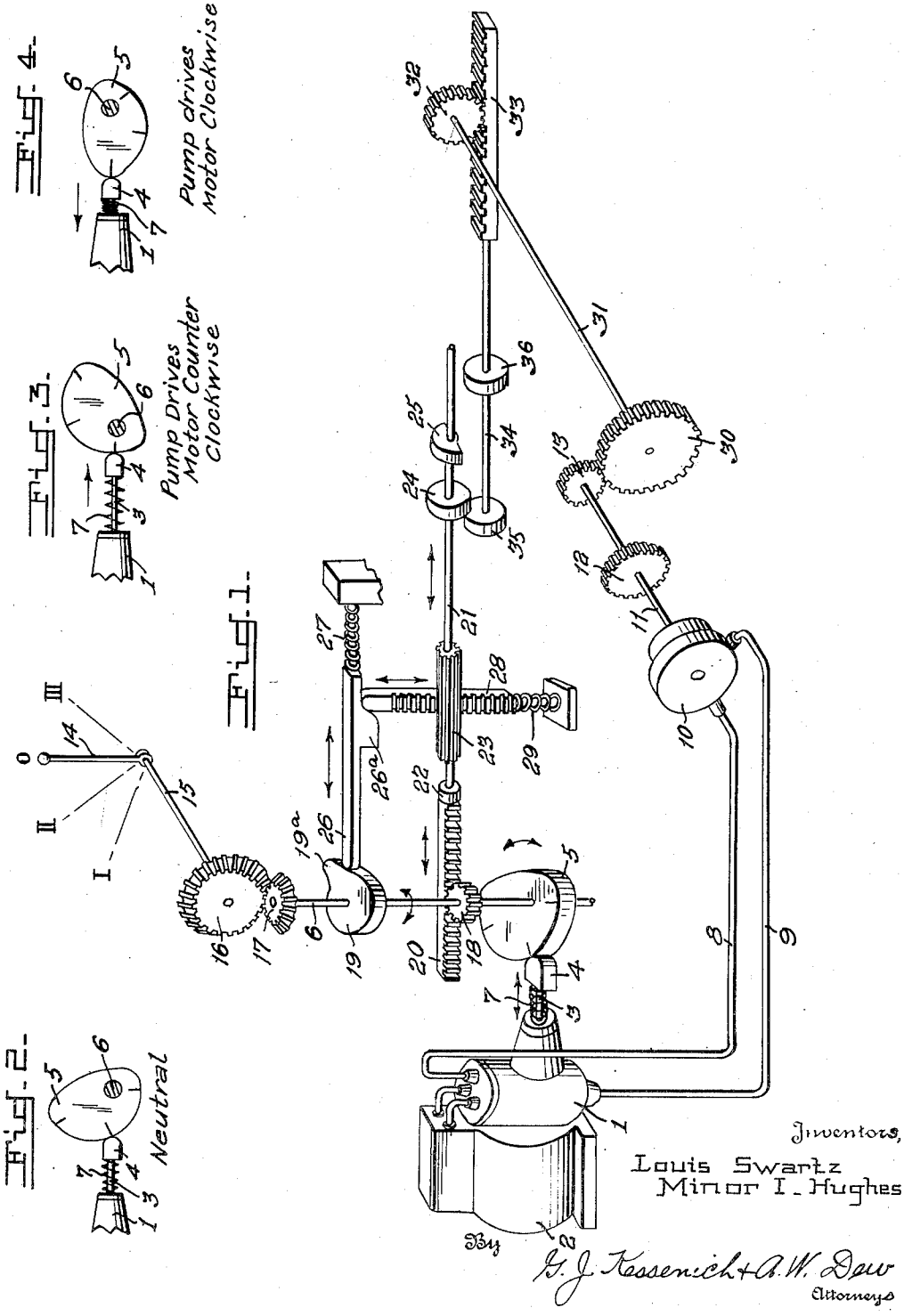
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SERVOMOTOR CONTROL

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SERVOMOTOR CONTROL

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8 Claims. (Cl. 60—53)

1

This invention relates to a mechanical stroking control for reversible hydraulic transmissions.

