

D. KEMBLE.
STEAM TURBINE.

APPLICATION FILED APR. 13, 1909.

992,566.

Patented May 16, 1911.

4 SHEETS-SHEET 1.

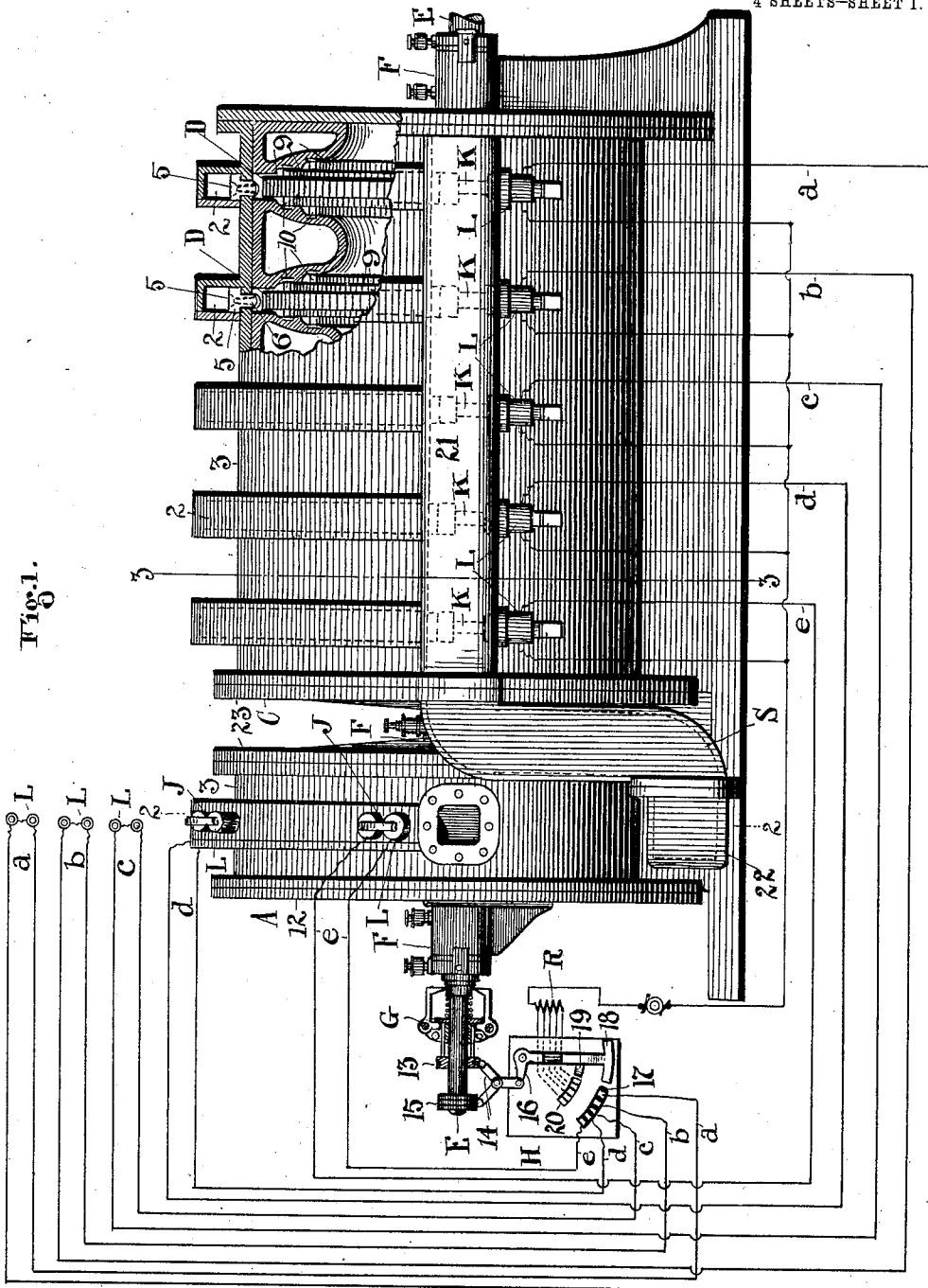


Fig. 1.

ATTEST
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Fig. 3.

