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E. P. WAGNER.

ELASTIC FLUID TURBINE.

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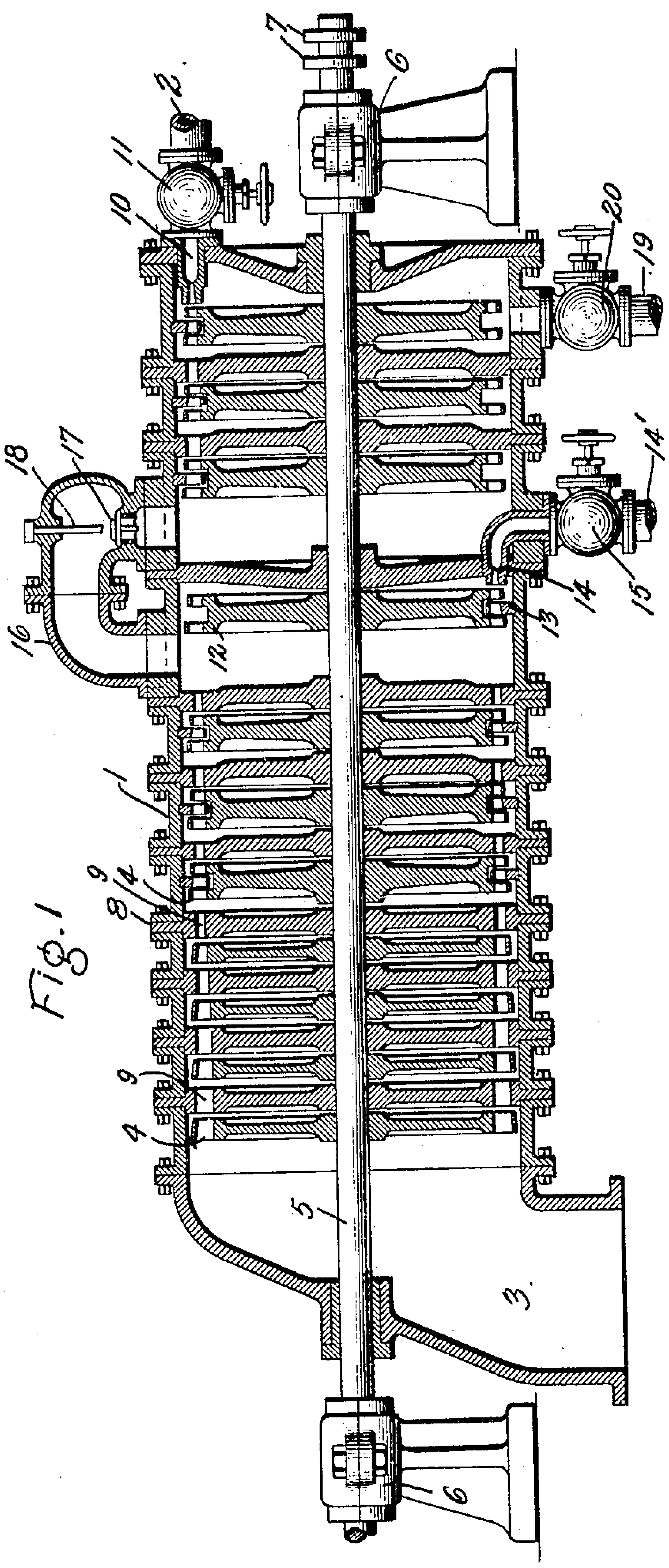

