No. 708,815. Patented Sept. 9, 1902.

A. KRANK.

STEAM TURBINE.

(Application filed Nov. 19, 1901.)

(No Model.)

2 Sheets—Sheet 1.

FIG: 1.

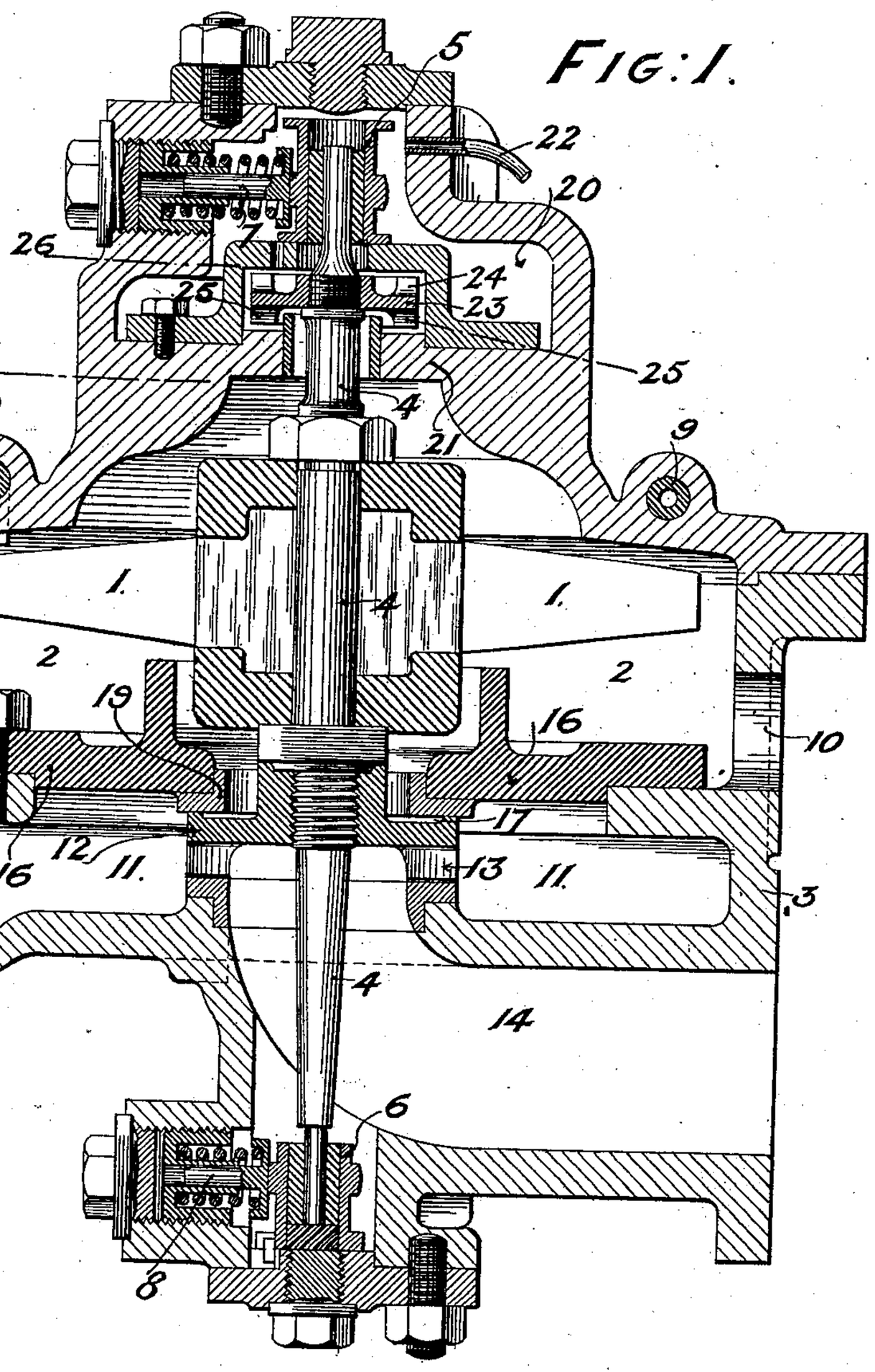

FIG: 4.