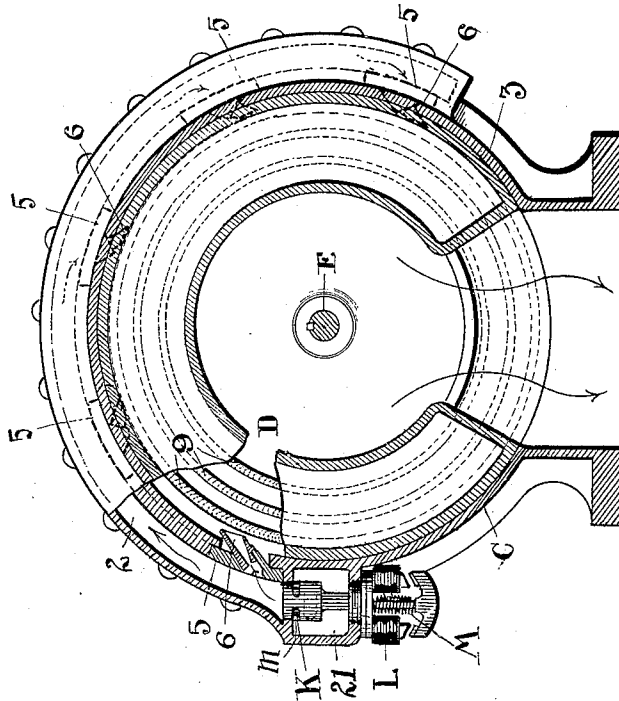
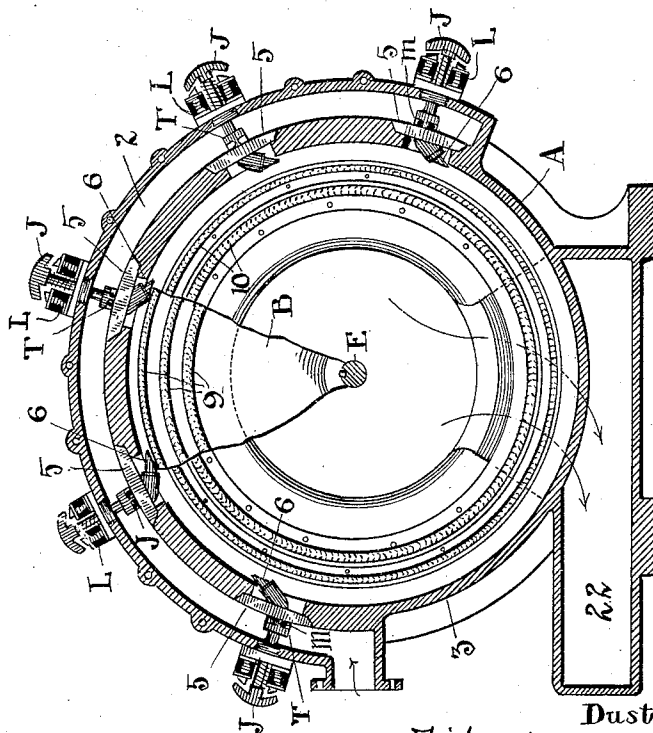


Fig. 2.



