No. 711,663.

Patented Oct. 21, 1902.

F. E. HERDMAN.

MECHANICAL MOVEMENT.

(Application filed Apr. 14, 1902.)

(No Model.)

5 Sheets—Sheet 1.

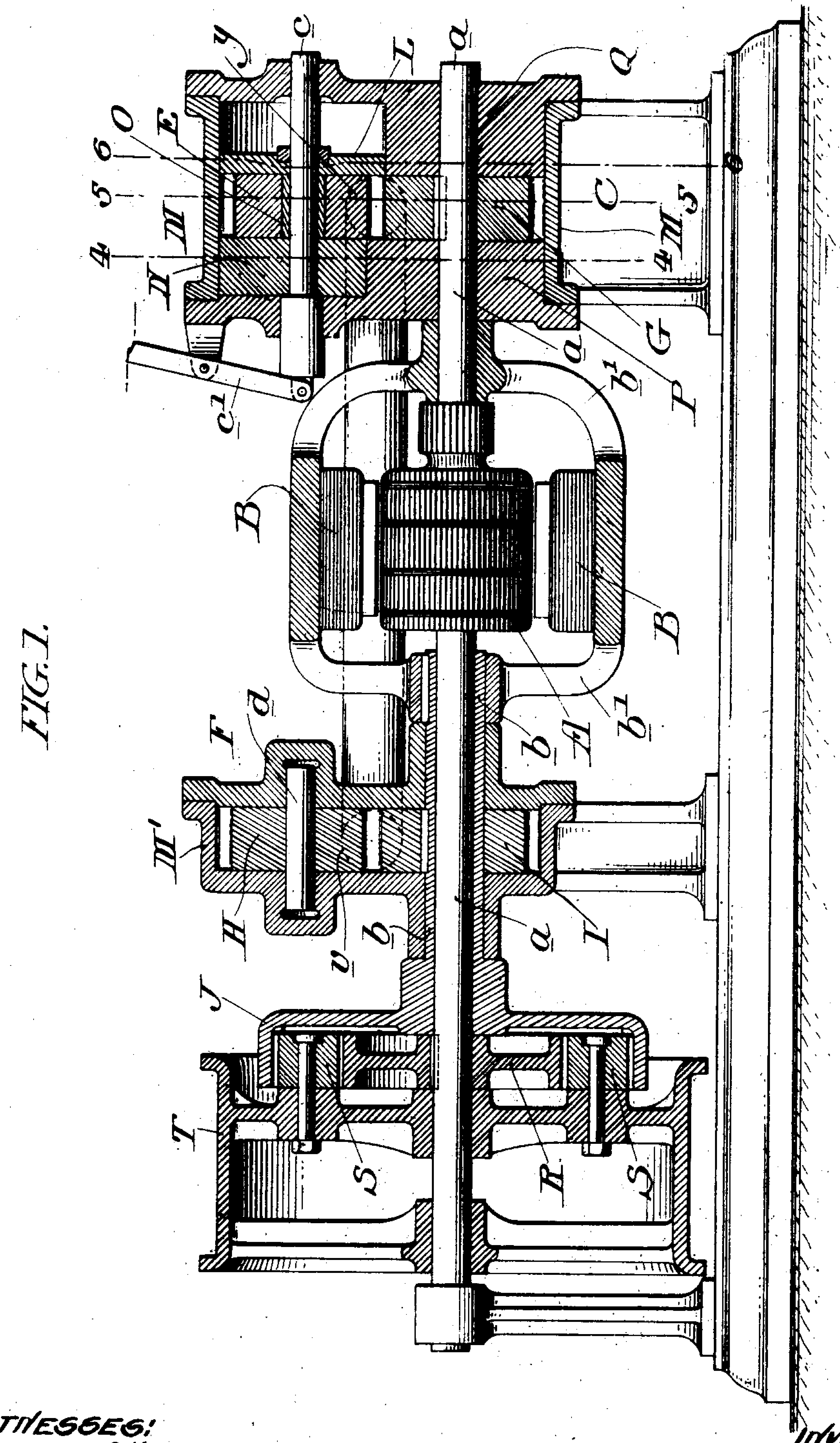

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FIG. 2.

