C. M. MANLY & H. CENTERVALL.

BALANCED CRANK MECHANISM FOR PUMPS, MOTORS, &c.

APPLICATION FILED AUG. 16, 1911.

1,137,877.

Patented May 4, 1915.

4 SHEETS—SHEET 1.

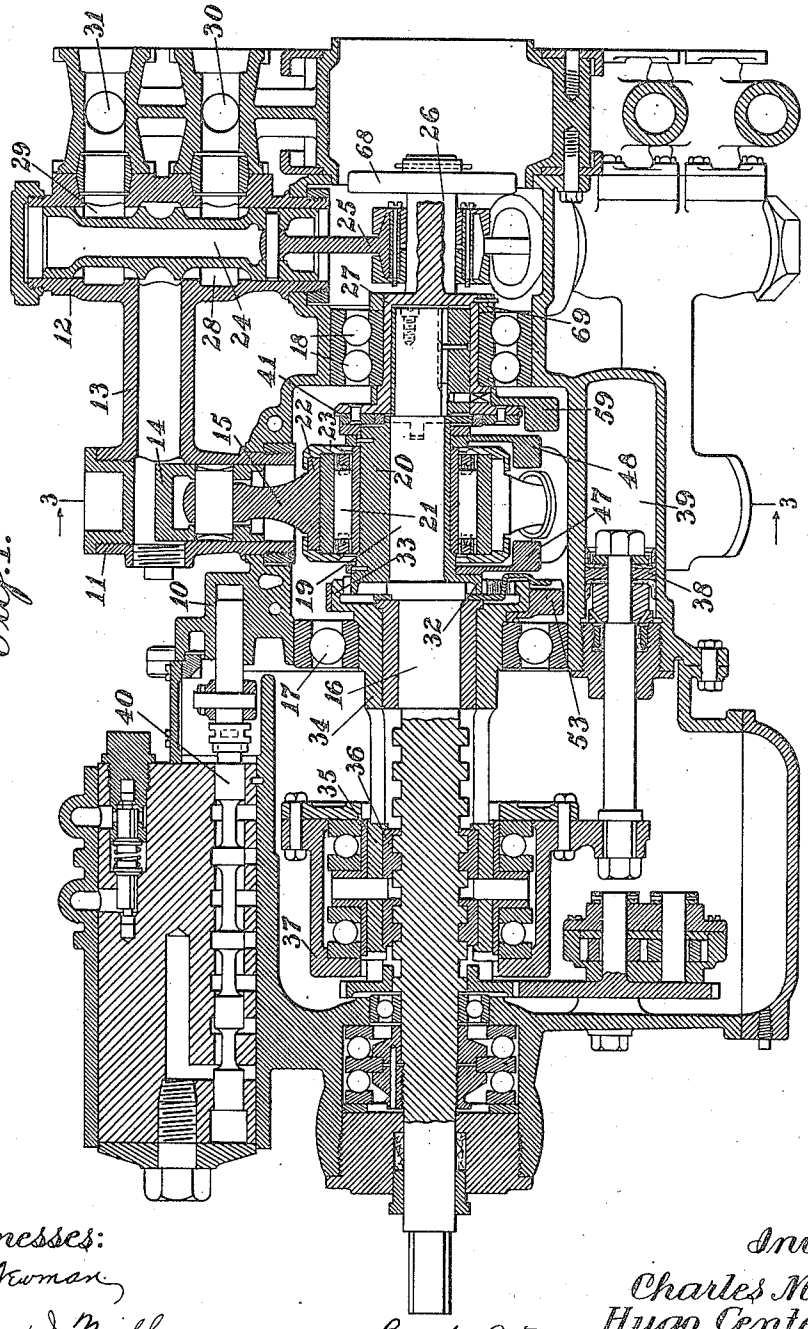


Fig. 1.

Witnesses:
S. Newman
Ada L. Miller.

Inventors:
Charles M. Manly
Hugo Centervall.
By W. B. Morton their Attorney.

C. M. MANLY & H. CENTERVALL.

BALANCED CRANK MECHANISM FOR PUMPS, MOTORS, &c.