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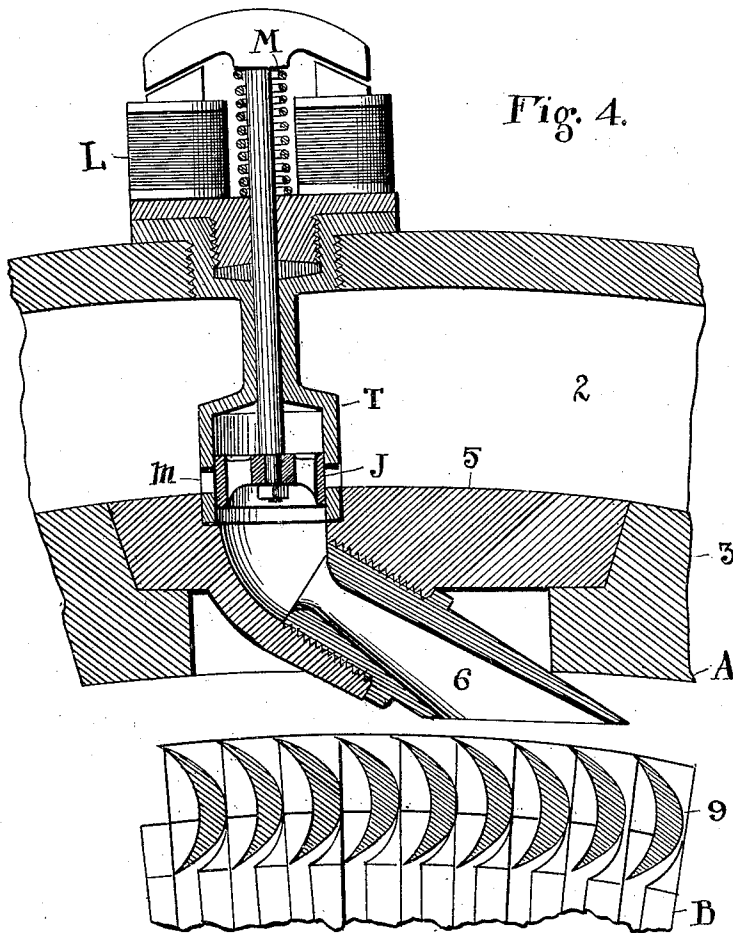
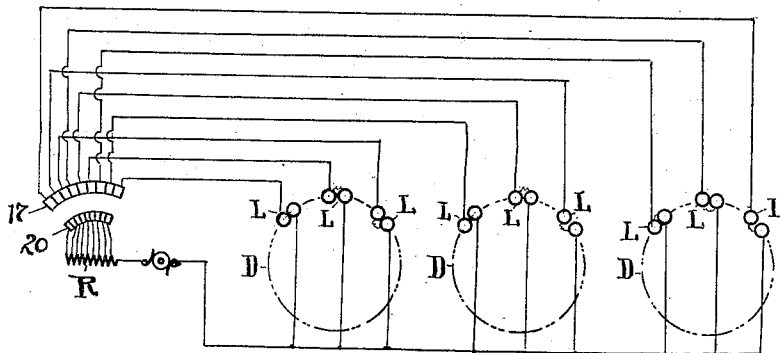


Fig. 5.



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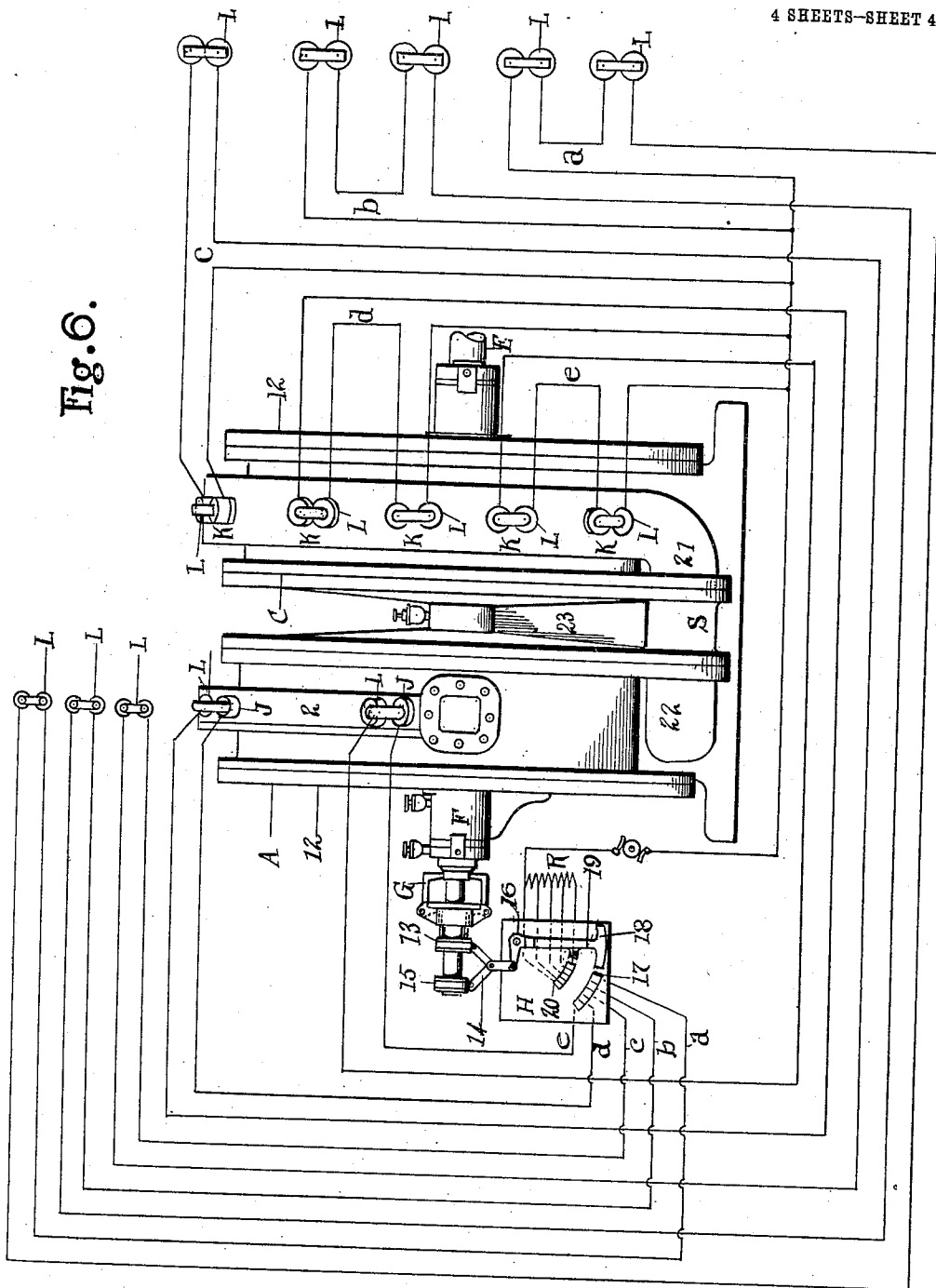
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4 SHEETS-SHEET 4.