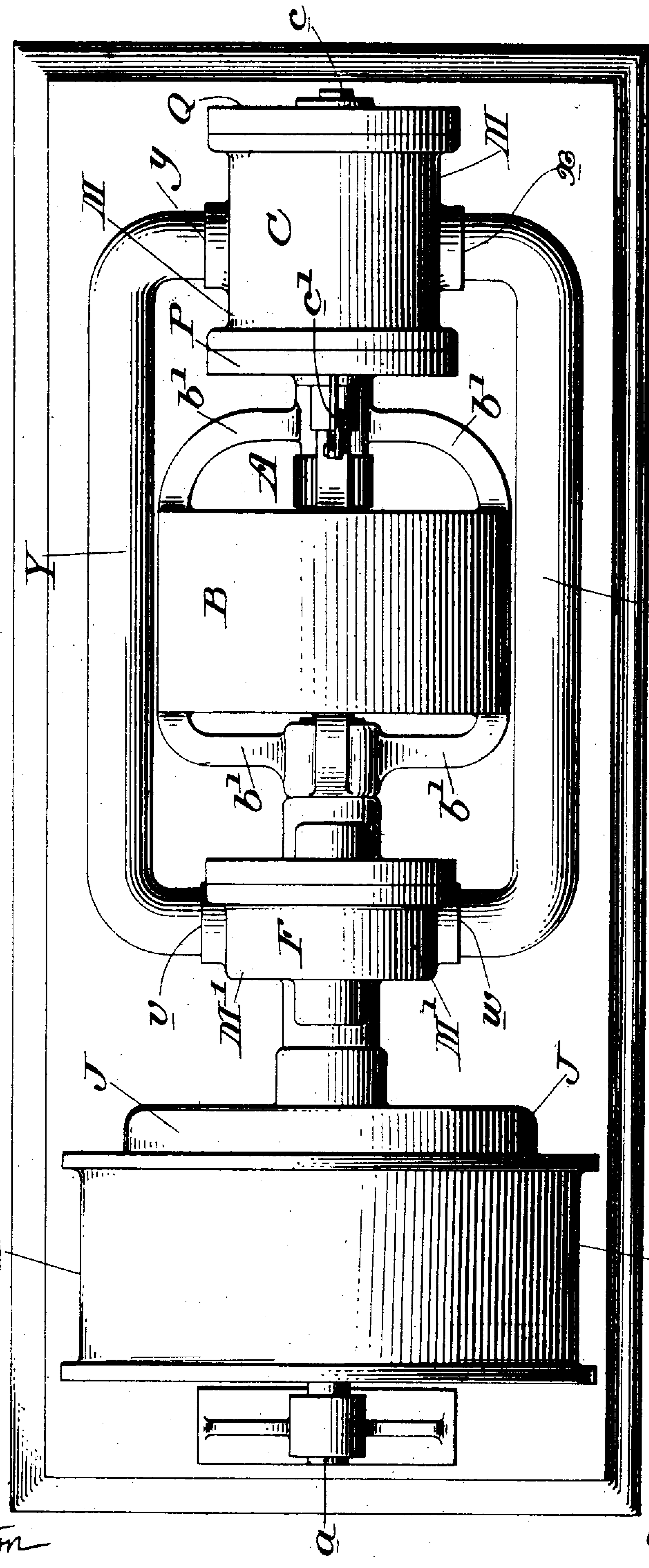

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FIG. 3.

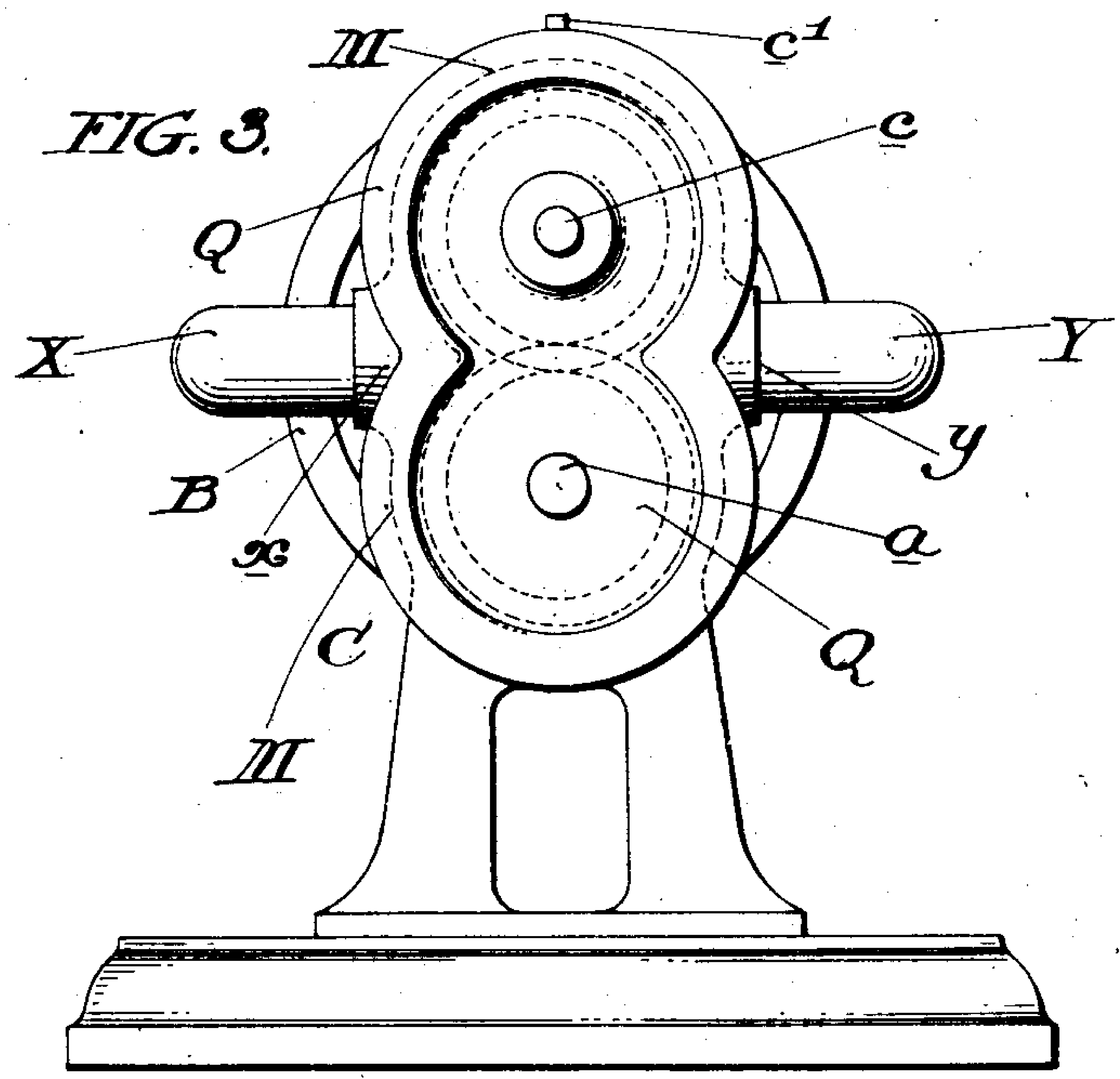


FIG. 4.