It is the principal object of the invention to provide a control of the type mentioned wherein a semi-automatic mechanical control enables the pump to be stroked manually to drive a hydraulic motor in either direction.

A further object is to provide a control for hydraulic transmissions wherein the pump is automatically unstroked at a predetermined fixed neutral or zero position of the hydraulic motor shaft when the motor has rotated to a selected one of two predetermined limiting positions.

A still further object is the provision of a servomotor system wherein a manually-operable control handle or means when moved from neutral to one limiting position in one direction effects a definite movement of the servo-motor in a corresponding direction and wherein the handle cannot again be moved to the aforesaid limiting position unless and until it is first moved from neutral in the other direction.

Still another object is the provision of a servomotor control as in the preceding paragraph wherein the servo-motor may be run in one direction a predetermined distance less than maximum and then subsequently and selectively run in either direction to limiting position.

Other objects and advantages will be apparent from a study of the following specification in connection with the drawing.

In the drawing:

Fig. 1 is a diagrammatic view of the complete control.

Fig. 2 is a detail view showing the position of the pump control cam and shaft when the pump is unstroked or in neutral, no-delivery position.

Figs. 3 and 4 are detail views corresponding to Fig. 2, but showing the pump control cam and shaft in positions, respectively, for full speed in respectively opposite directions.

Referring in detail to the disclosure, the numeral 1 identifies a pump driven by any suitable source of power such as a direct-connected electric motor 2. The pump has a control slide 3 with a cam follower 4 on its end riding upon the periphery of a control cam 5 fixed to control shaft 6. A compression spring 7 acts to continuously urge the follower 4 against the cam. The pump 1 may be of the well-known rotary, reversible delivery, variable displacement type in which the direction and amount of displacement from a neutral or no-delivery position, of a slide block connected with shaft 7. Since such pumps frequently have a spring incorporated in the

2

pump itself which urges the slide block in one direction of motion, spring 7 may be omitted when such a pump is used, or the spring 7 may be supplementary to the one incorporated in the pump and act in the same direction.

The discharge and intake pipes 8 and 9 lead from pump 1 to a reversible hydraulic motor 10 having its rotor connected to drive shaft 11 having gears 12 and 13 fixed thereto. For the purpose of definite description, the connections and arrangements are assumed to be, and may be, such that when control rod 7 is moved to the left, as viewed in Fig. 1, that is, when cam 5 and shaft 6 are rotated counterclockwise from the neutral or no-discharge position shown, the discharge from the pump is such as to cause motor 10 to rotate clockwise as viewed. The corresponding position of the cam and control shaft for maximum discharge is shown upon Fig. 4. Conversely, when the cam 5 and shaft 6 are rotated clockwise to the position shown upon Fig. 3, the control rod 6 is moved outwardly or to the right to its maximum position, the direction of delivery of the pump is reversed, and motor 10, is rotated counterclockwise. Rotation of control cam 5 is effected by a lever 14 fixed to a shaft 15. Gears 16 and 17 connect shafts 6 and 15 for simultaneous rotation.

Shaft 6 has a gear 18 and a cam 19 fixed thereto. Pinion 18 meshes with a rack 20. A first stop shaft 21 has a swivel connection at 22 with rack 20 whereby the shaft may rotate relatively to the rack, but is constrained to move as a unit with the rack in axial translation. Shaft 21 has an elongated gear 23 fixed thereto as well as a pair of stops 24 and 25 axially spaced therealong. The construction, purpose and operation of these stops will be subsequently described.

Cam 19 has a relatively abrupt riser portion 19*a*. The periphery of the cam is engaged by a slide 26 under the urge of a compression spring 27. Slide 26 carries a cam portion 26*a* engaged by one end of a rack 28 at right angles to the slide and parallel with shaft 6. Rack 28 meshes with, and drives, pinion 23 for all axial positions of shaft 21 and is urged upwardly into continuous contact with cam portion 26*a*, by a compression spring 29.

