E. THOMSON.

ELASTIC FLUID TURBINE.

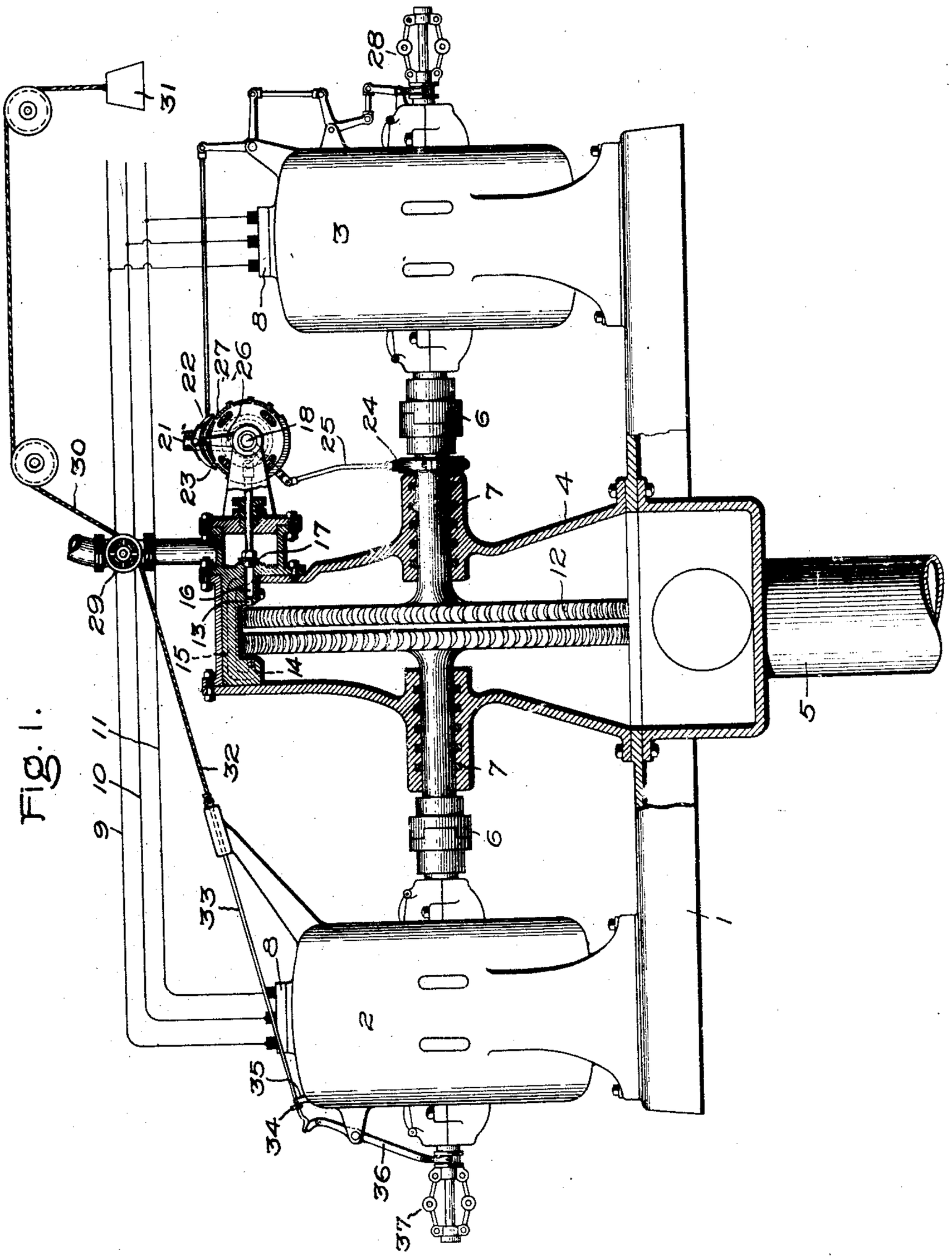
APPLICATION FILED JULY 3, 1907.

