C. W. DAKE.

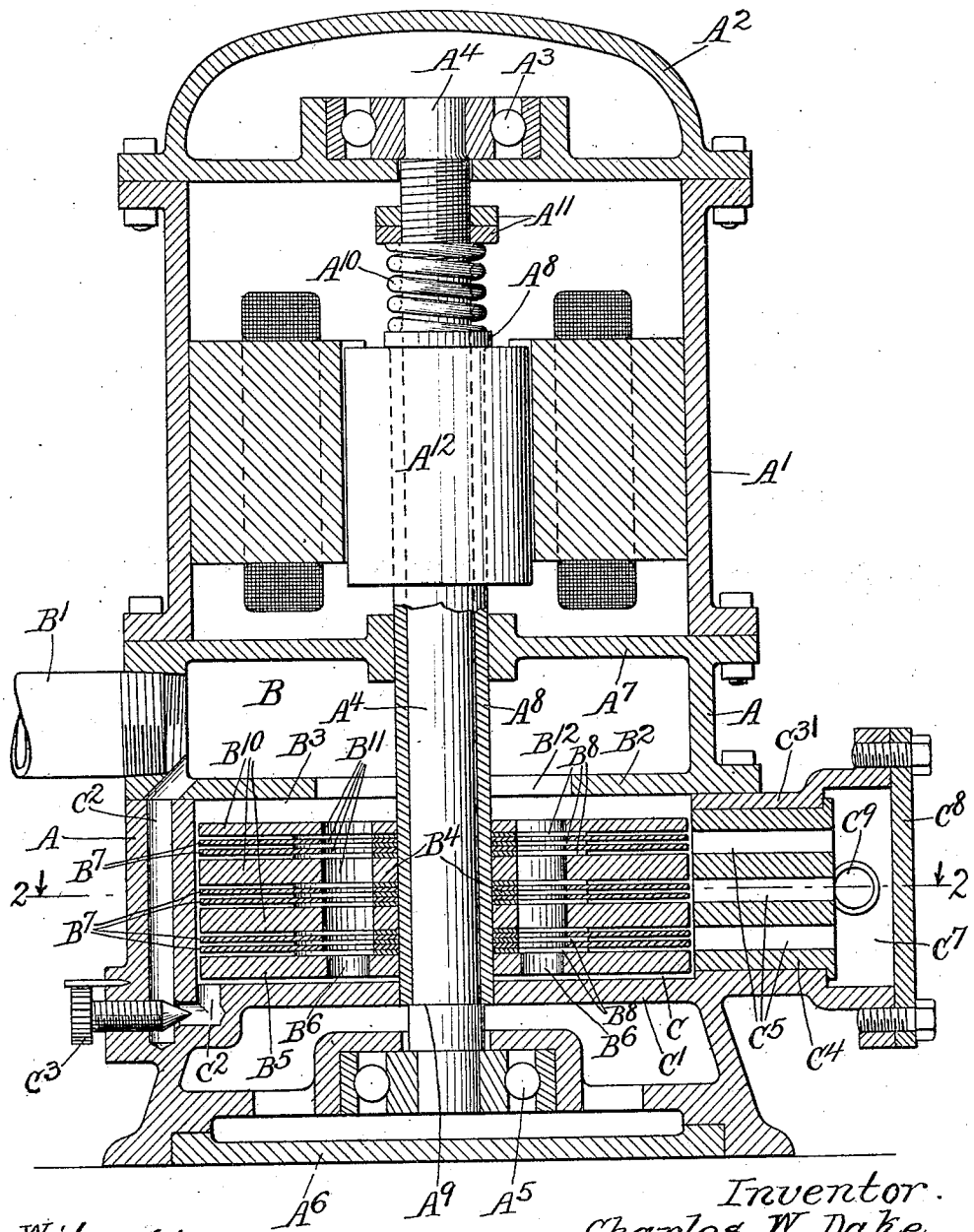
ELASTIC FLUID TURBINE.

APPLICATION FILED APR. 7, 1919.

1,402,053. Patented Jan. 3, 1922.

2 SHEETS—SHEET 1.

Fig. 1.



Witness.

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2 SHEETS—SHEET 2.

Fig. 2.