Gear 13 meshes with and drives a gear 30 fixed to a shaft 31 which has another gear 32 fixed to its other end. Gear 32 meshes with and translates a rack 33 in a direction parallel with shaft 21. This rack has an operating shaft 34 fixed to and extending from one end thereof parallel to and adjacent stop shaft 21. A pair of stops 35

and 36 are fixed to shaft 34 in axially spaced position therealong.

The gear ratios, dimensions and construction are such that both stops 35 and 36 engage with stop 24 on shaft 21. Stop 25 is cut away over a portion of its periphery and, in the rotational position shown, will pass stops 35 and 36 without contact. However, when shaft 6 has been rotated to a position wherein riser portion 19a of cam 19 has moved slide 26 to maximum position to the right, the resulting movement of rack 28 and rotation of gear 23 and shaft 21 also rotates stop 25 to a position wherein it will be engaged by stop 36 when the latter is axially translated in the manner previously described.

In the neutral position of the parts as shown, wherein manually operable handle 14 is at the neutral or "0" position, operation of the handle to position "III" is impossible because the slide block of the pump is in neutral, motor 10 is at rest and rack 33 and stops 35 and 36 are motionless. Since stop 24 is at this time in contact with stop 35, further movement of stop 24 to the left is impossible and handle 14 is thus prevented from movement to position "III."

Under such conditions handle 14 can be moved only in the counterclockwise direction to position "I" or "II." Assuming movement thereof to position "I" for maximum rotation of gear 12 counterclockwise, gear 18 is turned and shifts rack 20, shaft 21 and its stops 24 and 25 to the right. At the same time, cam 19 is rotated until its riser or nose 19a passes across and to the other side of slide 26. The action causes a momentary depression of rack 28 and a corresponding rotation of shaft 21 and its stops 24 and 25. The parts are so proportioned and related that, after handle 14 has been fully turned to position "I," slide 26 again rides upon the base circle of cam 19, with portion 19a at the other side of the slide 26 from that shown in Fig. 1. Thus shaft 21 is given a momentary rotation during movement of handle 14 to position "I" and then returned by spring 29 to its original or neutral position. The parts are so arranged that stop 25 is translated to the right past stop 36 without interference therefrom, so that, when shaft 21 is returned to its neutral rotational position, stop 36 can be shifted without obstruction from stop 25. Thus the movement of handle 14 to position "I" shifts stop 24 to the right a fixed distance for engagement by stop 36 when the latter is moved to the left. As shaft 6 is thus rotated clockwise, cam 5 is correspondingly rotated to effect movement of shaft 7 of the pump control to the position shown upon Fig. 3. This action causes the pump to discharge in a direction rotating motor 10 counterclockwise, whereby rack 33, shaft 34 and stops 35 and 36 are shifted to the left. Stop 36 then engages stop 24 and moves shaft 21, gear 23 and rack 20 to the left until the parts are restored to the initial or neutral position shown wherein the pump is restored to no-discharge position, motor 10 ceases rotation and handle 14 is restored to the "0" or neutral position. The action is such that motor 10, and driven element 12 are rotated a predetermined fixed number of rotations counterclockwise.

Since stop 36 is now in engagement with stop 24, the handle 14 cannot be turned to the "I" or "II" positions without first being turned to the "III" position. That is, before it can be again rotated counterclockwise, it must be rotated clockwise.

Movement of handle 14 clockwise to position "III" effects a corresponding and proportional movement of shaft 21 and stop 24 to the left. It also rotates cam 5 to force pump control shaft 7 inwardly and causes pump 1 to discharge in a direction rotating motor 10 and driven element 12 clockwise. Since the rotation of shaft 6 is counterclockwise, slide 26 continues to ride upon the base circle of cam 19 and no rotation of shaft 21 and its stops is effected. Clockwise rotation of motor 10 moves stop 35 to the right and causes it to engage stop 24, thus translating shaft 21 to the right, restoring handle 14 and the pump control shaft 7 to neutral positions and stopping further movement with all parts as shown on Fig. 1. The handle may now be again moved to either of positions "I" or "II."