957,915.

Patented May 17, 1910.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses:

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2 SHEETS—SHEET 2.

Fig. 2.

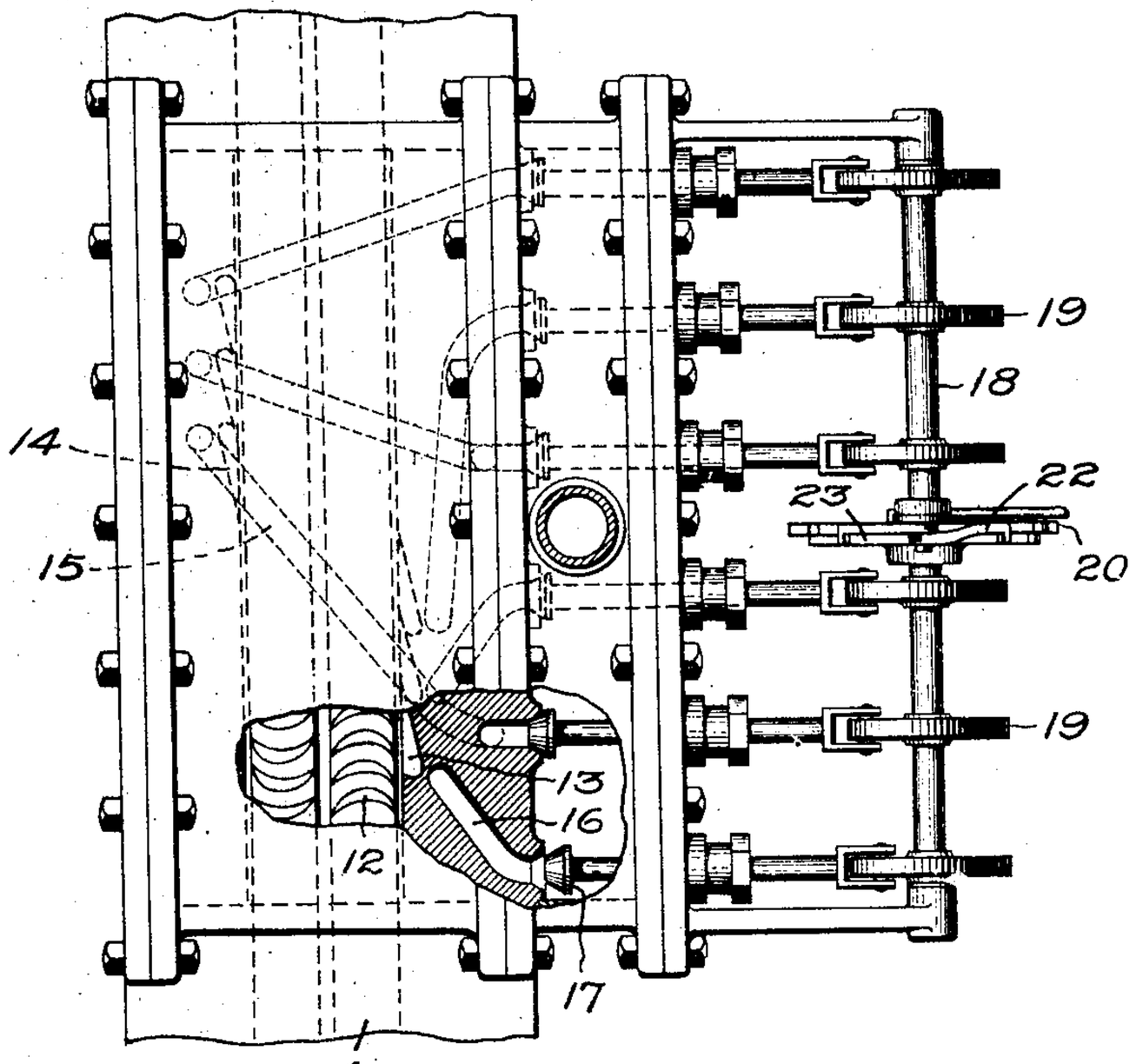
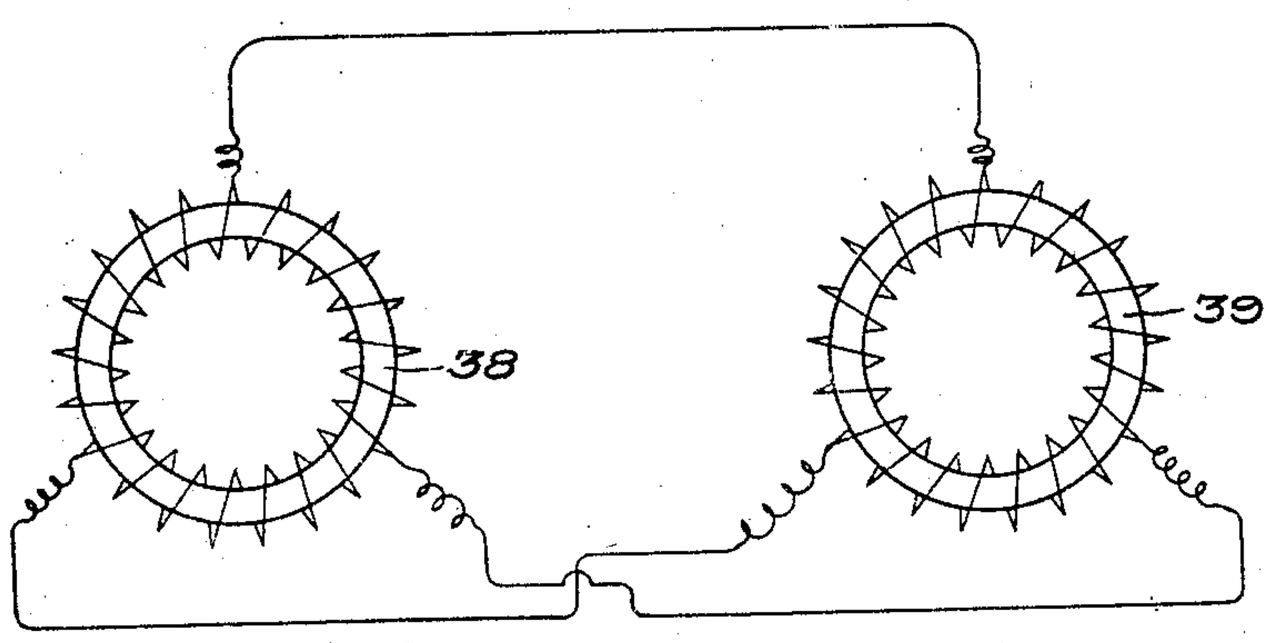