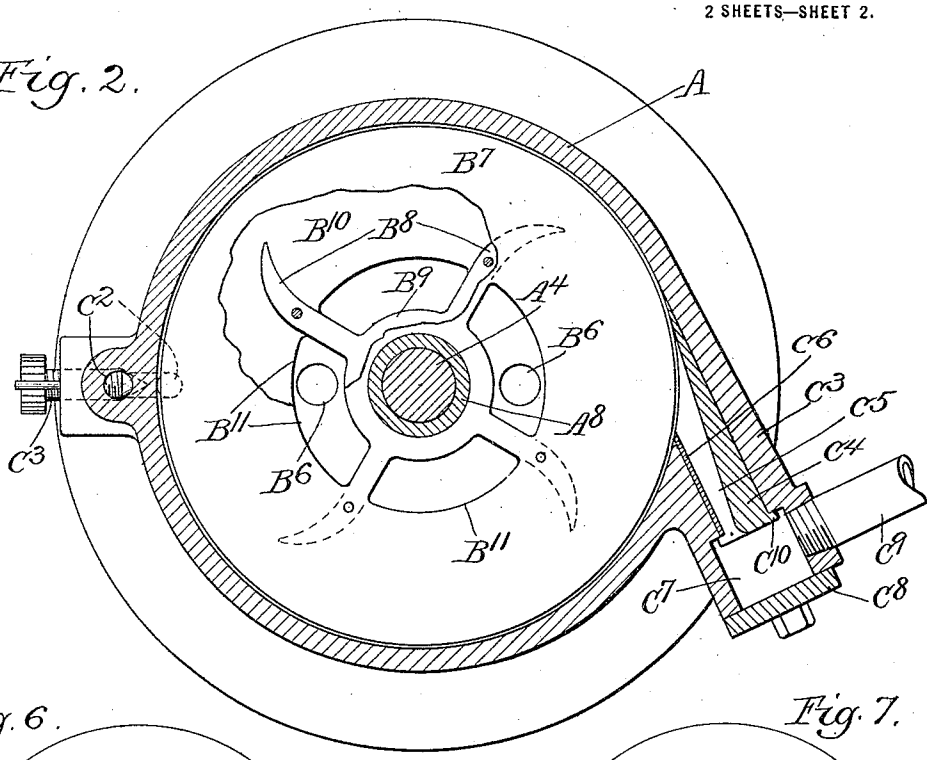


Fig. 6.

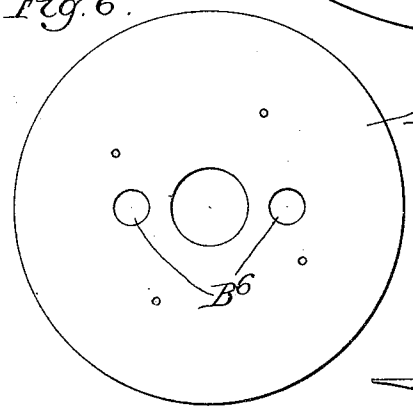


Fig. 7.

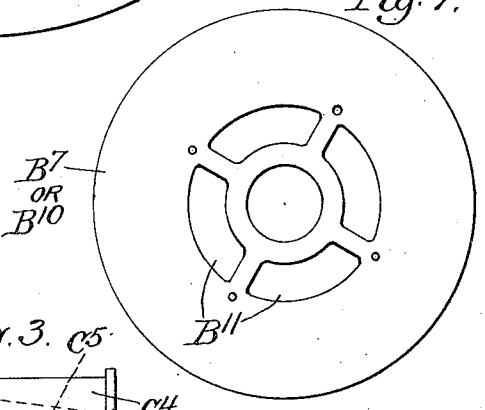


Fig. 3.



Fig. 5.

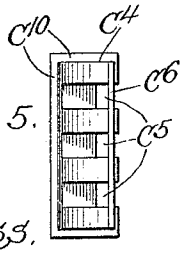
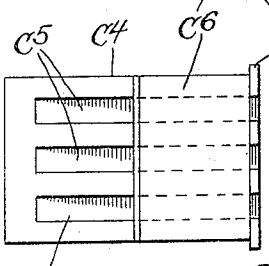


Fig. 4.



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UNITED STATES PATENT OFFICE.

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ELASTIC-FLUID TURBINE.

1,402,053. Specification of Letters Patent. Patented Jan. 3, 1922.

Application filed April 7, 1919. Serial No. 288,090.

To all whom it may concern:

Be it known that I, CHARLES W. DAKE, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Elastic-Fluid Turbines, of which the following is a specification.

