(No Model.)

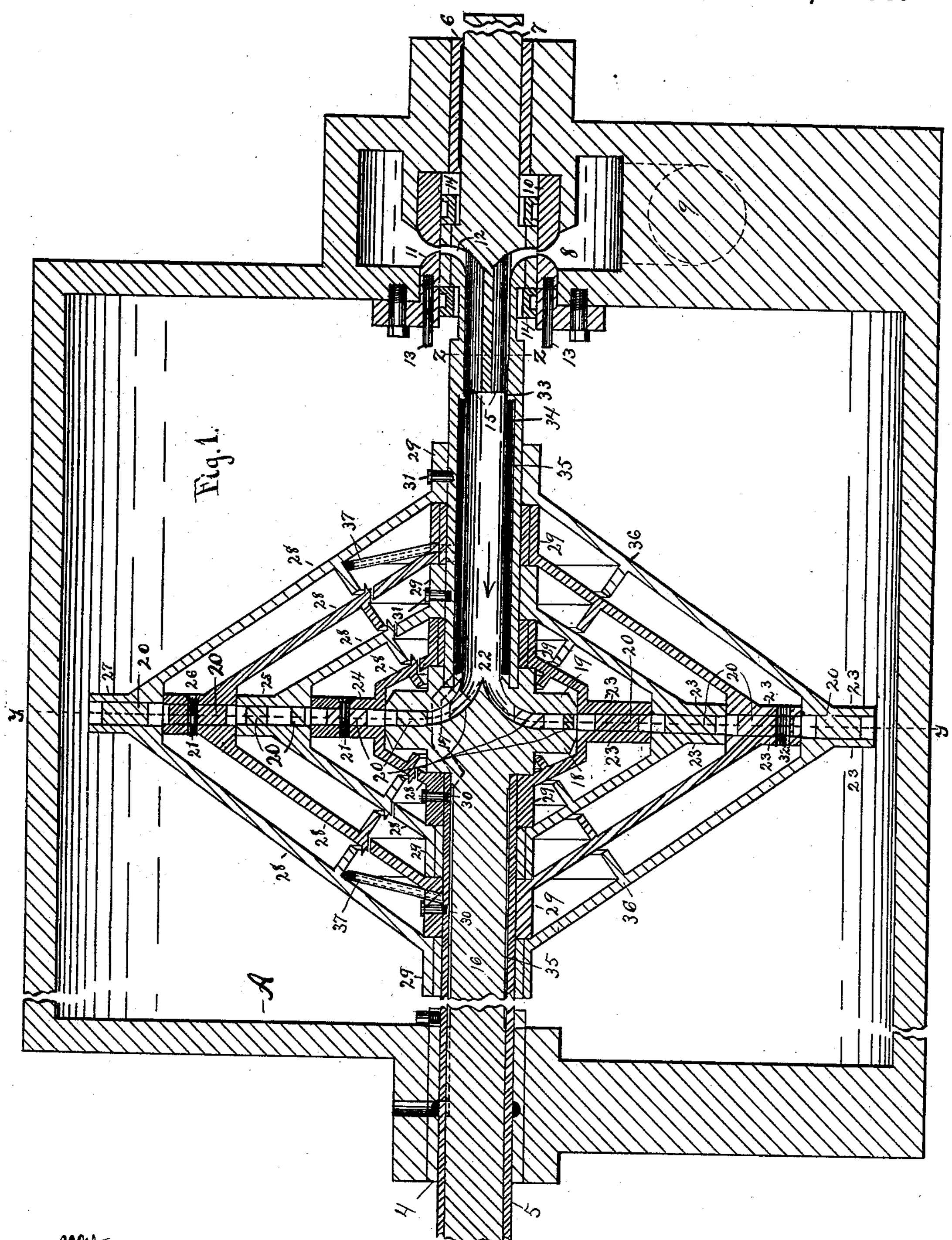
3 Sheets—Sheet 1.

E. C. TERRY.

STEAM TURBINE.

No. 508,190.

Patented Nov. 7, 1893.



Witnesses.

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(No Model.)

3 Sheets—Sheet 2.

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Fig. 2.

