Feb. 28, 1961 R. A. BENNETT 2,972,894

VARIABLE STROKE ADJUSTMENT MECHANISM

Filed March 26, 1959 5 Sheets-Sheet 1

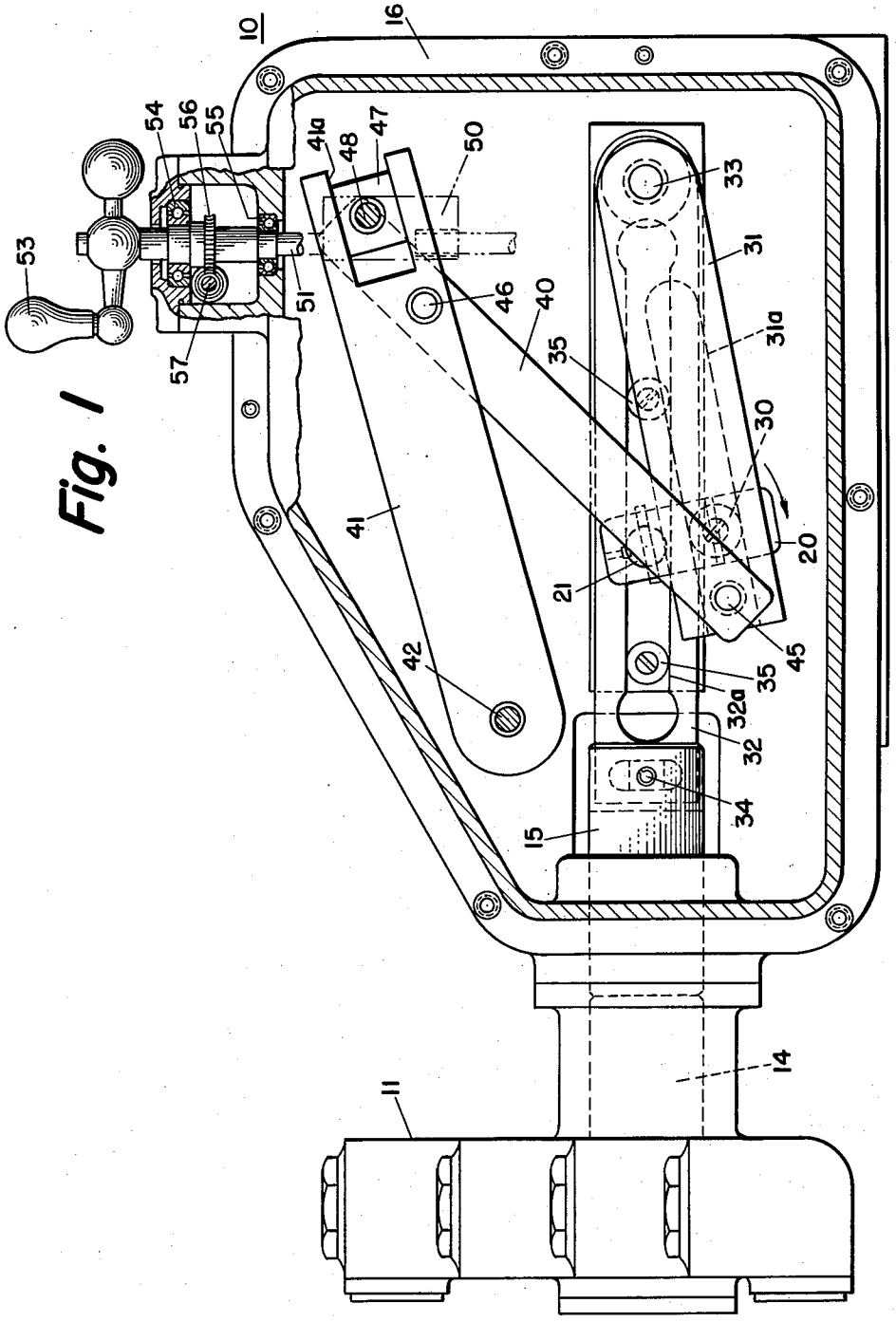


Fig. 1

VARIABLE STROKE ADJUSTMENT MECHANISM

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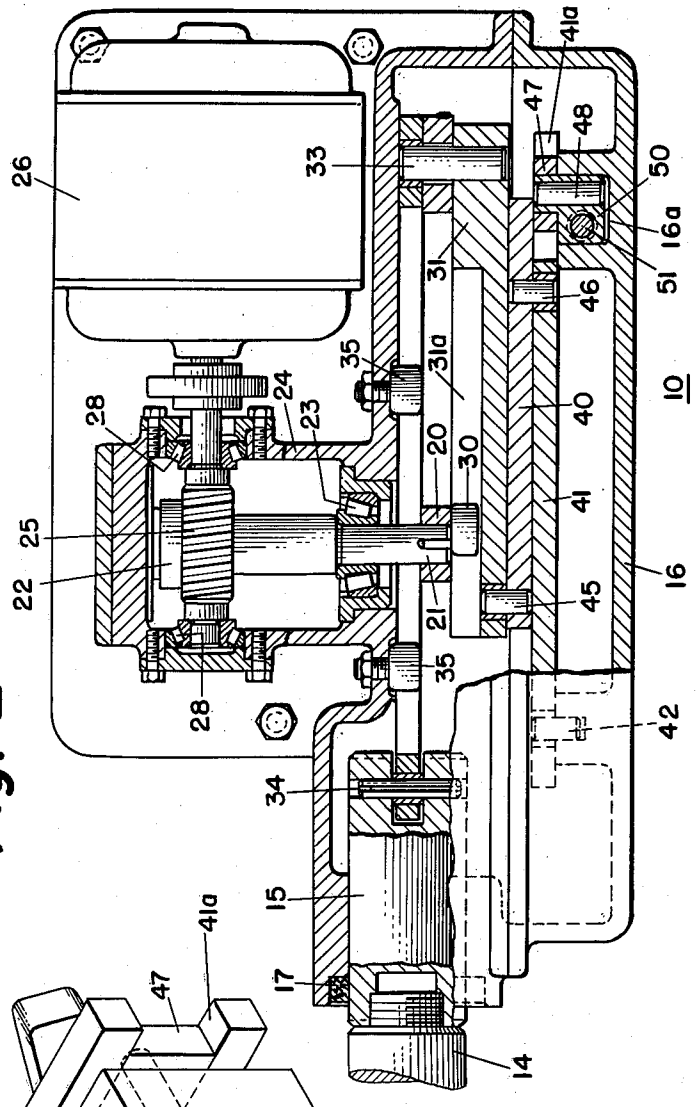