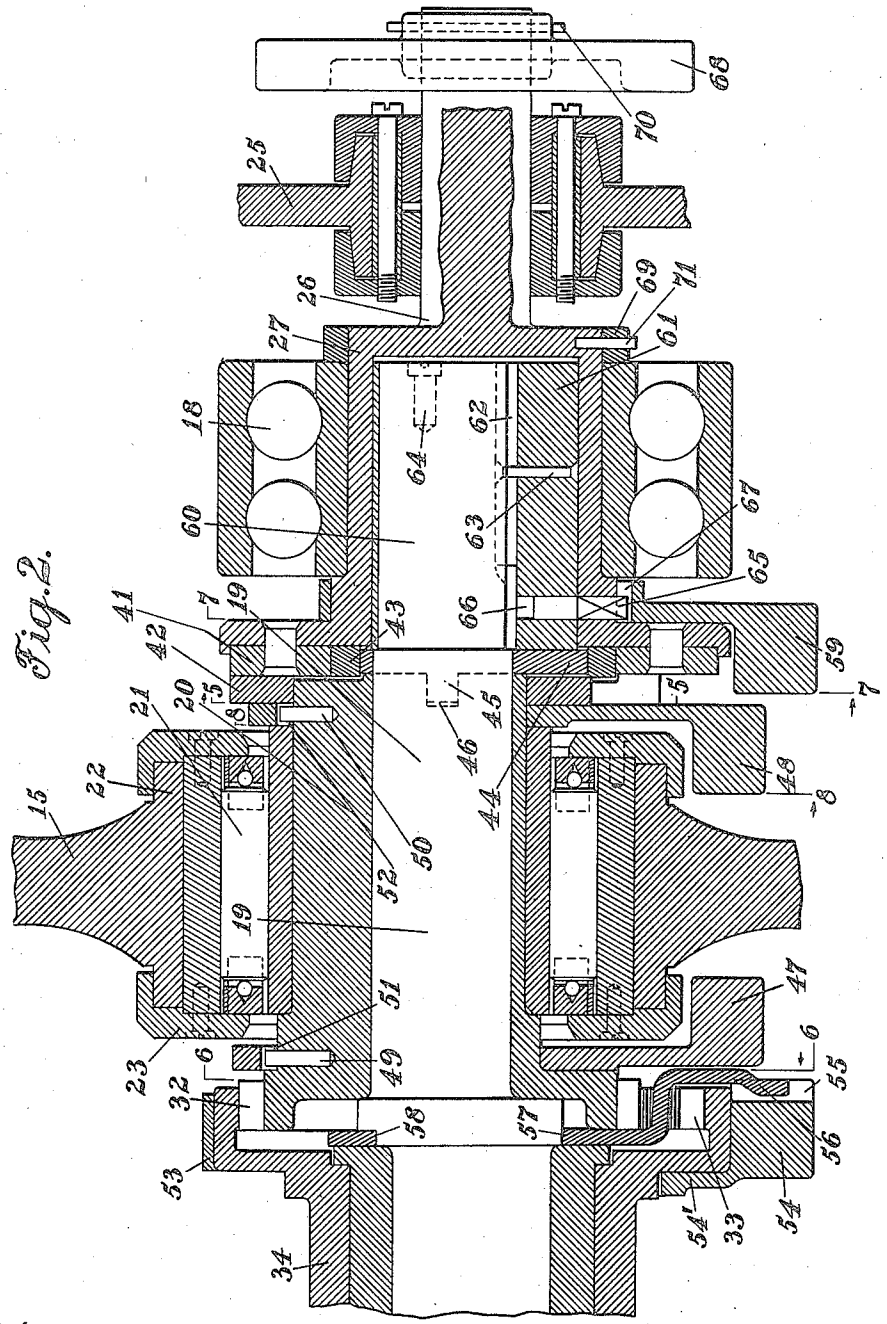
APPLICATION FILED AUG. 16, 1911.

1,137,877.

Patented May 4, 1915.

4 SHEETS—SHEET 2.

Fig. 2.



Witnesses:

S. Newman

Ada I. Miller

Inventors:

Charles M. Manly,

Hugo Centervall,

By W. B. Morton

their Attorney.

C. M. MANLY & H. CENTERVALL.

BALANCED CRANK MECHANISM FOR PUMPS, MOTORS, &c.

APPLICATION FILED AUG. 16, 1911.

1,137,877.

Patented May 4, 1915.

4 SHEETS—SHEET 3.

Fig. 10.

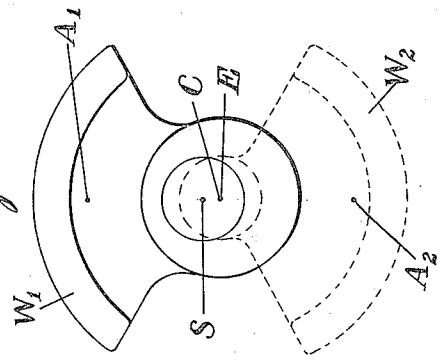


Fig. 9.

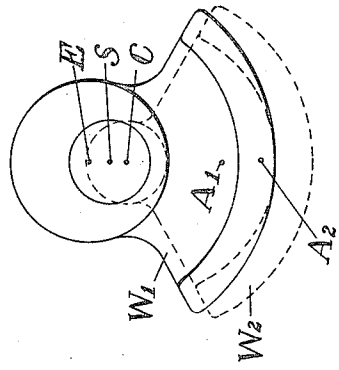


Fig. 11.