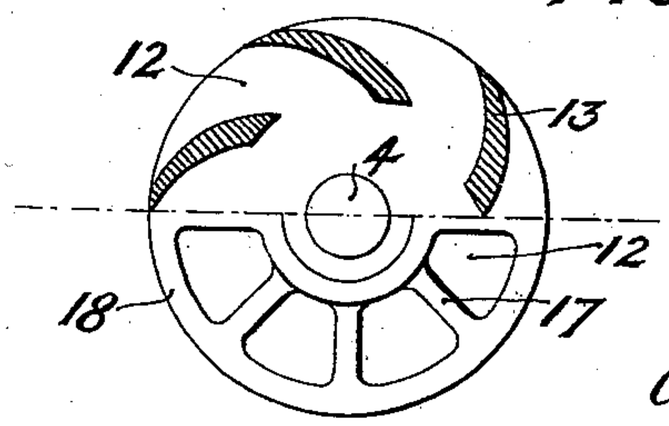

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FIG. 3.

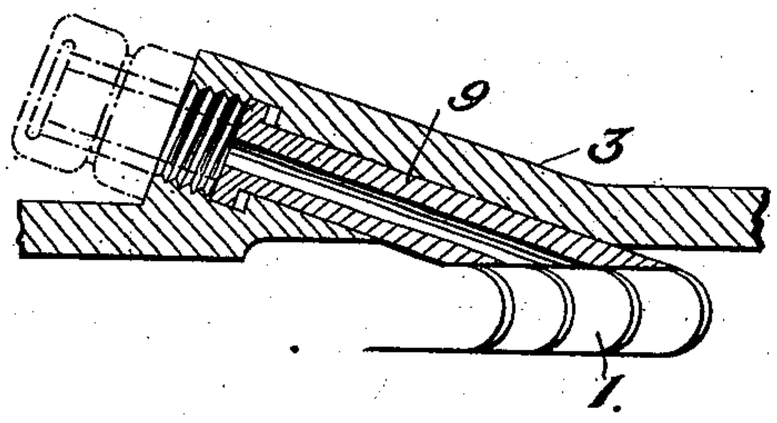
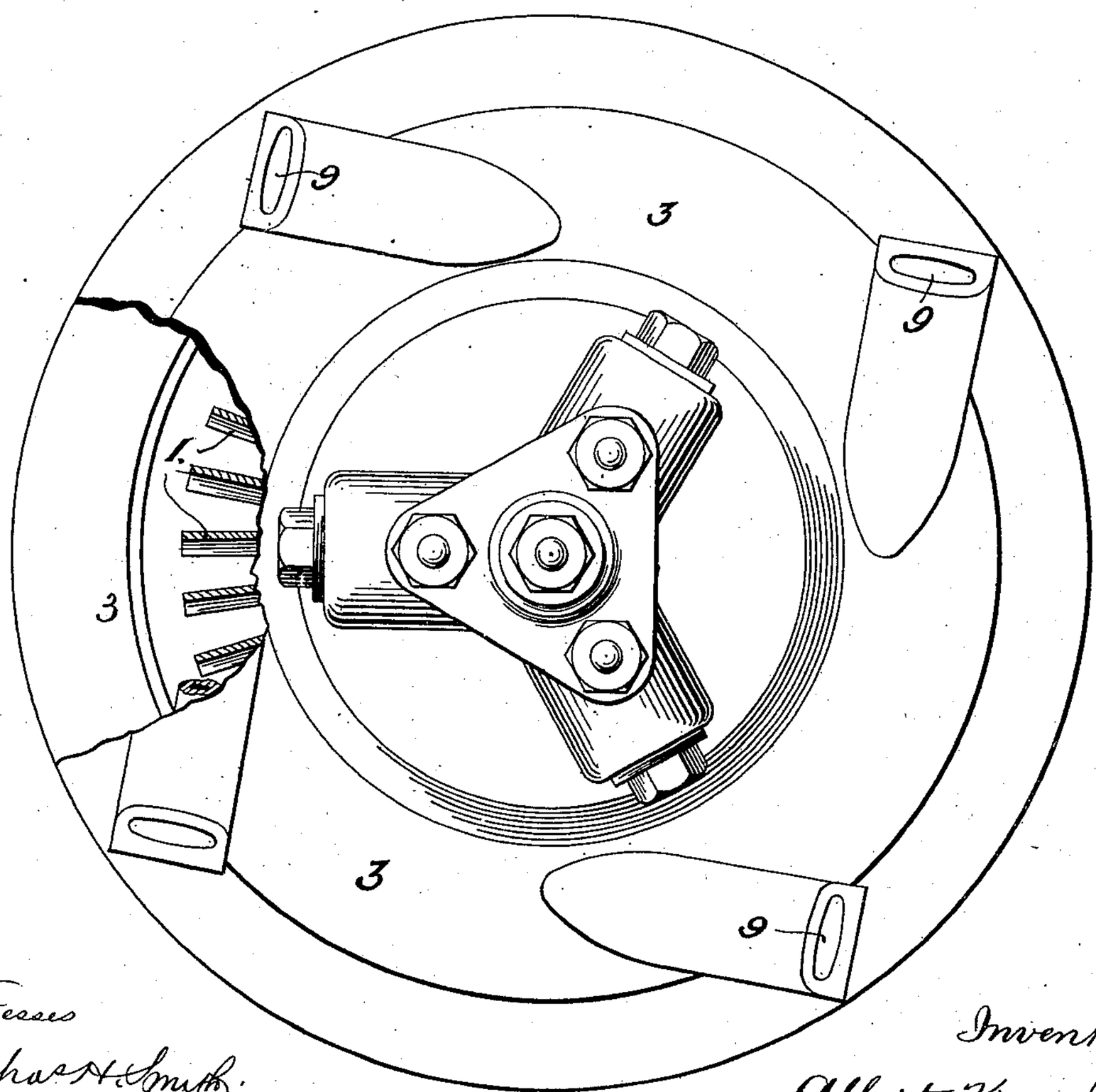