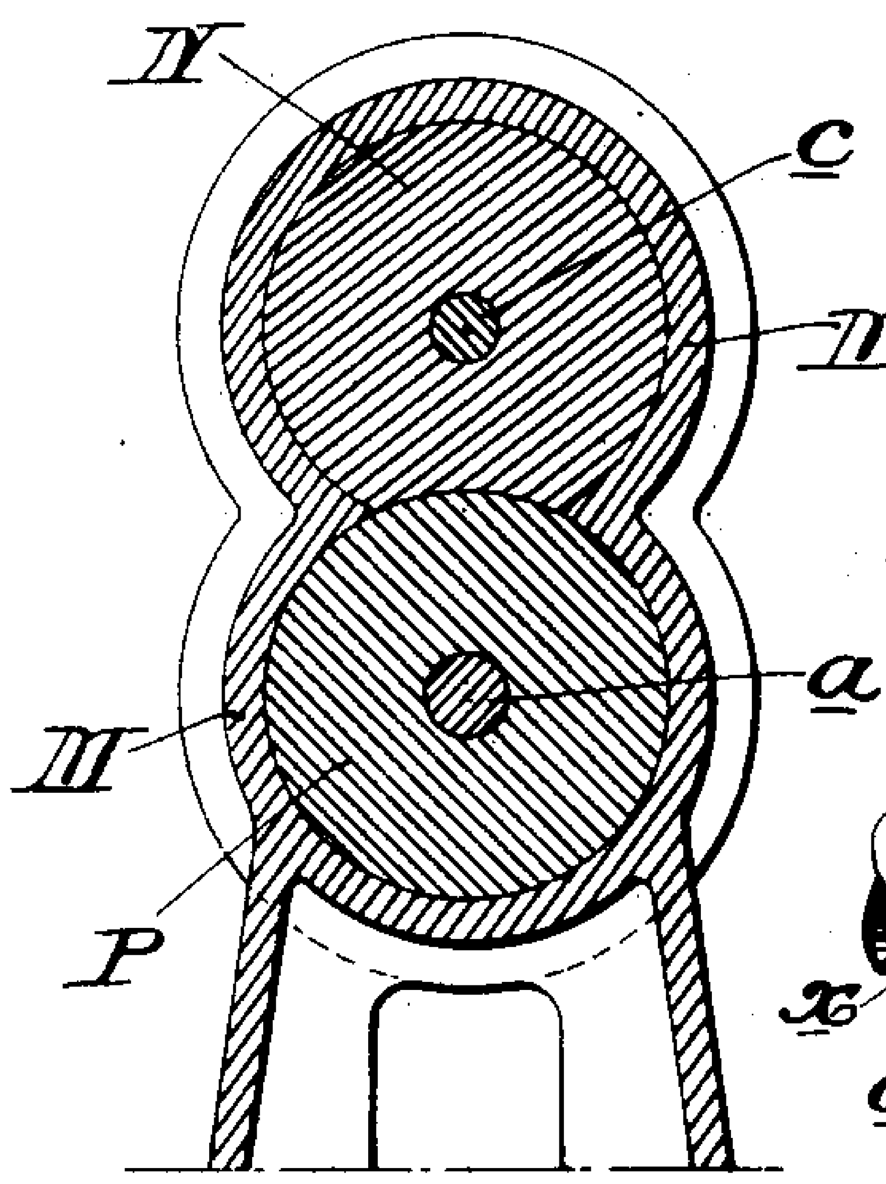


FIG. 6.

