No. 641,624. Patented Jan. 16, 1900.

W. H. CLARKE & F. J. WARBURTON.

TURBINE.

(Application filed Aug. 24, 1898.)

(No Model.) 4 Sheets—Sheet 1.

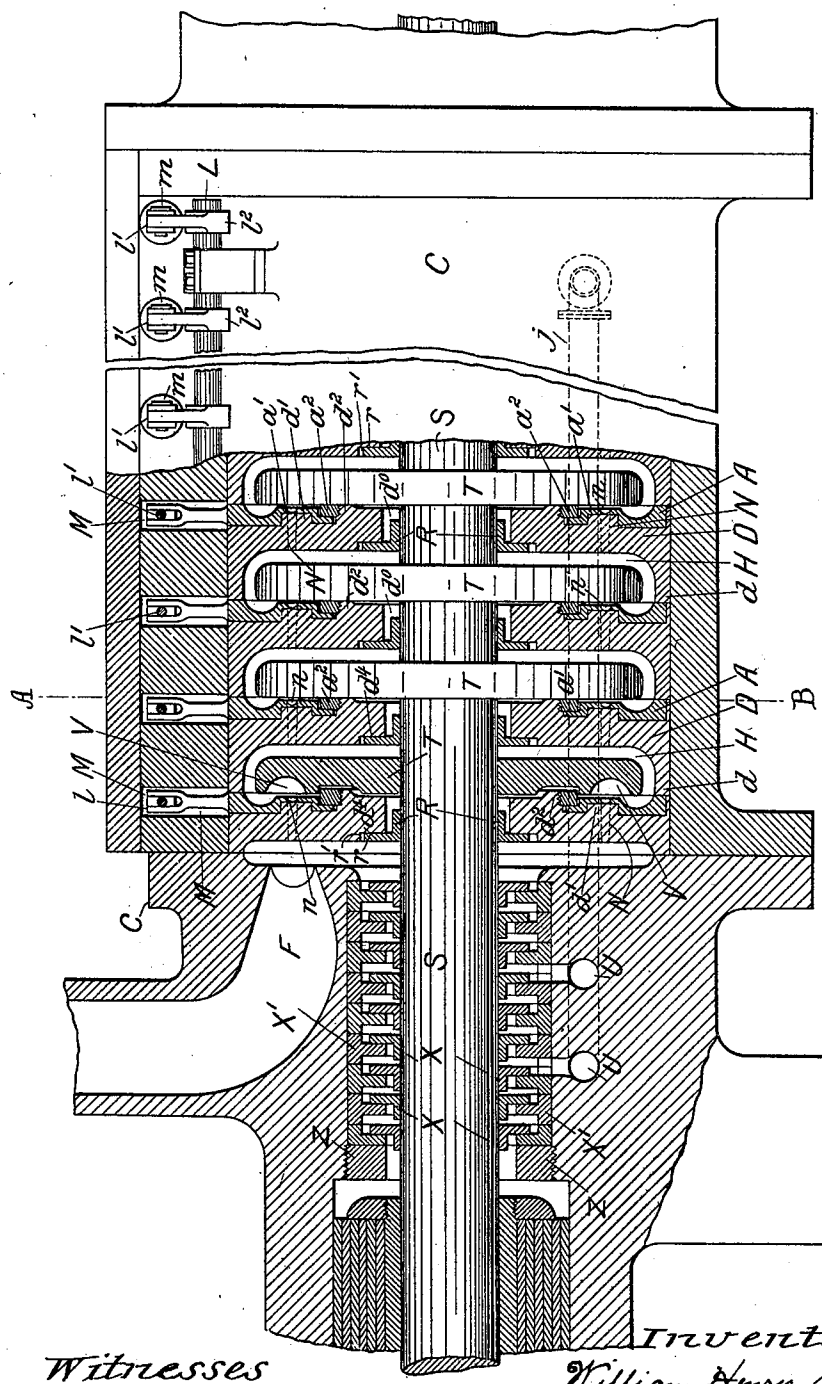

FIG. 1.