Fig. 2

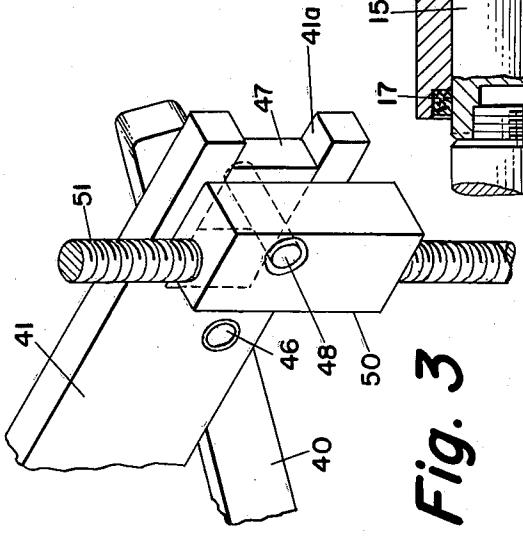


Fig. 3

VARIABLE STROKE ADJUSTMENT MECHANISM

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Fig. 4

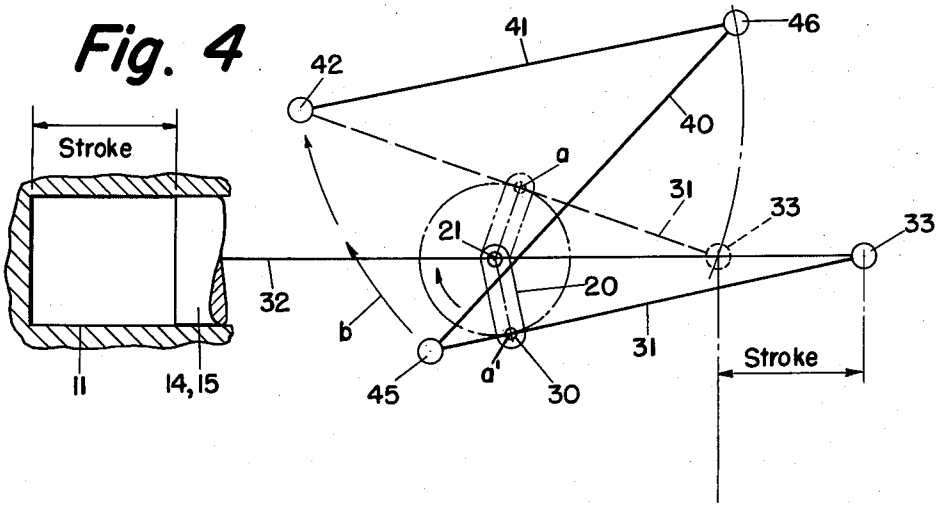


Fig. 5

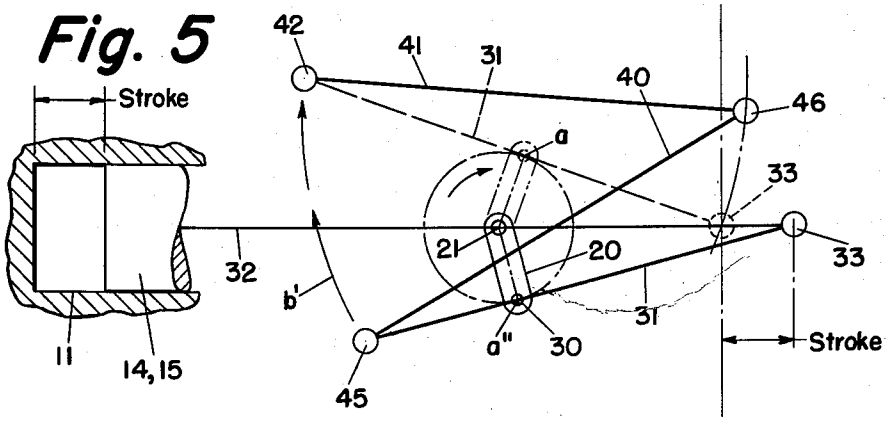
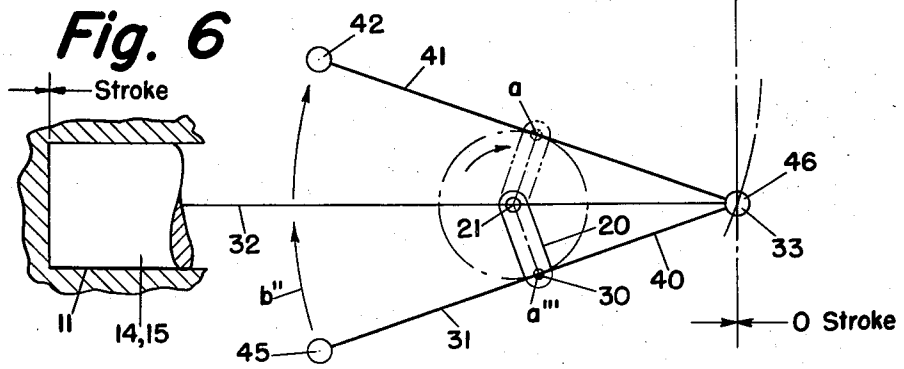