Fig. 3.



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UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELASTIC-FLUID TURBINE.

957,915. Specification of Letters Patent. **Patented May 17, 1910.**

Application filed July 3, 1907. Serial No. 381,995.

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification.

My invention relates to elastic fluid turbines, and has for its object to improve their construction and at the same time render them more efficient.

In carrying out my invention in its simplest form two oppositely rotating bucket-wheels contained in a casing are provided for the purpose of getting relatively high bucket-speed. In such a turbine as ordinarily constructed the wheel acted upon directly by the steam or other motive fluid issuing from the nozzle or nozzles develops a materially greater torque than does the second wheel which receives steam only after it has passed through the first wheel. To overcome this objection and obtain equal or substantially equal work from each wheel I provide two sets of nozzles, one set delivering directly to one wheel and the other set to the opposite, the steam exhausting from one wheel passing through and acting on the buckets of the other. If, for any reason the actual angles of the buckets and nozzles in such a combination have to vary too much from the theoretical angles, I may use intermediate buckets between the wheel-buckets to insure the proper relation. The wheels in such a turbine have a tendency to revolve at different and varying speeds, whereas they should either revolve at at the same speed or else one should revolve a certain definite percentage faster than the other. To connect the wheels for such operation electric generators are provided, one driven by each wheel and these are connected electrically in such manner that they preserve the speed relation. These generators may furnish alternating-current, and, for example, be of the three-phase type. In this event the machines will be interconnected in the proper manner to make them assist each other in feeding the main lines. This constitutes an electrical gearing which takes the place of any mechanical gearing and holds the turbines at proper speed.