Fig. 1

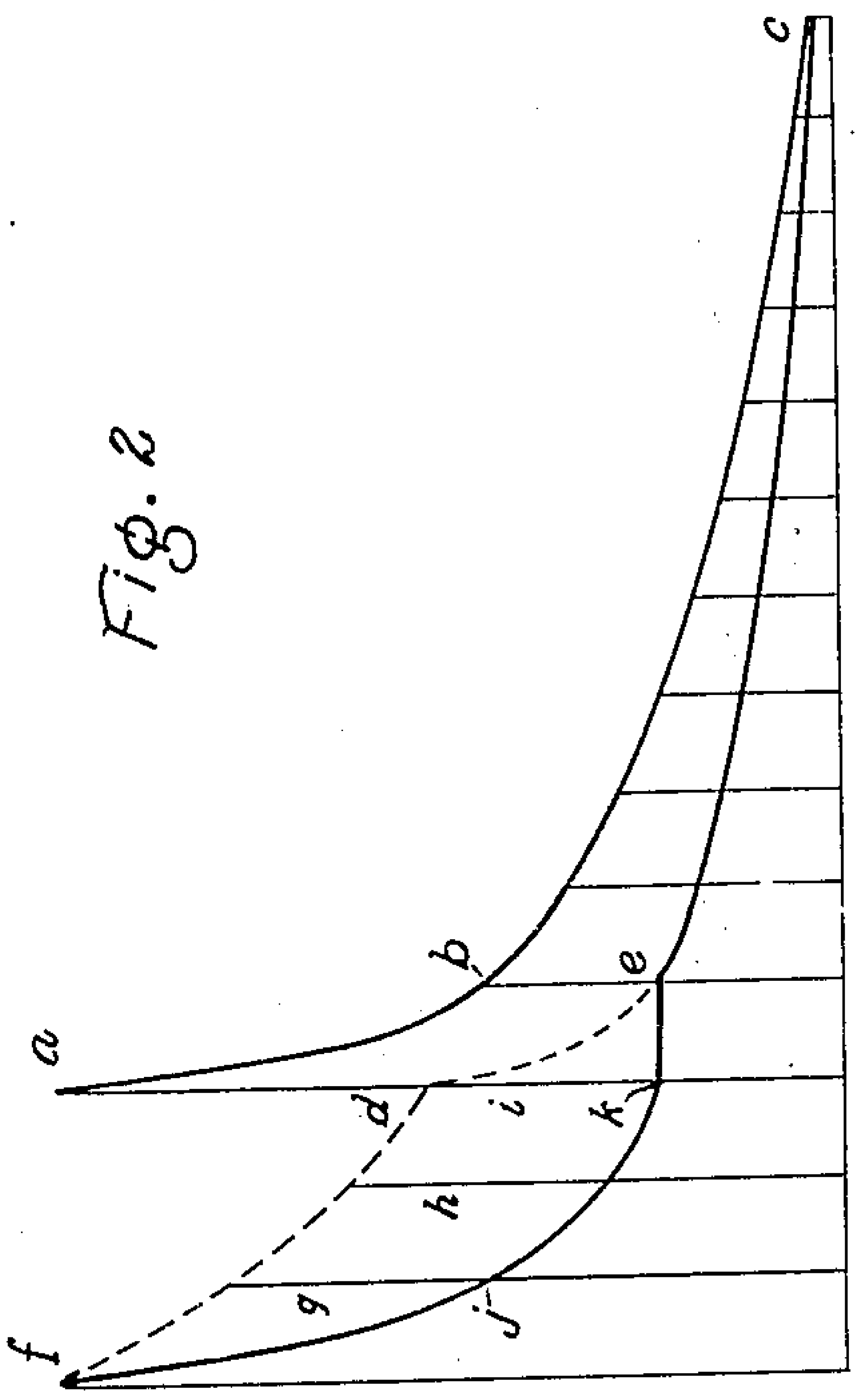

Fig. 2

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UNITED STATES PATENT OFFICE

ERNST PAUL WAGNER, OF CHARLOTTENBURG, GERMANY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELASTIC-FLUID TURBINE.

No. 887,361. Specification of Letters Patent. Patented May 12, 1908.

Application filed February 11, 1907. Serial No. 356,705.

To all whom it may concern:

Be it known that I, Ernst Paul Wagner, a citizen of the German Empire, residing at Charlottenburg, Germany, have invented certain new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification.

My invention has for its object to provide a turbine of improved construction which is capable of operating with high efficiency both at maximum and moderate loads, and this without subjecting the wheel casing or casings to excessive strains.

In the accompanying drawing, which illustrates one of the embodiments of my invention, Figure 1 is a longitudinal section of a turbine; and Fig. 2 is a curve showing the relation of the pressures in the different stages.