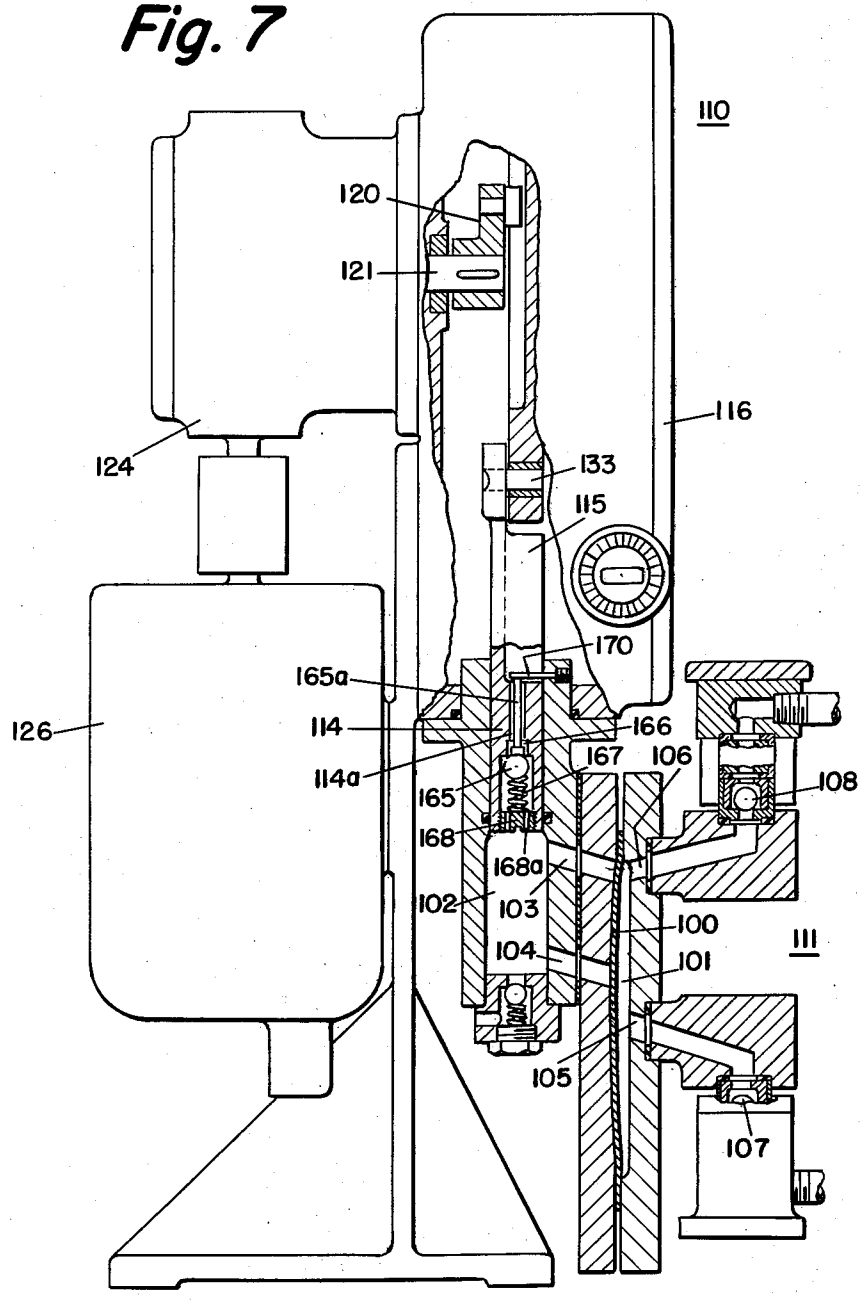
Fig. 6



VARIABLE STROKE ADJUSTMENT MECHANISM

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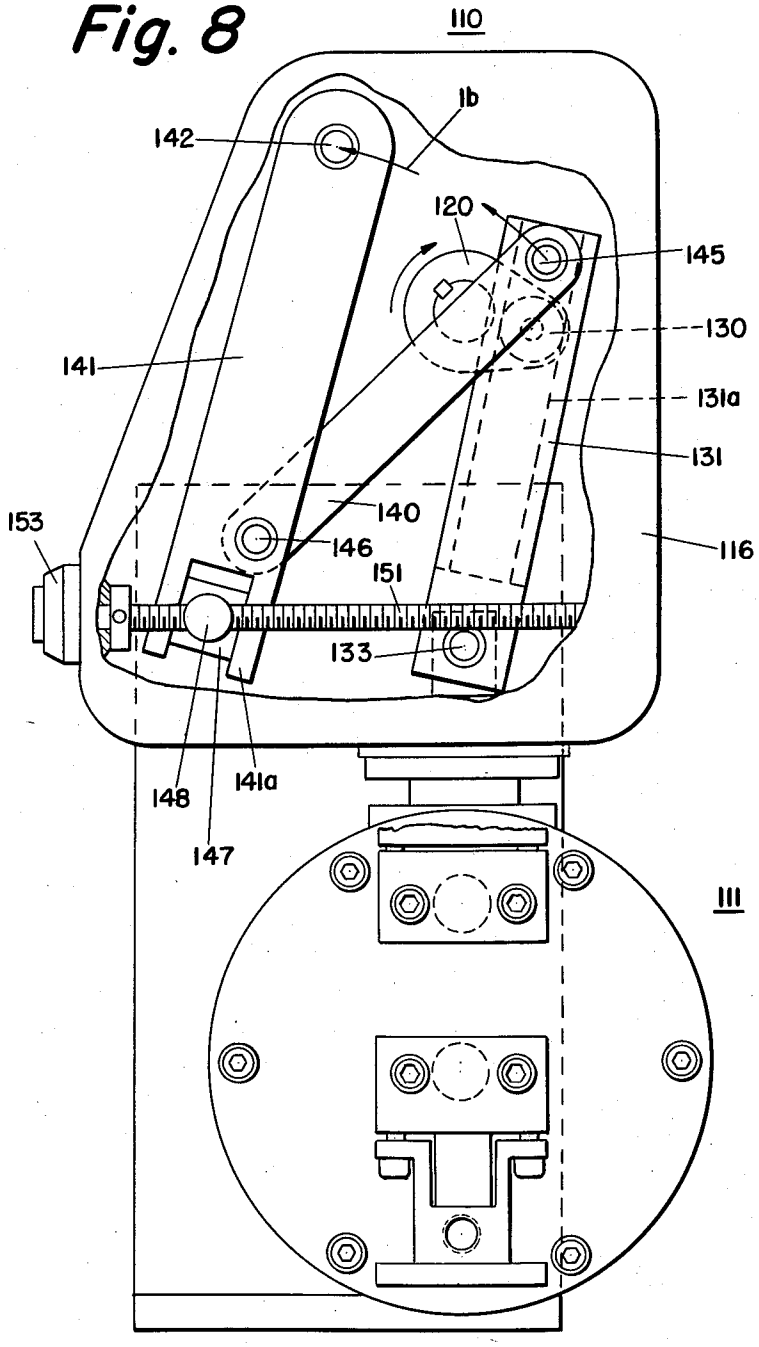
Fig. 7



VARIABLE STROKE ADJUSTMENT MECHANISM

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Fig. 8



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VARIABLE STROKE ADJUSTMENT MECHANISM

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Filed Mar. 26, 1959, Ser. No. 802,139

17 Claims. (Cl. 74—40)

This invention relates to variable stroke mechanisms and is particularly useful in the operation of pumps of the controlled volume type. It is an object of the invention to provide for manual or automatic adjustment of the stroke of a reciprocating pump plunger from maximum to zero while the pump is running or stopped and to provide a substantially linear relationship between the amount of adjustment and the resultant change in stroke.

It is a further object of the invention to provide adjustment of the plunger stroke from maximum to zero while maintaining the discharge end of the stroke (or suction end of the stroke if desired), at exactly the same point for all stroke lengths.

It is another object of the invention to provide a pump drive which enables the pump to be on discharge about sixty percent of the duration of each cycle in order to obtain greater capacity from a given size drive motor, without exceeding the motor rating at some time during the stroke, than is possible with a linkage system which permits the pump to be on discharge only fifty percent of the time.

In carrying out the present invention in one form thereof, there is provided a crosshead which is arranged to be reciprocated along a given path of travel. The crosshead may be formed integrally with a pump plunger which is movable within a plunger chamber. A connector member is pivotally connected at one end to the crosshead for movement of the pivotal connection along the path of travel of the crosshead. An adjuster member is disposed to one side of the crosshead path and has a fixed pivot at one end thereof. A swing member pivotally interconnects the