For governing the turbine the valve-chest may with advantage be located on one side of the wheel casing with parts or passages extending through the casing to the nozzles on the opposite side of the wheels as well as to those on the same side. The valves may be actuated in a variety of ways. As an illustration, I have shown the valves operated by cams through a ratchet and pawl mechanism that moves the cam shaft forward or back in a step-by-step manner under the control of a speed governor mounted on one of the turbine shafts. By preference a valve admitting steam to one wheel will first be opened or closed as the case may be and then one to the other wheel, and so on. Since the wheels are compelled to run at the same speed by reason of the electrical gearing one emergency governing mechanism will suffice for both and the emergency speed governor may advantageously be mounted on the shaft that does not support the ordinary speed governor. The emergency governor is so arranged that when the speed exceeds a certain predetermined limit it releases a latch and lets a weight or other motor close the main throttle valve of the turbine and thus shut the same down.

I have referred to wheels having single rows of buckets, since this arrangement is ideally simple, but wheels each having a greater number of rows of buckets may be employed. In both cases mentioned the velocity of the steam will be abstracted by successive fractions; but in the latter case the number of operations will be greater, and other things being equal a lower shaft speed may be obtained.

In the accompanying drawings which are illustrative of one embodiment of my invention, Figure 1 is a view partly in section of a turbine and two generators driven thereby; Fig. 2 is a plan view of the valve mechanism with a portion in section; and Fig. 3 is a diagrammatic view of the generator windings.

1 indicates the bed-plate of the turbo-generator, and mounted thereon are two electric generators 2 and 3 of the alternating-current type, and the casing 4 of the turbine, the latter being connected to a condenser by the conduit 5. Each generator is provided with its own shaft which is united to one of the turbine shafts by the coupling 6. Each generator shaft has its

own bearings carried by the generator casing, and each turbine shaft has a bearing in the wheel casing with suitable collars 7 to prevent axial movement of the bucket-wheels. The generators may be of any well known type and the rotating member may be the field or the armature as best suits the requirements. On each generator is a terminal board 8 carrying binding posts that are connected to its windings and to the conductors 9, 10, and 11 forming a part of the electrical gearing. From these same conductors current is supplied to the outside lines and the translating devices. In certain cases it may be desirable to insert a transformer in these conductors instead of making them direct as shown.

Each wheel has a single row of buckets 12 and mechanically is independent of the other. Steam or other elastic motive fluid is admitted to the wheels by a set of nozzles 13 on one side of the turbine and by a set 14 on the other side. These nozzles may be expanding or non-expanding in character as best suits the requirements of service. The nozzles are connected by passages 15 and 16 with the ports controlled by the valves 17.

The valves are actuated by the following means: Mounted in brackets on the right of the valve-chest is a rock-shaft 18 carrying as many cams 19 as there are valves, each cam serving to positively open or close a valve. On the shaft is rigidly mounted a ratchet-wheel 20. Loosely mounted on the shaft is an arm 21 carrying at its outer end pawls 22 and 23, one for moving the rock-shaft forward, the other for moving it backward. On one of the wheel-shafts is an eccentric surrounded by a strap 24 by means of which and the connecting rod 25 the pawls and the arm carrying them are constantly vibrated. Loosely mounted on the rock-shaft is a second arm 26 and this carries a shield-plate 27. The arm is connected by rods and bell-crank levers with the speed governor 28 mounted on the generator shaft. The governor changes the position of the shield-plate with changes in load, and said plate controls the action of the pawls on the ratchet-wheel and therefore the position of the rock-shaft, cams and valves.