FIG. 2.



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UNITED STATES PATENT OFFICE.

ALBERT KRANK, OF WARKAUS JOROIS, RUSSIA.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 708,815, dated September 9, 1902.

Application filed November 19, 1901. Serial No. 82,837. (No model.)

To all whom it may concern:

Be it known that I, ALBERT KRANK, a subject of the Grand Hesse of Finland, and a resident of Warkaus Jorois, Finland, Russia, have invented certain new and useful Improvements in Steam-Turbines, (for which I have made application for patent in Great Britain, dated the 24th of April, 1901, No. 8,440; in Belgium, dated May 3, 1901, No. 156,331; in Germany, dated May 7, 1901, Serial No. K 21,269; in France, dated October 15, 1901, Serial No. 303,680; in Austria, dated October 15, 1901, and in Denmark, dated October 19, 1901, Serial No. 1,190^{01},) of which the following is a specification.

In steam-turbines composed of a wheel having radiating vanes to which rotary motion is communicated by the motion and energy of jets of expanding steam the speed of rotation produced is necessarily very high in order to most fully take up the energy of the steam-jets. Now when the steam-turbine is to be utilized for what I may term "secondary purposes," such as driving machinery, it is in nearly all cases necessary to reduce the high speed given out by the turbine to such a speed or speeds as will be suitable for the purposes for which its power is to be employed, and such reduction of speed has hitherto been effected by mechanical means and has presented considerable difficulties.

Now the primary object of my present invention is to provide means for converting the energy of the turbine wheel produced by the expanding steam directly into fluid-pressure, and to thereby obtain a convenient and easily-transferable means for driving secondary machinery. Therefore according to my present invention I provide means whereby the high-speed motion produced by the steam-jet is utilized in a direct manner as well as simply and economically to bring under pressure a fluid heavier than steam, which pressure fluid may then be conveyed and employed for direct use or for driving secondary machinery. To this end I mount the steam turbine wheel upon a rigid shaft carried in elastic bearings, the said wheel being located in a chamber, and I connect directly to the same shaft a rotary pump which is located in another and separate chamber, so that the high-speed rotary motion of the steam-turbine shaft directly acts to pump fluid into the rotary pump-chamber and to produce a fluid-pressure therein, which fluid-pressure can be either directly used therefrom—say, for instance, for a fire-engine—or can be conveyed to directly operate a secondary machine, which latter can be driven with any desired reduced speed, without the necessity of employing intermediate and mechanical transference devices. I also provide means by which I prevent the pressure fluid escaping from the fluid-pressure chamber to the steam-chamber and by which the steam is prevented from escaping from its chamber, except in both cases, by passages which are especially intended and constructed for the exit and entrance of these elements.