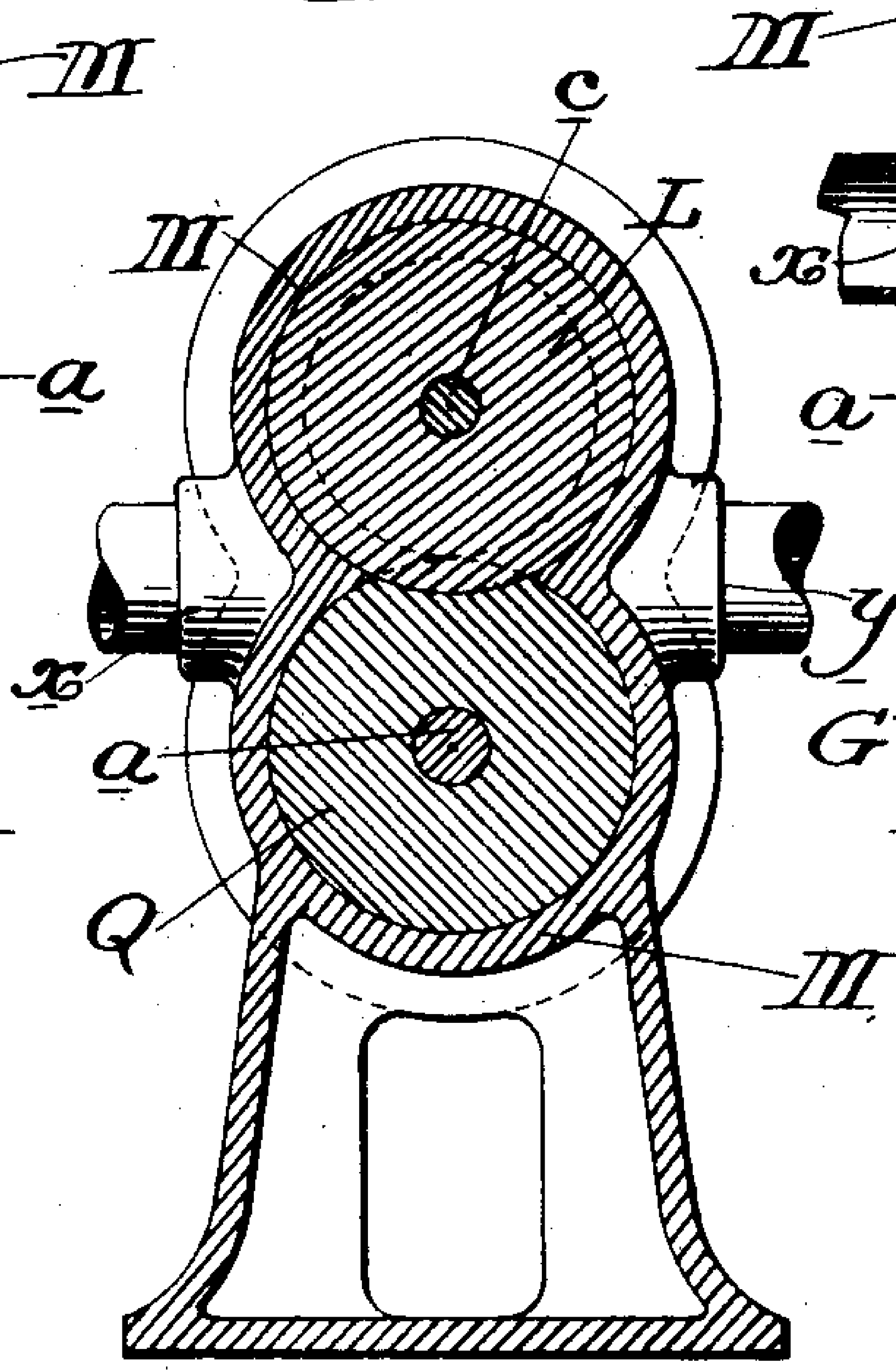
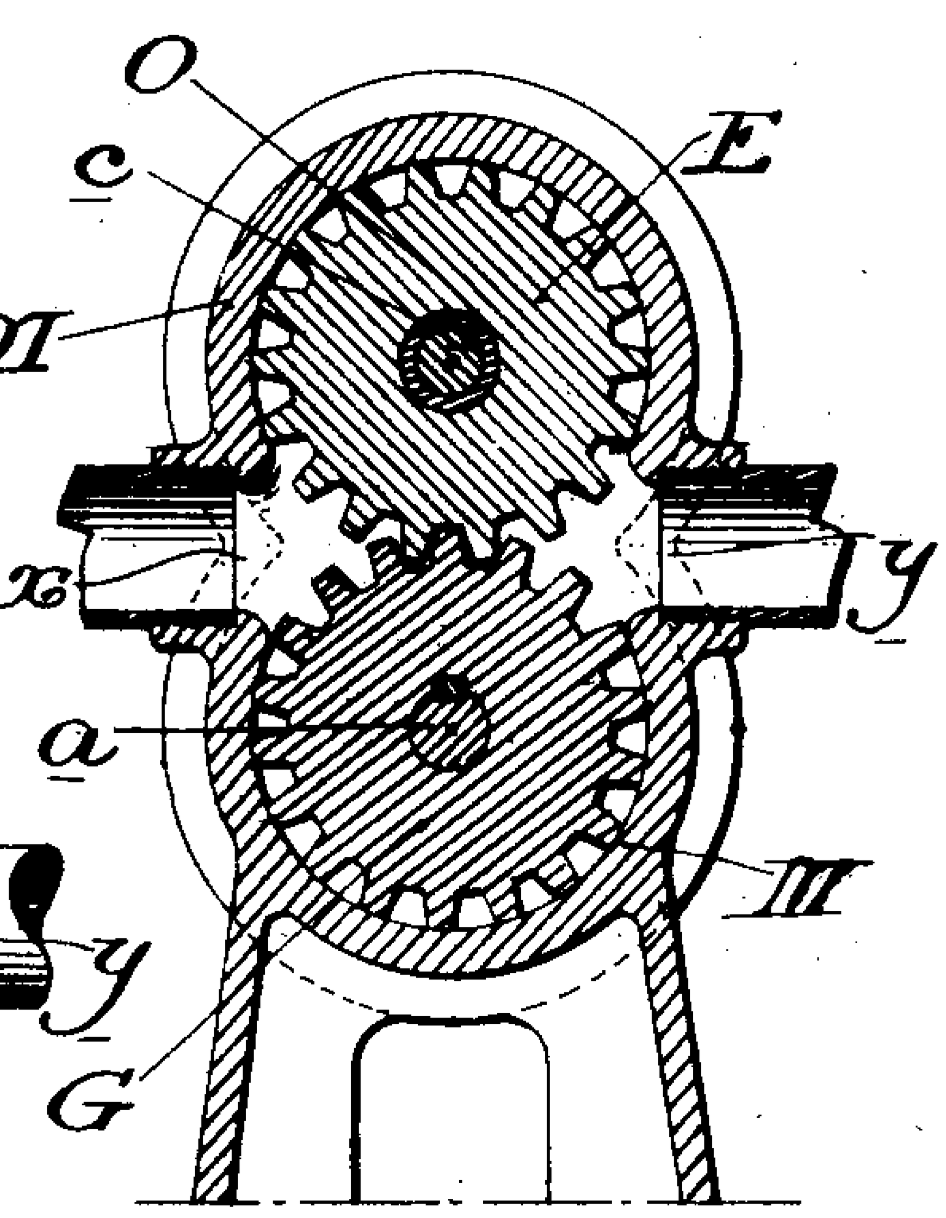


FIG. 5.



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(No Model.) 5 Sheets—Sheet 4.