opposite ends of the connector member and the adjuster member to form a three-member linkage, the effective lengths of each of the members of the linkage between their respective pivots being equal. A driving means is provided which is effective on the connector member to pivot the latter about its pivotal connection to the crosshead for moving the pivotal connection between the connector member and the swing member back and forth along an arcuate path extending from a position coincident with the fixed pivot of the adjuster member to a position at the opposite side of the path of the crosshead. The driving means is in the form of a crank having a cam adapted to move along a track on the connector member to reciprocate the crosshead along its path for a selected length of stroke. The stroke or movement of the crosshead and plunger can be varied from zero to maximum by adjusting means which changes the position of the pivotal connection between the adjuster member and the swing member relative to the path of the crosshead to adjust the position of the arcuate path which in turn adjusts the length of stroke of the crosshead.

For further objects and advantages of the invention and for a more detailed description thereof, reference is to be had to the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a side elevation of a variable stroke mechanism as applied to a controlled volume pump where the crosshead is brought to the same position at the discharge end of each stroke, the front portion of the casing for the mechanism having been broken away;

Fig. 2 is a top plan view partly in section;

Fig. 3 is a fractional perspective view showing parts of the stroke adjusting mechanism of Figs. 1 and 2;

Figs. 4–6 are geometric representations of the stroke adjusting mechanism of the embodiment shown in Fig. 1 illustrating the change of stroke from a maximum position in Fig. 4 to an intermediate position in Fig. 5 and a zero position in Fig. 6; and

Figs. 7 and 8 illustrate the invention as applied to a diaphragm pump of the type where the crosshead or plunger is brought to the same position at the suction end of each stroke.