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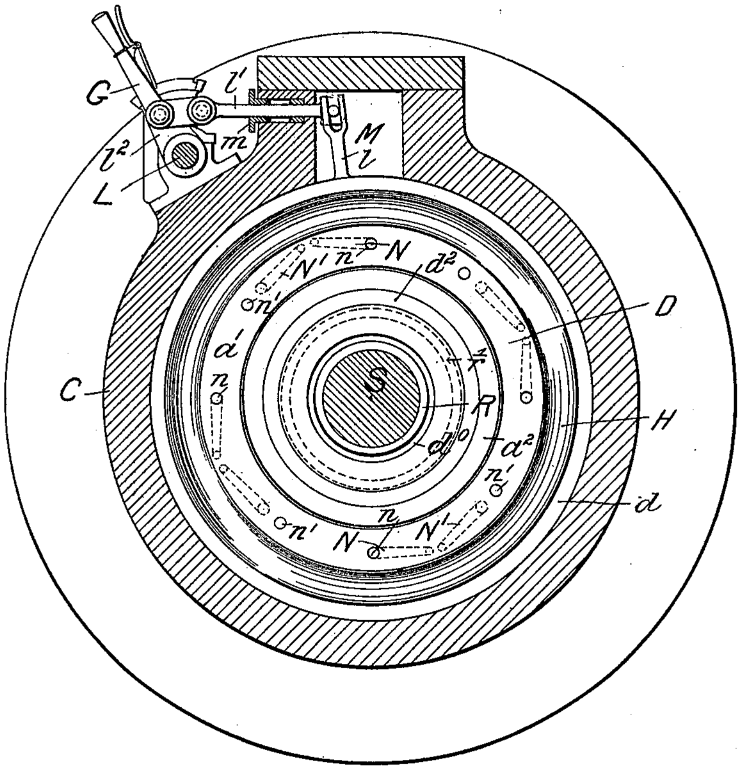
(No Model.) 4 Sheets—Sheet 2.

FIG. 2.



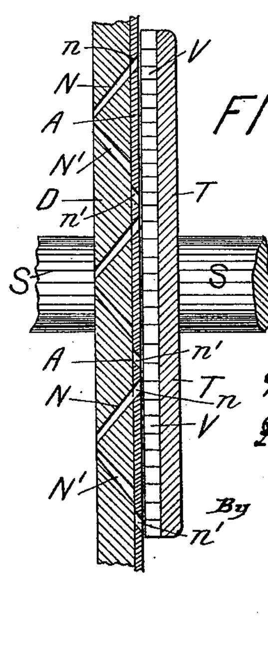


FIG. 3.

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TURBINE.

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(No Model.) 4 Sheets—Sheet 3.