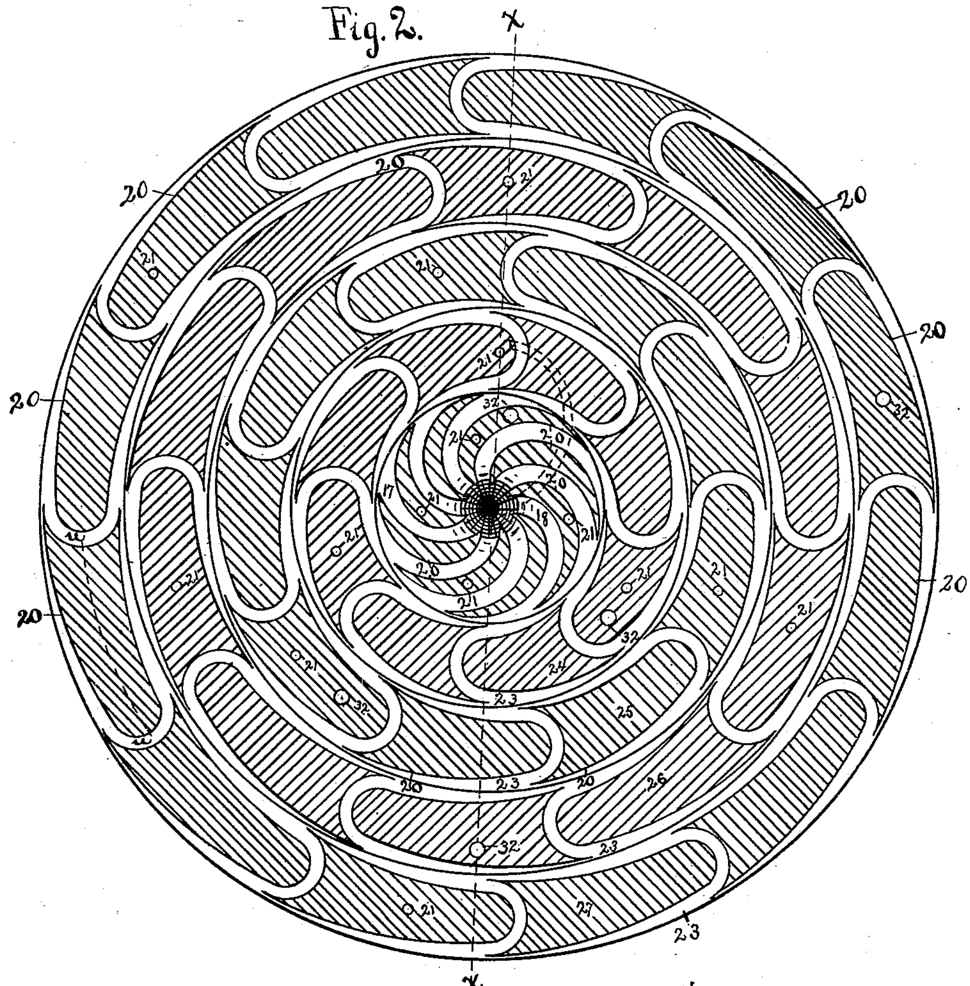

Fig. 3.

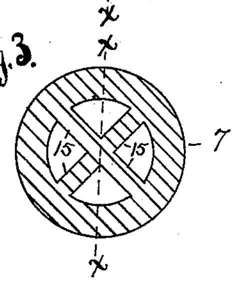

Fig. 3a

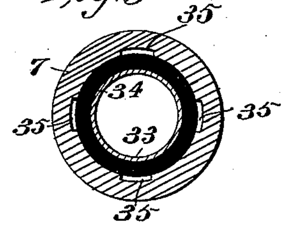

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Fig. 4.