Referring to Fig. 1 of the drawings, the improved drive and stroke-adjusting mechanism **10** has been illustrated as applied to a controlled volume pump of the type having a liquid end **11** utilizing a ball valve assembly as more fully described in the copending application, Serial No. 471,623 filed November 29, 1954, issued August 11, 1959 as United States Letters Patent No. 2,898,867. The liquid end **11** includes a plunger chamber within which there is adapted to reciprocate a plunger **14** which is supported for reciprocatory movement by a crosshead **15** of the mechanism **10**. As may be seen in Figs. 1 and 2, the variable stroke mechanism is disposed within a housing **16** which is adapted to be filled with a suitable lubricant, such as oil, for the moving parts of the mechanism. The crosshead **15** is adapted to extend from one side of the housing **16** and a seal in the form of a ring **17**, Fig. 2, extends around the crosshead **15** and prevents the oil from leaking past the crosshead.

The drive for reciprocating the crosshead **15** and the plunger **14** along a given path is provided by a crank arm **20**, Fig. 1, which is fixed to one end of a shaft **21**. The shaft **21** is provided at its other end with a worm gear **22**, Fig. 2, and is supported for rotation in bearings **23** in the walls of a gear case **24**. The worm gear **22** is adapted to mesh with a driving worm **25** which in turn is driven from a motor **26**. The shaft for the worm **25** is supported in bearings **28** which in turn are supported on the opposite sides of the gear case **24**.

The crank arm **20** is adapted to rotate in a clockwise direction as viewed in Fig. 1 and adjacent its outer end there is provided a cam roller **30** which is adapted to ride along a cam track **31***a* in the side of a connector member or link **31**. The connector member **31** is pivoted at one end to a slide bar **32** by a pivot pin **33**. The slide bar **32** is connected at its opposite end to the rear end of the crosshead **15** by means of a crosshead pin **34**. The slide bar **32** is provided with a central slot **32***a* and the motion of the slide bar **32** is restricted to reciprocating horizontal movement by means of a pair of spaced cam rollers **35** which are supported on the wall of the housing **16** and extend into the slot **32***a* of slide bar **32**. The opposite end of the connector member **31** is pivotally connected to a swing member or link **40** which in turn is pivotally connected to an adjuster member or link **41**. The adjuster member **41** has a fixed pivot **42** at one end thereof as shown in Fig. 2. The pivotal connection between connector member **31** and swing member **40**, Figs. 1 and 2, is provided by pivot member **45** and a pivotal connection between swing member **40** and adjuster member **41** is provided by a pivot member **46**. The end of adjuster member **41** adjacent the pivot member **46** is provided with a slot **41***a* which is adapted to receive a pivot block **47** through which there extends a pivot member **48**. The pivot member **48** also extends into and is carried by an adjuster block **50**, Figs. 1–3. The adjuster block **50** is threadedly carried by an adjuster

screw 51 and is adapted to be moved along a channel 16a, Fig. 2, in housing 16 by rotation of a handle 53 which is secured to the upper end of the adjusting screw 51, Fig. 1. The adjusting screw 51 is supported for rotation about its axis in housing 16 by means of a pair of bearings 54, 55. Between the bearings 54, 55, the adjusting screw 51 is provided with a worm gear 56 which is adapted to mesh with a worm shaft 57. The worm shaft 57 is connected with a suitable revolution counter, not shown, for counting the revolutions of the adjusting screw 51.

As will hereinafter be described more in detail in connection with Figs. 4–6, the rotation of crank arm 20 causes the pivot 45 to swing from its position shown in Fig. 1 to a position in alignment with fixed pivot 42 of the adjuster member 41. This movement causes pivot member 33 to move from its position shown in Fig. 1 to a forward position corresponding to the length of stroke for which the mechanism 10 is adjusted. Since pivot 33 is carried by the slide bar 2 which in turn is carried by the crosshead 15, it will be seen that the crosshead 15 and the plunger 14 will likewise move forward a similar distance, such distance being the stroke length of the plunger.

Adjustment of the stroke length is accomplished by rotation of handle 53 which in turn rotates adjusting screw 51. The rotation of adjusting screw 51 in turn causes movement of adjuster block 50 and causes the pivot member 48 to move parallel to the axis of the adjusting screw 51. As the pivot member 48 moves downwardly towards the path of travel of the crosshead 15, the adjuster member 41 will be pivoted about the fixed pivot 42. Since the pivot 48 is moving vertically, Fig. 1, while adjuster member 41 is rotating about a fixed pivot, there will be a sliding movement of block 47 in slot 41a of member 41. At the same time, the pivot 46 will be moving downward towards the path of the crosshead 15. However, the pivot 46 will be moving along an arcuate path about the fixed pivot 42 rather than in a straight line path as in the case of pivot 48.

One of the desirable features of the mechanism shown in Fig. 1 is the fact that regardless of the length of stroke for which the mechanism is adjusted, the forward position or discharge end of the stroke will be maintained constant. Another important advantage of the mechanism shown in Fig. 1 is the fact the pump will be on discharge more than fifty percent of the time and thus will enable greater capacity to be derived from a given size motor without exceeding the rating at sometime during the stroke. These features will be seen more clearly with reference to Figs. 4–6.

Fig. 4 is a geometric representation of the stroke-adjusting mechanism 10 of Fig. 1 adjusted for full stroke operation. The various lines and points in Figs. 4–6 have been identified with the same reference characters as the corresponding links and pivots in Fig. 1. With the adjusting mechanism 10 set for full stroke as shown in Fig. 1, the pivot 33 will advance from its full line position shown in Fig. 4 to its broken line position as the crank arm 20 moves from its position a' to its position a causing pivot 45 to move along the arcuate path b. It will be noted that shaft 21 for crank 20 has its axis along the same horizontal path as the path of the piston 14 and crosshead 15. It will be seen that the effective lengths of swing link 40 and adjuster link 41 between their respective pivots 46 and 45 and 46 and 42 are equal. At the discharge end of the stroke, the connector member or link 31 will assume the broken line position shown in Fig. 4. Since the crosshead 15 and piston 14, which may be integral therewith, are connected to pivot pin 33 by the slide bar 32, they will likewise move through a distance equal to that moved by pivot 33 and thus the stroke of the piston within the displacement chamber of the liquid end 11 will be the same as that diagrammatically indicated in Fig. 4. It will be noted that the pump plunger 14 is on discharge while the crank 20 is moving from position a' to position a in Fig. 4. This is a movement of the crank 20 through an angle of approximately 210° and thus the pump is on discharge for a period of time substantially greater than fifty percent of each cycle and in the order of an average of sixty percent, as will be seen with respect to Figs. 5 and 6.

