No. 840,039. PATENTED JAN. 1, 1907.

F. BURGER.

COMPOUND STEAM TURBINE.

APPLICATION FILED JAN. 20, 1903.

2 SHEETS—SHEET 1.

Fig. 2.

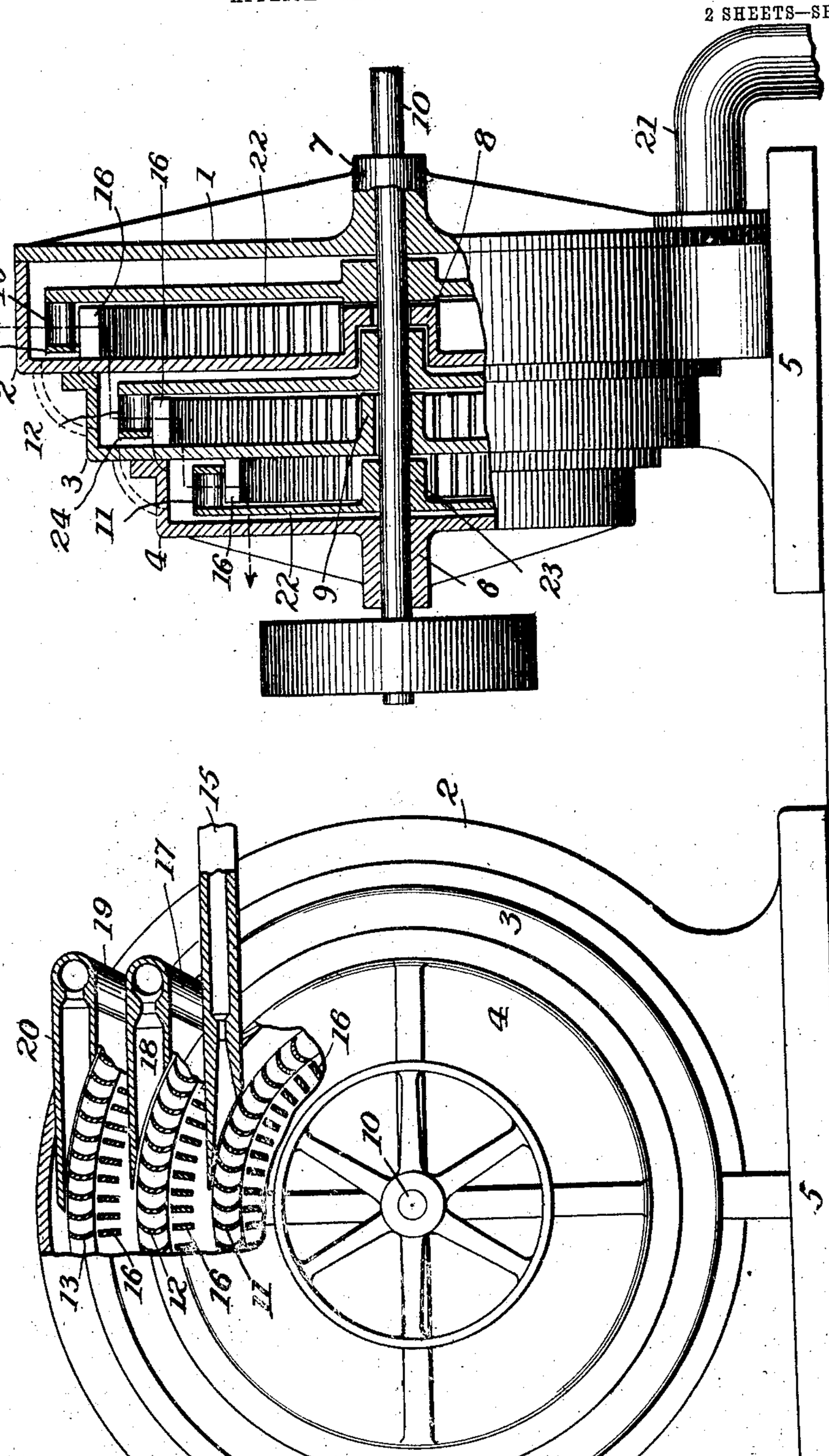

Fig. 1.