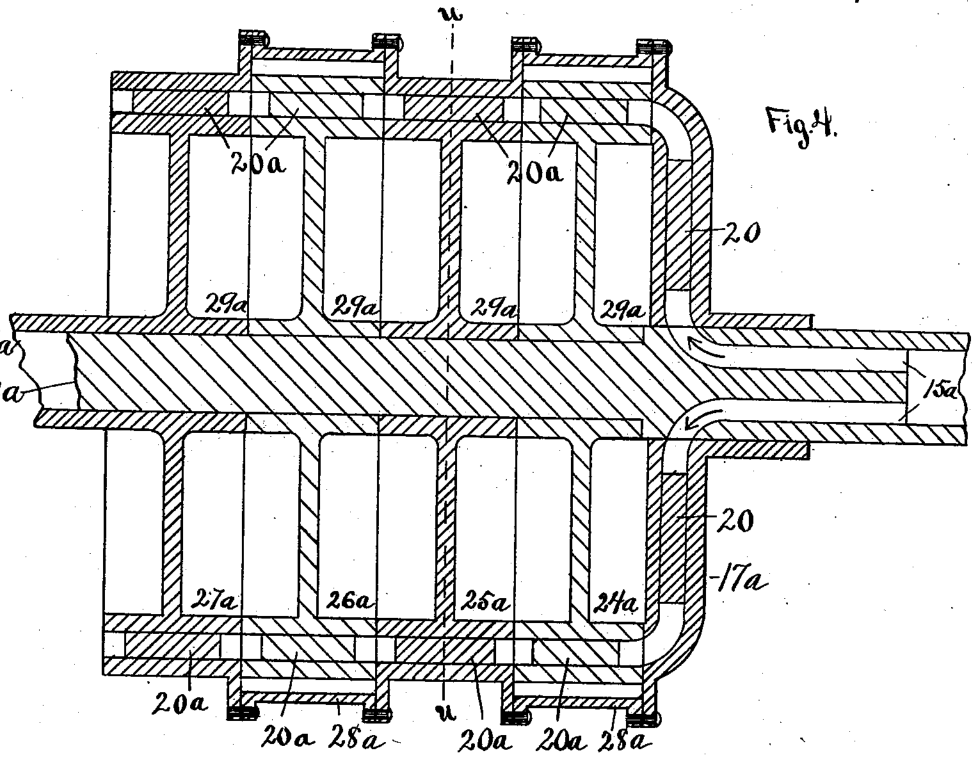


Fig. 5.

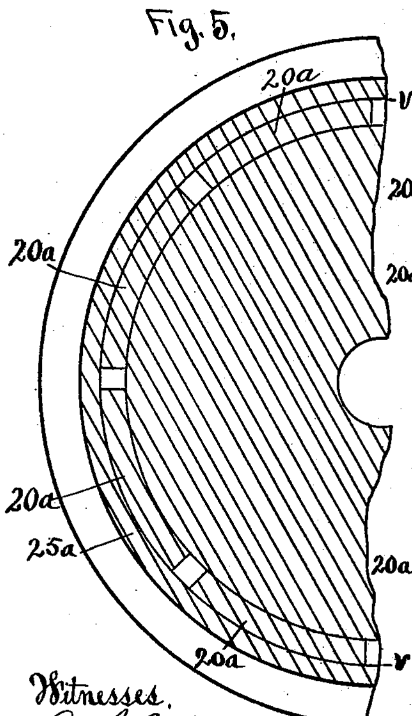
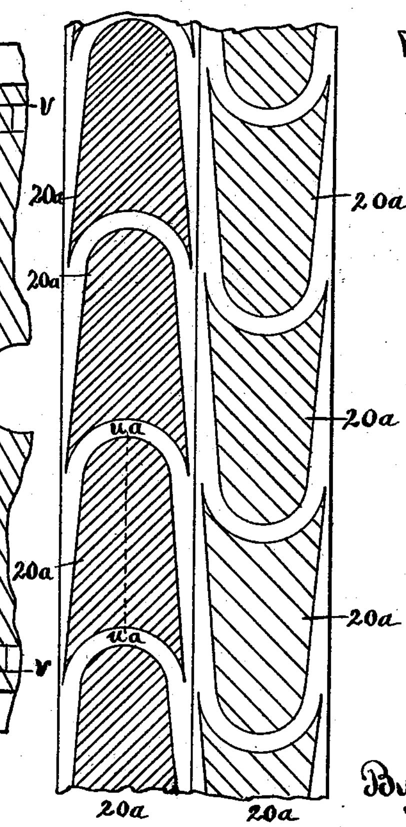


Fig. 6.



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UNITED STATES PATENT OFFICE.

EDWARD C. TERRY, OF HARTFORD, CONNECTICUT.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 508,190, dated November 7, 1893.