Fig. 5 is a geometric representation of the adjusting mechanism 10 adjusted for approximately half stroke position. The pivot 46 has been moved downwardly along an arc about pivot 42 with link 41 as a radius. Rotation of crank 20 about its drive shaft 21 from a position a'' to position a will cause the pivot 45 to move upwardly along an arcuate path b' so that the pivot 45 will coincide with the pivot 42. This causes the connector member 31 to move from its full line position in Fig. 5 to its broken line position, thereby advancing pivot 33 from its full line position to its broken line position. This advancement corresponds to the length of stroke for which the mechanism 10 is then adjusted and the piston displacement will be as indicated in Fig. 5. It will be noted that the arcuate path b' has shifted to the left about fixed pivot 42 with respect to the arcuate path b shown in Fig. 4. It is this shift in the arcuate path traversed by pivot 45 which produces the change in length of stroke of the pivot 33 and thus the crosshead 15 or plunger 14 of the pump. The pump is on discharge while crank 20 moves from a'' to a, an angle of approximately 215°.

In Fig. 6 the mechanism has been adjusted so that the pivot 46 coincides with the pivot 33 and thus the length of stroke of the piston has been reduced to zero. It will likewise be seen that the swing link 40 has the same effective length as the connector link 31 and thus they coincide with each other. As the crank 20 moves from a position a''' to its position a, through an angle of approximately 219°, as shown in Fig. 6, the pivot 45 will move along the arc b'' to a position where it coincides with pivot 42. Since members 31 and 40 are of the same length and they in turn are the same length as member 41, all three links will coincide when pivot 45 is coincident with pivot 42. The opposite ends of these links will be pivoting about an axis which is coincident with pivots 46 and 33.

It will be understood that the lengths of the members 31, 40 and 41 as well as the length of the crank arm 20 and the relative position of the crank shaft 21 and the fixed pivot 42 are related to the length of stroke of the plunger 14 and crosshead 15. By way of example, in one application with perfect scavenging in which the full stroke length was three inches, the effective lengths of members 31, 40 and 41, i.e. the distance between the axes of the respective pivots 33—45, 45—46, and 46—42, was about 9.375 inches. The effective length of the crank arm 20, i.e. the distance between the axes of crank shaft 21 and cam roller 30, was about 1.62 inches. The verticle spacing between the axes of crank shaft 21 and pivot 42 was about 3.114 inches and their horizontal spacing was about 3.894 inches.

As mentioned above, the present invention is also applicable to pumps where it is desired that the plunger occupy the same position at the end of each suction stroke regardless of the length of stroke. An application of this type is illustrated in Figs. 7 and 8 where the invention has been applied to a controlled volume pump of the type in which the liquid end includes a diaphragm. The stroke-adjusting mechanism 110 in Figs. 7 and 8 corresponds to the stroke-adjusting mechanism 10 described above in connection with Figs. 1–6 and for convenience the corresponding parts in the modification shown in Figs. 7 and 8 have been identified with corresponding reference characters in the 100 series.

In the modification shown in Figs. 7 and 8 the pump

plunger 114, Fig. 7, has been disposed for vertical operation rather than horizontal operation as in the preceding modification. A flexible diaphragm 100 forms a moving wall for the pump chamber 101 and also for the cylinder 102 which houses the piston or plunger 114. The cylinder 102 has a pair of passages 103 and 104 which enable the motion transmitting liquid within the chamber 101 to communicate with the moving wall 100. The pump chamber 101 is provided with suitable inlet and outlet ports 105 and 106 which in turn are provided with suitable check valves illustrated in the form of ball valves 107 and 108 respectively.

In the diaphragm pump 111 illustrated in Fig. 7 provision has been made for introducing makeup liquid into the motion transmitting liquid so as to correct any expansion or contraction or leakage of the transmitting liquid and thereby eliminate any errors in metering due to the hydraulic transmission. Briefly, this arrangement provides a mechanically-operated means which is effective at a predetermined position in each cycle of the pump operation, namely at the end of the suction stroke, to interconnect the liquid between the pump plunger and the diaphragm with a reservoir of liquid which is open to atmosphere. The make-up liquid for the motion transmitting liquid is contained in a reservoir within the housing 116 and surrounds the upper end of the plunger 114, Fig. 7. The plunger 114 is integral with the crosshead 115 which is pivotally connected at pivot 133 to the variable stroke-adjusting mechanism 110.