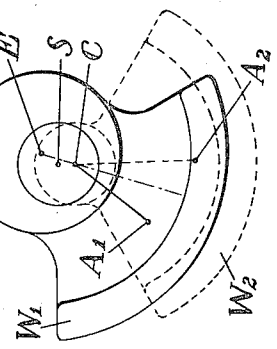
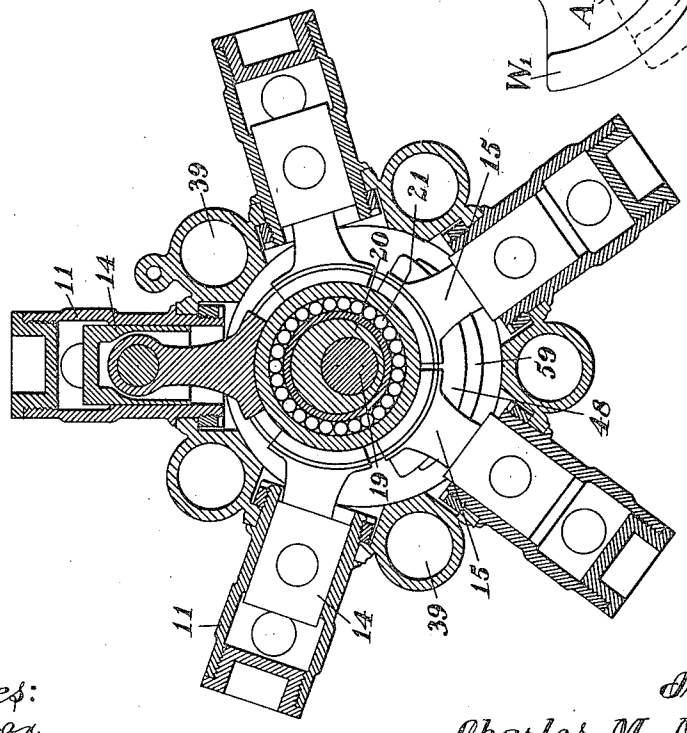


Fig. 3.



Witnesses:

S. Newman

Ada I. Miller

Inventors:

Charles M. Manly,

Hugo Centerball,

By Wm. B. Morton

Their Attorney.

C. M. MANLY & H. CENTERVALL.

BALANCED CRANK MECHANISM FOR PUMPS, MOTORS, &c.

APPLICATION FILED AUG. 16, 1911.

1,137,877.

Patented May 4, 1915.

4 SHEETS—SHEET 4.

Fig. 7.

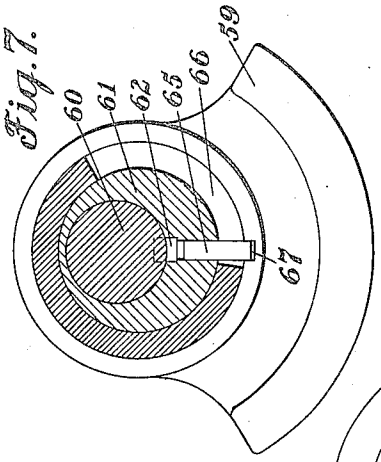


Fig. 8.

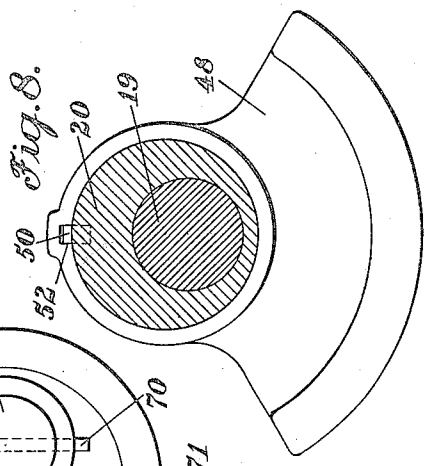


Fig. 4.

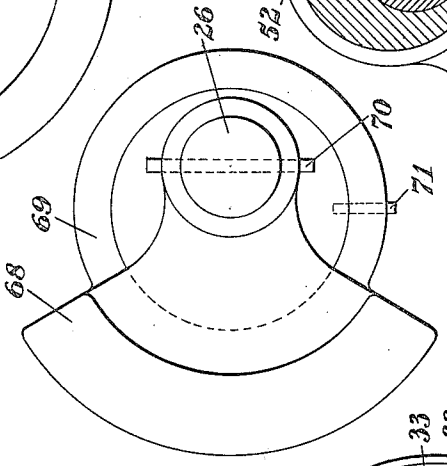


Fig. 5.

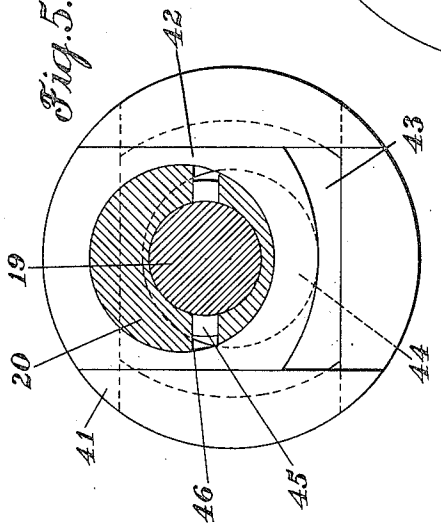
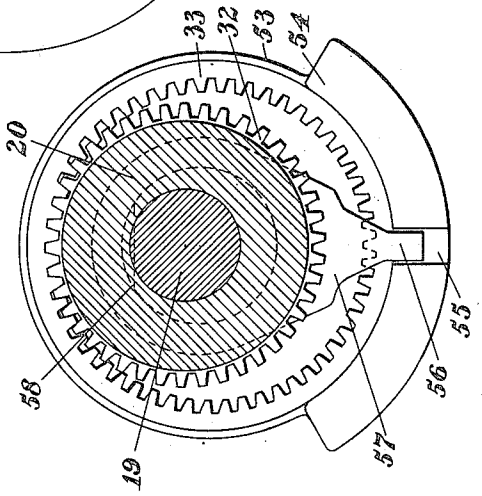


Fig. 6.