I will describe my invention with reference to the example of construction shown in the accompanying drawings, wherein—

Figure 1 is a vertical section of a steam-turbine with my mechanism or apparatus connected therewith for directly converting the energy thereof into fluid-pressure. Fig. 2 is a plan of the apparatus, a portion of the cover being broken away to show the vanes of the turbine wheel. Fig. 3 is a vertical section taken through one of the nozzles by which the steam-jet is introduced to the steam turbine wheel; and Fig. 4 shows, half in plan and half in horizontal section, a centrifugal pump-disk which is constructed with devices for preventing the fluid from passing from one compartment to another of the casing.

Referring to the drawings, the steam turbine wheel 1 rotates in an exhaust-chamber 2, formed in a casing 3, and is fixed to a vertical and rigid shaft 4. The shaft 4 is carried by bearings 5 6 at its upper and lower ends, which bearings are constructed to allow for sufficient freedom of motion to enable the shaft 4 and the parts thereon to automatically assume their natural axis of rotation. These bearings 5 6 are arranged to be movable within recesses in the interior of the casing in directions parallel with the axis of the shaft and are maintained in their normal positions by spring-actuated pressure-plungers 7 8, acting upon the bearing-boxes in directions at right angles to the shaft, their being, for instance, three radially-arranged

pressure-plungers to maintain such bearing-box. Steam at pressure is supplied to the turbine wheel by nozzles 9, Figs. 1 and 3, by which the steam passes into the casing in the form of jets which impinge at the proper angles upon the vanes of the steam-turbine wheel 1, the exhaust-steam finding its exit through an opening 10 into the open air or into a condenser. Below the chamber 2 there is formed in the casing a second chamber 11, through which the shaft 4 passes, and upon the shaft 4, within the chamber 11, I fix a centrifugal pump-disk 12, which latter is formed upon its lower side (see also Fig. 4) with curved or inclined vanes 13. The fluid is led by a tubular passage 14 into the lower part of the pressure-chamber 11, being conveyed by the vanes 13 of the centrifugal pump-disk 12 into the said chamber 11, wherein the fluid in consequence of the high speed of rotation of the disk 12 is brought into a state of compression. From the pressure-chamber 11, which is fitted with a suitable safety-valve, (not shown in the drawings,) the pressure fluid passes through an exit-passage 15 and is conveyed and applied to whatever use it is to be put to, such as to driving a secondary machine—for instance, a water-wheel—or the apparatus may be employed as a fire-engine, for which purpose it is especially adapted in that the fluid can be used directly from the pressure-chamber 11, wherein a very considerable pressure can be produced and maintained. As before stated, the shaft 4 extends through both chambers 2 and 11, passing in its passage through a partition or movable cover 16, which divides the chamber 2 from the chamber 11. Owing, however, to the fact that the shaft is so carried that it is or may be subject to lateral vibrations or self-adjustment, it cannot in practice pass through a gland in the partition between the chambers. Consequently it is necessary to provide means by which any passage of fluid or steam from one chamber to the other can be efficiently prevented. To this end I construct the centrifugal pump-disk 12 upon its upper side or upon that side adjacent and in contact with the partition 16 with radial ribs 17 (see Figs. 1 and 4) and an annular contact-rib 18, which ribs bear against the under side of the partition 16 or equivalently against the under side of a bearing-ring 19, carried by the said partition. The effect of this construction is that fluid entering between the upper surfaces of the disk 12 and the partition either from the fluid-pressure chamber 11 or from the steam-chamber 2 will be carried outward toward the fluid-pressure chamber by centrifugal force, the radial ribs 17 on the disk 12 producing a greater pressure above the disk 12 than is produced by the curved vanes 13 underneath the disk 12.