My invention relates to improvements in elastic fluid turbines of the type wherein a jet or jets of steam are projected tangentially against the edge or edges of flat plates to rotate them by frictional engagement of the jet with the surface of the plate. It has for one object, to provide a new and improved form of governing or speed control and particularly to provide such speed control as will dispense with the need of any separate governor parts such as valve, centrifugal weights, links, levers, and the like as are ordinarily used for that purpose.

In my invention, I make the rotor itself act as the valve to control the flow of steam for governing. I make it also act as its own valve controlling means by using the direct pressure of a certain part of the motive fluid to move the rotor along its axis.

Among the objects of my invention, therefore, are to provide an automatic self-contained motor generator set driven by an elastic fluid self-controlled and self-governing, and which may be set and adjusted for control at any suitable speed independent of the pressure in the steam or fluid line. Other objects of my invention will appear from time to time in the specification.

My invention is illustrated more or less diagrammatically in the accompanying drawings wherein—

Figure 1 is a vertical section through my device of Figure 2;

Figure 2 is a horizontal section along the line 2—2 of Figure 1;

Figure 3 is a plan view;

Figure 4 is a front elevation;

Figure 5 is a side elevation of the nozzle block;

Figure 6 is a plan view of the bottom rotor plate;

Figure 7 is a plan view of all the other rotor plates which vary one from the other in thickness only.

Like parts are indicated by the same letter in all the figures.

A is a motor housing having an integral base; A^1 a generator housing mounted on the motor housing; A^2 a cap closing the upper end of the generator housing. In this cap is a ball bearing A^3 carrying one end of a shaft A^4. The lower end of this shaft A^4 is mounted in a ball bearing A^5 in the base of the housing A. A^6 is a plate closing the base so that the entire apparatus is contained within a closed continuous housing. A^7 is a diaphragm extending across the top of the housing A and provided with a central thickened portion bored out to make a working fit with the sleeve A^8 which sleeve is slidably mounted on the shaft A^4 abutting normally at its lower end against a shoulder A^9 but free to move upwardly against the pressure of the spring A^{10} which pressure may be varied by the nut A^{11}. Supported on the shaft A^4 is an electric rotor A^{12} mounted on the sleeve A^8.

The diaphragm A^7 at the top of the motor housing A separates it from the generator housing. The upper portion of the motor contains an exhaust chamber B discharging into an exhaust pipe B^1. The pressure of the exhaust steam in this chamber is so low that there is no appreciable escape into the generator housing. The diaphragm B^2 separates the exhaust chamber from the working chamber B^3 in which the fluid driven rotor or turbine wheel, is located and contains a large central passage between these two chambers. The turbine rotor B^4 is mounted on the sleeve A^8. It is made up of a bottom plate B^5 having a plurality of small apertures B^6 therein. B^7 B^7 are a plurality of thin driving discs parallel with the bottom plate B^5 and separated one from another by spacing spiders B^8, which spiders have central hubs B^9 about the sleeve A^8. Above these discs B^7 B^7 is a thick cut off plate B^{10} and then above this some more driving discs and then another cut off plate, the idea being that between each group of driving discs, and there may be one or two or more driving discs in a group, is a cut off plate; and there may be only one group of driving discs or a plurality of groups of driving discs, but in any event, there is always a cut off plate on either side of each group of driving discs. Attention is called here also to apertures B^{11} through both the cut off plates and the driving discs, which apertures are in register with, but larger than, the apertures B^6 in the bottom plate

B^5, which bottom plate also acts as a cut off plate. B^{12}, the aperture through the diaphragm B^2, it will be observed, is larger than the apertures B^{11} so that any motive fluid passing through these various apertures will be able to pass freely out to and through the exhaust chamber.

The apertures B^6 are made smaller than the others so that those apertures will control and limit the flow of fluid into the annular governing chamber and so that the sizes of the other apertures will not in any way affect the conditions prevailing within the governing chamber.