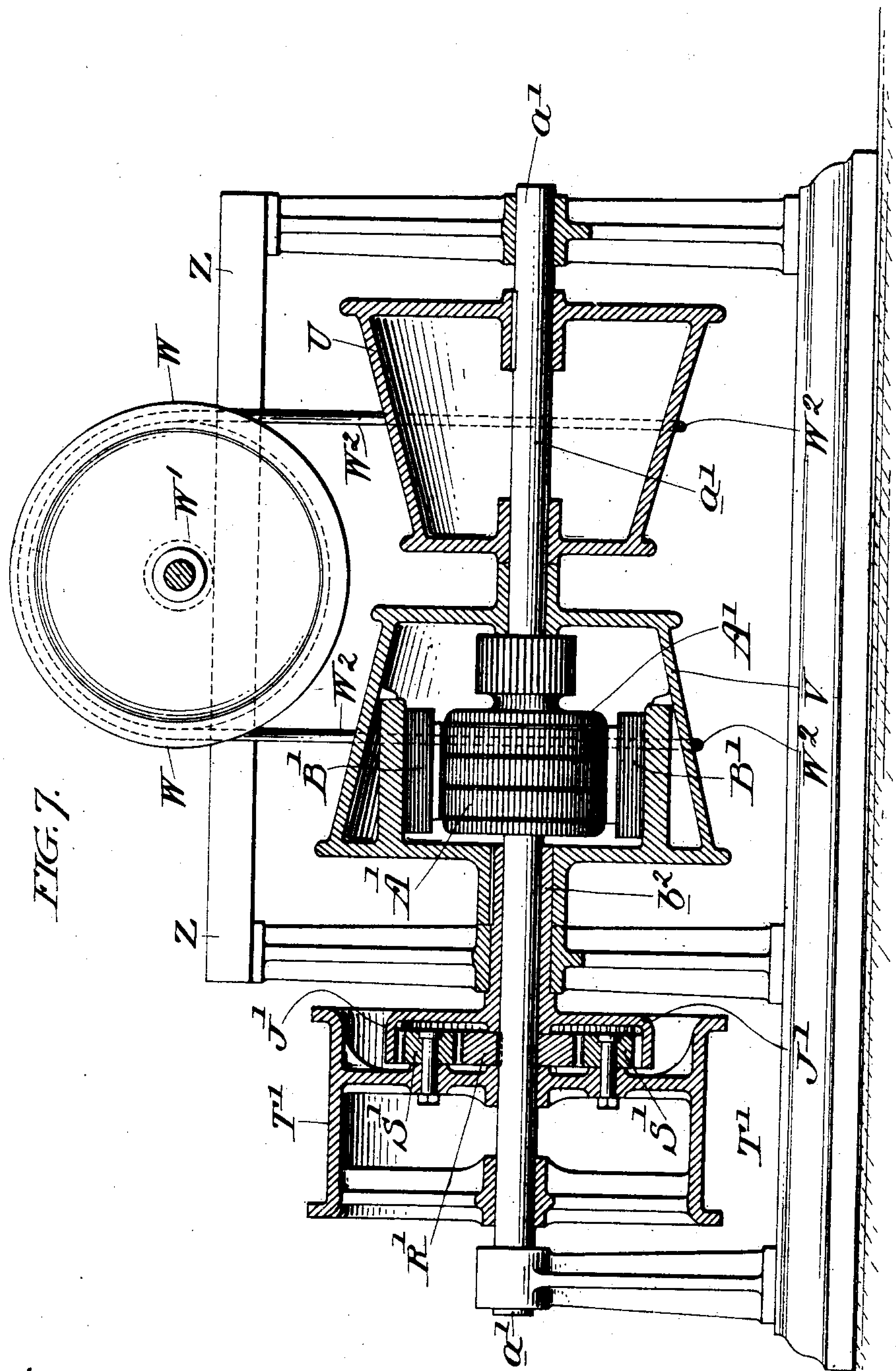

FIG. 7.

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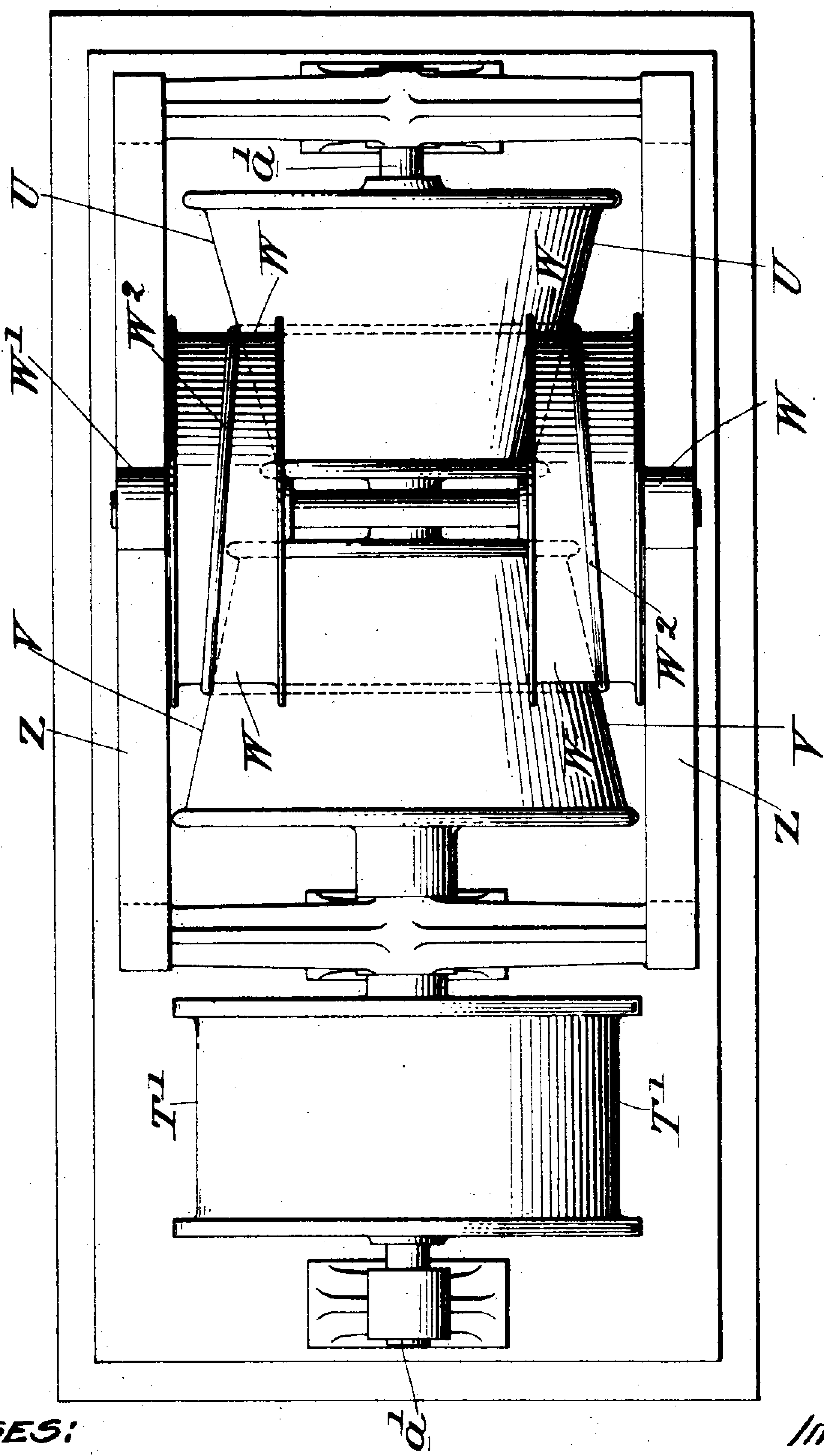
(No Model.) 5 Sheets—Sheet 5.