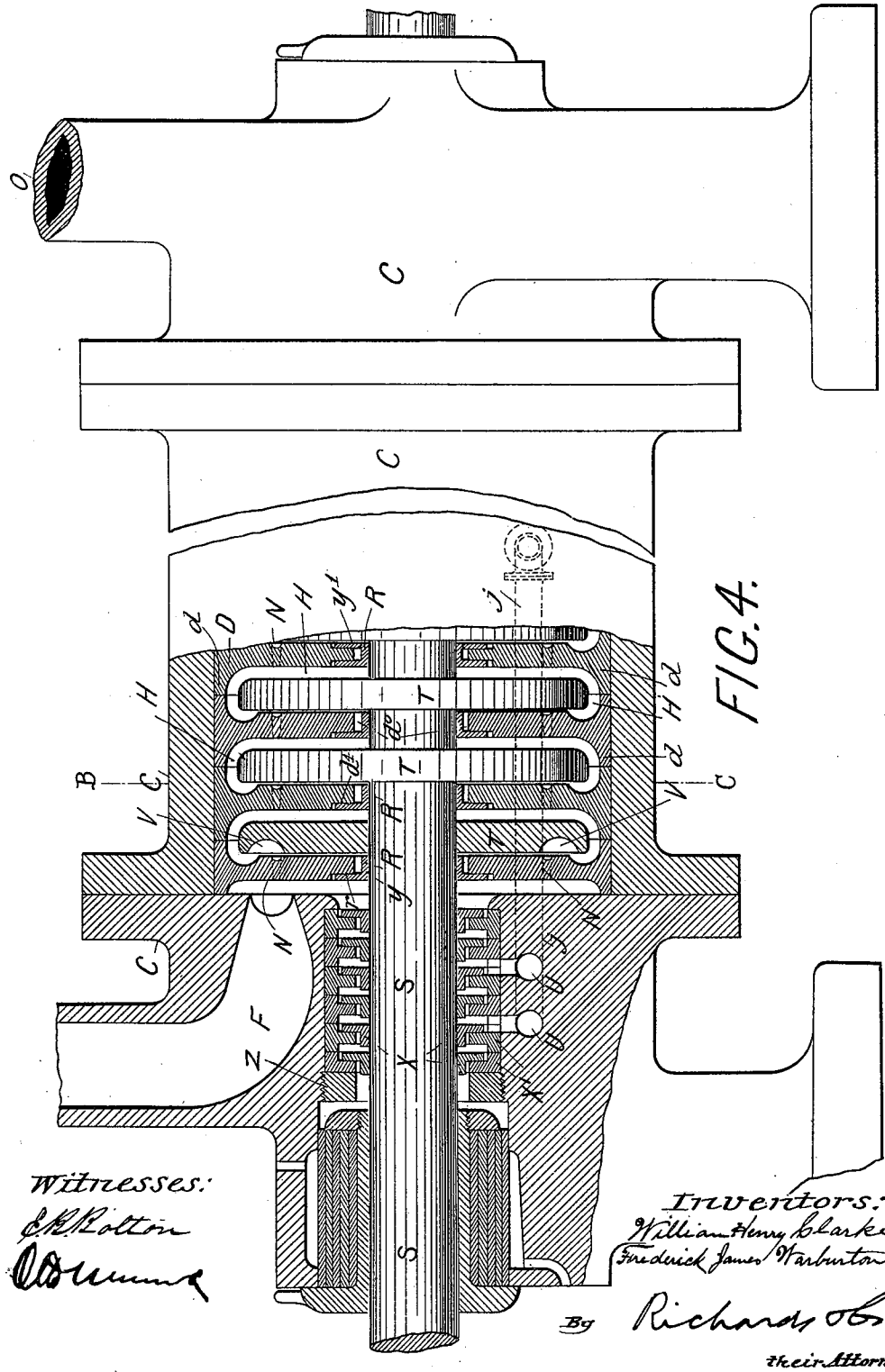

FIG. 4.

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TURBINE.

(No Model.) (Application filed Aug. 24, 1898.) 4 Sheets—Sheet 4.

FIG. 5.