Application filed May 12, 1892. Serial No. 432,749. (No model.)

To all whom it may concern:

Be it known that I, EDWARD C. TERRY, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented a certain new and Improved Steam-Turbine, of which the following is a specification.

My invention relates to improvements in steam turbines or compound wheels and the objects of my improvements are economy in construction, compactness in form, and general efficiency in use.

In the accompanying drawings, Figure 1 is a sectional view of my turbine on the line x x of Figs. 2 and 3. Fig. 2 is a sectional view of the same, (less the case) on the line y y Fig. 1. Fig. 3 is a transverse section of the main shaft on the line z z of Fig. 1. Fig. 4 is a central longitudinal section of my turbine in a modified form. Fig. 5 is a transverse section of the same on line u u of Fig. 4, and Fig. 6 is a developed sectional view on the line v v of Fig. 5. Fig. 3^a is a transverse section of said shaft on a line through its lining and non-conducting sleeve.

A designates a frame or support which may be of any desired form and which I show in the form of a cylindrical case so that it may be used as a condensing chamber if desired. I have also represented the same with parts broken out in order to get the drawings on the sheet without too much reduction. At one end of the case is the bearing 4 for the tubular shaft 5, and at the other end is the bearing 6 for the shaft 7. At this end I also form a steam chamber 8 which is provided with any suitable supply pipe as indicated by broken lines at 9, for the admission of steam. A stationary ring 10 on one side and a sliding ring or governor valve 11 on the other side, form the walls of an annular channel or passage way leading from the steam chamber 8 to the annular inlet passage 12 in the shaft 7 in a direction which at the junction of said passages is substantially at right angles to the axis of said shaft 7 so that the fluid entering at right angles to the joint will have less tendency to leak. The sliding annular ring is provided with rods 13 which may be acted upon by any ordinary governor in any ordinary manner to move said ring for cutting off or letting on steam as required. 14 and 14 designate packing rings of any ordinary construction. That portion of the shaft 7 which is outside of the inlet passage 12 is solid while the remainder is hollow, and in order to connect the parts on each side of said annular inlet passage a portion of said shaft is formed with cross webs 15 as shown in Figs. 1 and 3, thereby permitting the steam to pass longitudinally through said shaft. This shaft 7 is rigidly connected with a solid shaft 16 through what I may term the first wheel 17, so that said shafts 7 and 16 and wheel 17 all rotate together as if in one piece, whereby the combined shafts 7 and 16 are in effect a main shaft. A tubular shaft 5 surrounds the shaft 16 and is supported in the bearing 4 at that end of the frame A.

My turbine is a compound wheel, composed of a number of wheels or parts, each having a series of buckets or guides for the passage of the actuating fluid through the several parts successively, the same being capable of use with every alternate part fixed in a stationary position, while the other parts rotate, or with the alternate parts rotating in opposite directions. I will therefore for convenience term these parts wheels, but by so doing I do not wish to imply that all of them must necessarily rotate in use, although I prefer to so use them. I construct these wheels so that the only joint in the steam or fluid passage way between any two of them is at their opposite sides or edges instead of being on two adjoining sides and thereby said joints may be, and as shown, are parallel to each other instead of at substantially right angles as in other turbines of this class.

The first wheel 17 is, for convenience of making, composed of two hubs or disks 18 and 19 and inclosed buckets 20 held together by screws 21. The hubs or disks may be formed solid with the respective shafts 16 and 7, or separately formed and rigidly secured thereto. Instead of making the face of the hubs flat I prefer to form the face of the hub 18 with a flat portion extending at right angles to its axis from the outer edge inwardly and with a central projection 22 which gradually curves to a point while the face of the hub 19 is correspondingly cut out at its central portion, whereby the opening or passage between said hubs opens into the hollow part of the shaft

7 and receives the steam therefrom in a direction substantially lengthwise with said shaft and discharges it at the periphery of the wheel in a direction which is at a right angle to the length of said shaft while at the same time the change in direction is gradual. The buckets 20 have the two sides that confront the hubs 18 and 19 fitted tightly thereto and the buckets are so shaped that the spaces between them has parallel sides and that the fluid passing through them makes a complete reversal, entering tangentially and discharging tangentially.