Movement of handle 14 to position "II" effects an angular movement of cam 19 such that riser 19a rests in contact with the end of slide 26, rack 28 is held in depressed position, and shaft 21 and stop 25 are rotated to a position wherein stop 25 will be engaged by stop 36 when the latter is axially translated with rack 33. Also stop 25 is shifted to the right a fixed distance and cam 5 effects an outward movement of pump-control shaft 7 to drive motor 10 counterclockwise. As a result stop 36 is shifted to the left into engagement with stop 25, whereby shaft 6 is rotated to restore cam 5 and handle 14 to neutral position and to restore cam 19 to the position shown in Fig. 1. The construction and relation of the parts are such that stop 25 is rotated out of contact with stop 36 at the instant the pump is restored to neutral or no-discharge position and control handles 14 restored to "0" position.

From this position it is possible to run the gear or driven element 12 the maximum number of rotations counterclockwise by moving lever 14 either to position "I" or to position "II." Since the movement of handle or lever 14 to either the "I" or "II" positions merely moves stop 24 to the right a distance varying with the position selected, but always to the left of stop 36, the operation of motor 10 ceases when stop 36 under movement of the motor, has engaged and restored stop 24 and shaft 21 to the neutral or no-delivery position. Hence, no matter whether handle 14 is shifted to position "I" or position "II," as identified on Fig. 1, motor 10 always comes to rest at the same maximum number of revolutions from zero or neutral position. Also from the final position mentioned in the preceding paragraph, handle 14 can be shifted to position "III" to thereby effect clockwise rotation of motor 10 to its maximum position.

In the claims, the term "neutral" or "neutral position" as applied to mechanism including control handle 14 means a position thereof wherein motor 10 is at rest. The term "positive" as applied to the driving connections means a connection in which the driving movement is at all times directly proportional to the resulting driven movement.

Having now fully disclosed the invention what I claim and desire to secure by Letters Patent is:

1. In a servo-motor system, a reversible servo-motor, control means manually operable between first and second limiting positions to effect operation of said servo-motor in respective opposite directions of rotation, first and second stops in fixed relation, means responsive to operation of said servo-motor shifting said stops as a unit, a third stop positioned between said first and second stops and engageable thereby, and a driving

connection between said third stop and said control means.

2. In combination, a reversible servo-motor, power means driving said servo-motor, control means for said power means and manually operable between first and second limiting positions, through neutral, movement of said control means to said limiting positions effecting movement of said servo-motor in respectively opposite directions and in neutral effecting stoppage of said servo-motor, first and second spaced stops, a driving connection between said motor and stops moving the latter as a unit, a third stop positioned between and engageable by each of said first and second stops for a corresponding direction of movement of said motor, and a positive driving connection between said control means and said third stop.

3. In a servo-motor system, a reversible hydraulic servo-motor, a reversible delivery hydraulic pump, connections between said motor and pump to drive said servo-motor from said pump in a direction corresponding to the direction of delivery of said pump, manual control means movable between pre-determined limiting positions and operable to effect the discharge of said pump from maximum in one direction, through neutral, to maximum in the other direction to thereby control the direction of rotation of said motor, a control stop, means positively moving said stop between predetermined limits in response to operation of said control means, a pair of spaced stops movable in fixed relation, and a positive driving connection between said servo-motor and said spaced stops moving the latter as a unit, whereby to return said control means and pump to neutral position in response to a predetermined corresponding movement of said servo-motor.

4. In a servo-motor system, a reversible hydraulic servo-motor, a reversible-delivery hydraulic pump, connections driving said servo-motor from said pump in a direction corresponding to the direction of discharge of said pump, control means movable to vary the discharge of said pump from maximum in one direction, through neutral, to maximum in the other direction, when said control means is moved between first and second limiting positions, respectively, first and second spaced stops, a connection between said servo-motor and stops moving the same as a unit in a first fixed path, a third stop movable between said first and second stops in a second path parallel to said first path for selective engagement and movement by said first and second stops, and a positive driving connection between said control means and said third stop whereby said third stop is moved to return said control means and pump to neutral in response to movement of said control means to either of said limiting positions whereby to effect a predetermined movement in a corresponding direction, of said servo-motor.