1 represents a casing having a suitable inlet 2 and an exhaust conduit 3. The buckets 4 are mounted on suitable wheels and the latter are carried by a shaft 5 mounted in bearings 6. On the shaft are thrust collars 7, the casing therefor being removed, to take the end thrust of the shaft, as for example where the machine is intended to drive a propeller for marine purposes. The wheels are provided with two rows of buckets in the high-pressure stages and single rows in the low-pressure stages. Between the stages and forming walls thereof are diaphragms or partitions 8 which support or contain the nozzles 9. The initial nozzle or nozzles 10 is or are constructed and arranged to have a greater ratio of expansion than the nozzles 9 between stages, thereby creating a greater pressure drop and avoiding the strains on the casing incident to high pressure. This is especially important where the initial pressure is high and the diameter of the wheel casing large. The admission of motive fluid, such as steam for example, to the initial nozzle or nozzles is controlled by one or more valves 11. As shown the valve is operated by hand but it may be operated by a suitable motor in response to load changes, as is well understood.

At some intermediate point in the turbine a stage of special construction is provided which for the purpose of distinguishing it from the others may be called the auxiliary overload stage. This stage comprises a wheel 12 that is mounted on the main shaft and is provided with one, two or more rows of buckets. In the present instance two rows are shown with intermediate buckets 13 between and acting to extract energy from the motive fluid by successive operations. High-pressure fluid is admitted to the stage by one or more nozzles 14 having a greater ratio of expansion than the stage nozzles 9 so as to create a greater pressure drop and thereby reduce the pressure in the wheel chamber and consequently the strains on the casing. This stage is normally in operation only under conditions of overload, as will appear later.

Steam or other elastic fluid is admitted to the nozzle or nozzles by the conduit 14 containing a throttle valve 15 that in the present illustration of the invention is actuated by hand, but which may be operated automatically in response to a governor in a manner well understood.

Located on the outside of the casing or at some other convenient point is a conduit 16 which normally shunts the motive fluid past the overload stage and thereby renders it inactive. In this conduit is an automatic valve 17 which opens when fluid under pressure is admitted to the machine by the valve 11 and closes automatically when the valve 15 is opened and the valve 11 closed. A suitable stop 18, which may be adjustable, is arranged to limit the opening of the valve. The conduit 16 is shown as being bolted to the outside of the casing, since this is a convenient arrangement, but it may be formed in the casing itself if desired. Only one of these conduits is shown in the illustration, but it is to be understood that two, three or more may be provided if desired to handle the volume of fluid.

Under conditions of from moderate up to full load, for example, the motive fluid enters the turbine through the valve 11 and nozzles 10 where it expands to a relatively low pressure and the energy is converted into velocity and the wheel and intermediate buckets convert the velocity into useful work. The fluid is then renozzled, and the operation repeated. It then passes through the conduit 16 into the stage compartment containing the overload wheel. It does no work in this compartment but passes through the adjacent nozzles into the next stage of lower pressure where the conversion of energy into useful work is continued. Instead of passing through three stages before entering the compartment of the overload wheel, it may pass through only one or two. Where the load conditions are satisfied by such an arrangement, a conduit 19 is provided which shunts the motive fluid past two rows of wheel buckets and discharges it either into the compartment of the overload wheel or to a compartment beyond if desired. This conduit is provided with a regulating valve 20 of suitable construction. Assuming now a load condition greater than the normal and approaching the maximum overload, the valve 11 is closed and the valve 17 drops to its seat and the valve 15 is opened. The entering fluid is expanded by the nozzle 14 to a point where the pressure within the compartment will not be injurious to the casing. The velocity of the fluid leaving the nozzle or nozzles is converted into useful work by the wheel 12 by successive operations. After the fluid leaves the wheel it is renozzled and the operation repeated until the available energy is extracted, after which it leaves the turbine by the conduit 3.

The turbine shown is so designed that it operates most efficiently under conditions of maximum steam consumption. In Fig. 2 are shown curves representing the pressures in the different stages under different load conditions. *a* represents the pressure of the source of supply and *b* the pressure in the auxiliary or overload stage. From this point the pressure drops from stage to stage by small amounts until it reaches *c* which corresponds with the exhaust.