Witnesses:

J. Newman

Asa L. Miller

Inventors:

Charles M. Manly,

Hugo Centervall,

By W. B. Morton their Attorney.

UNITED STATES PATENT OFFICE.

CHARLES MATTHEWS MANLY, OF FREEPORT, AND HUGO CENTERVALL, OF BROOKLYN, NEW YORK.

BALANCED-CRANK MECHANISM FOR PUMPS, MOTORS, &c.

1,137,877. Specification of Letters Patent. Patented May 4, 1915.

Application filed August 16, 1911. Serial No. 644,358.

To all whom it may concern:

Be it known that we, CHARLES M. MANLY and HUGO CENTERVALL, citizens of the United States and the Kingdom of Sweden, respectively, and residing at Freeport, Long Island, New York, and Brooklyn, Kings county, New York, respectively, have invented certain new and useful Improvements in Balanced-Crank Mechanism for Pumps, Motors, &c., of which the following is a specification.

This invention relates to variable stroke crank mechanisms for pumps, motors, etc., and has for its object to provide a mechanism of that type in which the weight of the crank shaft and the parts actuated thereby will be balanced relative to the center of rotation whatever the position of adjustment of the variable throw crank.

A further object of the invention is to provide a mechanism of the character described in which the parts are of simple construction and may be quickly and easily assembled.

In the accompanying drawings we have illustrated a preferred embodiment of our invention as applied to the pump element of a variable speed hydraulic transmission of the character disclosed in the application of Charles M. Manly, Serial No. 639,464 filed July 19, 1911. It is to be understood, however, that our invention is not limited to such application or to the details of the mechanism here shown, but covers all such modifications of the same as fall within the scope of the appended claims.

In the drawings, Figure 1 is a vertical longitudinal sectional view of the pump element of a hydraulic transmission of the type described equipped with our novel balancing mechanism. Fig. 2 is similar sectional view on an enlarged scale showing a portion of the crank shaft and the parts connected thereto. Fig. 3 is a transverse sectional view on line 3—3 Fig. 1 looking in the direction of the arrows. Fig. 4 is a detail view showing the balance weights for the valve crank pin. Fig. 5 is a transverse sectional view on line 5—5 of Fig. 2 looking in the direction of the arrows. Figs. 6, 7 and 8 are similar views on the lines 6—6, 7—7 and 8—8, respectively, of Fig. 2 looking in the direction of the respective arrows. Figs. 9, 10, 11 are diagrammatic views showing the positions of the weights for different positions of the adjustable eccentric on the pump crank pin.

Referring to the drawings, and particularly to Fig. 1, 10 represents the crank casing of our improved variable stroke pump, to which are rigidly attached the pump cylinders 11 and valve chambers 12. The pump cylinders are here shown as five in number and are radially arranged around a common center, as shown in Fig. 3. Each pump cylinder has its valve chamber 12 integrally connected to it by a tubular part 13 forming a fluid transmitting passage. Mounted in each of the pump cylinders 11 is a piston 14, each of which has a connecting rod 15. The pistons 14 are adapted to be reciprocated in their respective cylinders by a crank shaft 16 suitably supported in the casing 10 by bearings 17 and 18, and adapted to be rotated from any suitable source of power. The crank shaft 16 is formed with an integral crank pin 19, and rotatably adjustable on the crank pin 19 by a mechanism which will be hereinafter described, is an eccentric bush 20 whose eccentricity is equal to the eccentricity of the crank pin. Surrounding the eccentric bush 20 is a roller bearing 21 against the outer sleeve of which the inner ends of the connecting rods 15 bear. As shown, the inner ends of the connecting rods 15 are formed in the shape of curved shoes 22 fitting the outer sleeve of the roller bearing, which shoes are held in place by flanged rings 23, the flanges of which fit over the ends of the shoes. From the above description it will be obvious that the length of the stroke of the pistons effected by the rotation of the shaft 16 will be determined by the angular position of the eccentric bush 20 on the crank pin, and, as the eccentricity of the bush 20 is the same as that of the crank pin, in one position of the bush as shown in the drawings, the pistons will have their maximum stroke, equal to four times the eccentricity of the crank pin, and in a position 180 degrees angularly from the position shown, the bush and crank pin will counteract each other and the pistons will not be moved by the rotation of the crank shaft.