Fig. 6.



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UNITED STATES PATENT OFFICE.

DUSTON KEMBLE, OF LAKEWOOD, OHIO.

STEAM-TURBINE.

992,566.

Specification of Letters Patent.

Patented May 16, 1911.

Original application filed February 8, 1909, Serial No. 476,833. Divided and this application filed April 13, 1909. Serial No. 489,678.

To all whom it may concern:

Be it known that I, DUSTON KEMBLE, citizen of the United States, residing at Lakewood, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Steam-Turbines, of which the following is a specification.

My invention relates to steam turbines and more particularly to the steam turbine shown and described in my application of February 8, 1909, Ser. No. 476,833, this being a division thereof, and the general object of the invention is to abridge the number of pressure stages that may be necessary in that class of machines to secure an economical steam consumption at a given rotational speed and at the same time to provide means for a thorough regulation of the steam supply in due proportion to varying loads on the driven machine, which is usually an electric generator. This regulating means comprises a governor and electrical devices operated thereby to variably control the respective valves of the turbine, and involves, first, a new operating toggle connection and two slip rings on the main shaft instead of only one as in others, whereby an easier throw of the switch lever is obtained; second, the introduction of resistance coils to adjust the strength of current to equalize the resistance of more or less of the magnetizing coils to its passage; third, the arrangement of one valve for each nozzle for the high pressure stage member and a single valve for a series of nozzles for the lower stage members; and fourth, the plan of cutting off one nozzle at a time of each of the several vane wheels operated in parallel, etc., when constructed as a single stage machine.

Other features of operation and advantages are also embodied in other details of construction, all as hereinafter set forth.

In the accompanying drawings, Figure 1 is a side elevation partly in section of my improved steam turbine, and a diagram of the electrical connections therefor. Fig. 2 is a vertical section on line 2—2, Fig. 1, of the high pressure chamber, but showing only a portion of the vane wheel therein. Fig. 3 is a vertical section on line 3—3, Fig. 1, of the low pressure chamber, showing a portion broken away to disclose a nozzle in section. Fig. 4 is an enlarged cross sectional view of the high pressure chamber on the

line of the valve controlled nozzles and showing a portion of a vane wheel. Fig. 5 is a diagrammatic view of a single stage machine having three vane-wheels with three nozzles each connected electrically to permit one nozzle at a time to be cut off successively from successive vane-wheels. Fig. 6 is a diagrammatic view of a two-stage machine having two vane wheels, the first or high pressure member having a series of five nozzles each connected electrically in series with two nozzles of the second or low pressure member which has ten nozzles.

The invention comprises a high pressure chamber A having a single vane wheel B, see Fig. 2, and a low pressure chamber C having a series of vane wheels D, all said vane wheels being mounted and secured in any suitable manner on a central shaft E rotating in suitable bearings F which are either integral or separate parts of the casing walls, as may be desired. A circular channel 2 is provided in casing 3 opposite each vane wheel in both pressure stages, and removable blocks 5 are seated within said channels at different radial points about the casing, and said blocks are each provided with a removable nozzle 6 set tangentially to vane wheels D, which nozzles have open communication with channels 2. The nozzles in chamber A are controlled by valves J slidably mounted in a removable tube T set radially in the casing opposite each block 5. Vane wheels B and D and chambers A and C, are preferably constructed as described in my co-pending application referred to, and have moving and stationary vanes 9 and 10 as also described therein, but as their detail construction is not absolutely necessary to an understanding of this invention further description thereof is omitted.