5. In a servo-motor, a reversible servo-motor, control means operable between first and second fixed limiting positions, through neutral, to effect movement of said servo-motor in corresponding directions, first and second spaced stops movable in a first direction as a unit in fixed relation, a first positive driving connection between said servo-motor and said stops, a third stop between said first and second stops for engagement and movement by said first and second stops for a corresponding direction of movement of said servo-motor, a second positive driving connection between said third stop and control means, moving the same in said first direction, a fourth stop movable as a unit with said third stop in said first direction and movable relatively to said third stop in a second direction from a first position out of the path of said first and second stops to a second position for engagement by one of said first and second stops, and means responsive only to predetermined movement of said control means from neutral to a predetermined position short of one said limiting position to effect movement of said fourth stop to its said second position.

6. A servo-motor system comprising, a reversible hydraulic servo-motor, a reversible-delivery pump, fluid pressure connections between said servo-motor and pump, control means for said pump, said control means being operable between first and second limiting positions, through neutral, to effect reversal of delivery of said pump and a corresponding direction of movement of said servo-motor, first and second spaced stops, a positive, irreversible driving connection between said servo-motor and first and second stops, moving said stops as a unit, a third stop movable between and selectively engageable by said first and second stops, a positive driving connection between said third stop and control means, said driving connections being constructed and arranged to restore said control means to neutral by engagement between said first or second stops, with said third stop, whereby a predetermined movement of said servo-motor in a selected direction restores said control means to neutral and stops said servo-motor, a fourth stop movable in a first direction as a unit with said third stop and movable in a second direction relatively to said third stop from a first position out of the path of said first and second stops to a second position in said path, and means responsive only to movement of said control means from neutral to a predetermined position short of one said limiting positions, to move said fourth stop into its said second position.

7. In a servo-motor system, a reversible hydraulic servo-motor, a variable delivery pump, a control element for said pump movable from a first limiting position effecting maximum discharge of said pump in one direction, through neutral to a second limiting position effecting maximum discharge of said pump in the other direction, connections between said pump and servo-motor driving the latter in opposite directions for respective directions of discharge of said pump, a cam shaft, a cam on said shaft in operating engagement with said control element, a handle manually operable between limiting positions, operative connections between said handle and cam shaft to effect operation of said control element and pump to corresponding limiting positions, an operating shaft, first and second spaced stops fixed to said operating shaft, a positive driving connection between said servo-motor and operating shaft axially translating the latter in response to operation of said motor, a control shaft parallel and axially translatable adjacent said operating shaft, a third stop on said control shaft between and selectively engageable with said first and second stops, and a positive driving connection whereby said cam shaft and control shaft are respectively rotated and translated in unison.

8. In a servo-motor system, a reversible hydraulic servo-motor, a reversible-delivery pump, a control element for said pump movable between

first and second limiting positions, said positions corresponding to maximum discharge of said pump through neutral in opposite directions, respectively, connections between said pump and servo-motor driving the latter in opposite directions for respective directions of discharge of said pump, a cam shaft, a cam fixed on said shaft and in operating engagement with said control element, a handle operable between limiting positions, a driving connection between said handle and cam shaft to effect operation of said control element between limiting positions for corresponding limiting positions of said handle, an operating shaft, first and second longitudinally-spaced stops on said operating shaft, a positive driving connection between said servo-motor and operating shaft longitudinally translating the latter in response to operation of said motor, a control shaft mounted for rotation and longitudinal translation, a driving connection whereby said cam shaft rotates in timed relation with longitudinal translation of said control shaft, a third stop on said control shaft between and selectively engageable with said first and second stops for all positions of rotation of said control shaft, a fourth stop on said control shaft and engageable with one of said first and second stops for a predetermined rotational position of said control shaft only, and means responsive to movement of said handle to a position short of one said limiting position to rotate said control shaft into said predetermined rotational position.

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