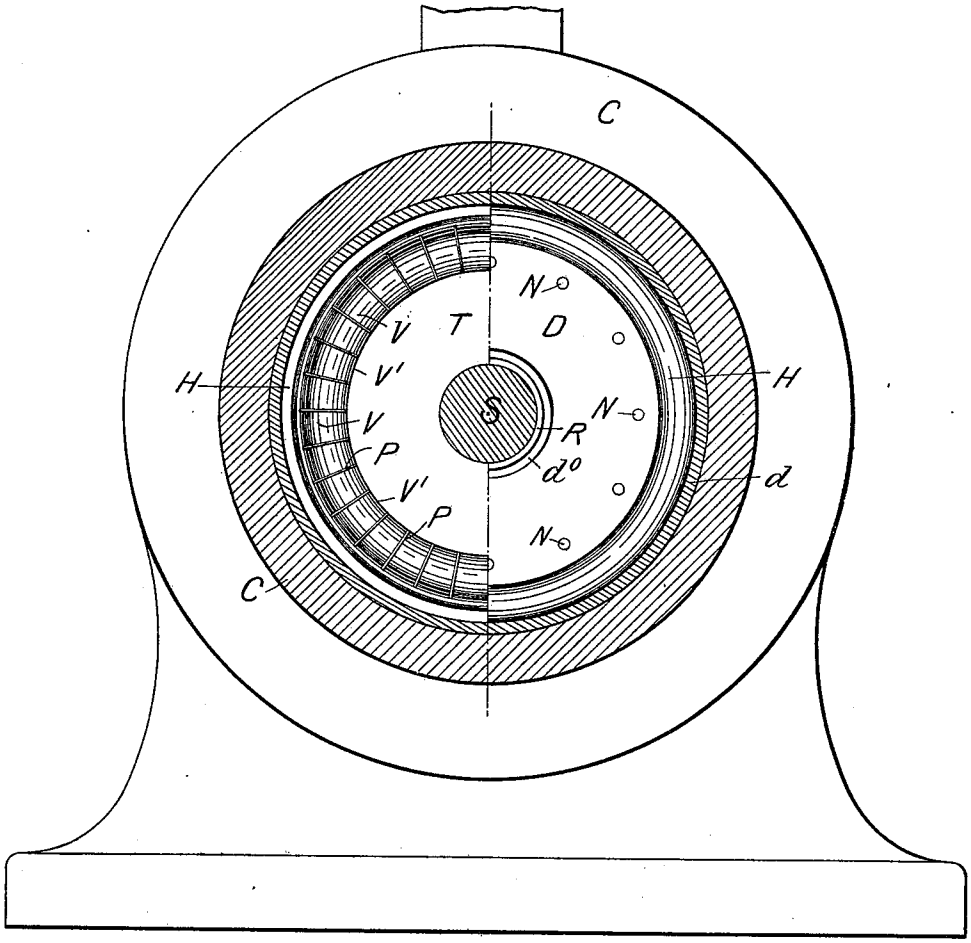


FIG. 6.

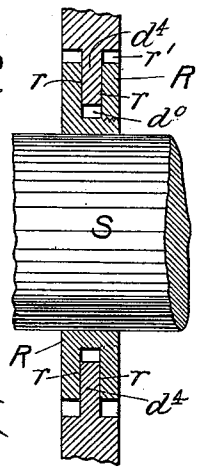
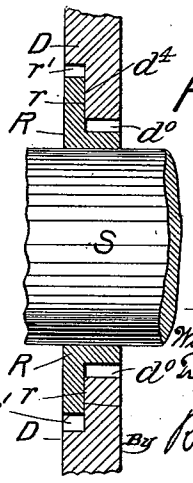


FIG. 7.



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UNITED STATES PATENT OFFICE.

WILLIAM HENRY CLARKE, OF GATESHEAD, AND FREDERICK JAMES WARBURTON, OF NEWCASTLE-UPON-TYNE, ENGLAND.

TURBINE.

SPECIFICATION forming part of Letters Patent No. 641,624, dated January 16, 1900.

Application filed August 24, 1898. Serial No. 689,448. (No model.)

To all whom it may concern:

Be it known that we, WILLIAM HENRY CLARKE, a resident of The Hermitage, Gateshead, in the county of Durham, and FREDERICK JAMES WARBURTON, a resident of 15 Callerton Place, in the city and county of Newcastle-upon-Tyne, England, subjects of the Queen of Great Britain and Ireland, have invented certain new and useful Improvements in Turbines, of which the following is a specification.

Our invention relates to compound and other turbines for use with steam, gas, or other motive power, and has for its object to so construct and arrange the turbine as to render the same readily reversible and to reduce to a minimum the loss of power arising from leakage of the operating fluid at those parts where the shaft passes through the casing or separating-partitions, at the same time not retarding the speed of the shaft.