In the apparatus shown at Fig. 1 the lower elastically-supported bearing-box 6 is so arranged within the casing 3 that it is surrounded for lubrication purposes by fluid, and of course the bearing-bush is on this account constructed of a material which admits of being lubricated by water—for instance, lignum-vitæ. In order that the upper bearing 5 may also be lubricated by water, the said bearing-box 5 is contained within a chamber 20, which is divided by a partition 21 from the chamber 2, and the chamber 20 is connected by a tube 22 with the fluid-pressure chamber 11, and so supplied with fluid for lubricating purposes. It now becomes necessary to provide means to prevent the contents of the chamber 20 passing into the chamber 2, or vice versa, by way of the aperture in the partition 21 through which the shaft 4 passes, and to this end I provide and fix upon the shaft 4 and above the said partition 21 a disk 23, provided upon its upper and lower faces with radial vanes 24 25, the vanes 25 upon the lower side of the disk and next to the partition 21 being of greater radial length than those vanes 24 which are on the upper side of the disk 23. This vane-carrying disk 23 is inclosed by a cover 26 in the chamber 20, the cover 26 being so formed that the fluid from the chamber 20 may have free access to the disk 23, and by reason of the lower vanes 25 of the disk 23 having a greater centrifugal force than have the vanes 24 the greater pressure thus produced from below effectually prevents the flow of fluid from the bearing-chamber 20 into the steam-chamber 2.

The apparatus constructed according to my invention and as I have described in the foregoing specification presents considerable advantages not only in its operation, but in the simplicity of its construction. For instance, the rigid shaft by being mounted in elastically-held bearings is rendered capable of assuming its natural center of rotation. The shaft only has to carry the turbine wheel and the centrifugal pump, which latter is also made to fill the office of preventing intercommunication between the condensed-steam chamber and the fluid-pressure chamber, while the construction provides that the fluid-pressure chamber and the condensed-steam chamber are so adjacent, being simply separated by a partition, whereby the condensation of the expanded steam is facilitated and a more useful and economical effect of the turbine is produced, while also the construction is such that the fluid lubrication of the shaft-bearings can be conveniently effected.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In steam-jet turbines, the combination with an inclosing casing, a rotary shaft passing through the interior of the casing, bearing-boxes located at each end of the casing to receive the ends of the shaft, means for supporting and permitting the bearing-boxes to have motions in directions parallel with the axis of the shaft, spring-actuated devices for normally maintaining the bearing-boxes coincident with the axis of the casing, a steam-

jet turbine-wheel fixed on the said shaft, a chamber in the casing within which chamber the wheel is located, jet-nozzles entering the turbine wheel chamber to deliver the steam-jets to the vanes of the wheel, and a steam-exhaust aperture to the said wheel-chamber; of a second chamber within the casing through which also the turbine-shaft passes, a dividing-wall between the chambers, devices for preventing intercommunication of the contents of the chambers by leakage around the shaft and for permitting the elastically-held rigid shaft to have automatic lateral adjustment so that it may assume its natural axis of rotation, a centrifugal pump-disk fixed on the shaft within the second chamber, a fluid-supply passage to the centrifugal pump-disk by which fluid is pumped into the second chamber and maintained at pressure therein, and an exit-pipe from the second chamber by which the pressure fluid is conveyed for either direct utilization or for driving secondary machinery, substantially as set forth.

2. In steam-jet turbines, the combination with an inclosing casing, a rotary rigid shaft passing through the interior of the casing, bearing-boxes located at each end of the casing to receive the ends of the shaft, means for supporting the bearing-boxes and permitting them to have motions in directions parallel with the axis of the shaft, radially-arranged plungers to act laterally against the laterally-movable bearing-boxes, sleeve-ferrules in the casing to carry and guide the plungers, helical springs around the plungers to force the same against the bearing-boxes to normally maintain the latter in a resilient manner coincident with the axis of the casing, a steam-jet turbine wheel fixed on the shaft, a chamber in the casing within which chamber the wheel is located, jet-nozzles entering the turbine-wheel chamber to deliver the steam-jet to the vanes of the wheel and a steam-exhaust aperture to the said wheel-chamber; of a second chamber within the casing through which also the turbine-shaft passes, a dividing-wall between the chambers, devices for preventing intercommunication of the contents of the chambers by leakage around the shaft and for permitting the elastically-held rigid shaft to be capable of automatic lateral adjustment for assuming its natural axis of rotation, a centrifugal pump-disk fixed on the shaft within the second chamber, a fluid-supply passage to the centrifugal pump-disk by which fluid is pumped into the second chamber and maintained at pressure therein, and an exit-pipe from the second chamber by which the pressure fluid is conveyed for either direct utilization or for driving secondary machinery, substantially as set forth.