The plunger 114 has been provided with a centrally-disposed passage or conduit 114*a* which extends from the liquid reservoir 116 to the plunger cylinder 102. The lower end of the plunger 114 is counterbored to receive a check valve 165 in the form of a ball which is adapted to be held on a seat 166 by means of a compression spring 167. The end of the plunger 114 is provided with a threaded plug member 168 with a plurality of flow passages 168*a* which enable the liquid in the reservoir 116 to flow through passage 114*a* around the ball 165 and through the passages 168*a* into the cylinder 102 when the check valve 165 is in open position. The check valve 165 is in open position, i.e. off of its seat 166, when the plunger 114 is at the end of the suction stroke. At this time the valve operator or stem 165*a* is in engagement with a projection or pin 170 which is mounted in stationary position on the housing 116. When the plunger 114 moves downward on the discharge stroke, the valve operator 165*a* moves out of engagement with the pin 170 and the spring 167 returns the ball valve 165 into engagement with its seat 166, closing the flow passage from the reservoir to the cylinder 102. Thus it will be seen that there is a positive mechanical operation of the check valve at the end of the suction stroke in each cycle of the plunger 114. This arrangement insures that once during each cycle of the plunger the reservoir of motion transmitting liquid is connected by way of a conduit to the motion transmitting liquid which is in communication with the moving wall or flexible diaphragm so as to correct for any expansion or contraction of the transmitting liquid and thereby eliminate any errors in metering due to the hydraulic transmission. Such positive mechanical connection to the check valve from the pump actuator avoids the necessity of relying upon pressure for operation of the check valve or for friction or other non-positive means.

The variable stroke-adjusting mechanism 110 is driven by means of a crank arm 120 which is carried by a shaft 121 which is in turn driven through suitable gearing in a gear housing 124, in turn connected with a suitable drive motor 126.

As may be seen in Fig. 8, the variable stroke-adjusting mechanism 110 corresponds very closely to the mechanism 10 shown in Fig. 1. However, the parts thereof have been reversed and the slide bar 32, Fig. 1, has been eliminated with the crosshead being connected directly to the three-member linkage. As may be seen in Fig. 8, the linkage includes a connector member 131, an adjuster member 141, and an intermediate swing member 140 which pivotally interconnects members 131 and 141 at pivots 145 and 146 respectively. The adjuster member 141 has a fixed pivot at 142 and a slot 141*a* at the opposite end of member 141 which is adapted to receive a slideable block 147 carried by pivot 148 which in turn is threadedly carried by an adjusting screw 151. The crank arm 120 is adapted to rotate in a clockwise direction as shown in Fig. 8 and is provided with a cam roller 130 which is received within a cam slot 131*a* in connector link 131. Rotation of crank arm 120 causes the pivot 145 to move along the arc 1*b* as indicated by the arrows so that it coincides with fixed pivot 142 during each cycle of operation. Since the connector member 131 is connected by pivot 133 to the plunger 114 and the crosshead 115, reciprocating movement is transmitted thereto corresponding with the length of stroke for which the mechanism 110 has been adjusted. The stroke may be adjusted by means of handle 153 which rotates the screw 151, thus moving the adjustable pivot 146 relative to the path of travel of the crosshead 115. When the pivot 146 has been moved to the right to a position on the path of travel of the crosshead 115, it will be seen that it coincides with pivot 133 and the stroke will have been reduced to zero.

As in the case of the modification described in connection with Figs. 1–6, the distance between pivots 146 and 142 is equal to the distance between 146 and 145 which in turn is equal to the distance between pivots 145 and 133. Thus the effective lengths of the links 141, 140 and 131 are equal.

With the mechanism illustrated in Fig. 8, it will be seen that the pivot 133 and thus crosshead 115 and the plunger 114 will assume the same position at the end of each suction stroke in the pump cycle regardless of the length of stroke for which the mechanism 110 is adjusted. This arrangement assures that the check valve 165, Fig. 7, will be operated at the same predetermined time in each cycle of the pump mechanism.

It shall be understood that the invention is not limited to the specific arrangements shown and that changes and modifications may be made within the scope of the appended claims.

What is claimed is:

1. A variable stroke mechanism comprising a crosshead to be reciprocated along a given path, a connector member pivotally connected at one end to said crosshead along said path, an adjuster member having a fixed pivot at one end thereof disposed to one side of said path, a swing member pivotally interconnecting the opposite ends of said connector member and said adjuster member, the effective lengths of all of said members between their respective pivots being equal, driving means effective on said connector member to pivot said connector member about its pivotal connection to said crosshead on said given path for moving said pivotal connection of said connector member to said swing member along an arcuate path from a position coincident with the fixed pivotal axis of the adjuster member to the opposite side of said path of said crosshead, and means for adjusting the position of said pivotal connection between said adjuster member and said swing member relative to said given path of said crosshead to adjust the position of said arcuate path which in turn adjusts the stroke of said crosshead.

2. A variable stroke mechanism comprising a crosshead to be reciprocated along a given path in accordance with a selected length of stroke, a connector link pivotally connected at one end with said crosshead for movement of said pivotal connection along said path, an adjuster link having a fixed pivot at one end thereof disposed at one side of said path, a swing link pivotally interconnecting the other ends of said connector link and

said adjuster link, the effective lengths of each of said links between their respective pivots being equal, driving means effective on said connector link to pivot said connector link about its pivotal connection to said crosshead for moving said pivotal connection of said connector link to said swing link back and forth along an arcuate path extending from a position coincident with said fixed pivot of said adjuster link to a position at the opposite side of said path of said crosshead, said movement along said arcuate path controlling the reciprocation of said crosshead in accordance with the selected length of stroke, and means for adjusting the position of said pivotal connection between said adjuster link and said swing link relative to said path of said crosshead to adjust the position of said arcuate path which in turn adjusts the length of stroke of said crosshead.