According to our invention we so arrange the shaft carrying the turbine wheels that it may have a slight transverse movement in its bearings to allow for any eccentric motion which may occur when rotating at high speeds, owing to its imperfect homogeneity, and for preventing the leakage of working fluid at the parts where the shaft passes through the partitions between each turbine wheel we arrange thereat an annular collar or ring fitting well but easy upon the shaft and adapted to fit into or onto and make a joint by its vertical surface or surfaces with a recessed or reversely-formed part of the said partition, in which recessed part the said ring is capable of a sliding movement in a radial direction. The adjacent surfaces of the ring and partition may be coned or flat, as desired, and the ring may be of L form in cross-section, with its larger surface toward the chamber having the greatest pressure, or it may be of more or less U form in cross-section, adapted to receive the annular parts of the partition between the two sides and make a good sliding joint thereat, or the partition and ring may be reversely formed. The steam or gas in the spaces between the partition and the ring sides serves as a means for damping or retarding the said eccentric motion of the shaft when it occurs.

We will further describe our invention in reference to the accompanying drawings, in which—

Figure 1 is a sectional elevation of a compound reversible turbine constructed in accordance with our invention, and Fig. 2 is a section on line A B thereof. Fig. 3 is a diagram illustrating the means for reversing the turbine. Fig. 4 is a cross-sectional elevation of a non-reversible compound turbine; and Fig. 5 is a section of same on line B C of Fig. 4, half looking to the right and half to the left. Figs. 6 and 7 are enlarged views of the steam-tight joint with shaft.

Referring to the reversible turbine shown in Figs. 1 and 2, T T are the turbine wheels, inclosed in a suitable cylindrical casing C, said wheels T being placed therein upon the shaft S alternately with dividing-partitions D, the latter having suitably-formed outer ends or peripheries, as at *d d*, for providing the proper spacing of the parts, and chambers or ways H for the passage of the operating fluids. In these divisions the usual apertures or nozzles N are arranged and adapted to direct the operating fluid at the proper angle upon the turbine vanes V as it passes from chamber to chamber.

For rendering the turbine reversible the partitions D are provided with two sets of oppositely-inclined tangentially-arranged apertures or nozzles, as shown at N N′ in the diagram Fig. 3 and also in Fig. 2. These nozzles or apertures are adapted to be opened and closed by means of a movable disk, diaphragm, or slide arranged within or upon the partitions D and adapted to be moved in an annular or other direction and provided with sets of holes or ports *n n′*, adapted to register one at a time with one of the double sets of apertures or nozzles N N′ referred to. These tangentially-arranged apertures may be arranged to deliver the operating fluid upon the vanes at the same distance from the shaft, or to avoid merging of the apertures when arranged in close proximity they may deliver at different distances, the reversing-ports, or those less in use, delivering at the lesser point of efficiency.

The diaphragm or port-carrying slide may be disposed on the entering or outlet side of

the partitions. The latter form is shown in Figs. 1 and 2, where the said slide A is formed of an annular collar or ring recessed, as at a', to fit over an enlarged annular portion d' of the partitions D, where the nozzles N N′ are disposed, the said slide A being kept in position by a ring or collar h^2, screwed, as shown, or otherwise secured to the partition or a projecting part d^2 thereof. The whole is so arranged that the said slide A is capable of being readily moved around upon the partition D to open and close the ports by means of operating-levers, such as l l' l^2 and counter-shaft L or otherwise conveniently. One or more of the said levers is or may be inclosed in a chamber or chambers, such as M M, and provided with stuffing-boxes m. Suitably arranged reversing-gear, such as G, may be provided.