If the machine, including the auxiliary or overload and the subsequent stages, was regulated by throttling, the pressure curve at light loads would be represented by *d*, *e*, *c*, the thermo-dynamic efficiency falling rapidly as the supply of motive fluid was decreased. In order to improve the economy of a turbine operating under these conditions, it has been proposed to interpolate a turbine between the main turbine and the source of supply, in which case the pressure drop *a d* is utilized therein. The pressure conditions in the system are then as represented by *f d e c*, in which case the pressures in the stages of the interpolated machine are represented by the lengths of the lines *g h i* and are greatly in excess of pressure *b* which is considered a safe working pressure for a machine of given diameter. It is therefore apparent that with such arrangement the interpolated machine must either have a much smaller diameter, or else it can be used only with very much smaller loads where the pressure is materially less. With all except the overload stage in service, the pressure curve will be represented by *f j k e c*. It will be noted that the pressure at *j*, initial stage, is the same as that at *b*, auxiliary stage, whereas with the previous arrangements it would have to be much higher, as represented by the points of intersection of the lines *g h i* and the dotted line. This arrangement also has the advantage of better utilizing the drop in pressure between *d* and *e*. It will thus be seen that my invention overcomes the objections above noted and the wheels and casing can have diameters best suited for the work; the early stages can be utilized even with comparatively heavy loads without causing undue strains, and the machine as a whole will have a high efficiency.

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. A turbine comprising a plurality of stages, one of which is inactive for certain load conditions, and means for cutting one or more stages out of operation and for cutting said inactive stage into service for other load conditions.

2. A turbine comprising a plurality of stages arranged to handle certain predetermined loads, an auxiliary stage which is inactive for said loads, and means for cutting one or more of the first-mentioned stages out of and the auxiliary stage into service for other loads.

3. A turbine comprising a plurality of stages including an initial and an overload stage, fluid-discharging devices for the stages, those of the initial and overload stages having a greater ratio of expansion than those of the remaining stages, and means for controlling the admission of fluid to the initial and overload stages.

4. A turbine comprising a plurality of stages, including an initial and one which is operative only under heavy load conditions, fluid-discharging devices for the stages, those of the initial and heavy load stages having a greater ratio of expansion than those of the other stages to prevent excessive casing strains, and means for cutting one or more stages out of operation and the heavy load stage into operation.

5. A turbine comprising a plurality of stages, one of the intermediate of which is operative only under conditions of overload, fluid-discharging devices for the several stages, those of the initial and overload stages having a greater ratio of expansion than those of the other stages, and means for cutting the initial stage and overload stages into and out of communication with a source of supply.

6. A turbine comprising a plurality of stages some of which are only in operation

for certain loads, while the remainder are always in operation, an auxiliary stage which is in operation only at certain loads, a conduit for shunting the auxiliary stage at certain loads, and means for cutting out the initial stage, closing the shunt conduit, and admitting fluid to the auxiliary stage for other load conditions.

7. A turbine comprising a plurality of stages arranged in series to receive motive fluid for certain load conditions, an auxiliary stage that is operative under different load conditions and discharges into the low-pressure stages, a conduit for shunting the auxiliary stage while the remaining stages are in operation, a valve in the conduit for interrupting the passage of fluid, means for cutting the high-pressure stages out of service, and means for admitting high-pressure motive fluid to the auxiliary and the succeeding stages.

8. An elastic-fluid turbine comprising a plurality of low-pressure stages, two or more high-pressure stages, independent conduits admitting motive fluid to the turbine in such manner as to cause it to act in different high-pressure stages, valve means for controlling the passage of fluid through the conduits, an auxiliary stage which is normally inactive, and means for closing the high-pressure stages against the admission of fluid when the auxiliary stage is inserted.

9. An elastic-fluid turbine comprising a plurality of stages each containing buckets and devices discharging motive fluid against the buckets, independent conduits for admitting motive fluid to the initial stage and also to subsequent and lower-pressure stages, and a valve which automatically closes when fluid is admitted to one of the lower-pressure stages to prevent it from filling the preceding portion of the turbine.

In witness whereof, I have hereunto set my hand this 9th day of January, 1907.

E. PAUL WAGNER.

Witnesses:

Walther Fritz,

Alfred Bettmann.