To control the intake and delivery of fluid from the pump cylinders, each valve chamber 12 is provided with a two-port piston valve 24, which valves are connected for reciprocation by connecting rods 25 to a

crank pin 26 carried by a sleeve 27 rotatably mounted in the bearing 18 and connected for rotation to the eccentric bush 20 by mechanism which will be hereinafter described. As shown, the valve chambers are provided with inner and outer ports 28, 29 respectively, which are, by the reciprocation of the valves 24, alternately connected to the cylinders 11 so that one set of ports 28 or 29 constitute intake ports and the other set, delivery ports, according to the relative positions of the crank arms of the pump pistons and valves, all as fully explained in the prior application above referred to. The inner ports 28 are preferably connected by an inner manifold 30 and the outer ports 29 by an outer manifold 31 to form common intake and delivery channels for all the cylinders, and when the pump is employed as an element of a variable speed transmission as disclosed in the said prior application, the inner and outer manifolds are connected respectively to the inner and outer ports of the motor valve chambers, which are substantially similar to the pump valve chambers here shown, thereby forming a closed fluid circuit having a high pressure side and a low pressure side as will be readily understood.

For adjusting the eccentric bush 20 around the crank pin 19, we preferably employ a fluid pressure actuated mechanism operated by the pressure of the fluid in the high pressure side of the fluid circuit. This mechanism is identical with that disclosed in the said prior application, of Charles M. Manly, and forms no part of the present invention. It has not therefore been shown in detail in this application and will be but briefly described. Formed on the end of the eccentric bush 20 adjacent the bearing 17 is a spur gear 32 which meshes with an internal gear 33 formed on a slotted sleeve 34 which surrounds the shaft 16 between the same and the bearing 17. Mounted in the slots of the sleeve 34 are shoes 35 attached to a nut 36 working on a threaded portion of the shaft 16. A yoke 37 is connected by suitable bearings to the nut 36 and is provided with pistons 38 working in horizontal cylinders 39 formed in the casing 10. A suitable valve mechanism controlled by a manually operatable valve 40 is provided to control the admission of fluid under pressure to either side of the pistons 38. The movement of the pistons adjusts the nut 36 longitudinally of the threaded portion of the shaft thereby rotating the slotted sleeve on the shaft and by means of the gears 33, 32 rotating the eccentric bush on the crank pin 19.

When the eccentric bush is adjusted from the "no-stroke" position through 180 degrees to the position of maximum stroke, the real crank arm of the pistons, that is, the line from the center of rotation to the center of the outer periphery of the eccentric bush 20 moves through an angle of only 90 degrees and therefore in order that the crank arm of the valve crank pin 26 may at all adjustments of the eccentric bush maintain the proper angular relation to the real crank arm of the pump pistons, the sleeve 27 of the crank pin 26 is connected to the eccentric bush by a mechanism that gives a two-to-one reduction between the bush and the sleeve. The mechanism shown in this application for this purpose operates on the same principle as the mechanism disclosed in the prior application above referred to, but has here been modified to properly coöperate with the crank balancing mechanism of the present invention.

Referring particularly to Figs. 2 and 5, 41 represents a plate or housing riveted to a flange on the end of the sleeve 27 adjacent the pump crank and having in each face a slot or guide way, the said slots extending at right angles to each other. Working in the slot of the plate 41 in the face adjacent the bush 20 is a shoe 42 provided with a central bore whereby it is rotatably mounted on the end of the bush 20, and working in the other slot of the plate 41 is a shoe 43 exactly similar to the shoe 42 which shoe is rotatably mounted on an eccentric disk 44 supported on the crank pin 19 and connected for rotation with the eccentric bush 20 by lugs 45 on the disk which fit in recesses 46 cut in the adjacent face of the bush 20. The eccentricity of the disk is equal to that of the bush 20 and the lugs 45 and recesses 46 are so arranged that the disk is maintained in a position diametrically opposite to that of the bush 20. The crank pin 26 is positioned on the sleeve 27 so that its crank arm is maintained by the above described mechanism at all times 90 degrees distant angularly from the real crank arm of the pump pistons, and when the eccentric bush 20 is adjusted from one side to the other of the "no-stroke" position, the position of the crank arm of the crank pin 26 changes from 90 degrees in advance of the crank arm of the pump pistons in the direction of rotation to a position 90 degrees angularly behind the crank arm of the pump pistons thereby reversing the direction of flow of the fluid in the manifolds 30, 31, all as fully explained in the prior application above referred to.

It is obvious that in a pump mechanism constructed as disclosed, the center of gravity of the pump crank pin and the parts carried thereby is not coincident with the center of rotation of the crank shaft except when the eccentric bush is adjusted to its "no-stroke" or zero position and therefore in all other positions of the eccentric bush the centrifugal force of the unbalanced weight of the parts produces an unbalanced

side thrust accompanied by undesirable stresses on the shaft and increased friction on the bearings. To properly balance the parts and nullify this side thrust is the leading object of the present invention, and in the embodiment of the invention here shown this object is accomplished by the means which will now be described.