Steam is admitted to the valve-chest by a throttle valve 29 which can be operated by hand for starting and stopping the turbine or by a weight under emergency conditions. On the spindle of the valve is a drum and wound around the drum is a wire rope or cord 30 having a weight 31 attached to one of its ends. The throttle-valve is normally kept from turning by means of a cord 32 attached at one end to the drum or hand-wheel at one point and at the other end to a sliding rod 33. The end of the cord attached to the hand-wheel is provided with a connector so arranged that the wheel can be set to any desired position by hand to give any desired opening of the throttle. The rod 33 is held in tension by the weight 31 and the collar 34 on the rod engaging a stop 35 on the frame of the generator. Pivotally mounted on the generator is a lever 36 having a fork at the lower end engaging with the collar of a fly-ball emergency governor 37 mounted on the generator shaft. The other end is adapted to engage the rod 33, and release it from the stop 35 when the speed of the turbo-generator becomes abnormally high, or, if desired, it could be set to trip the valve when the speed becomes abnormally low by proper modification. When the sliding rod is released by being pushed upward the weight 31 overcomes the inertia of the valve and its attached parts, and closes it.

In Fig. 3 is shown diagrammatically two armatures connected by a three-phase connection to form an electrical gearing between the two. This connection does not necessarily feed the work circuit as in Fig. 1. In this case the rings 38 and 39 may be taken to indicate the armatures of direct-current machines with the commutators and connections omitted. Instead of utilizing either alternating or direct-current machines, I may use one alternating and one direct-current machine with a multiphase connection between, and take off alternating-current single or multiphase at one end of the machine and direct-current at the other.

It will be understood that the different sets of nozzles or the separate nozzle arcs on opposite sides of the pair of wheels are peripherally displaced with respect to each other so that there shall be no interference by the steam moving one way with the steam moving from the opposite side. In fact, where the arc covered by the nozzles is extended the nozzles on opposite sides of the pair of wheels may be so placed with respect to each other as to be diametrically opposite. If the nozzle arc for one wheel should cover an angle of approximately from 120° to 180° this latter disposition would be of course necessary.

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

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

1. In an elastic fluid turbine, the combination of bucket-wheels mounted to revolve in opposite directions and receive motive fluid one from the other, nozzles arranged on opposite sides of the wheels to discharge fluid through the wheels in opposite directions to

equalize the torque thereof, electrical gearing for causing the proper speed relation of the wheels to be maintained, and a governing mechanism that is common to both wheels.

2. In an elastic fluid turbine, the combination of bucket-wheels mounted to revolve in opposite directions and receive motive fluid one from the other, nozzles disposed on opposite sides of the wheels and arranged in sets, a valve-chest, passages extending from the valve-chest to the sets of nozzles, valves for varying the passage of fluid therethrough, and an actuating mechanism common to the valves.

3. In an elastic fluid turbine, the combination of bucket-wheels mounted to revolve in opposite directions and receive motive fluid one from the other, nozzles disposed on opposite sides of the wheel and arranged in sets, a valve-chest, passages extending from the valve-chest to the sets of nozzles, valves for varying the passage of fluid therethrough, an actuating mechanism common to the valves, and electrical gearing for causing the proper speed-relation of the wheels to be maintained.

4. In an elastic fluid turbine, the combination of bucket-wheels mounted to revolve in opposite directions and receive motive fluid one from the other, nozzles disposed on opposite sides of the wheel and arranged in sets, a valve-chest located on one side of the wheels, passages extending from the valve-chest to the sets of nozzles, valves for varying the passage of fluid therethrough, an actuating mechanism common to the valves, electrical gearing for causing the proper speed-relation of the wheels to be maintained, and a governor responsive to the speed of the electrically-geared wheels for shutting off the supply of motive fluid when the speed becomes abnormal.

In witness whereof, I have hereunto set my hand this 28th day of June 1907.

ELIHU THOMSON.

Witnesses:

JOHN A. MCMANUS, Jr.,

CHARLES A. BARNARD.