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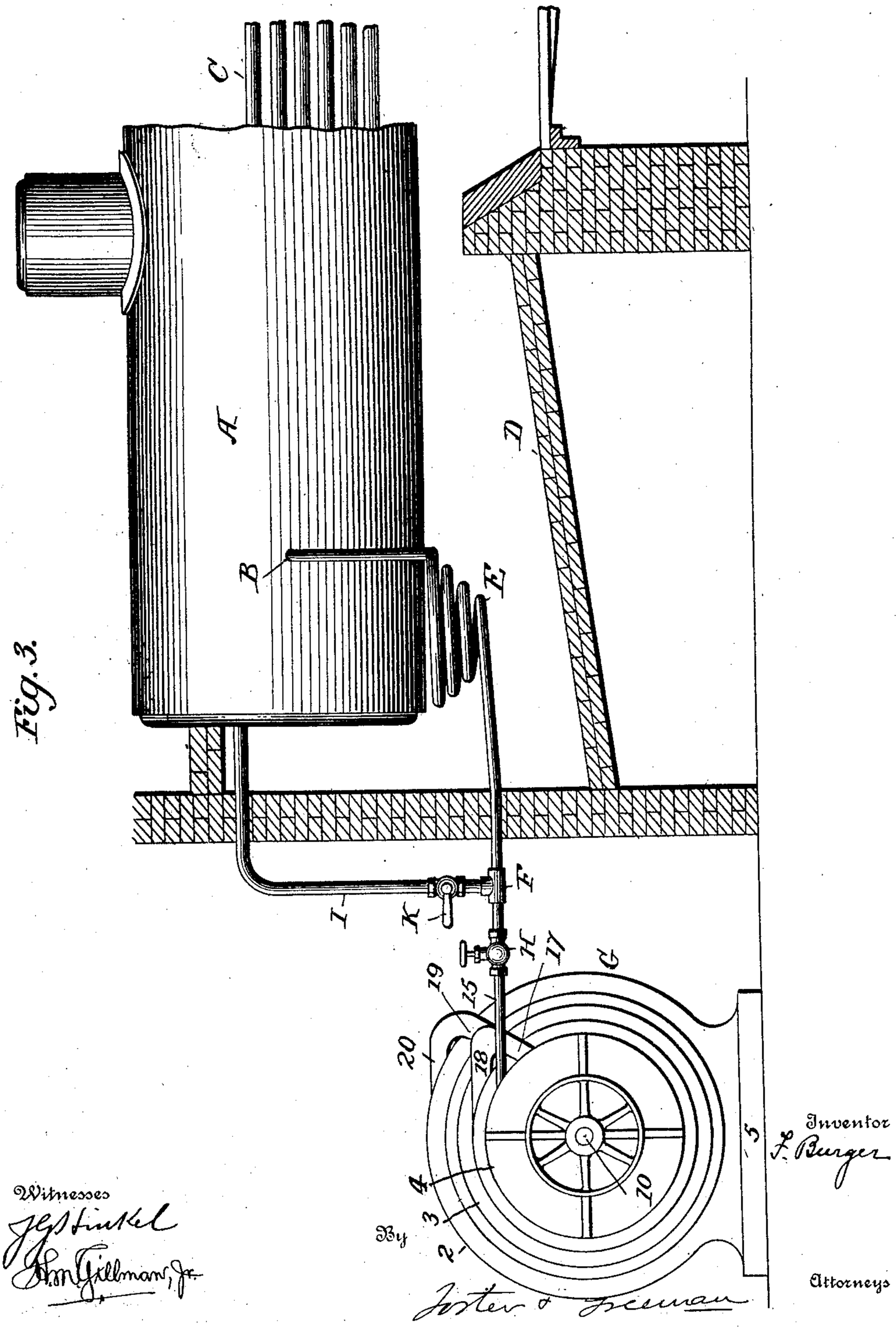
Fig. 3.