3. A variable stroke mechanism for regulating the stroke of a plunger comprising rotatable crank means, a connecting member having a cam track extending lengthwise thereof, said crank means including cam structure movable along said track, one end of said connecting member being connected to the plunger through a connecting element for reciprocatory movement therewith in accordance with the stroke of the plunger, the other end of said connecting member being connected to stroke control means for arcuate movement, said stroke control means including a swing link and adjustable positioning means, one end of said swing link being pivotally connected to said positioning means and the other end of said link being pivotally connected to said other end of said connecting member thereby positioning the arcuate path through which said one end of said connecting member passes when driven by said crank means, said positioning means being adjustable for positioning said one end of said swing link relative to the path of the plunger thereby adjusting the position of said arcuate path of said other end of said connecting member which in turn adjusts the stroke of the plunger.

4. A variable stroke mechanism comprising a crosshead to be reciprocated along a given path of travel, a flexible linkage including a pair of end members pivotally interconnected by an intermediate member, one of said end members being pivotally connected with said crosshead along its path of travel and the other said end member being connected to a fixed pivot disposed to one side of said path of travel, each of said members of said linkage being effectively equal in length, and adjustable means for supporting the pivoted connection between said other end member and said intermediate member at predetermined positions relative to said given path for travel bearing a substantially linear relationship between the amount of adjustment and the resultant change in the stroke of said crosshead.

5. A variable stroke mechanism according to claim 4 including rotating means effective on said linkage for cyclically moving said intermediate member thereof into alignment with said other end member during each stroke of said crosshead.

6. A variable stroke mechanism according to claim 4 including a slide bar interconnecting said crosshead and said one end member and said linkage, and means for guiding said slide bar for reciprocating movement.

7. A variable stroke mechanism according to claim 6 wherein said slide bar includes a cam track, and a pair of spaced cam rollers supported in fixed position and engaging said cam track for reciprocating movement thereof.

8. A variable stroke mechanism according to claim 4 including a slideable pivotal connection at the opposite end of said end member having said fixed pivot.

9. A variable stroke mechanism comprising a crosshead to be reciprocated along a given path of travel, a flexible linkage including a pair of end members pivotally interconnected by an intermediate swing member, one of said end members being pivotally connected with said crosshead along its path of travel and the other said end member being connected to a fixed pivot disposed to one side of said path of travel, each of said members of said linkage being effectively equal in length, adjustable means for supporting the pivotal connection between said other end member and said intermediate swing member at predetermined positions relative to said given path of travel for a selected stroke length, and driving means pivotally connected to said linkage and predetermining the limit of movement of said swing member for swinging it to and fro about its adjustable supporting pivot between limits one of which is fixed by said fixed pivot, the position of said adjustable means determining the length of travel of said crosshead which for all positions of said adjustable means and stroke lengths has the same position at one end of the stroke, the position of said crosshead at the opposite end of the stroke varying from zero to a maximum relative to said one end of said stroke.

10. A variable stroke mechanism according to claim 9 wherein said crosshead for all stroke lengths has the same forward position, the rearward position of said crosshead varying from zero to a maximum relative to said forward position.

11. The variable stroke mechanism according to claim 9 wherein said crosshead for all stroke lengths has the same rearward position, the forward position of said crosshead varying from zero to a maximum relative to said rearward position.

12. A variable stroke mechanism comprising a crosshead to be reciprocated along a given path of travel, flexible linkage including a pair of end members pivotally interconnected by an intermediate swing member, one of said end members being pivotally connected with said crosshead along its path of travel and the other said end member being connected to a fixed pivot disposed to one side of said path of travel, each of said members of said linkage being effectively equal in length, and adjustable means for supporting the pivoted connection between said other end member and said intermediate swing member at predetermined positions relative to said given path of travel to provide a selected stroke length of said crosshead.

13. A variable stroke mechanism according to claim 12 including crank means for swinging said swing member to and fro between limits, one of said limits being determined by the position of said end member having said fixed pivot.

14. A variable stroke mechanism according to claim 2 including a slide bar interconnecting said crosshead and said connector link, and means for guiding said slide bar for reciprocating movement.

15. A variable stroke mechanism according to claim 2 including a slideable pivotal connection at the opposite end of said adjuster link from said fixed pivot.

16. A variable stroke mechanism according to claim 2 wherein said adjuster link has a slot in the end thereof opposite said fixed pivot, and said adjusting means comprises a pivoted member slideably received within said slot, said pivoted member being adapted for straight line movement while permitting rotational movement of said adjuster link about its said fixed pivot.

17. A variable stroke mechanism for a pump comprising a crosshead to be reciprocated along a given path of travel, a flexible linkage including a pair of end members pivotally interconnected by an intermediate swing member, one of said end members being pivotally connected with said crosshead along its path of travel and the other said end member being connected to a fixed pivot disposed to one side of said path of travel, each of said members of said linkage being effectively equal in length, adjustable means for supporting the pivoted connection between said other end member and said intermediate swing member at predetermined positions relative to said given path of travel bearing a substan-

tially linear relationship between the amount of adjustment and the resultant change in stroke of said crosshead, and driving means pivotally connected to said linkage and predetermining the limit of movement of said swing member for swinging it to and fro about its adjustable supporting pivot between limits one of which is fixed by said fixed pivot, the position of said adjustable means determining the length of travel of said crosshead which for all positions of said adjustable means and stroke lengths has the same forward position, the rearward position of said crosshead varying from zero to a

maximum relative to said forward position, said driving means being so constructed and arranged to enable the pump to be on discharge during about sixty percent of the duration of each cycle in order to obtain greater capacity from a given size drive motor.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,972,894 February 28, 1961

Richard A. Bennett

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 20, for "bar 2" read -- bar 32 --; column 4, line 48, for "position" read -- positions --; line 58, for "verticle" read -- vertical --; column 7, line 50, for "for" read -- of --.

Signed and sealed this 9th day of January 1962.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents