No. 742,300. PATENTED OCT. 27, 1903.

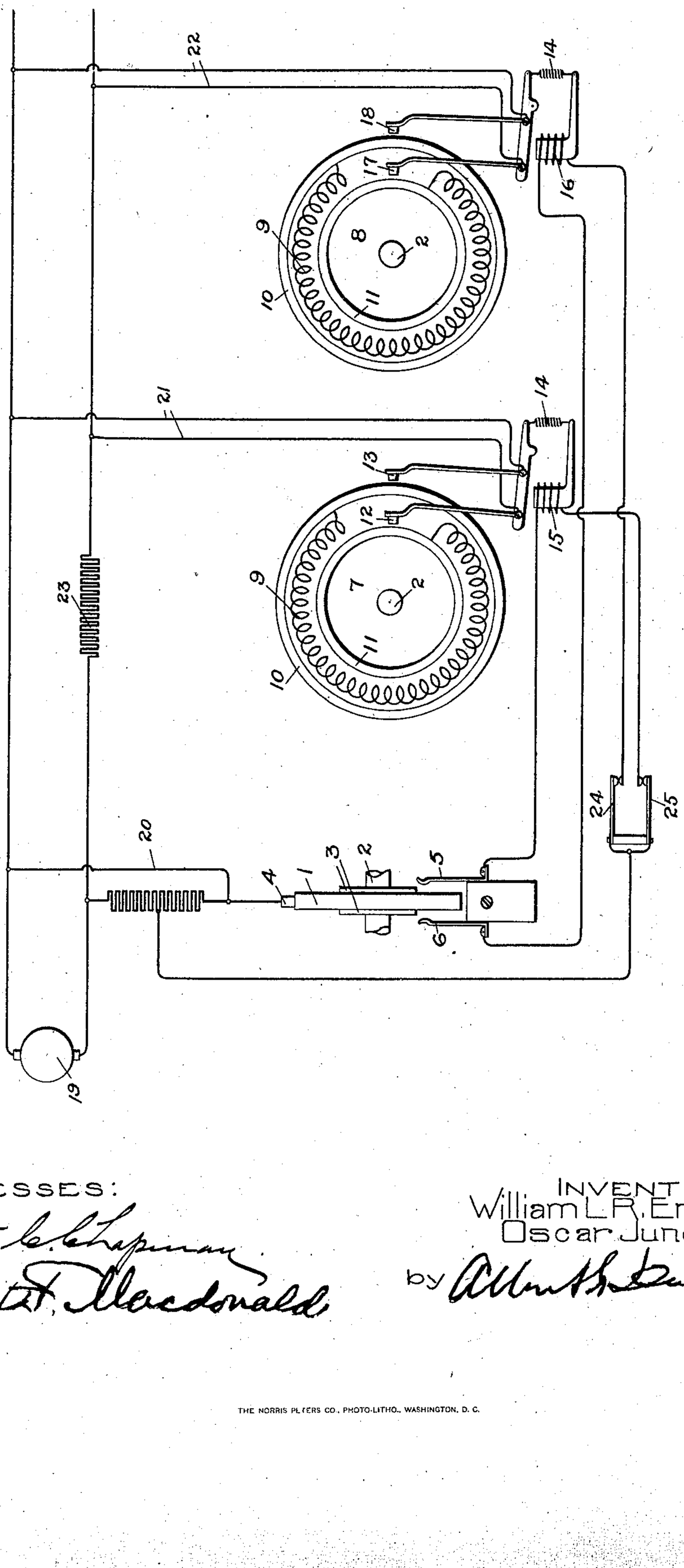
W. L. R. EMMET & O. JUNGGREN.

ELECTRIC GOVERNOR FOR TURBINES.

APPLICATION FILED FEB. 14, 1903.

NO MODEL. 6 SHEETS—SHEET 1.

FIG 1



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NO MODEL. 6 SHEETS—SHEET 2.

Fig. 2.

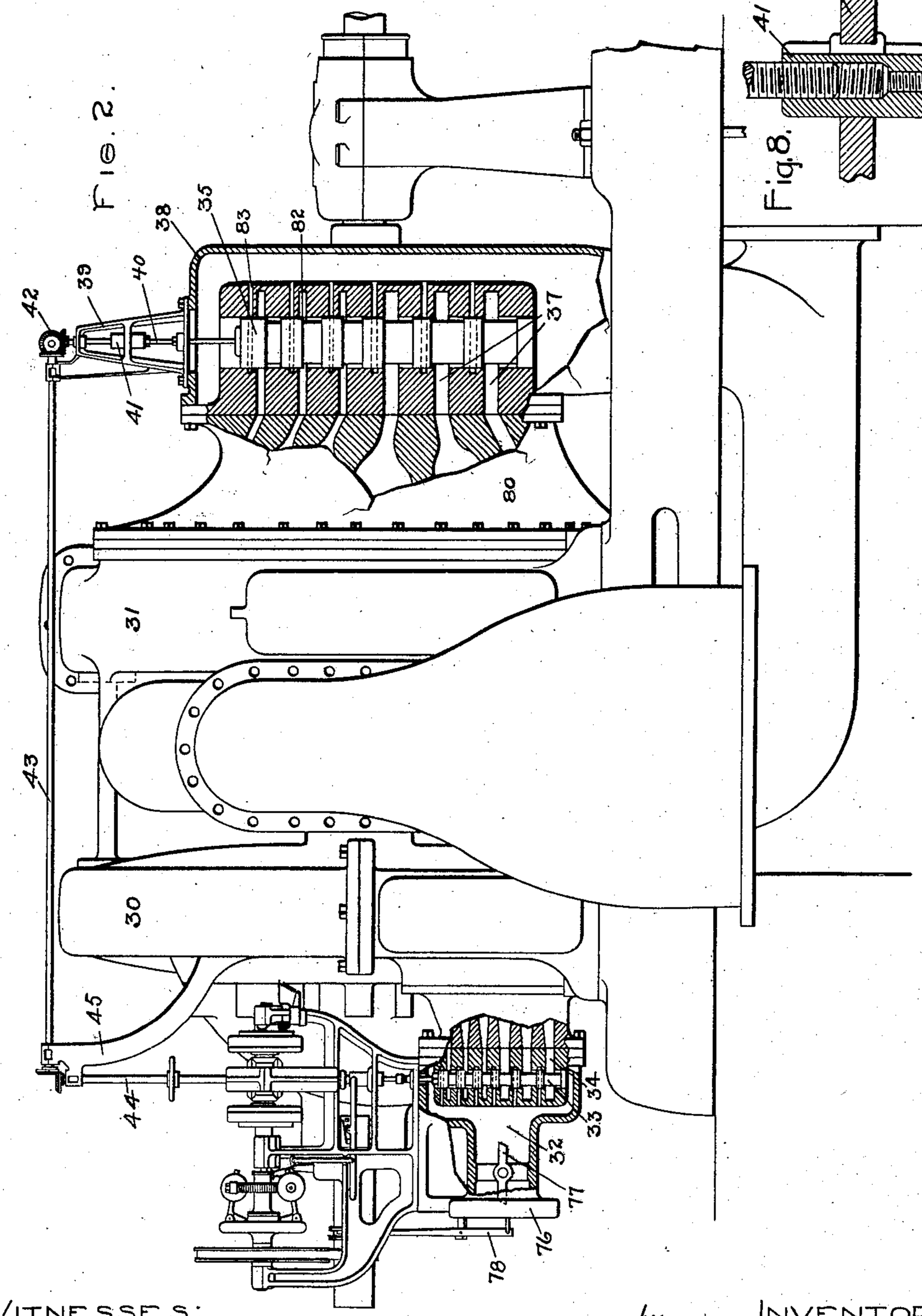

Fig. 8.

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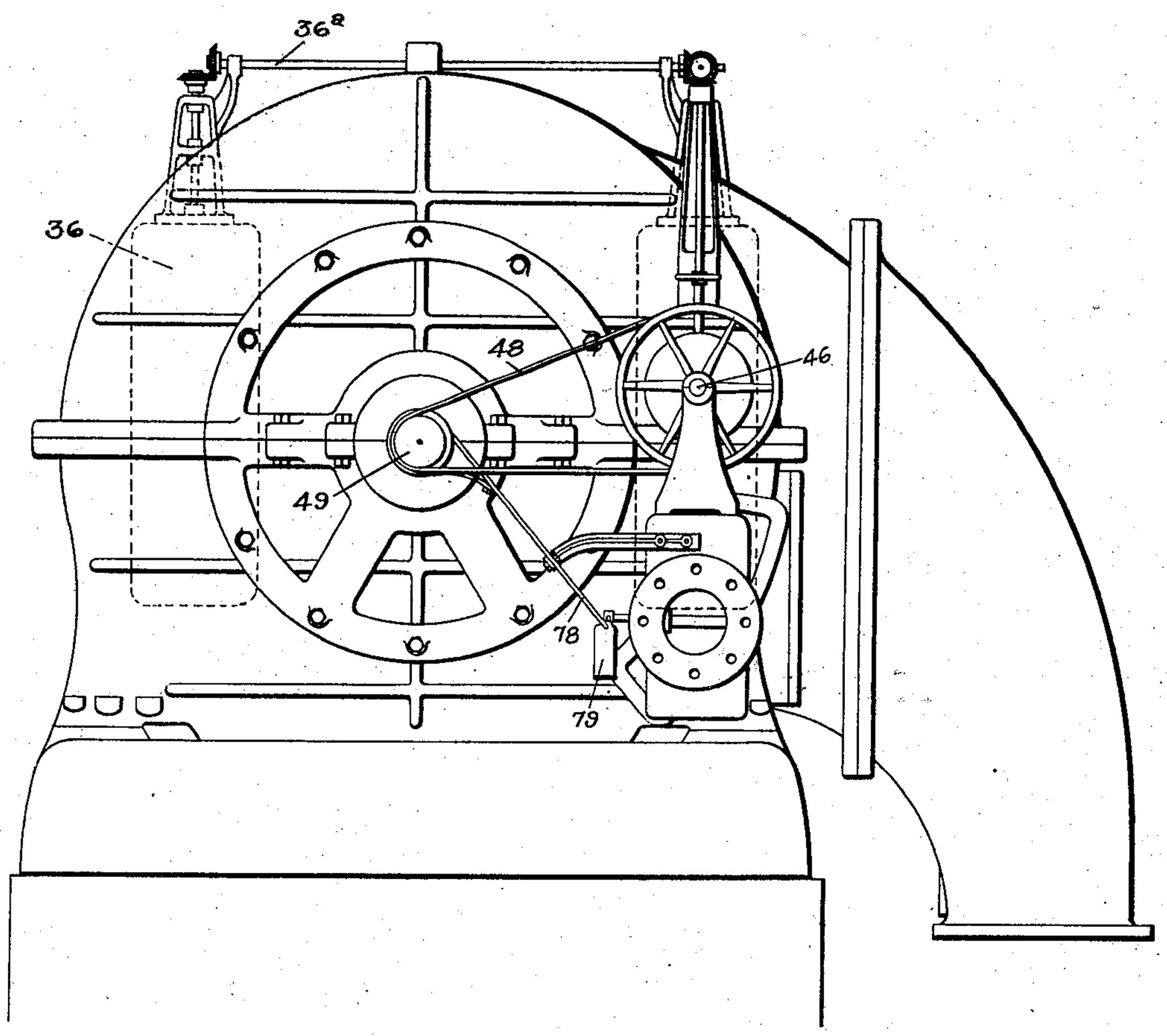
NO MODEL. 6 SHEETS—SHEET 3.

Fig. 3.



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NO MODEL. 6 SHEETS—SHEET 4.

Fig. 6.

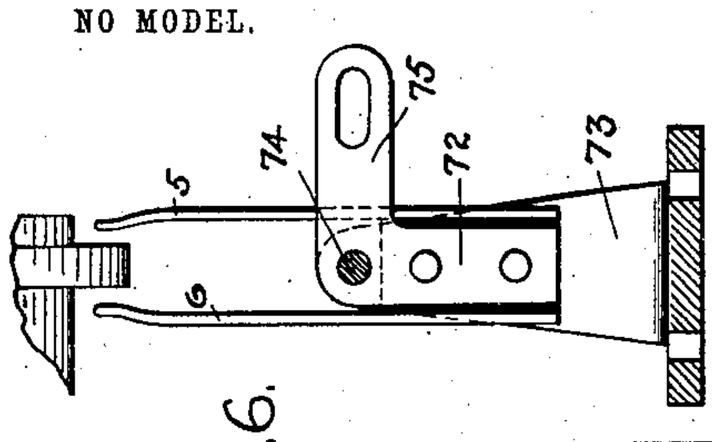


Fig. 7.

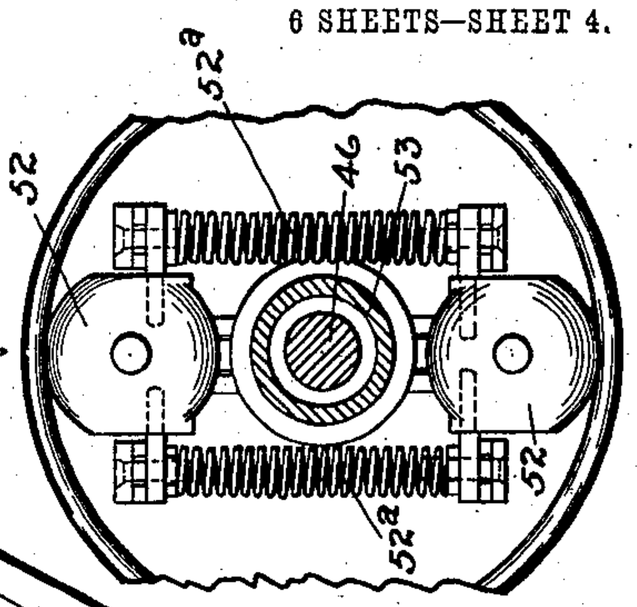
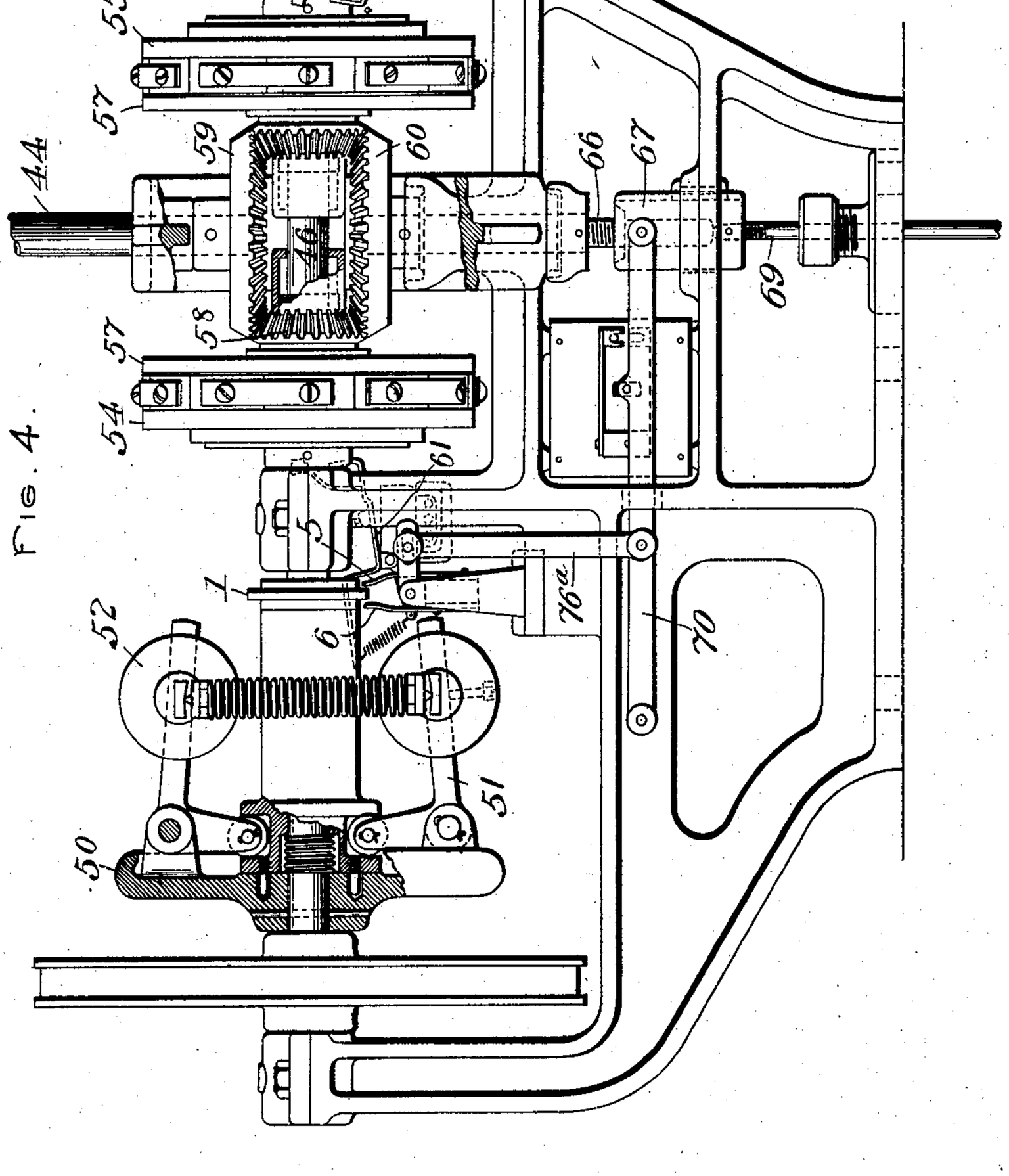


Fig. 4.



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NO MODEL. 6 SHEETS—SHEET 6.

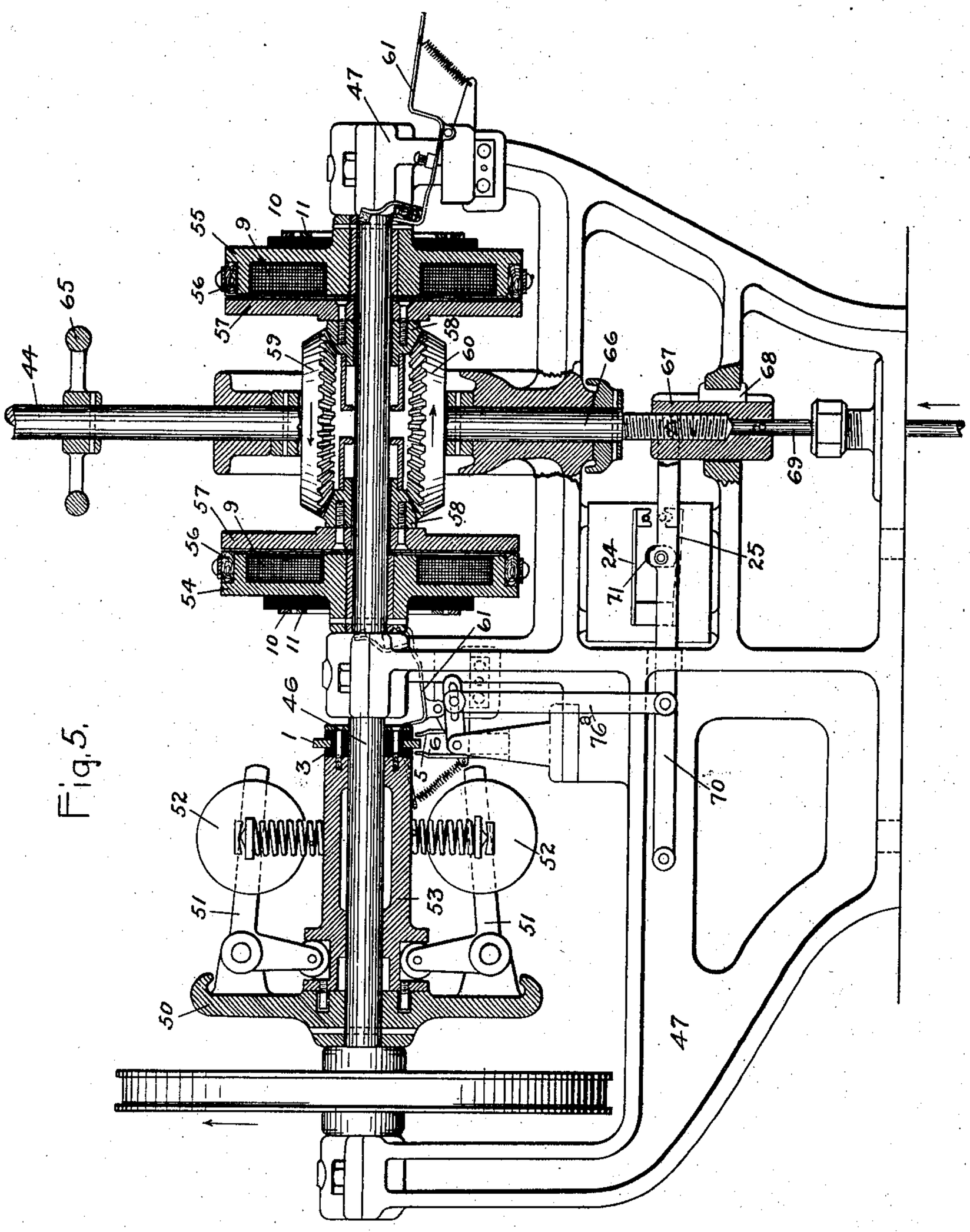

Fig. 5.

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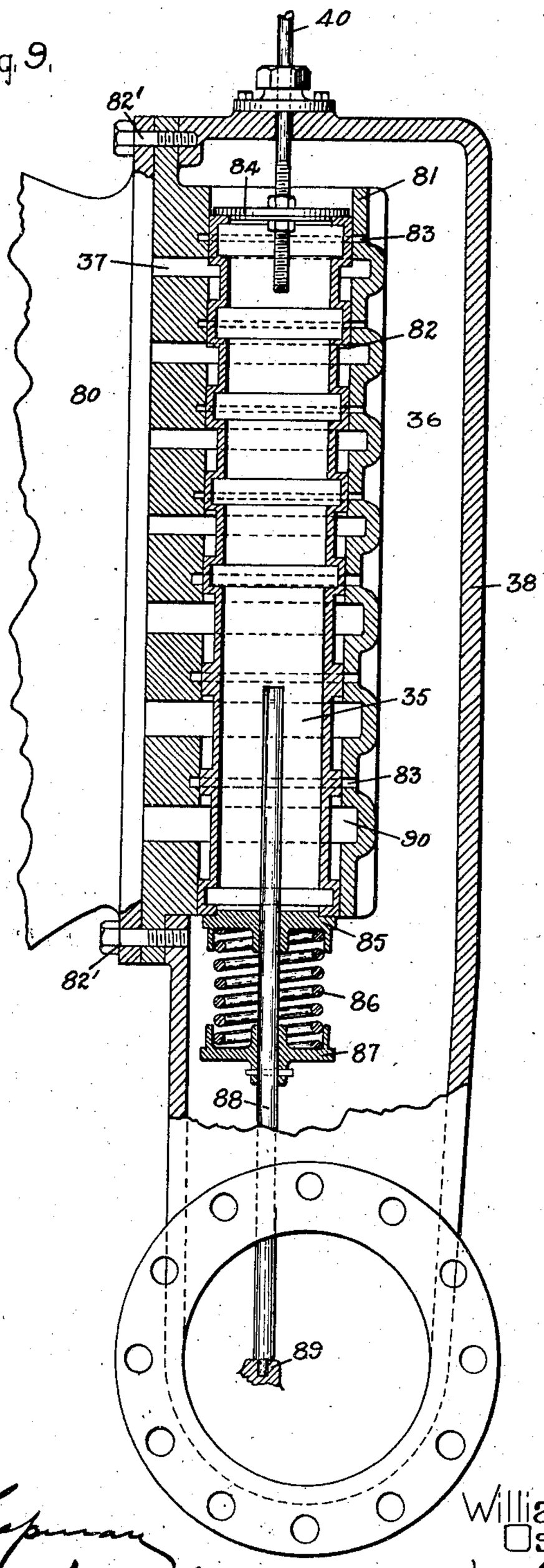
ELECTRIC GOVERNOR FOR TURBINES.

APPLICATION FILED FEB. 14, 1903.

NO MODEL. 6 SHEETS—SHEET 6.

Fig. 9.



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No. 742,300. Patented October 27, 1903.

UNITED STATES PATENT OFFICE.

WILLIAM L. R. EMMET AND OSCAR JUNGGREN, OF SCHENECTADY, NEW YORK, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC GOVERNOR FOR TURBINES.

SPECIFICATION forming part of Letters Patent No. 742,300, dated October 27, 1903.

Application filed February 14, 1903. Serial No. 143,282. (No model.)

To all whom it may concern:

Be it known that we, WILLIAM L. R. EMMET and OSCAR JUNGGREN, citizens of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric Governors for Turbines, of which the following is a specification.

It is important in connection with all turbines, and more especially those designed to drive dynamo-electric machines, to maintain a constant or approximately constant speed under all changes in load. It is also important with jet-turbines which utilize elastic-motive fluid under high velocities and relatively low pressure to regulate the speed by varying the volume while maintaing the velocity constant, or substantially so. It is customary to divide the turbine into two or more stages, and in regulating it is preferable to vary the volume of motive fluid supplied to all of the stages in order to obtain the greatest economy.

The present invention has for its object to provide a governor which will accurately control the speed of an elastic-fluid motor under wide variations in load and this in an efficient manner.

For a consideration of what we believe to be novel and our invention attention is called to the description and claims appended hereto.

In the accompanying drawings, which illustrate one embodiment of our invention, Figure 1 is a diagrammatic view illustrating the circuit connections of a governor. Fig. 2 is a side elevation of a turbine to which our improved governor is applied. Fig. 3 is an end view of a turbine. Fig. 4 is a side elevation of the governor with some of the parts broken away. Fig. 5 is a side elevation, partially in section, of the governor. Fig. 6 is a detail view of the antihunting device. Fig. 7 is a detail view showing the arrangement of the springs for the governor-weights. Fig. 8 is a sectional detail view of the nut employed to move the second-stage valves, and Fig. 9 is a vertical section of a valve controlling the admission of motive fluid to a bucket-wheel.

In carrying out our invention we subdivide to a greater or less degree the total amount of fluid to be handled, thereby avoiding the use of unduly large parts, which have considerable inertia. On the main or bucket-wheel shaft, or connected so as to rotate in synchronism therewith, is a speed-responsive device which controls the circuits of a pair of electromagnets. A constantly-running governor-motor is provided, which may with advantage rotate at the same speed as the said speed-responsive device; but the invention is not limited thereto. Each of said magnets controls a clutch-coil, by means of which the governor-motor is operatively connected to a valve or equivalent mechanism for varying the admission of fluid to the bucket wheel or wheels. When one clutch-coil is energized, the controlling valve or valves tend to decrease the supply of energy and when the other is energized to increase the supply of energy. Connection between the source of electric supply and the magnets and clutch-coils is made through relatively rotating contacts, so that new contact-surfaces are presented when the circuit closes and all danger from imperfect connection is prevented.

With a governor of the centrifugal type there is a tendency to overcompensate for changes in load, which tendency is commonly called "hunting." This hunting causes certain variations in speed above and below that desired, which is highly objectionable. To prevent this, we provide an "antihunting" device, which releases the motor after it has performed a certain amount of work and before it has had time to move the controlling valve or valves too great a distance. This releasing action takes place entirely independently of the position of the governor-weights. To restate the matter in a different way, the governor-weights set themselves in a definite position for a given speed, which causes a movement of the device that controls the admission of fluid to the motor through a suitable intermediary. Now instead of keeping the governor-weights and the said intermediary in operative connection until the desired position as to fluid de-

livery to the motor is established they are disconnected shortly before this condition is reached, and the momentum of the parts is relied upon to bring the parts into the desired relation. In this way objectionable fluctuating is prevented.

In order to prevent the governor-motor from imparting excessive movement to the fluid-controlling mechanism in either direction, maximum and minimum stop devices are provided, which disconnect the motor when the mechanism reaches either of its extreme positions. We find it desirable to provide circuit-interrupters for the pair of magnets which are acted upon by the fluid-controlling mechanism—such as a valve-stem, for example—but this can be done in various ways without departing from our invention. The essential thing is to disconnect the governor-motor after it has moved the controlling mechanism a certain distance in either direction from a given position and this before it can in any way injure the apparatus.

Referring to Fig. 1, 1 represents a contact-disk which is driven by the shaft 2, that may be the shaft the speed of which is to be governed or a shaft that is connected thereto for synchronous movement. The disk is mounted on an insulating-support 3 and is alternately brought into electrical engagement with the brushes 5 and 6, which are mounted on a rocking support. The brush 5 is brought into service when the speed of the shaft to be governed exceeds a certain amount and the brush 6 when the speed decreases below a predetermined amount. The brushes are rocked on their support under certain conditions, to be hereinafter described in connection with the antihunting device.

Mounted on the shaft 2 or on a shaft which is geared to the shaft that is to be governed are two magnetic clutches 7 and 8. Current to the magnet-coils 9 for actuating the clutches is furnished by the contact-rings 10 and 11. Mounted on an arm and arranged to be moved toward and away from the contact-rings are brushes 12 and 13. A similar arm is provided for brushes 17 and 18. The contact-rings 10 and 11 are always rotating. Hence new surfaces are continually being presented to the brushes whenever they are brought into engagement therewith. This insures a good contact each time the circuit is made. The same remarks apply to the contact-disk 1 and its coöperating brushes. The arm which carries the brushes is moved in a direction to take them out of engagement with the contact-rings by an extension-spring 14 and is moved in the opposite direction by an electromagnet 15, the circuit of which is controlled by the brush 5. The magnetic clutch 7 in the present structure is arranged to be energized when the speed of the turbine exceeds a predetermined amount, and by means of suitable mechanism, to be hereinafter described, the supply of motive fluid is decreased. When the speed of the driving-shaft tends to decrease below a certain point, the contact-disk 1 moves into engagement with the brush 6 and causes the magnet 16 to be energized. The arm which carries the brushes 17 and 18 is attracted by the magnet, and thus moved to a position where the brushes engage with the traveling contact-rings 10 and 11, and the clutch-coil is energized, which in turn causes certain of the parts to move in a manner to increase the supply of motive fluid to the bucket wheel or wheels. Current for supplying the various magnets and coils is received from a generator 19. The disk 1 is connected to one side of the generator by the brush 4 and conductor 20. Current to the coil of clutch 7 is conveyed by the conductors 21. Current to the coil of clutch 8 is conveyed by conductors 22. A suitable resistance 23 may be provided for decreasing the flow of current through the coils.

In order to limit the extreme movements of the governor mechanism, so as to prevent injury to the apparatus as a whole, special means are employed for rendering the fluid-admitting valves or equivalent means inoperative. In the present instance circuit-breakers 24 and 25 are provided, the former being included in circuit with the magnet 15, that controls one clutch-coil, the other being in circuit with the magnet 16, which controls the second clutch-coil. Mechanism to be hereinafter described is so arranged that when the upward limit is reached the contact 24 is moved and when the lower limit is reached the contact 25 is moved. In this manner the clutches are rendered inoperative, irrespective of the relation between the brushes 5 and 6 and the contact-disk 1.

In controlling steam-turbines of the jet type more especially it is preferable to vary the volume of the motive fluid without changing its velocity. This we find to be more readily accomplished by dividing the nozzle structure into sections and cutting the sections into and out of service one after the other. In this manner we are enabled to prevent throttling except on the last active nozzle in the series. In order to more conveniently handle the motive fluid, it is desirable to subdivide it and to control each subdivision by a valve or equivalent device. As an example, in the present illustration we have shown one piston-valve for controlling the admission of steam to the first or high-pressure stage and two piston-valves for controlling the supply of motive fluid to the second or low-pressure stage. In Figs. 2 and 3, 30 represents the high-pressure stage and 31 the low. Fluid is supplied to the high-pressure stage from the valve-chest 32, in which is mounted a balanced piston-valve 33. As the piston-valve moves up and down the ports 34, leading to the nozzle-sections, are cut into and out of service. It will be noted that the piston-like heads between the ports are nearer together at the upper end than at the lower and that the space between them gradually

increases. The object of this arrangement is to permit the various ports to be successively cut into and out of service without throttling except at the last or lowest port. The admission of steam to the second stage is controlled by two piston-valves 35 and 36, the former being shown in section in Figs. 2 and 9 and the latter in dotted lines in Fig. 3. These piston-valves are balanced, and as they move up and down the admission of motive fluid to the nozzle-sections through the ports 37 is controlled. Mounted on the casing which surrounds the valve 35 and its chest is a casing 38, that supports a standard 39. In the standard are suitable bearings for the valve-stem 40, which stem is divided into two parts, and the adjacent ends are threaded to engage with the nut 41. The nut is splined, as shown in Fig. 8, so that as the upper half of the stem is rotated by the bevel-gear 42 the nut causes the piston-valve 35 to move up or down, depending upon which way the gear is rotated. Motion is transmitted to the bevel-gear 42 by means of the horizontal shaft 43 and the vertical shaft 44. The shaft 43 is supported at one end by the standard 39 and at the other end by an arm 45, that is attached to the wheel-casing or high-pressure shell 30. The shaft 44 is also partially supported by the arm and partly by the frame which carries the clutches. Motion between the various shafts is imparted by suitable means, such as bevel-gears.

In Fig. 3 is clearly shown the shaft 36ª for actuating the second-stage valve 36. The shaft is connected by bevel-gears to the shaft 43 and is supported at its ends by suitable standards. The valve-stem is raised and lowered by a nut in the same manner as described in connection with valve 35.

From the foregoing it will be seen that it is necessary in order to control the turbine to move the piston-valves 33, 35, and 36 up or down, as the case may be. This we accomplish in a very simple manner—such, for example, as by means of a constantly-running motor comprising a shaft 46, Fig. 5, which is mounted in suitable bearings formed in the frame 47, the latter being bolted to an extension on the first or high-pressure stage. The shaft is provided with a pulley at one end, which is driven by a belt 48, Fig. 3, from the main shaft 49 of the turbine that is to be governed. The particular form of connection is immaterial so long as the two shafts are arranged to move together.

Keyed or otherwise secured to the governor-shaft 46 is a head 50, that carries two bell-crank levers 51, each of which is provided with a weight 52. The short ends of the levers are placed in operative relation to the sleeve 53, so that as the weights move toward or away from the shaft the sleeve will be given a certain amount of longitudinal movement. The weights are normally drawn toward the shaft 46 by the springs 52ª, Fig. 7. To the end of the sleeve is secured a body of insulating material 3, and mounted thereon is a contact-disk 1. Situated below the disk and on opposite sides thereof are brushes 5 and 6. These brushes are arranged to alternately engage with the disk as it moves to and fro under the action of the governor-weights. Since the shaft 46 rotates continuously in one direction, it is necessary to provide means for obtaining a return movement of the piston-valves. To accomplish this, two heads 54 and 55 are provided, both of which are rigidly secured to the shaft 46. Each of these heads is chambered out to receive a clutch-coil 9, and since the construction of both of these clutches is similar only one of them will be described. On the periphery of the head are detachable wearing-blocks 56, made of wood or similar material. Situated adjacent to the head is a disk or armature 57, which is loosely sleeved on the shaft 46. Rigidly secured to the disk or armature is a pinion 58, which meshes with the bevel spur-gears 59 and 60. Since the pinion is permanently in mesh with the gears 59 and 60 and loosely supported on the shaft 46, it follows that the gears will not be rotated except when a magnet-coil is energized. It also follows that the gear 59 will rotate to the left in the direction of the arrow and the gear 60 to the right in the direction of the arrow when the motor-shaft 46 rotates away from the observer or in an anticlockwise direction when viewed from the left-hand end. When the one clutch-coil is energized, it follows that the other clutch-coil must be deënergized; otherwise the parts will be locked in place. Current is conveyed to and from the clutch-coils by contact-rings 10 and 11, which are mounted on the outside faces of the heads. Pivotally mounted on the frame 47 are contact-carrying arms 61, which are normally moved out of engagement with the rings by an extension-spring and are moved into engagement with the rings by a magnet, as best illustrated in Fig. 1. The brushes being in the same horizontal plane one only is shown for each clutch-coil in Figs. 4 and 5.

The upper bevel-gear 59 is keyed to a vertically-extending shaft 44, which shaft is provided with a hand-wheel 65, by means of which it can be rotated manually for the purpose of adjusting the position of the valves. The vertically-extending shaft 44 is supported at its lower end in an extension of the frame 47 and at its upper end in a projection on the arm 45, Fig. 2. The lower bevel-gear 60 is rigidly secured to the shaft 66, the lower end of which is screw-threaded and engages with the vertically-sliding nut 67. It is evident that as the shaft 66 revolves either to the right or left it will cause the nut to move up or down, the nut being prevented from rotating by the spline 68. Secured to the lower end of the nut is a valve-stem 69, which is attached to the first-stage piston-valve 33. The relation between the valve-stem 69 of the first stage and the valve-stems 40 and 36 of the second or low-pressure stage is such

that when the bevel-gears 59 and 60 are rotated in the direction of the arrows the volume of steam admitted to the stages is decreased, and, conversely, when the gears are rotated in the opposite directions the volume of motive fluid admitted to the stages is increased.

It is evident that an occasion might arise where the connection between the brushes 5 and 6 and the clutch-coils remained unbroken even after the piston-valves had been moved to their extreme positions. Such an occurrence would of course be in the nature of an accident. In order to safeguard against such accidents, a circuit-interrupting device is provided, consisting of two circuit-interrupters 24 and 25, which are mounted on an insulating-support on the frame 47. These are connected in circuit, as shown in Fig. 1. Pivotally mounted on the frame 47 is an arm 70, which is connected by a pin and slot to the nut 67. Hence as the nut moves up and down the arm will be rocked about its pivot. Mounted on the arm at a point between the blades 24 and 25 of the circuit-interrupter is a piece of insulating material 71, which is adapted to alternately engage with the blades and move them away from the adjacent stationary contacts. In the present illustration, Fig. 5, the blade 25 is shown as out of engagement with its contact, while the circuit through the blade 24 is closed.

The means for preventing the overtravel or "hunting" of the fluid-admitting valves will now be described. The contact-brushes 5 and 6 are mounted on a support 72 and suitably insulated therefrom. The support is attached to a standard 73, carried by the frame 47 by a pivot 74. Attached to the support is a slotted arm 75, Fig. 6, for rocking it and also the brushes attached thereto. The object in moving the brushes is to break the electrical connection between them and the contact-disk 1 in order to interrupt the circuit of the clutch-coils before the governor-weights shall have been adjusted or returned to the proper position for the predetermined speed. If the circuit of the clutch-coils is preserved until the governor-weights adjust themselves to the proper position for said speed, the inertia of the motor, valves, and operating parts causes an overcompensation for the change in load; but by interrupting the circuit of said coils shortly before the proper speed is attained we are enabled to make use of the inertia to properly adjust the parts, and this without hunting. By this arrangement a succession of short movements of the valves is generally produced, which maintain the speed of the turbine-shaft within the prescribed limits for all changes in load. It remains now to describe how this breaking of the clutch-coil circuits is accomplished. Since the valve-stem 69 is directly acted upon by the motor, we attach thereto an arm or lever which rocks the brush-support. For this purpose the pivoted arm 70 can be employed with advantage, although our invention is broad enough in this particular to include a separate connection. Pivotally attached to the arm is a link 76^a, that connects it with the slotted arm 75. Now when the nut 67 is moved a certain distance either up or down by the governor-motor (meaning by the "governor-motor" the shaft 46 and coöperating parts) the link 76^a will rock the support 72 in a direction to move the brushes 5 or 6, as the case may be, away from the contact-disk 1. The inertia of the parts will cause the admission-valves to move slightly after the clutch-coil circuit is broken. If it so happens that the change in load is not quite compensated for, the weights will again cause the disk to engage the proper brush, and the action will be repeated. It is to be noted that the antihunting device is effective under an increase or a decrease in speed. For convenience the said device is actuated by the nut 67; but this is immaterial, the essential thing being to cause a movement of the antihunting device which anticipates the separation of the brushes and disk 1.

Steam is admitted to the high-pressure stage by the conduit 76. Mounted within this conduit is a butterfly-valve 77, which is normally open and held in the position shown in Figs. 2 and 3 by the arm 78. When for any reason the speed of the wheel-shaft 49 becomes abnormally great, the arm 78 is acted upon by a suitable device on the turbine-shaft to cause it to release the butterfly-valve, and the latter closes under the action of the weight 79. Under normal conditions this butterfly-valve is open. It is only in case of abnormal high-speed conditions that it closes, and in this manner forms a safety device for the machine.

In Fig. 9 we have shown an enlarged sectional view of one of the second-stage valves arranged to admit motive fluid to the bucket-wheel of the low-pressure stage. The same general construction is followed with both the high and low pressure stages; but the valves in the low-pressure stage are naturally larger. 80 represents a neck, which is provided with a number of conduits which register with the ports 37 in the valve-casing 81. The valve-casing is secured to the neck by bolts 82′ or other equivalent means. The inclosure or casing 38, which surrounds the valve, is also united with the neck by the same bolts. The valve-casing 81 is provided with a cylindrical central bore, in which is mounted the balanced piston-valve 35. The valve is provided with a series of piston-like heads 82, that make a working fit with the bore of the casing. These heads are arranged to cover and uncover the ports 83, which admit steam to the ports or passages 37. The valve 35 is made hollow in order to reduce its weight, and the upper end is closed by a head 84 and the lower end by a head 85. It is evident that the pressure within the casing 38 will be the same on the heads 84 and 85.

Hence the valve as a whole is balanced as to pressures. In order to compensate for the weight of the valve, a compression-spring 86 is provided, which is seated in the support 87. The latter is permanently affixed to the rod 88. The rod is provided with a suitable step or support 89 and extends through a head 85. As the valve 35 moves up and down under the action of the valve-stem 40 the spring 86 is compressed to a greater or less degree. The inlet-ports 83 are so arranged that the lowest one is uncovered first, then the next one above it, and so on. By this means only the nozzle section or sections receiving steam from the lowest ports are throttled. It is also to be noted that any steam which enters the space 90 exerts equal pressures on the adjacent heads or enlargements of the piston-valve.

It is evident that a turbine having more stages can be controlled by our improved governor or we can disconnect the second stage and regulate only the high-pressure stage.

For convenience and simplicity the weights 52 are driven by the shaft of the governor-motor; but obviously this can be modified, if desired, without departing from our invention.

In accordance with the provisions of the patent statutes we have described the principle of operation of our invention, together with the apparatus which we now consider to represent the best embodiment thereof; but we desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What we claim as new, and desire to secure by Letters Patent of the United States, is—

1. In combination, an elastic-fluid turbine, a plurality of independent valves for controlling the admission of fluid thereto, a constantly-running motor controlling the action of all of the valves, a speed-responsive device which connects the motor to and disengages it from said valve, and an antihunting device which modifies the action of the governor.

2. In combination, a plurality of bucket-wheels, an inclosure for each wheel, nozzle-passages for delivering fluid to the bucket-wheels, independent valves controlling the admission of fluid to the passages, a motor which actuates the valves, a driving connection between a bucket-wheel and the motor, and a speed-responsive device which regulates the action of the motor.

3. In combination, a prime mover which is divided into stages working at different pressures, a plurality of admission-valves, a single motor for positively moving all of the valves, and a speed-responsive device which modifies the action of the motor.

4. In combination, a prime mover which is divided into stages working at different pressures, a plurality of admission-valves, a single motor for positively moving all of the valves, a speed-responsive device which modifies the action of the motor, and an antihunting device which cuts the motor out of service.

5. In combination, a prime mover, a valve for regulating the admission of fluid thereto, a constantly-running motor, contact-surfaces driven thereby, brushes movable into and out of engagement with said surfaces, electromagnets for moving the brushes, and a governor responsive to speed variations for controlling the action of the electromagnets.

6. In a driving-shaft, constantly-moving contact devices, brushes for engagement therewith, magnets in circuit with the brushes, a device responsive to speed variations for controlling the action of the magnets, and an antihunting device for modifying the action of the magnets.

7. In combination, a driving-shaft, a driven shaft, a governor, electromagnets controlled by the governor, clutch-coils which are rendered active and inactive by the magnets, and an antihunting device which modifies the action of the governor.

8. In combination, a driving-shaft, a driven shaft, a governor, electromagnets controlled by the governor, clutch-coils which are rendered active and inactive by the magnets, an antihunting device which modifies the action of the governor, and a limiting device which renders the magnets inoperative.

9. In combination, a prime mover, a governor, a governor-motor, a plurality of valves, means connected to the motor for simultaneously operating the valves in one direction, and means connected to the motor for moving the valves in a different direction.

10. In combination, a prime mover, a governor-motor, clutch-coils for throwing the motor into and out of service, constantly-running contacts, current-carrying brushes mounted for engagement therewith, magnets for actuating the brushes, a governor for closing and opening the circuit of the magnets, and an antihunting device for modifying the action of the governor.

11. In combination, a prime mover which is divided into stages, one or more valves for each stage, a mechanical driving connection between one valve and the next, and a single motor for actuating all of the valves.

12. In combination, a plurality of bucket-wheels, an inclosure for each wheel, a plurality of nozzle-sections delivering fluid to the wheels, independent valves each of which controls a number of sections, a shaft which actuates the valves, a driving connection between the bucket-wheels and the shaft, and a device responsive to speed changes which regulates the action of the motor.

13. In combination, a prime mover, a plurality of admission-valves therefor, a motor, mechanical driving connections between the valves and said motor, and a means for disengaging the motor from the valves when the latter have reached the limit of their movement.

14. In combination, a prime mover, a plurality of admission-valves therefor, a motor,

mechanical driving connections between the valves and said motor, and an antihunting device for said motor.

15. In combination, a prime mover, a plurality of admission-valves therefor, a motor, mechanical driving connections between the valves and said motor, a means for disengaging the motor from the valves when the latter have reached the limit of their movement, and an antihunting device for said motor.

16. In combination, a fluid-motor, an admission-valve therefor, a motor, a governor, a contact acted upon by the governor for controlling the motor, and a device acting under changes in position of the valve to break the connection between the governor and the contact independent of the position of the governor.

17. In combination, a fluid-motor, an admission-valve therefor, a motor, a governor, a contact acted upon by the governor for controlling the motor, a device acting under changes in position of the valve to break the connection between the governor and the contact, a magnet included in circuit with the contact, and a limiting device which breaks the circuit of the magnet independently of the governor.

18. In combination, a fluid-motor, an admission-valve, a motor for actuating the valve, a centrifugally-acting device, current-carrying brushes mounted for engagement therewith, and means for rocking the brushes to break the circuit at the brushes.

19. In combination, a fluid-motor, an admission-valve, a motor for moving the valve, centrifugally-acting weights that are responsive to speed variations, a magnet for connecting the motor to the valve, and a pair of circuit-interrupting devices in the circuit of the magnet, one of said devices being operated by the weights and the other by the movements of the valve.

20. In a governor, the combination of a reciprocating admission-valve, a rotary motor for moving the valve, a means for transforming the motion of the motor from rotary to rectilinear, a speed-responsive device, and an antihunting device.

21. In a governor, the combination of a plurality of admission-valves, a rotary motor, a sectional shaft driven by the motor, and means situated between the sections of the shaft for actuating the admission-valves.

22. In combination, a fluid-motor, a reciprocating admission-valve which is balanced as to pressures, a spring for sustaining the weight of the valve, a motor which moves the valve, and a governor which connects and disconnects the motor and valve.

23. In combination, a bucket-wheel, an inclosure therefor, a passage delivering fluid to the wheel, a valve controlling the admission of fluid to the passage, a constantly-running motor, a driving connection between the valve and the motor, and a means for disengaging the motor and the valve when the latter has reached the limit of its movement.

In witness whereof we have hereunto set our hands this 12th day of February, 1903.

WILLIAM L. R. EMMET.
OSCAR JUNGGREN.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.