FIG. 8.



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UNITED STATES PATENT OFFICE.

FRANK E. HERDMAN, OF WINNETKA, ILLINOIS.

MECHANICAL MOVEMENT.

SPECIFICATION forming part of Letters Patent No. 711,663, dated October 21, 1902.

Application filed April 14, 1902. Serial No. 102,709. (No model.)

To all whom it may concern:

Be it known that I, FRANK E. HERDMAN, a citizen of the United States, residing at Winnetka, county of Cook, and State of Illinois, have invented a new and useful Improvement in Mechanical Movements, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form a part of this specification.

My invention relates to mechanical movements, and has for its object to give change of speed or change of direction or rest to a driven device from a continuously-running motor.

My invention consists of an arrangement wherein a revoluble armature and a revoluble field are connected to a differential mechanism and the differential mechanism to the driven device in such manner as to drive the driven device and regulate the speed thereof by regulating the speeds of the armature and field.

It also consists of the last-named arrangement combined with a hydraulic or liquid motor or pumping apparatus in such manner as to cause the motor to drive the hydraulic pumping apparatus and permit the latter to be operated to regulate the speeds of the armature and field-magnet.

In the drawings, Figure 1 is a longitudinal section; Fig. 2, a plan; Fig. 3, an end view; Fig. 4, a transverse section on the line 4 4 of Fig. 1; Fig. 5, a transverse section on the line 5 5 of Fig. 1; Fig. 6, a transverse section on the line 6 6 of Fig. 1. Fig. 7 is a longitudinal section of a modification. Fig. 8 is a plan of the construction shown in Fig. 7.

A is the armature of an electric motor; B, the field-coils carried by a bracket b', secured to a sleeve b on the armature-shaft a. The armature and field-coils are both capable of revolving. Secured to the armature-shaft a is one gear of a pump or motor C. Secured to the field-coil sleeve b is one gear of a pump or motor F.

The pump C is constructed as follows: M is the casing, through which extend the armature-shaft a and a controlling-shaft c. G and E are intermeshing gears, the former being secured to shaft a and the latter loose on shaft c. The shaft c is capable of sliding longitudinally to cause the teeth of gears E and G to mesh wholly or partly, as may be desired, for the purposes hereinafter described, and for the purpose of operating this shaft a lever c' is attached to the end of this shaft, which may be either directly operated or, if the situation requires, connected through any desired mechanism with suitable operating means. L is a disk of the extreme diameter of gear E and secured to shaft c on one side of gear E. N is a disk, also of the extreme diameter of gear E, but cut out on its lower side on a line coincident with the circumference described by the rotation of the tips of the teeth of gear G (see Fig. 4) and is secured to shaft c on the other side of gear E. The disks L and N are kept from binding on gear E by means of the spacer O, against which they are clamped.

On one side of gear G and loosely surrounding shaft a is the stationary head P, of the same diameter as gear G and fitting closely against the sides of the case M. The head Q also loosely surrounds shaft a on the other side of gear G and fits closely against the sides of case M. Head Q is cut out on the upper side on a line coincident with the circumference described by the rotation of the tips of the teeth of gear E. (See Fig. 6.)

It will be seen that the gears E and G always revolve in a closed chamber, the only space being occupied by the teeth of the gears, whether the gears be in full mesh, as shown in Fig. 1, or whether the gear E be drawn to the right, so as to be more or less partly out of mesh. In the opposite walls of the casing M and opposite the point where the teeth of gears E and G intermesh are the suction-port x and delivery-port y.

As will be understood by reference to Figs. 4 and 6, that portion of the teeth of gears E and G which are not in mesh exert no pumping action on the liquid, which merely passes around with the teeth. The active and effective portion of the pump is that portion of the teeth of gears E and G that are in mesh, this portion blocking the return of the liquid carried around by the teeth, (see Fig. 5,) so that, in effect, as much liquid is pumped from the suction to the delivery side of the gear-chamber as is carried around by the portion of the gears that are in mesh. Assuming a constant speed of the armature-shaft a, the amount of delivery of the pump is in direct ratio to the width of the teeth in mesh. By sliding shaft c endwise the width of teeth in mesh can be controlled, and consequently the output of the pump can be varied from a little more than nothing (when shaft c is moved to the extreme right, bringing the teeth almost entirely out of mesh) to maximum, (when the shaft c is moved to the extreme left, bringing the gears opposite each other in full mesh, as shown in Fig. 1.)