Now referring to Fig. 1, it will be seen that turbine shaft E extends through and beyond the end bearings F in the center of the cap 12 on the high pressure chamber A, and I reduce its diameter in order to place thereon a centrifugal governor G for controlling the speed of the turbine. Thus, in action this governor operates a sliding ring 13 having toggle link connection 14 with a second ring 15 fixed against longitudinal movement on the end of the shaft but otherwise free thereon which connection is also linked with bell-crank 16 pivotally mounted on the electrical switchboard H. This form

of toggle connection provides an even side pull on the shaft and avoids end strains or pull which might otherwise affect the shaft bearings whether used with electrical or mechanical connections for the valves. Switch board H is provided with a series of contacts 17 and 20 arranged in concentric arcs of a circle and corresponding in number to the electrically operated admission valves J for the high pressure chamber. Bell crank 16 is in effect a switch with two contact portions 18 and 19 at its longer end which engage contacts 17 and 20, respectively. Contacts 20 are electrically connected with resistance coil R to permit a gradual cutting out of the resistance as an increasing number of valves J and K are cut into the electrical circuit.

As here shown, I provide one admission valve J of the hollow piston type for each nozzle in the high pressure chamber A and locate each valve in the steam feed channel 2 directly over the opening in block 5 which leads into its nozzle 6. I also provide a similar admission valve K of larger caliber for each steam supply channel 2 of the low pressure wheel chamber C at the intake end of each where the said channels respectively join with the longitudinal leader or passage 21 at the side of chamber C, which passage communicates with the exhaust passage 22 of the high pressure chamber by pipe S. Each valve J and K is operatively controlled by an electrical magnet L or its equivalent to shut off the steam from the vane wheels, and a coiled spring M encircling the stem of the valve is utilized to lift the valve and open the intake ports *m* when the electrical current is cut off. The magnet L of each valve J is electrically connected in series with the magnet L of its corresponding valve K, and the respective circuits for the different magnets are designated by *a*, *b*, *c*, *d* and *e*, see Fig. 1. Now it is evident that if the number of feed nozzles in the first or high pressure member of the turbine be made to correspond with the number of separate feed channels and their corresponding vane-wheels in the second or lower pressure member, as for example, five nozzles in the first member and five feed-channels, with as many vane-wheels in the second member, then by electrically connecting the magnet of one valve and its nozzle of the first on the same electric circuit with a magnet of the valve for one feed-channel of the second; see Fig. 1, they will be operated simultaneously by the action of the governor. The circuits may be variously arranged and connected, so that if the number of nozzles in the first member be less than in each vane wheel of the second member, then two nozzles of the one may be operated with one feed channel of the other, and so on, the object being to utilize the

steam leaving the first member of the turbine at its corresponding pressure velocity in the second member without any waste or dissipation of energy by lost expansion. Now, if I employ the second member of this turbine alone, as a single stage machine, running at a peripheral vane velocity, say, of 540 feet more or less per second, and at 3,600 revolutions more or less per minute, then, it is evident that I may place an electrically controlled admission valve at the inlet of each and every one of its numerous feed nozzles; and by arranging a suitable switch-board and resistance coils with the governor as before, with a separate contact for each and every one of the admission valves, (not having any valves in this case for each of the steam-feed channels), I can graduate the steam supply to the entire turbine into as many steps as are equal to the whole number of admission valves. Moreover, the electrical connections with these admission valves may be arranged according to either of two or more methods of distribution; first, to cut off all the nozzles successively for any single vane wheel, then for another wheel, and then another, until all the vane wheels are cut off but one, and that one operating with but a single nozzle in action; and second, to cut off one nozzle on one vane-wheel, then one nozzle on a succeeding vane-wheel, and so on until one nozzle is shut off on each of the vane-wheels, then beginning with a second nozzle on the first vane-wheel, and so on, until all the vane wheels have two nozzles each cut off and out of commission, and so on for a third and fourth nozzle each, until all nozzles but one are cut off. This last is diagrammatically, illustrated in Fig. 5. But nothing here is to be construed as preventing me from using three or more pressure stages with this type of vane-wheel, if that is desirable; nor from changing the rotational speeds and vane velocities, or the forms and sizes of the vanes, wherever so required.