The other wheels 24, 25, 26 and 27 are each composed of two parts and inclosed buckets 20, each part consisting of an annular plate like portion 23, a hub portion 29, and a connecting portion 28, all preferably cast in one and the same piece. These two parts and their buckets are held together by screws 21 as in the first wheel. The passages through the wheels are inclosed on four parallel sides and are curved with a return bend so that the fluid enters tangentially, reverses its course gradually and discharges tangentially. By being thus shaped the buckets or parts between each passage through the wheels are longer at the middle (measured on a line that is parallel to the circumference of the wheel as at *u u* Fig. 2), than they are upon each side of said middle. The distance between the annular plate like portions in each wheel is a little greater in each successive wheel from the first to the last or discharging wheel as shown in Fig. 1, and the number of buckets in the different wheels increases toward the last wheel, whereby the sum of passages in each wheel increases from the inlet to the last or discharging wheel and the expansion of steam and the decrease in its speed is provided for. This result can be attained by the two above features combined or by either one of them alone. If desired the width of the buckets measured on a radial line might vary in the different wheels.

I have before noted that the first wheel 17 moves with the connected shafts 16 and 7. The hub 29 on one side (the left side in Fig. 1), of the next outer wheel 24 is secured to the tubular shaft 5 by a screw 30 while the hub on the opposite side or end of said wheel takes its bearing on the shaft 7. The hub 29 on one side (the right hand side in Fig. 1) of the next wheel 25 is secured by a screw 31 to the shaft 7, while the hub on the opposite side or end of said wheel takes its bearings on the tubular shaft 5, and so on throughout the entire set of wheels every alternate wheel being secured to the central shaft and the others to the tubular shaft 5. By this construction the wheels may rotate in opposite directions, they are well supported and balanced, and the joints in the fluid passage between two wheels are confined to two opposite sides or edges of the wheels, and whatever leakage there may be at this point is caught within the connecting portions 28 of the wheels where the only possible chance of escape is through the close fitting joints at the hubs. I perforate each wheel with one or more holes as at 32, so that when there is any pressure within the connecting part of the wheels it will be alike on both sides thereof. For clearness of illustration I have deviated in Figs. 1 and 4 from the usual rule of giving a different direction to the section lines in each separate piece and given the section-lines in the moving parts the same direction in all those pieces that move together as one piece. I have also designated in Figs. 1 and 2 all those wheels that move with the central shafts 16 and 7 by odd numbers 17, 25 and 27, and those that move with the tubular shaft 5 by even numbers 24 and 26. The last wheel at its outer edge opens into free air, if the frame A is open, or into the interior thereof if the frame is made in the form of an inclosing case or chamber.

In the hollow portion of the shaft 7 I place a lining 33 surrounding which is a non-conducting sleeve 34. I also form oil spaces or channels 35 outside of said lining, and the shafts inside the wheel hubs that move on the shafts may be perforated to let the oil pass from said channels to the joint between said hubs and shaft. The connecting portion 28 of each wheel is provided with an angular flange or dam 36 and just inside of said dam (except in the last wheel) I perforate the connecting portion 28 as shown in the upper part of Fig. 1. The dams in the successive wheels from the center outwardly are each farther from the center so that the oil escaping through one and working outwardly by centrifugal force will be caught by the next dam and so on, thereby taking the oil away from the exhaust steam and preventing it from being mixed therewith. In this last wheel I place an oil pump which may be nothing but a curved tube 37 with one end connected with the wheel hubs and its other end lying in the corner formed by the dam and connecting portion of said last wheel as shown in Fig. 1, and as indicated by broken lines in Fig. 2. Of course suitable holes or passageways should be made in the shafts opposite the ends of these tubes or pumps. As the lubricating material works outwardly under centrifugal force it is caught in the dam of the last wheel and as said last wheel moves swiftly in one direction and the adjacent wheel and pump or tube move in the opposite direction the oil thus caught is taken up by the pump and forced back into the oil channels.

Inasmuch as the fluid leaves and enters the wheels in a tangential direction it follows that it passes from one wheel to the next without substantially changing its direction, although it changes its direction by a gradual and easy curve in passing through each wheel.