The pump F is constructed as follows: M′ is a casing through which the armature-shaft a and field-coil sleeve b extend, the latter having bearings in the casing. I and H are intermeshing gears, the former being secured to sleeve b and the latter to idle shaft d, turning in bearings in the casing M′. The gears I and H occupy the entire width of the chamber formed by the casing. In the opposite walls of the casing M′ and opposite the point where the teeth of gears I and H′ intermesh are the supply-port v and the discharge-port w.

Y is a pipe connecting the delivery-port y of pump C with the supply-port v of pump F.

X is a pipe connecting the discharge-port w of pump F with the suction-port x of pump C.

J is an internal gear of a differential mechanism, said gear being secured to the field-coil sleeve b. R is another gear of the differential mechanism, said gear being secured to the armature-shaft a.

S S, &c., are a set of gears of the differential mechanism and mesh with gears J and R. The gears S are shown as attached to a drum T, which represents the device to be driven and which may be assumed to represent the drum of an elevator apparatus around which the hoisting-cables are wound.

The operation of the device is as follows: Assume the parts to be in the position shown in Fig. 1, in which gears E and G are in full mesh and the working gear-tooth surface is at the maximum. Let it also be assumed that the constant-working gear-tooth surface of pump F and the maximum working gear-tooth surface of C are equal and that the diameters of gears G and I are equal. The armature and field-coils will revolve in opposite directions when current is admitted to the motor. Liquid will be circulated through pump C, out port y, through pipe Y, into port v, through pump F, out port w, through pipe X, into port x, through pump C, and so on continuously around. The quantity of liquid discharged from pumps C and F must of course always be equal. Inasmuch as the working gear-tooth surfaces of the two pumps are assumed to be equal, the result must necessarily be that the gears G and I revolve at the same angular velocity, and inasmuch as the liquid is fed into one side of pump C and the other side of pump F the gears G and I must revolve in opposite directions. Consequently the armature and field-magnet revolve in opposite directions at the same rate of speed and the gears R and J revolve in opposite directions at the same angular velocity. As the pitch diameter of gear J is greater than the pitch diameter of gear R, the gear J tends to rotate the gears S on their axes at a higher rate of speed than the gear R tends to rotate them. The result is that the gears S are carried bodily around in the direction of rotation of gear J at an angular speed with reference to the axis of shaft a and sleeve b equal to the difference of the absolute speeds of the gear-surfaces of gears J and R. This imparts a maximum speed of rotation in one direction to the drum. If the shaft c is moved to the right—say one-fourth of its extreme movement—the following operation takes place. The quantity of liquid discharged through pumps C and F must of course still be equal. Inasmuch, however, as the working gear-tooth surface of pump C has been decreased and has therefore fallen below the working gear-tooth surface of pump F, the result is that the gear I revolves at lower angular velocity than gear G. Consequently the field-magnet revolves at a lower rate of speed than the armature and the gear J revolves at a lower angular velocity than the gear R. Still the pitch diameter of J is so proportioned to the pitch diameter of R that it still tends to rotate the gears S on their axes at a higher rate of speed than the gear R tends to rotate them. The result is that they are still carried bodily around, but at a slower speed than when the gears E and G of pump C were in full mesh. If the shaft c is moved farther to the right, so that it occupies an intermediate position and so that the gear E is half in mesh and half out of mesh with gear G, the following operation takes place. The quantity of liquid discharged through pumps C and F must of course still be equal. Inasmuch, however, as the working gear-tooth surface of pump C has been reduced one-half, which is also one-half of the working gear-tooth surface of pump F, the result must necessarily be that the gear I revolves at half the angular velocity of gear G. Hence the field-magnet revolves at half the speed of the armature and the gear J revolves at half the angular velocity of gear R. If we assume that the pitch diameter of J is just twice the pitch diameter of R, it will be understood that the absolute speeds of the gear-surfaces of J and R are equal, so that each gear will tend to rotate the gears S on their axes at the same rate of speed. The result will be that the gears S will merely turn on their axes and will have no bodily rotation and the drum T will be stationary. The intermediate position of the shaft c is therefore the position to which it is brought when it is desired to stop the driven device. If the shaft c is moved still farther to the right, so that between one-half and all of the gears E and G are out of mesh, the following operation takes place. The quantity of liquid discharged through pumps C and F must of course still be equal; but the working gear-tooth surface of pump C has been so far reduced below that of pump F that the result is that the gear G revolves at several times the velocity of gear I. Hence the armature revolves at several times the speed of the field-magnet and the gear R revolves at several times the angular velocity of gear J. The absolute speed of the gear-surfaces of R is therefore more or less in excess of the absolute speed of the gear-surface of J. The result is that the gear R tends to rotate the gears S on their axes at a higher rate of speed than the gear J tends to rotate them. The result is that they are carried bodily around in the direction of rotation of R, which imparts a movement of rotation to the drum in a direction opposite to that imparted to it when the shaft *c* is moved to the left of its central position. Thus by operating the shaft *c* the speed, direction of travel, and stopping and starting of the driven device may be controlled to a nicety, the shaft occupying a central position to bring the driven device to rest and being moved to one side or the other of its central position to cause the driven device to travel in one direction or the other and being moved a greater or less distance toward one extreme position or the other to regulate the speed of the driven device.

It will be understood that in the specific combination of parts shown the relative dimensions of the pumps and elements of the differential may be different from those described, and it will also be understood that the method of driving the driven device through a differential from a motor whose opposing elements are both revoluble and the method of regulating the relative speeds of the elements of a motor through a hydraulic pumping apparatus are separately novel and that the specific combination of parts shown may be varied without departing from my invention.