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UNITED STATES PATENT OFFICE.

FRANZ BURGER, OF FORT WAYNE, INDIANA, ASSIGNOR OF THREE-FOURTHS TO HENRY M. WILLIAMS, OF FORT WAYNE, INDIANA.

COMPOUND STEAM-TURBINE.

No. 840,039. Specification of Letters Patent. Patented Jan. 1, 1907.

Application filed January 20, 1903. Serial No. 139,780.

To all whom it may concern:

Be it known that I, FRANZ BURGER, a citizen of the United States, residing at Fort Wayne, in the county of Allen and State of Indiana, have invented certain new and useful Improvements in Compound Steam-Turbines, of which the following is a specification.

My invention relates to improvements in turbines in which the motive fluid is projected against the periphery of revolving wheels provided with buckets and arranged in separate compartments, so that the motive fluid will operate upon the compound principle; and it consists in the various features of construction and arrangement of parts, having the general mode of operation substantially as hereinafter more particularly set forth.

Referring to the accompanying drawings, wherein is illustrated a preferred embodiment of my invention, Figure 1 is a side view, partly in section, of the turbine. Fig. 2 is an end view, also partly in section; and Fig. 3 is a side view, partly in section, of an improvement for supplying superheated water to the turbine.

While the broad features of my invention may be carried out in different details of construction and arrangement of parts which can be varied by those skilled in the art, I have shown in the accompanying drawings a typical turbine which embodies the essential features of the invention and have also illustrated one means, broadly considered, of supplying the superheated water to be applied to the turbine in the manner hereinafter set forth.

The turbine comprises a base 5, upon which is mounted a circular casing 2, which is provided with a hub 8, and connected to this casing in any suitable way is a cover or head 1, also provided with a hub 7, and this casing provides a steam-pipe compartment provided with a suitable outlet or exhaust port, as 21. Also mounted on the base and connected to the casing 2 is another similar casing 3 of smaller diameter than the first casing and also provided with a hub 9, and this casing forms a second steam-pipe compartment, which is provided with a suitable inlet and outlet, hereinafter described. Also connected to this second casing is another similar casing 4, provided with a hub 6 and of a smaller size than the other casings, and this forms a smaller steam-pipe compartment provided with suitable inlets and outlets, hereinafter described, and all these casings are secured together to form a combined compound casing providing three separate and independent compartments, each having suitable inlet and outlet connections, and the hubs of the separate casings combine to form a support for the shaft 10.

I have thus described and illustrated a compound turbine providing three separate compartments of different sizes; but is it understood that the number of compartments may be varied, and the particular construction and arrangement of casings will also vary according to the particular circumstances of any special embodiment of my invention.

Mounted on and secured to the shaft 10 are a series of bucket-wheels, and while these wheels may be variously constructed I have shown each of them as comprising a disk 22, projecting from a central hub 23 on the shaft 10, and each is provided with a series of buckets 11, 12, and 13, arranged at or near the periphery of the disk and provided with a rim 24 at their ends opposite the disk, so as to close the buckets on their sides, while they are open on their outer and inner peripheries. In this instance these buckets are shown in the form of curved plates extending between the disks and rims of the bucket-wheels, the edges of the curved plates being practically in radial lines projecting from the hubs of the wheels. There is also provided in each compartment in connection with each bucket-wheel a series of vanes 16, and these are shown as formed on or attached to the various portions of the casings, so that a number of these vanes extend within the inner periphery of each bucket-wheel, and they are arranged adjacent the buckets where the motive fluid is to be delivered to the buckets, and these vanes may vary in number, but preferably do not extend entirely around the bucket-wheels, but only adjacent the buckets in the immediate vicinity of the nozzles.