Although I have described the parts 17, 24, 25, 26 and 27 as wheels with the shafts 16 and 7 or the main shaft, and the wheels 24 and 26 rotating in the opposite direction with the tubular shaft 5, it is evident that the tubular shaft 5 and its wheels might be secured in a stationary manner and the other wheels rotate or vice versa, but when so used there should be a greater number of wheels. Thus by having all the wheels rotate I make a less expensive and more compact turbine. A driving pulley should be secured to the shaft 7 at one end and to the tubular shaft at the opposite end and power can be transmitted from said pulleys to a main shaft by a straight and a cross belt running on these pulleys to pulleys on said main shaft.

Instead of arranging the wheels in the form of concentric rings all inclosed within the last or outer wheel some features of my invention may be embodied in a compound wheel of substantially a cylindrical form as illustrated in Figs. 4, 5, and 6. In these figures 5^a is the tubular shaft, 16^a the solid shaft and 6^a the hollow inlet shaft with cross webs 15^a. The first wheel 17^a is substantially flat instead of cylindrical and its hub 29^a is fitted to turn on the shaft 6^a. The other wheels are cylindrical and the wheels 24^a and 26^a have their hubs 29^a rigidly secured to the solid shaft 16^a so as to rotate therewith while the hub of the wheel 25^a turns on the shaft 16^a and the hub of the last wheel 27 is one and the same piece with the tubular shaft 5^a. The wheels 17^a, 25^a and 27^a are connected rigidly together by connecting bands or portions 28^a so that these wheels all rotate with the tubular shaft 5^a while the other wheels 24^a and 26^a rotate with the solid shaft 16^a. The buckets 20^a are substantially the same as in the wheels first described excepting as they are differently located in the wheel. The middle line u^a u^a in Fig. 6 like the middle line u u in Fig. 2 is the longer part of the bucket.

I claim as my invention—

1. In a compound wheel the buckets or guides between the passages therethrough made longer or thicker in the middle (measured on a line parallel to the circumference of the wheel) and gradually thinner upon each side of said line, the **U** shaped passages between said guides being of the same cross sectional area throughout their length in each wheel, substantially as described and for the purpose specified.

2. A compound wheel consisting of a series of concentric wheels, the first one of which has its passages or channels opening into a hollow shaft at their inner or influent ends, and the other wheels of which each have **U** shaped passages through them that make a complete reversal and open tangentially at their opposite ends, the effluent ends of the passage through said first wheel corresponding in form and direction of discharge substantially with the effluent ends of the passages through the other wheels, substantially as described and for the purpose specified.

3. A compound wheel composed of three or more wheels concentrically mounted, each of which is connected with and supported on a shaft by a disk-hub at each end, the several wheels being arranged with every alternate disk-hub loose on its shaft and every alternate one fast thereon, substantially as described and for the purpose specified.

4. A compound wheel consisting of a series of concentric wheels having **U** shaped buckets, each wheel having a disk hub of its own at each end, substantially as described and for the purpose specified.

5. A compound wheel consisting of a series of concentric wheels each having a disk-hub at each end, a shaft for the hubs at one end of said compound wheel and another shaft for the disk-hubs at the opposite end thereof, the several hubs at one end being alternately fast and loose on the shaft for that end while the several hubs at the opposite end are alternately fast and loose on their shaft substantially as described and for the purpose specified.

6. A compound wheel consisting of three or more wheels and two shafts, each wheel having two disk-hubs, one hub of each wheel being fast on one shaft and one hub loose on the other shaft, every alternate hub on each shaft being fast and every other alternate one loose, substantially as described and for the purpose specified.

7. A compound wheel consisting of two or more wheels having supporting hubs a shaft upon which said wheel hubs are mounted having a longitudinal passage for the actuating fluid on its way to the wheel, a non-conducting sleeve within said shaft at the portion surrounded by said hubs, and a lining within said non-conducting sleeve, substantially as described and for the purpose specified.

8. A compound wheel consisting of a series of wheels concentrically arranged with each wheel inclosed by the succeeding wheel, the dams 36 on the perforated connecting portions between the shafts on which the wheels rotate and the discharging side of each wheel, substantially as described and for the purpose specified.

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Witnesses:
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BRAYTON S. LEWIS.