C is an annular pressure or governing chamber the top wall of which is formed by the bottom plate B^5, and the lower wall by the diaphragm C^1. The slight clearance between the peripheral wall of the chamber and the periphery of the rotor is such that the escape of steam outwardly from the chamber about the periphery thereof is negligible. There is also a clearance above the rotor between it and the diaphragm B^2, but this clearance and the annular chamber thus formed is so directly connected to the exhaust that there is no appreciable piling up of pressure in such chamber. C^2 is a passage leading from the outer periphery of the chamber C and discharging into the exhaust chamber B. It is adapted to be controlled by the valve C^3 whereby the pressure in the chamber C may be controlled. $C^{3'}$ is a nozzle housing extending laterally from the housing A. It is preferably rectangular in its inner cross section, though it might be of other shape. In it is located a rectangular nozzle block C^4. This nozzle block has cut into one face, a plurality of nozzle slots or passages C^5, there being one in register with each group of driving discs, with the walls between them in register one with each of the cut off plates, the relation being such that if the rotor is moved up, the cut off plates come into register with the nozzle slots and cut off substantially all the flow of steam if the movement extends far enough. C^6 is a cover plate associated with the rectangular nozzle block, and protecting the wall of the housing against erosion by the steam. The nozzle passages are of substantially constant height throughout their length but expand laterally as illustrated in Figure 3 whereby the pressure of the steam as it enters the nozzle is, in the usual manner, transformed into velocity as it leaves the nozzle to impinge upon the rotor. The shape of the nozzle block is as indicated, such that it closely conforms to the periphery of the driving discs to prevent wastage of steam between the nozzle and the discs. C^7 is a steam chest closed by a cap C^8 and supplied with steam or other motive fluid from a boiler or other source of pressure through the pipe C^9. The nozzle block is flanged as at C^{10} to engage one wall of the steam chest so that the pressure of the steam in the chest tends always to keep the block properly seated in its housing.

It will be evident that while I have shown in my drawings an operative device, still many changes might be made both in size, shape and arrangement of parts without departing materially from the spirit of my invention, and I wish, therefore, that my drawings be regarded as in a sense diagrammatic.

While in my form I show a plurality of cut off discs each with a plurality of thin driving discs between, it is obvious that the cut off discs operate partially as driving discs and if I omitted all but a single cut off disc and used but a single nozzle, you would still have an operative machine because the motive fluid frictionally engaging one-side of the disc would cause it to rotate, and the pressure built up on the other side would cause it to register with the nozzle for governing.

Attention is called to the fact that in order that the thin discs may be shown in cross section, it has been necessary to exaggerate the thickness of the thin and thick discs and nozzles, though, of course, they might be made of varying thickness in this machine depending upon the situation.

The use and operation of my invention are as follows:

The apparatus will be assembled so that it takes the form and arrangement shown in the drawings. The steam line will be coupled up and the electric line will be coupled up and the throttle valves not here shown, will be opened admitting steam into the steam chest and transferring its pressure into velocity. This steam is then directed into the annular spaces between the driving discs, and since the space between them is comparatively small, the skin friction resistance to the travel of the steam caused by its engagement with the plates will cause the plates to rotate, and as the steam velocity decreases, the steam will tend in the well known manner to move inwardly toward the center as the rapidly moving steam forces itself outwardly by centrifugal force. The result of this is that as steam is fed in, the highly energized rapidly moving steam engages the periphery and does the work, and as it loses its power, it will tend to travel inwardly toward the exhaust passages arranged adjacent the center of rotation. Most of this steam will pass up and out through the discs, into the exhaust chamber, and thence off. A comparatively small amount of this steam will find its way downwardly into the annular governing chamber, and once it reaches that chamber, it will be forced outwardly by the rotational speed which will be imparted

to it by its frictional engagement with the under side of the bottom plate, and there will thus be built up a pressure underneath that plate and since there is an ample supply of steam, that pressure will depend on the rotational speed. In other words, the higher the speed is, the greater the pressure. This pressure will tend to raise the whole apparatus upwardly and bring the cut off plates into register with the nozzle, thus decreasing the amount of steam and reducing the speed. This reduction of speed will, of course, reduce the pressure in the governing chamber, and the force of gravity assisted by the spring pressure will tend to move the parts down to admit again a full flow of steam.

The by pass arrangement shown is provided with a valve which may be manipulated by the operator and experience will show just how much the valve ought to be open to cause the rotor to operate at any particular speed and that arrangement can be made empirically and having once been made, the turbine can operate without further adjustment.

I claim:

1. In a turbine, a driving and cut off disc mounted for rotation, means for discharging a motive fluid against it to rotate it, and means created by its rotation responsive to its rotational speed for moving it and the fluid supply means toward register to shut off the motive fluid.