Mounted on the bush 20 on each side of the bearing of the pump piston connecting rods are two counterweights 47, 48, as shown in Fig. 2. These weights are of the same size and weight and, as shown in Fig. 8, which shows the weight 48 in position on the bush 20, are substantially sector shaped and are positioned on the bush 20 so that the middle of the arc is in line with and opposite the point of greatest thickness of the eccentric bush. The weights 47, 48 are held in position on the bush 20 for rotation therewith by pins 49, 50 in the bush which fit in recesses 51, 52 in the weights 47, 48 respectively. Rotatably mounted on the outer periphery of the internal gear 33 is a counterweight 53, shown in detail in Fig. 6, and consisting essentially of a ring having a thickened or weight forming portion 54 constituting about 120 degrees of its circumference, and extending inwardly from this portion of the ring is a flange 54′ adapted to hold the weight against axial displacement. In the middle of the part 54 a radial slot 55 is cut, which slot receives a tongue 56 forming the end of an arm 57 mounted on the crank shaft 16 between the bearing bush of the internal gear and the end face of the spur gear and held for rotation with the crank shaft by the engagement of cooperating flat faces on the arm and shaft, as shown in dotted lines at 58 in Fig. 6, in such position that the middle of the weight forming part 54 is maintained in line with and opposite the crank arm of the crank pin 19.

Mounted on the sleeve 27 between the flange thereof and the bearing 18 is a fourth weight 59, shown in detail in Fig. 7, which weight is also connected to the crank shaft for rotation therewith. The end of the crank shaft which fits the sleeve 27 is formed for convenience in assembling, in two parts, consisting of a pin 60 forming a slightly reduced extension of the crank pin 19 and an eccentric sleeve 61 fitting the part 60 and rigidly connected therewith by a key 62 held in place in the sleeve 61 by a pin 63 and fitting in a slot in the part 60. A screw 64 in the end of the part 60, with its head engaging a recess (not shown) in the sleeve 61 may also be employed to hold the parts 60, 61 of the shaft together. By means of this construction the shaft 16 may be axially withdrawn from the bush 20 and sleeve 27 without disturbing the parts mounted on the sleeve and bush. As stated above, the weight 59 is attached to the shaft 16 for rotation therewith. This connection comprises a pin 65 set in a hole in the sleeve 61 and having a square portion working in a slot 66 in the sleeve 27 and extending into a recess 67 in the weight 59 so as to hold the weight in the same position relatively to the crank pin 19 as the weight 53. The slot in the sleeve 27 extends through about 120 degrees of the circumference of the sleeve so as to permit stroke adjusting movement of the bush 20 from the full stroke position through zero to one third full stroke position beyond so that when the pump is used as an element of a variable speed gear the driven motor can be given any reverse speed up to about one third maximum speed. Where it is desired to have the variable speed gear capable of all speeds reverse as well as forward, the slot 66 would have a length of 180 degrees.

In order to balance the valve crank pin 26 and the parts connected thereto two equal weights 68, 69, are employed, the one 68 being rigidly attached to the end of the crank pin 26 by the cross pin 70 and the one 69 being mounted on the sleeve 27 and attached thereto by the pin 71. The weights are so attached that their centers are diametrically opposite the center line of the crank pin.

In Figs. 9, 10 and 11 we have diagrammatically illustrated three different positions of adjustment of the stroke adjusting parts, Fig. 9 showing the parts in their full stroke position, Fig. 10 showing them in their zero position, and Fig. 11 in an intermediate position. In these figures C indicates the center of rotation, S the center of the crank pin around which the eccentric bush 20 and the weights 47, 48 rotate during the adjustment of the stroke, and E the center of the outer periphery of the eccentric bush, which is obviously the center of the weights to be balanced, which for convenience will be referred to as weight W. A_1 indicates the center of gravity of the weights 47, 48 carried by the eccentric bush, hereinafter referred to as weight W_1, and A_2 indicates the center of gravity of the weights 53 and 59 carried by the crank shaft and hereinafter referred to as weight W_2. In the full stroke position of the parts as shown in Fig. 9, the centers of the weights W_1 W_2 are diametrically opposite the center of the weight W to be balanced, as regards the center of rotation C, and hence in order for the parts to be balanced in this position it is necessary that the sum of the moments of the weights W_1 and W_2 equal the moment of the weight W. This relation may be expressed in the form of an equation thus,

$$W_1(CA_1)+W_2(CA_2)=W(CE)$$

or letting r equal the length of the crank arm of the crank pin 21, l_1, the distance from

the point A_1 to the point S, that is, to the center of support of the weight W_1, and l_2 the distance from the point A_2 to the point C which is the center of support of the weight W_2 the equation becomes,

$$W_1(l_1-r)+W_2l_2=2rW.$$

When the eccentric bush 20 is rotated 180 degrees around the crank pin 19 from the full stroke position to adjust the parts to the zero position, the point A_1 has a position diametrically opposite the point A_2 as regards the center of rotation, as shown in Fig. 10. In this position the center E of the weight to be balanced coincides with the center of rotation. Hence this weight is self-balancing and therefore for all parts to be balanced in this position it is necessary for the weights 47, 48 and 53, 59 to counterbalance each other, that is, the moment of the weight W_1 must equal the moment of the weight W_2 or as an equation,

$$W_1\ (l_1+r)=W_2l_2.$$

From these equations the proper proportions for the counterweights may be easily determined.

In one size of the machine as actually constructed the weight of the parts to be balanced, W in the above equations, is 28 pounds, and the length of the crank arm of the crank pin 19, or r, is $\frac{3}{8}$ of an inch. Each of the weights 47, 48, on the eccentric bush 20 weighs approximately 1.91 pounds or the weight W_1 equals 3.82 pounds, and the distance from the center of gravity of the weights to their center of support, l_1 in the above equations, is $2\frac{3}{4}$ inches. Each of the weights 53, 59 attached to the crank shaft weighs approximately 2.11 pounds or W_2 equals 4.22 pounds, and the distance l_2 equals $2\frac{5}{8}$ inches.