Arranged in proper relation to each bucket-wheel is a nozzle, and while the specific construction of these nozzles may vary and, in fact, do differ from each other, in the construction illustrated I so arrange them that their delivery end or mouth is cut away to

conform substantially to the curvature of the bucket-wheel to which it is applied and so that the mouth will cover a plurality of buckets, four or more being shown in the drawings, and also so arranged as to deliver the motive fluid to the periphery of the wheels in contradistinction to the usual arrangement of delivering to the sides of the wheels. Thus in the drawings, 15 is a nozzle arranged to deliver the motive fluid tangentially to the buckets 11 and to receive its supply of motive fluid from any proper source outside of the turbine, one being hereinafter described. The nozzle 18 is similarly arranged to deliver its motive fluid to the buckets 12, and it is shown arranged to receive its supply from the smallest compartment 4 through the medium of a pipe 17. The nozzle 20 likewise is arranged to deliver motive fluid to the buckets 13 and to receive its supply from the intermediate compartment through the pipe or connection 19. It will thus be seen that the motive fluid is first supplied to the buckets of the smaller bucket-wheel, which is inclosed in its own separate and independent compartment, and then the fluid is taken from this compartment and delivered to the second bucket-wheel, which is similarly inclosed, and so on from this to the last bucket-wheel, also separately inclosed, from which after the motive fluid has practically expended its energy it is exhausted to the air or a suitable condenser, and in this way the compound effect of the motive fluid is produced in driving the shaft and producing power and practically all the energy of the fluid expended in useful work.

The motive fluid to be supplied to the compound turbine is in the form of superheated water, and this is supplied to the nozzle 15, and the superheated water impinges upon the buckets adjacent the open mouth of the nozzle, and I therefore make use not alone of the velocity of the motive fluid, but also of the pressure of the same. By covering a series of buckets by the open or delivery end of the nozzle and extending it in the manner shown leakage between the wheel and nozzle is reduced to a minimum, but the fluid after impinging on the buckets reacts upon the vanes 16 and then flows into the inclosed compartment containing the wheel, and this impingement on the vanes also tends to rotate the wheel, giving more power. After the superheated water has been delivered to the first bucket-wheel and after it expands into steam and fills the smaller compartment it is under a considerable pressure and passes through the compartment through the pipe 17 and nozzle 18 to the next larger bucket-wheel, where it impinges upon the bucket 12, again acting in the same way as before and expanding into the compartment containing the wheel, and from this it is again led, as through the pipe 19 and nozzle 20, to the next and in this instance the last bucket-wheel, impinging upon the buckets 13 and expending its energy therein, after which it has been expanded so as to be in a condition to be economically exhausted to the atmosphere or condensed. It will be noted that the nozzles 18 and 20 increase in size relatively to the first nozzle, and the size varies in accordance with the expansion of the motive fluid in the compartment from which it is received.

As above intimated, I supply the first wheel with superheated water instead of steam, and this water will flash into steam the instant it leaves the buckets of the wheel or when the buckets pass the nozzle. The water will thus expend its energy or velocity against the buckets and will expand into steam in the first compartment on account of the reduced pressure on the water in the compartment, but there will still be steam under a relatively high pressure in this compartment, which, as above intimated, will be transferred to the next compartment, where the steam expends its velocity on the buckets and still further expands in this compartment, and so on until it has reached the last bucket-wheel and compartment, when it will have expended substantially all of its energy.