In Fig. 7 I have shown a modification in which A′ is the armature, and B′ the field-magnet, of a motor, both elements being free to revolve. Loose on the armature-shaft *a*′ is the internal gear J′ of a differential mechanism, said gear being secured to the field-magnet sleeve b^2. R′ is another gear of the differential mechanism, said gear being secured to the armature-shaft *a*′. S′ S′, &c., are a set of gears of the differential mechanism and mesh with gears J′ and R′. The gears S′ are shown as attached to a drum T′, which represents the device to be driven. U is a cone-drum secured to the armature-shaft. V is a cone-drum secured to the field-magnet. W W are guiding-sheaves, on the shaft of which are rollers W′, resting and adapted to roll upon tracks Z. W^2 is an endless cable extending from drum U, over one sheave W, over drum V, over the other sheave W, and over drum U.

It will be understood that as the armature and field-magnet necessarily rotate in opposite directions when current is admitted to the motor the drums U and V always travel in opposite directions, and as the cable is fed off of one drum it is fed onto the other. When the guiding-sheaves W are moved toward the right along the tracks Z, so that the cable passes around equal diameters of the two drums, the necessary result is that the two drums rotate at the same speeds, as the cable must feed onto one drum as fast as it is fed off the other. Consequently the armature and field-magnet rotate at the same speeds. When, however, the guiding-sheaves are moved to the center or toward the left, the diameter of the driving or cable-engaging face of drum V is increased and the diameter of the driving or cable-engaging face of the drum U is decreased. Given equal speeds of the armature and field, the cable would be fed to and from drum V faster than it would be fed to and from drum U. As, however, neither drum is bodily movable, the cable must be fed to and from one drum at exactly the speed that it is fed to and from the other drum, and this necessarily means that the peripheral speeds of the cable-engaging faces of the two drums must always be equal. The result is that the drum having the cable-engaging face of the smallest diameter will have the highest angular speed, and consequently the drum U will rotate at a higher angular speed than drum V and the armature will travel at a higher speed than the field-magnet. By this means the relative speeds of the two driving-gears of the differential are absolutely controlled, and this control (as will be understood by the description of the arrangement of Fig. 1) enables the drum T′ to be absolutely controlled as to its speed and direction of travel and to be stopped and started at will. Any other means of varying the relative diameters of the cable-engaging faces of the two drums may be substituted for the two cone-drums shown. Any suitable means may be used for moving the drums W upon track Z.

It will be understood that the speed of the motor, properly speaking, is preferably at all times uniform. The speed of the motor is simply the sum of the speeds of the two elements thereof, and the foregoing description clearly shows that to the extent that the speed of one element is increased the speed of the other element is correspondingly decreased. Thus the proportionate speeds of the driving elements may be varied without varying the speed of the motor.

It will be appreciated that the elements of the motor instead of being made to drive a single driven device through the medium of a differential may be made to drive two separate and distinct driven devices. It will also be understood that where a differential is used it need not be a differential gear in the narrow and restricted sense of the term "gear," but substitutes for the gears may be used.

Having now fully described my invention, what I claim, and desire to protect by Letters Patent, is—

1. The combination with a motor having a revoluble armature and a revoluble field, of a hydraulic or liquid apparatus between and connected with said motor elements, and means to vary the feed of the said hydraulic or liquid apparatus, thereby varying the proportionate speed of the motor elements without altering the speed of the motor.

2. The combination, with a motor, of a device to be driven, a hydraulic or liquid motor or pumping apparatus, the motor having a revoluble armature and a revoluble field, connections between said hydraulic apparatus and the field and armature of the motor and from the field and armature of the motor to the device to be driven, the driven device tending to be revolved by the field and armature in opposite directions, and means to vary the feed of the said hydraulic apparatus, thereby regulating the relative speeds of the armature and field and thereby controlling the stoppage, direction or speed of the driven device.

3. The combination, with a motor and a device to be driven, of a hydraulic or liquid motor or pumping apparatus, consisting of two pumps, the motor having a revoluble armature and a revoluble field, connections between one pump and the armature and between the other pump and the field, and connections between the field and armature and the device to be driven tending to drive the latter in opposite directions, and means to vary the relative feed of the two pumps, thereby regulating the relative speeds of the armature and field and thereby controlling the stoppage, direction or speed of the driven device.

4. The combination, with a device to be driven, and a motor having a revoluble armature and a revoluble field, a differential mechanism between and connected with the elements of the motor and the driven device, two hydraulic motors or pumps, connections between the pumps, the armature being arranged to drive one pump and the field the other pump, and means to vary the relative feed of said pumps, thereby varying the relative speeds of the armature and field, and thereby controlling the speed or direction or stoppage and starting of the driven device.

5. The combination, with a motor having a revoluble armature and a revoluble field, of a differential mechanism consisting of two driving elements and a driven element, the said driving elements being respectively connected with the field and armature, and means independent of said driven element to vary the proportionate speeds of the motor elements without altering the speed of the motor, thereby varying the speed of the driven element of the differential mechanism.

6. The combination, with a device to be driven and a motor having a revoluble armature and a revoluble field, a differential mechanism consisting of two driving elements and a driven element, the driven element being connected with the driven device, and the driving elements being connected respectively with the armature and field, and means to vary the relative speeds of the armature and field, thereby varying the relative speeds of the driving elements of the differential mechanism and thereby controlling the speed, direction or stoppage of the driven element of the differential mechanism.

7. The combination, with a device to be driven and a motor having a revoluble armature and a revoluble field, a differential mechanism consisting of two driving elements and a driven element, the driven element being connected with the driven device, and the driving elements being connected respectively with the armature and field, two hydraulic motors or pumps, connections between the pumps for maintaining a circulation of the liquid in an endless path through said pumps, the armature being connected with one of said pumps and the field with the other pump, and means to vary the relative feed of said pumps, thereby varying the relative speeds of the armature and field, and thereby varying the relative speeds of the driving elements of the differential mechanism and controlling the speed, direction or stoppage of the driven device.

In testimony of which invention I have hereunto set my hand, at Winnetka, on this 30th day of January, 1902.

FRANK E. HERDMAN.

Witnesses:
HENRY C. JOHNSON,
D. J. O'MEARA.