of the cam followers **17** are aligned. However, insofar as the mutual relationship of these members is concerned, the important feature is that the rotational radius of the cam followers be equal to the pivotal radius of the cam plate, such a relationship assuring a smooth translation of movement between the input and output. In this respect, it will be apparent that any substantial variation in these radii would product a jump or discontinuity in the output movement at the time that the plate rotates.

In its neutral position, it will be realized that customarily the cam plate will be swung in one or the other directions and the amount of its swing can be controlled by stops **36** which may be integrally formed on the carrier sections. The amount or angle of the swing can be varied as desired, the swing represented in the drawings being one of 45°. Preferably, a rubber bumper **38** is inset on the surface of the cam adjacent each stop for absorbing shock and reducing noise, and, if needed, such bumpers also can be included in the stops. When the carrier is displaced from the illustrated neutral position by the input device, the spring force of the followers applies a torque to the cam and if the cam has not been previously displaced to its designated limit position, the applied torque will cause the cam to rotate and assume such a position, the particular limit position depending, of course, upon the direction of the carrier displacement from neutral. With the mechanism illustrated, it has been found that a carrier movement of .005 inch will provide sufficient torque to induce rotation of the plate. As the carrier is moved away from neutral in either direction, the pivot point of the cam is offset from the axis of the cam followers and the followers, being spring-pressed against the cam, ride along the inclined surface moving valve stem **6** an amount proportionately equal to the carrier displacement and, of course, the direction of output movement will be the same regardless of whether the carrier is displaced to one side or the other of the neutral position.

One important advantage of the cam mechanism arises as the carrier is moved rapidly from a position on one side of the center to a position on the other side. Thus, during this travel there is a minute time delay as the cam swings from one limit position to the other in passing through the center position. This delay, however, is sufficient to permit the follower to decelerate before changing its direction of movement. As a consequence, this pivotal feature with its time delay materially increases the life of the cam mechanism by reducing shock which otherwise would cause eventual fatigue failure when the cam followers are rapidly accelerated through neutral position. Such durability, of course, is a particularly important consideration in servomechanisms where reliable response is necessary for long periods of time without opportunity for normal maintenance. Further, it will be appreciated that the particular mechanism is unusually simple and easily adjustable, so that the complications arising upon earlier attempts to reproduce the V-block action are eliminated.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. Pivotal cam mechanism comprising a reciprocable carrier, a cam plate pivotally mounted on the carrier, a cam follower reciprocable toward and away from said plate, and means urging said follower toward the plate, said follower engagement causing said cam plate to pivot during said carrier reciprocation.

2. Pivotal cam mechanism comprising a reciprocable carrier, a cam plate pivotally mounted on the carrier, a cam roller follower reciprocable toward and away from said plate, and means urging said follower toward the plate, said follower engagement causing said cam plate to pivot during said carrier reciprocation for imparting movement to said follower, said cam plate being spaced from its pivotal axis a distance equal to the rotational radius of said cam roller.

3. Pivotal cam mechanism comprising a reciprocable carrier, a cam centrally pivoted on the carrier, stops mounted on the carrier on each side of the pivot point of the cam for limiting the angular displacement of the cam, a stem reciprocable toward and away from said cam, a roller cam follower mounted on said stem, means mounted on the stem urging said stem and follower toward the cam, and means for reciprocating the carrier transversely of said stem whereby a motion imparted to the cam in one direction will be transmitted to the follower in another direction.

4. Pivotal cam mechanism comprising a reciprocable carrier, a cam centrally pivoted on the carrier, a stem reciprocable toward and away from said cam, a roller

cam follower mounted on said stem, means urging said stem and follower toward the cam, means for guiding the cam follower along the cam, and means for reciprocating the carrier transversely of said stem whereby a motion imparted to the cam in one direction will be transmitted to the roller in another direction.

5. Pivotal cam mechanism comprising a reciprocable carrier, an elongate cam plate centrally pivoted on the carrier, a stem reciprocable toward and away from said cam, a roller cam follower mounted on said stem, means urging said stem and follower toward the cam plate, and means for reciprocating the carrier transversely of said stem whereby a motion imparted to the cam in one direction will be transmitted to the roller in another direction, said cam plate being spaced from its pivotal axis a distance equal to the rotational radius of said cam roller.

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