3. In steam-jet turbines, the combination with an inclosing casing, a rotary shaft passing through the interior of the casing, bearing-boxes located and supported within the casing to receive the ends of the shaft, fluid-supply passages to the portions of the casing carrying the bearing-boxes for effecting the liquid lubrication of the bearings, means for holding the bearing-boxes and permitting them to have motions in directions parallel with the axis of the shaft, spring-actuated devices for normally maintaining the bearing-boxes coincident with the axis of the casing, a steam-jet turbine wheel fixed on the said shaft, a chamber in the casing within which chamber the wheel is located, jet-nozzles entering the turbine-wheel chamber to deliver the steam-jet to the vanes of the wheel, and a steam-exhaust aperture to the said wheel-chamber; of a second chamber within the casing through which also the turbine-shaft passes, a dividing-wall between the chambers, devices for preventing intercommunication of the contents of the chambers by leakage around the shaft and for permitting the elastically-held rigid shaft being capable of automatic lateral adjustment for assuming its natural axis of rotation, a centrifugal pump-disk fixed on the shaft within the second chamber, a fluid-supply passage to the centrifugal pump-disk by which fluid is pumped into the second chamber and maintained at pressure therein, and an exit-pipe from the second chamber by which the pressure fluid is conveyed for either direct utilization or for driving secondary machinery, substantially as set forth.

4. In steam-jet turbines, the combination with an inclosing casing, a rotary shaft in the interior of the casing, bearing-boxes located and supported within the casing to receive the ends of the shaft, means for holding the bearing-boxes and permitting them to have motions in directions parallel with the axis of the shaft, spring-actuated devices for normally maintaining the bearing-boxes coincident with the axis of the casing a steam-jet turbine wheel fixed on the rotary shaft, a chamber in the casing in which chamber the turbine wheel is located, steam-jet nozzles to deliver steam to the vanes of the turbine wheel, and a steam-exhaust aperture from the said chamber; of a second chamber within the casing through which also the turbine-shaft passes, a dividing-wall between the chambers, a disk fixed on the shaft adjacent to the dividing-wall, centrifugal pump-vanes formed on one side of the disk, and a fluid-supply pipe to the pump through which fluid is pumped into the second chamber and maintained at a pressure therein, and exit-pipe from the second chamber for the delivery of the pressure fluid for use, radial ribs formed on the side of the pump-disk which is in contact with the dividing-wall of the chambers, the ribs being calculated to act with greater force than the pump-vanes on the other side of the disk to produce an overbalance of pressure and prevent intercommunication of fluids between the first and second chambers, while the aperture in the dividing-partition through which the shaft passes is greater than the diameter of the shaft so as to permit the shaft

to be self-centering, substantially as set forth.

5. In steam-jet turbines, the combination with a rotary shaft, a steam-jet turbine wheel fixed on the said shaft, a chamber within which the wheel is located, jet-nozzles entering the chamber to deliver the steam-jet to the vanes of the wheel, a steam-exhaust aperture from the said chamber, a second chamber within the casing through which the turbine-shaft passes, a centrifugal pump-disk fixed on the shaft within the said second chamber, a fluid-supply passage to the centrifugal pump-disk, and an exit-pipe from the said chamber, centrifugally-acting vanes to prevent the fluid from the pressure-chamber entering the steam-chamber formed upon the upper side of the centrifugal pump-disk which is adjacent and in contact with the dividing-partition between the first and second chambers, the said upper surface of the pump-disk covering the aperture through which the turbine-shaft passes, which aperture is of larger diameter than the shaft to allow the freely-carried shaft to assume its natural axis of rotation, elastically-carried bearing-boxes in the casing to receive the ends of the shaft, supply-passages for liquid lubricant to chambers containing the bearing-boxes, a disk having radial vanes, mounted on the turbine-shaft adjacent to the partition of the compartment which contains that bearing-box upon the exterior side of a turbine-wheel compartment, and operating by centrifugal action to prevent entry of lubricating fluid from the bearing-box chamber to the turbine-wheel chamber, substantially as set forth.

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