Fig. 11 shows the position of the parts when the eccentric bush 20 has been adjusted partially around the crank pin 19 to give some stroke to the pump pistons intermediate full stroke and zero stroke. It will be observed that the lines CA_1 and CA_2 which represent the directions of the centrifugal forces of the weights W_1, and W_2 lie on opposite sides of the diametric continuation of the line CE which represents the direction of the centrifugal force of the weight W. This is true in all intermediate positions of adjustment for the reason that the line CE changes angularly during the adjustment of the eccentric bush 20 to which the weights 47, 48, constituting the weight W_1, are attached, at but one half the rate of the bush 20, and it may be mathematically proven that the resultant of the centrifugal forces of the weights W_1 and W_2 when their proportions have been determined by the above equations is always equal and opposite to the centrifugal force of the weight W at E.

In determining the proportions of the counterweights, it is not essential for their weights to be a fixed fraction of the weight to be balanced. It is merely necessary that their moments have the proper values as determined by the above equations, hence the shape, weight and dimensions of the counterweights may be varied as may be necessary to suit the proportions of the particular mechanism to which they are applied.

While we have shown our improved counter-balancing mechanism as applied to the particular pump mechanism disclosed in the application of Charles M. Manly above referred to, it is to be understood that such showing is by way of example only and that the invention is equally applicable to various other mechanisms operated by variable throw cranks or embodying shifting eccentrics as well as to other types of pumps than the one selected for illustration.

We claim,—

1. In a mechanism of the class described, the combination of a rotatable member, mechanism carried thereby and adjustable thereon, and means for balancing said member and said mechanism, substantially as described.

2. In a mechanism of the class described, the combination of a rotatable member, mechanism carried thereby and adjustable relative to the center of rotation of said member, and means for balancing said member and mechanism, substantially as described.

3. In a mechanism of the class described, the combination of a rotatable crank shaft, mechanism carried by the crank pin of said shaft and shiftable thereon, and means for balancing said crank shaft and said mechanism, substantially as described.

4. In a mechanism of the class described, the combination of a rotatable member having a variable throw crank and means for balancing said crank, substantially as described.

5. In a variable stroke crank shaft, the combination with means rotatably adjustable for varying the stroke of said crank shaft, of means for counter-balancing the said stroke adjusting means at all positions of stroke variation, substantially as described.

6. A variable stroke crank shaft, comprising rotatably mounted and rotatably adjustable members coacting to vary the stroke of the said shaft, the sum of the moments of the centrifugal forces of the said members being zero at all positions of stroke variation, substantially as described.

7. In a mechanism of the class described, the combination of a rotatable member, mechanism carried thereby and adjustable thereon, and means for balancing said member and mechanism comprising a counter-

weight carried by said member and adjustable thereon, substantially as described.

8. In a mechanism of the class described, the combination of a rotatable member, mechanism carried thereby and adjustable relative to the center of rotation of said member and means for balancing said member and mechanism comprising a counterweight adjustable relative to the center of rotation of said member, substantially as described.

9. In a mechanism of the class described, a balanced variable throw crank mechanism, comprising an eccentric adjustable relatively to the center of rotation of said mechanism and a counterweight carried by said eccentric, substantially as described.

10. In a mechanism of the class described, a balanced variable throw crank mechanism comprising a rotatable member, an eccentric carried thereby and adjustable circumferentially and radially thereof, and a counterweight carried by said eccentric, substantially as described.

11. In a mechanism of the class described, a balanced variable throw crank mechanism comprising a rotatable member, an eccentric carried thereby and adjustable thereon, a counterweight rotatable with said member and a counterweight rotatable with said eccentric, substantially as described.

12. In a mechanism of the class described, a balanced variable throw crank mechanism comprising a rotatable member, an eccentric carried thereby and adjustable circumferentially and radially thereof, a counterweight rotatable with said member and a counterweight rotatable with said eccentric, substantially as described.

13. In a mechanism of the class described, a balanced variable throw crank mechanism, comprising a rotatable crank shaft having an immovably fixed crank pin, an eccentric rotatably adjustable on said crank pin, a counterweight rotatable with said crank shaft and a counterweight rotatable with said eccentric, substantially as described.

14. In a variable stroke pump, the combination of a cylinder, a piston therein, a crank for reciprocating said piston comprising a radially adjustable crank pin, and means for balancing the centrifugal moment of said crank pin in different positions of adjustment thereof.

15. In a variable capacity pump, the combination of a cylinder, a piston therefor, a crank shaft for operating said piston having a radially adjustable crank pin, and means for balancing the centrifugal moment of said crank pin in different positions of adjustment comprising a rotatably adjustable counterweight.