2. In a turbine, a driving and a cut off disc spaced apart, means for discharging a motive fluid against them to rotate the turbine, and means created by its rotation responsive to its rotational speed for moving the cut off disc and the fluid supply means toward register to shut off the motive fluid.

3. In a turbine a thin driving, and a thick cut off disc, spaced apart, means for discharging a motive fluid against them to rotate the turbine, and means created by its rotation responsive to its rotational speed for moving the cut off disc and the fluid supply means toward register to shut off the motive fluid.

4. In a turbine, a thick cut off, and a plurality of thin driving discs, spaced apart, and means for discharging a motive fluid against them to rotate the turbine and means created by its rotation responsive to its rotational speed for moving the cut off disc and the fluid supply means toward register to shut off the motive fluid.

5. In a turbine a plurality of thick cut off discs, a plurality of groups of thin driving discs arranged between them, all the discs being spaced apart one from the other, means for discharging a motive fluid against them to rotate the turbine and means created by its rotation responsive to its rotational speed for moving the cut off discs and the fluid supply means toward register to shut off the motive fluid.

6. In a turbine a plurality of thick cut off discs, a plurality of groups of thin driving discs arranged between them, all the discs being spaced apart one from the other, means for discharging a motive fluid against them to rotate the turbine and means created by its rotation responsive to its rotational speed for moving the cut off discs and the fluid supply means toward register to shut off the motive fluid, the fluid supply means comprising a plurality of separate discharge nozzles adapted to normally be in register with the groups of thin driving discs, the walls separating them being normally in register with the cut off discs.

7. In an elastic fluid turbine a rotor mounted for lateral movement, a nozzle adapted to discharge a motive fluid against the rotor to drive it, means carried by the rotor adapted when the rotor is moved laterally to come into register with the nozzle, a pressure chamber one wall of which is formed by the rotor itself, and means for diverting a portion of the motive fluid after it has expended substantially all of its motive force to said chamber.

8. In an elastic fluid turbine a rotor mounted for lateral movement, a nozzle adapted to discharge a motive fluid against the rotor to drive it, means carried by the rotor adapted when the rotor is moved laterally to come into register with the nozzle, a pressure chamber one wall of which is formed by the rotor itself, and means for diverting a portion of the motive fluid to said chamber, a pressure relief for such chamber and means independent of the rotation of the rotor for adjusting the operation of such pressure relief.

9. In an elastic fluid turbine a rotor, means for discharging a motive fluid thereagainst, a governing chamber, means for diverting a portion of the motive fluid thereto, means for varying the pressure therein in direct response to the rotational speed, and means created by its rotation responsive to such pressure variations for controlling the flow of motive fluid.

10. In an elastic fluid turbine a rotor, means for discharging a motive fluid thereagainst, a governing chamber, means for diverting a portion of the motive fluid thereto, means created by its rotation for varying the pressure therein in direct response to the rotational speed, and means responsive to such pressure variations for moving the rotor laterally to throw the motive fluid discharge means out of register with the rotor.

11. In an elastic fluid turbine a rotor, means for discharging a motive fluid thereagainst, a governing chamber one side of which is closed by the end of the rotor, means for diverting a portion of the motive fluid

thereto the rotor being laterally movable into and out of register with the fluid discharging means created by its rotation responsive to pressure variations in the governing chamber caused by the frictional engagement of the end of the rotor with the motive fluid in the chamber.

12. In an elastic fluid turbine a housing, a rotor therein, a governing chamber formed between one end of the rotor and the housing, means for discharging the motive fluid against the rotor, means for diverting a portion of the spent fluid into the governing chamber, the rotor being laterally movable to control the flow of motive fluid under the influence of the pressure variations caused within such governing chamber by the frictional engagement of the rotor with the governing fluid in such chamber.

13. In an elastic fluid turbine a housing, a rotor therein, a governing chamber formed between one end of the rotor and the housing, means for discharging the motive fluid against the rotor, means for diverting a portion of the spent fluid into the governing chamber, the rotor being laterally movable to control the flow of motive fluid under the influence of the pressure variations caused within such governing chamber by the frictional engagement of the rotor with the governing fluid in such chamber, a pressure release discharging from such chamber and means independent of the rotor for adjusting such release.