When the turbine is to be of comparatively low power, say from 25 k. w. upward, two single vane wheels may be employed in two separate pressure stages, see Fig. 6, with a cap like 12 in Fig. 1 set in at each end, the main support being under the H shaped casting 23 in the center, which may also contain the principal shaft-bearing, besides the two bearings in the two cap pieces. In this case the first or high pressure member A may have as few as only one or two nozzles or their equivalent in a series of smaller nozzles as in Fig. 2 placed on opposite sides of the vane circle, while the second member may have as many as ten nozzles extending around the vane circle as far as necessary, and these may be larger than the first if necessary. This simplified plan can be graduated for higher powers of turbines, and

it is also obvious that the number of nozzles, or of vane-wheels, may be increased as desired, without changing the radial and circumferential dimensions of the vane-wheels, or the vane velocities and rotation speed at which the turbine is to run, until a power is reached in which it becomes desirable to change the number of shaft rotations or electrical cycles per minute; and then the former dimensions must be changed to correspond with the new requirements. In all these modifications, the same plan of electrical control for the valves will be followed as described.

15 What I claim is:

1. In a steam turbine, the combination of a governor with an electrical switch and means operatively controlled by said governor comprising a pair of free rings mounted on the turbine shaft, one of said rings being slidable and both rings having a toggle link connection engaged with said switch.

2. In a steam turbine, a vane wheel and a set of steam nozzles therefor, and a valve for each nozzle having an electrical device to operate the same, combined with a governor and an electrical switch and resistance coils electrically connected therewith to variably control the current proportionately to the number of the said valve operating devices in circuit.

3. In a steam turbine, a vane wheel and a set of steam nozzles radially disposed in respect thereto, a valve for each nozzle, an electrical operating device for each valve, an electrical switch and resistance coils and circuits for said devices to permit a gradual cutting out of the resistance as an increasing number of said valve operating devices are cut into circuit, and a governor for said turbine having operating connections with said switch.

4. In a steam turbine, a high pressure stage member having a series of nozzles, each provided with an admission valve, combined with a low pressure stage member comprising a series of vane wheels and a set of nozzles radially about the periphery of each wheel, a single valve for each low pressure wheel to control admission of steam to all the nozzles therefor, and a governor and means to simultaneously operate corresponding valves for both pressure stage members.

5. In a steam turbine, a high pressure stage member having a series of steam nozzles, each provided with an admission valve, combined with a low pressure member comprising a series of vane wheels each having a series of radially arranged nozzles open to a separate steam channel about its periphery, and each channel having a separate ad-

mission valve, and a governor and means connected therewith and with said respective valves adapted to regulate the steam supply to both pressure stage members in a corresponding degree.

6. In a steam turbine, a high pressure stage member having a series of steam nozzles and a valve for each nozzle combined with a low pressure stage member consisting of a plurality of vane wheels, each having a steam supply channel about its periphery and a series of nozzles in said channels radially about each vane wheel, and a governor and means operated thereby to successively operate the respective valves of the high pressure member and simultaneously actuate the corresponding valves for each low pressure vane wheel.

7. In a steam turbine, a high pressure stage member having a plurality of nozzles each provided with a steam admission valve, and electrical devices to operate said valves, in combination with a low pressure stage member having a series of vane wheels corresponding in number to the nozzles of said high pressure stage member and each vane wheel having a series of nozzles and each series of nozzles having a common admission valve and electrical operating device therefor, and a governor and electrical devices operatively connected therewith and electrically connected with said respective valve operating devices of both pressure stage members.

8. In a steam turbine, a series of vane wheels operating in a common chamber and each of said vane wheels having a series of nozzles, in combination with electrical devices and circuits adapted to cut off one nozzle on each vane-wheel successively and then repeat this operation on the remaining nozzles in commission.

9. In a steam turbine, a high pressure stage member having a vane wheel and a plurality of nozzles therefor each provided with a steam admission valve, in combination with a low pressure stage member having a vane-wheel provided with a series of nozzles and valves in number proportional to the nozzles and valves in said high pressure stage member, and electrical devices to operate valves jointly in both pressure stage members in proportion to their respective capacities.

In testimony whereof I affix my signature in presence of two witnesses.

DUSTON KEMBLE.

Witnesses:

R. B. MOSER,
E. M. FISHER.