16. In a variable capacity pump, the combination of a cylinder, a piston therefor, a crank shaft for operating said piston having a radially adjustable crank pin, means for balancing the centrifugal moment of said crank pin in different positions of adjustment comprising a rotatably adjustable counterweight, and connections between said crank pin and counterweight whereby the adjustment of said crank pin effects the proportionate movement of said counterweight.

17. In a mechanism of the class described, the combination with a rotatable member having a variable throw crank mechanism adjustable from a position concentric with the center of rotation of said member or zero position, to a predetermined maximum throw position, of means for balancing said crank mechanism comprising a plurality of counterweights so adjustable relatively to each other that in the zero position of the crank mechanism they counter-balance each other and in the maximum stroke position they augment each other and counter-balance said crank mechanism, substantially as described.

18. In a mechanism of the class described, a balanced crank mechanism comprising a crank shaft having a crank pin, a bush rotatably adjustable on said crank pin, a sleeve rotatable on said crank shaft and having driving connection with said bush for adjusting the same, a counterweight rotatably mounted on said sleeve and means for connecting said weight with said shaft for rotation therewith, substantially as described.

19. In a mechanism of the class described, a balanced variable throw crank mechanism, comprising a crank shaft having a crank pin, an eccentric bush rotatably adjustable on said crank pin, a sleeve rotatable on said crank shaft and having driving connection with said eccentric bush for adjusting the same, a counterweight rotatably mounted on said sleeve, means for connecting said weight with said shaft for rotation therewith, and a counterweight carried by said eccentric bush, substantially as described.

20. In a mechanism of the class described, the combination of a crank shaft having a crank pin, an eccentric bush rotatably adjustable on said crank pin and having a spur gear on one end, a sleeve rotatable on said crank shaft and having an internal gear meshing with said spur gear, a counterweight rotatably mounted on said internal gear, an arm fixed to said crank shaft extending between said gears and engaging said weight, and a counterweight carried by said eccentric bush, substantially as described.

21. In a mechanism of the class described, the combination of a crank shaft having a crank pin, an eccentric bush rotatably adjustable on said crank pin, a plurality of counterweights rotatably connected to said

crank shaft and a plurality of counterweights rotatably connected to said eccentric bush, substantially as described.

22. In a machine of the class described, the combination of a crank shaft, a sleeve rotatably adjustable on said crank shaft, and a counterweight rotatably mounted on said sleeve, and means for connecting said weight to said shaft for rotation therewith, substantially as described.

23. In a machine of the class described, the combination of a crank shaft, a sleeve rotatably adjustable on said crank shaft, and a counterweight rotatably mounted on said sleeve, and means for connecting said weight to said shaft for rotation therewith comprising a pin fixed in said crank shaft, extending through a slot in said sleeve, and engaging said weight, substantially as described.

24. In a machine of the class described, the combination of a crank shaft having a crank pin and rotatably supported by bearings on either side of said crank pin, a sleeve rotatably adjustable on said crank shaft in one of said bearings and having a crank pin projecting beyond said bearing, and a counterweight rotatably mounted on said sleeve and connected for rotation with said crank shaft, substantially as described.

25. In a mechanism of the class described, the combination of a crank shaft having a crank pin and rotatably supported by bearings on either side of said crank pin, an eccentric bush rotatably adjustable on said crank pin, a sleeve on said shaft extending through one of said bearings and having driving connection with said eccentric, means for rotating said sleeve to adjust said eccentric, a second sleeve on the other end of said shaft and extending through the other bearing, a second crank pin connected to said second sleeve beyond the bearing, a driving connection between said second sleeve and said eccentric bush, a counterweight mounted on each of said sleeves, means for rotatably connecting said counterweights to said shaft with their centers of gravity diametrically opposite to the center of said first crank pin, a plurality of counterweights attached to said eccentric bush with their centers of gravity diametrically opposite to the point of greatest thickness of said bush, and counterweights rigidly attached to said second sleeve and crank pin with their centers of gravity diametrically opposite the center of said crank pin, substantially as described.

26. In a mechanism of the class described, the combination of a crank shaft having a crank pin and an extension beyond said crank pin and in line with said crank pin, a sleeve mounted on said crank pin and operatively connected to the mechanism to be actuated, an eccentric sleeve detachably connected to said extension of the crank shaft whereby the crank shaft may be axially withdrawn from the sleeve of the mechanism to be actuated, said eccentric sleeve having the center of its outer periphery in line with the center of rotation of said shaft, and a bearing supporting said eccentric sleeve, substantially as described.

27. In a mechanism of the class described, the combination of a shaft having an integral crank pin, an eccentric bushing rotatably mounted on said crank pin for varying the throw of said crank, and a member detachably connected to the end of said crank pin and provided with a shaft portion in line with said first mentioned shaft.

28. In a mechanism of the class described, the combination of a shaft having an integral crank pin, an eccentric bushing rotatably mounted on said crank pin for varying the throw of said crank, and a member having a telescopic connection with the end of said crank pin and provided with a shaft portion in line with said first mentioned shaft.

In testimony whereof, we have signed our names to this specification in the presence of two subscribing witnesses, this 12 day of August 1912.

CHARLES MATTHEWS MANLY.
HUGO CENTERVALL.

Witnesses:
ANDREW SEGALA,
R. E. RUNDELL.