14. In an elastic fluid turbine a housing, a rotor therein, a governing chamber formed between one end of the rotor and the housing, means for discharging the motive fluid against the rotor, means for diverting a portion of the spent fluid into the governing chamber, the rotor being laterally movable to control the flow of motive fluid under the influence of the pressure variations caused within such governing chamber by the frictional engagement of the rotor with the governing fluid in such chamber, the means for diverting such fluid comprising perforations in the end of the rotor communicating with such chamber, there being free and unobstructed passage through the rotor in register with and larger than such perforations, and arranged for a direct and free exhaust.

15. A rotor for elastic fluid turbines comprising a plurality of thick cut off discs separating a plurality of groups of thin driving plates all spaced apart and centrally perforated for mounting upon a shaft, perforations through them arranged about and adjacent the axle, the perforations through the lower cut off plate being smaller than the perforations through all the other cut off plates.

16. Spacing spiders for fluid turbines comprising a central thin perforated hub and a plurality of radial arms projecting outwardly and terminating at their ends in curved pointed members, the points of said members extending backwards into the current of motive fluid.

17. A rotor for fluid turbines comprising a plurality of thick perforated discs, a plurality of groups of thin perforated discs interposed between the thick ones, spacing spiders between each two discs, the perforations between the discs being all in register one with the other, the spiders bridging the spaces between the perforations, and means for holding the discs all together independent of their position.

18. In an elastic fluid turbine a housing containing an exhaust and a working chamber, an open and unobstructed passage between the chambers, a steam chest, a socket adapted to contain a nozzle block interposed between the steam chest and the working chamber.

19. In an elastic fluid turbine a housing containing an exhaust and a working chamber, an open and unobstructed passage between the chambers, a steam chest, a socket adapted to contain a nozzle block interposed between the steam chest and the working chamber, a by-pass leading from the periphery of the working chamber at a point far removed from the exhaust chamber and discharging into the exhaust chamber.

20. A nozzle block for elastic fluid turbines having a plurality of parallel channels in one side thereof and a cover plate adapted to close them.

21. In an elastic fluid turbine a housing containing an exhaust and a working chamber, an open and unobstructed passage between the chambers, a steam chest, a socket adapted to contain a nozzle block interposed between the steam chest and the working chamber, a by-pass leading from the periphery of the working chamber at a point far removed from the exhaust chamber and discharging into the exhaust chamber, the thickness of the passages being constant, their width increasing towards their discharge ends.

22. A nozzle block for elastic fluid turbines having an inclined end formed by a cylindrical surface, steam passages disposed in one side of the block discharging at said curved surface, and a cover plate extending along one side of the block closing said passages and terminating at their cylindrical surface.

23. In a steam turbine, a rotor, a steam nozzle adapted to discharge the driving fluid for driving it, a cut off member therefor, means for diverting a portion of the motive fluid after it has expended substantially all of its motive impulse varying its pressure responsive to the rotational speed of the rotor, and for directing such pressure against the cut off to operate it.

24. In a steam turbine, a rotor, means for discharging the driving fluid for driving it, cut-off means therefor, means for diverting a portion of the motive fluid after it has expended substantially all of its motive impulse, and means for directing said diverted portion against the cut-off means, to operate it.

25. In a steam turbine, a rotor, means for discharging the driving fluid for driving it, cut-off means therefor, means for diverting a portion of the motive fluid after it has expended substantially all of its motive impulse and means for directing said diverted portion against the cut-off means, to operate it, the pressure of said diverted portion varying in response to the rotational speed of the rotor.

26. In a steam turbine, a rotor, means for discharging the driving fluid for driving it, a cut-off member, means for diverting a varying portion of the motive fluid after it has expended substantially all of its motive impulse to operate it, said cut-off member adapted to move said rotor along its axis.

27. In a steam turbine, a rotor, means for discharging the driving fluid for driving it, a cut-off member, means for diverting a portion of the motive fluid after it has expended substantially all of its motive impulse, varying its pressure responsive to the rotational speed of the rotor, to operate said cut-off member, said cut-off adapted, in response to said pressure, to move said rotor along its axis, away from the driving fluid discharge.

28. A steam turbine rotor comprising a plurality of thick cut off discs, spaced apart, together with a plurality of sets of thin driving discs spaced therebetween, in combination with a nozzle block having a plurality of parallel channels, said channels, adapted normally to be in communication with said sets of thin driving discs.

In testimony whereof, I affix my signature in the presence of two witnesses this 26th day of March, 1919.

CHARLES W. DAKE.

Witnesses:

MINNIE M. LINDENAU,

MARION L. INGRAHAM.