The aperture d^0 in each partition D, through which the shaft S passes, is, as described, of somewhat larger diameter than the shaft and adapted to receive an annular collar or ring R of more or less ⌊ or ⌊⌋ section, as shown, respectively, at y y', Fig. 4. Figs. 6 and 7 are respectively enlarged views of each form of ring R. These rings are adapted to fit well, but easy and movable upon the shaft S and make a steam-tight joint by their transverse face or faces r r against a correspondingly-formed surface d^4 upon the partition D, upon which surface the said ring R is adapted to move for a suitable distance transversely, clearance being allowed, as at r' r'. Thus free eccentric movement of the shaft S is allowed, should it occur, without shock, at the same time preventing loss of power and leakage of working fluid at these parts. To form a fluid-tight joint where the shaft passes out of the casing, it is arranged to receive thereat a number of rings constructed and arranged as before described—for instance, as shown at X X in Figs. 1 and 4—the casing C having a suitable number of projecting parts or partitions, such as X′, to receive them, and these may be kept in position by a ring or sleeve, such as Z. At suitable points in such series a collecting chamber or chambers, such as U U, is or are provided with pipes or the like communicating with one or more of the low-pressure chambers of the turbine—for instance, as shown at j, Fig. 4. Suitable flexible packing or bearings may be provided where required.

Figs. 4 and 5 illustrate a compound turbine arranged to run in one direction only, the reversing-diaphragm A and operating-levers being dispensed with. The partitions D may be each in one piece, as shown, and only one set of apertures N are provided. The other parts of the turbine remain the same. Similar reference-letters are employed to these parts as in the description of the reversible turbine.

Fig. 5 shows the construction of the turbine wheels T and the vanes which are formed by an annular groove or recess or recesses V′, turned or otherwise cut or formed in or on the face of the wheels T and divided into a suitable number of cells V by means of radial partitions P. These may be inserted in radial saw cuts or otherwise conveniently fixed in the groove V′ at proper distances apart, although it will be obvious that cells or vanes of similar symmetrical shape may be formed upon or in the wheels T by stamping, casting, or like means. Although we have shown the vanes or cells V in the turbine as of symmetrical form, they may with an increased efficiency for a non-reversing turbine be inclined at an angle more or less coinciding with the angle of the tangential nozzles.

The steam, gas, or other operating fluid is admitted at one end of the reversible turbine, as shown at F, and discharged at O, Fig. 4. In all cases the nozzles or apertures N N′ are of proper dimensions in each succeeding partition in regard to the expansion of the working fluid in its passage through the series of chambers.

From the foregoing it will be seen that the turbine is readily reversible when arranged to be so, as described, and may be worked at very high speeds without appreciable loss of working fluid or power.

Having now described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. In turbines, the combination with partitions or projecting rings upon the casing of free floating rings having vertical and lateral annular flanges and fitting well but easy on the shaft and having a sliding movement and being free upon or in the said partitions or projecting rings and kept tight thereon by the steam-pressure on one of their transverse faces, substantially as described.

2. In turbines the combination with the series of partitions or projecting rings X′ X′ upon the casing of free floating rings X, X, having vertical and lateral annular flanges and fitting well but easy on the shaft and having a sliding movement and being free upon or in the said partitions or projecting rings, kept tight thereon by the steam-pressure on one of their transverse faces, substantially as set forth.

3. In turbines, the combination of a series of turbine wheels having symmetrical cells or vanes and a series of dividing partitions each having a double set of oppositely-inclined apertures, ports or nozzles for directing the operating fluid upon the turbine wheels and also having a movable slide disposed directly over the said apertures, nozzles or ports and provided with a double set of oppositely-inclined holes or ports, each set of the latter being adapted, on the proper operation of the slide, to form with the corresponding set of apertures, nozzles or ports in the partition, a set of nozzles or ports inclined in one or the opposite way, so that the direction in which the operating fluid issues to act upon the vanes or cells, and consequently the rotation of the

shaft can be reversed, substantially as set forth.

4. In turbines, the combination of partitions D, D, each having apertures, ports or nozzles N, N′, and a slide A having holes or ports n, n' and being connected to parts l, l', l^2, l^3; chambers M, M, a shaft L and a reversing-lever G, all arranged and adapted to operate, substantially as and for the purposes herein set forth.

In witness whereof we have hereunto set our hands in presence of witnesses.

WILLIAM HENRY CLARKE.
FREDERICK JAMES WARBURTON.

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