The advantages of using superheated water in preference to steam in connection with the first or smallest bucket-wheel are very substantial. It is well known that water in its liquid state cannot exist at a temperature above 212° Fahrenheit at atmospheric pressure. If the pressure is increased, the evaporation of the water or the formation of steam decreases. The increased pressure means increased temperature of the water. Water in a steam-boiler at two hundred pounds pressure has a temperature of 381° Fahrenheit. Steam at a pressure of one hundred pounds has a temperature of 327° Fahrenheit, and thus there is a drop of 54° in temperature with a fifty per-cent. reduction in pressure. In view of this as soon as the superheated water leaves the nozzle and the buckets it must be converted into steam on account of the reduced pressure, but not reduced temperature. Thus the pressure in the first compartment is about fifty per cent. that of the boiler-pressure, and under this pressure the steam formed in this compartment is transferred through a suitable pipe and nozzle to the next bucket-wheel, and after leaving this wheel it will further expand in the compartment surrounding the wheel and be at a relatively lower pressure—in the instance suggested about fifty pounds pressure. From this compartment the steam passes to the third nozzle and again expands after impinging upon the buckets of the third wheel until the pressure is reduced to a rela-

tively small amount, when it can be exhausted or condensed.

Among some of the advantages obtained by the use of superheated water instead of steam may be mentioned the following: It requires a considerably smaller conducting-pipe to carry the proper amount of fluid to produce a given amount of power, and the cooling effect is proportionately reduced. Again, water being a liquid can carry more calorics than the gaseous steam. Therefore it is less affected by cooling effects from the outside. Further, the impact of the water against the buckets on the wheel is proportionately greater under the same degree of pressure as the difference of density is between the water and steam. No more water is used in this manner of use than if the water were converted into steam in the boiler or source of supply and then delivered to the turbine, and the same number of calorics would have to be utilized in both cases to produce the superheated water and steam.

While various means may be used to supply the superheated water to the turbine, in Fig. 3 I have illustrated one convenient means comprising a boiler A, having a pipe B connected to the boiler below the water-level, (indicated at C,) and this pipe is shown as extending into the flue D under the boiler and being formed into a coil E, by means of which the hot gases from the fire under the boiler tend to superheat the water in the coil. From this coil the pipe extends to the nozzle 15, and there is conveniently provided a cut-off valve H in the pipe. If perchance this valve were closed, so that water could not circulate in the coil and pipe, steam would soon be formed in the coil, forcing the remaining water in the coil back into the boiler, which would be objectionable, and to obviate this I have placed in the pipe between the coil and the cut-off valve H a connection F, provided with a pipe I, leading to the boiler A below the water-level thereof and provided with a suitable valve K, and by proper manipulation of the latter when the valve H is closed a by-pass is provided for the circulation of the water through the superheating-coil E. Any other means of providing superheated water can be utilized.

Having thus described the preferred embodiment of my compound turbine and one means of providing superheated water to be supplied thereto and having explained the purpose of my invention, so as to enable those skilled in the art to understand the same, what I claim is—

1. In a compound turbine, the combination with the separate steam-tight compartments, of a series of bucket-wheels mounted in said compartments provided with buckets closed at each side and open at their outer and inner peripheries and a series of vanes mounted on the casings and projecting into the compartments within the inner peripheries of the buckets, and a series of nozzles of varying sizes arranged to deliver the motive fluid in succession to the various wheels.

2. The combination, with a compound turbine having a series of compartments of different sizes each containing a bucket-wheel, nozzles arranged to deliver the motive fluid to the periphery of each bucket-wheel, and means for supplying superheated water to the first nozzle, such means including a superheated coil, substantially as described.

3. The combination, with a compound turbine having a series of compartments of different sizes each containing a bucket-wheel, nozzles arranged to deliver the motive fluid to the periphery of each bucket-wheel, means for supplying superheated water to the first nozzle, such means comprising a boiler, a water-supply pipe attached to the boiler below the water-level, a superheating-coil in said pipe, and a by-pass between the superheating-coil and the nozzle connected to the boiler below the water-line; substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

FRANZ BURGER.

Witnesses:
GEO. K. TORRENCE,
B. D. ANGELL.