E. HAGER.

ROTARY ENGINE.

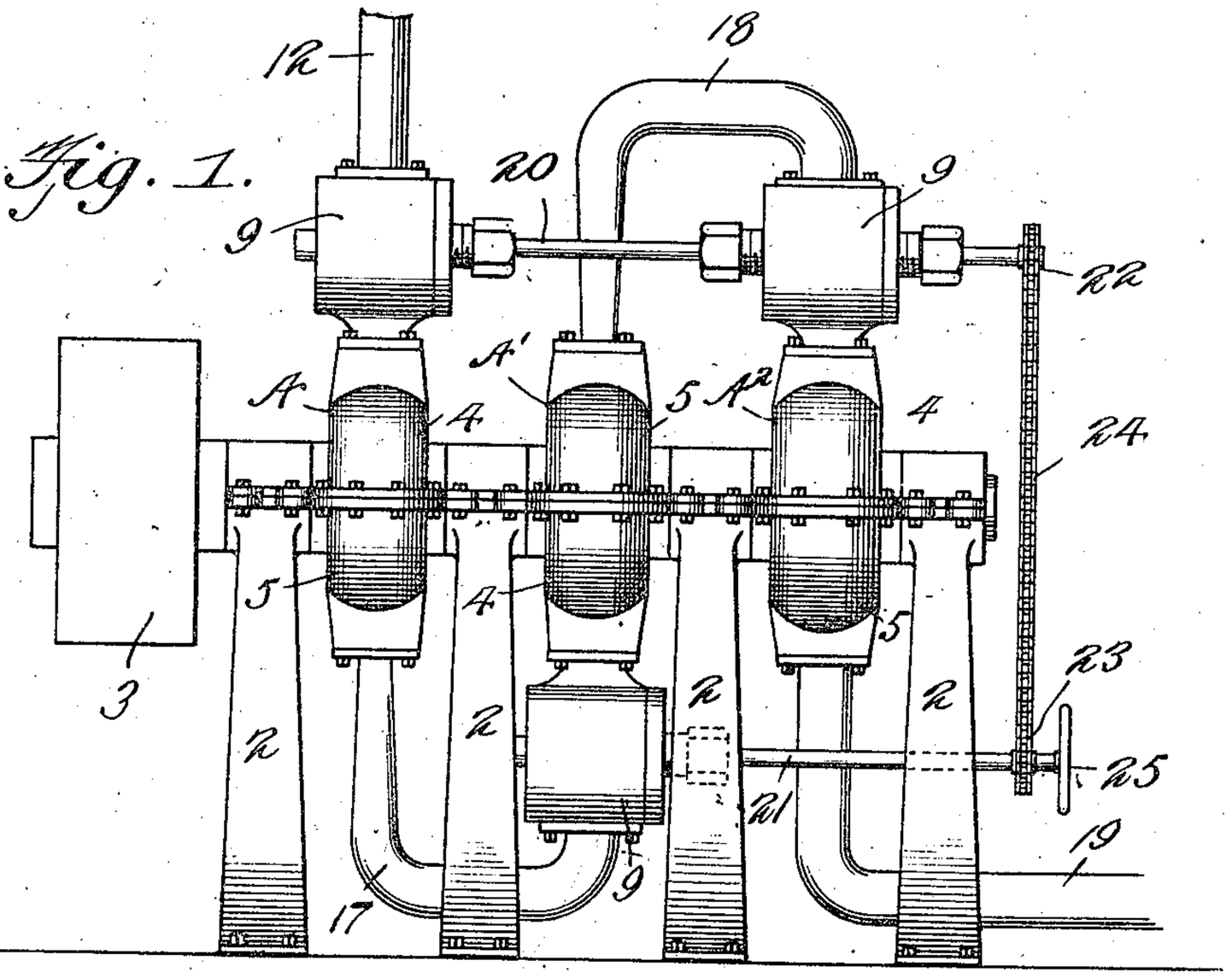
APPLICATION FILED JUNE 14, 1910.

982,054.

Patented Jan. 17, 1911.

3 SHEETS—SHEET 1.

Fig. 1.



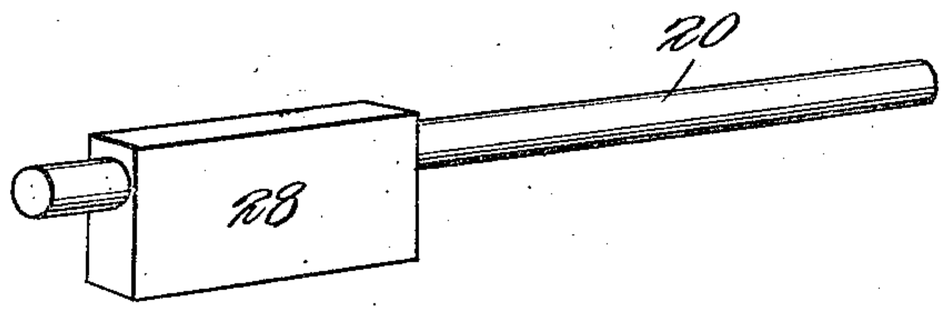
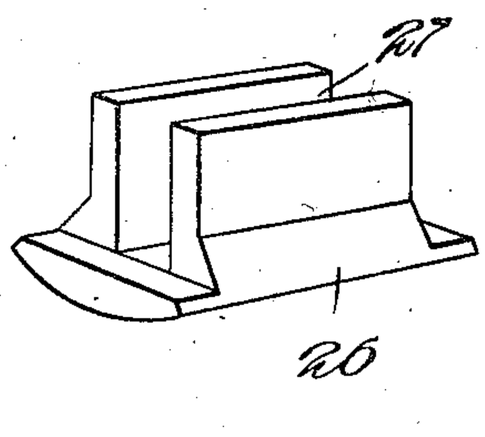


Fig. 4.



Witnesses

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3 SHEETS—SHEET 2.

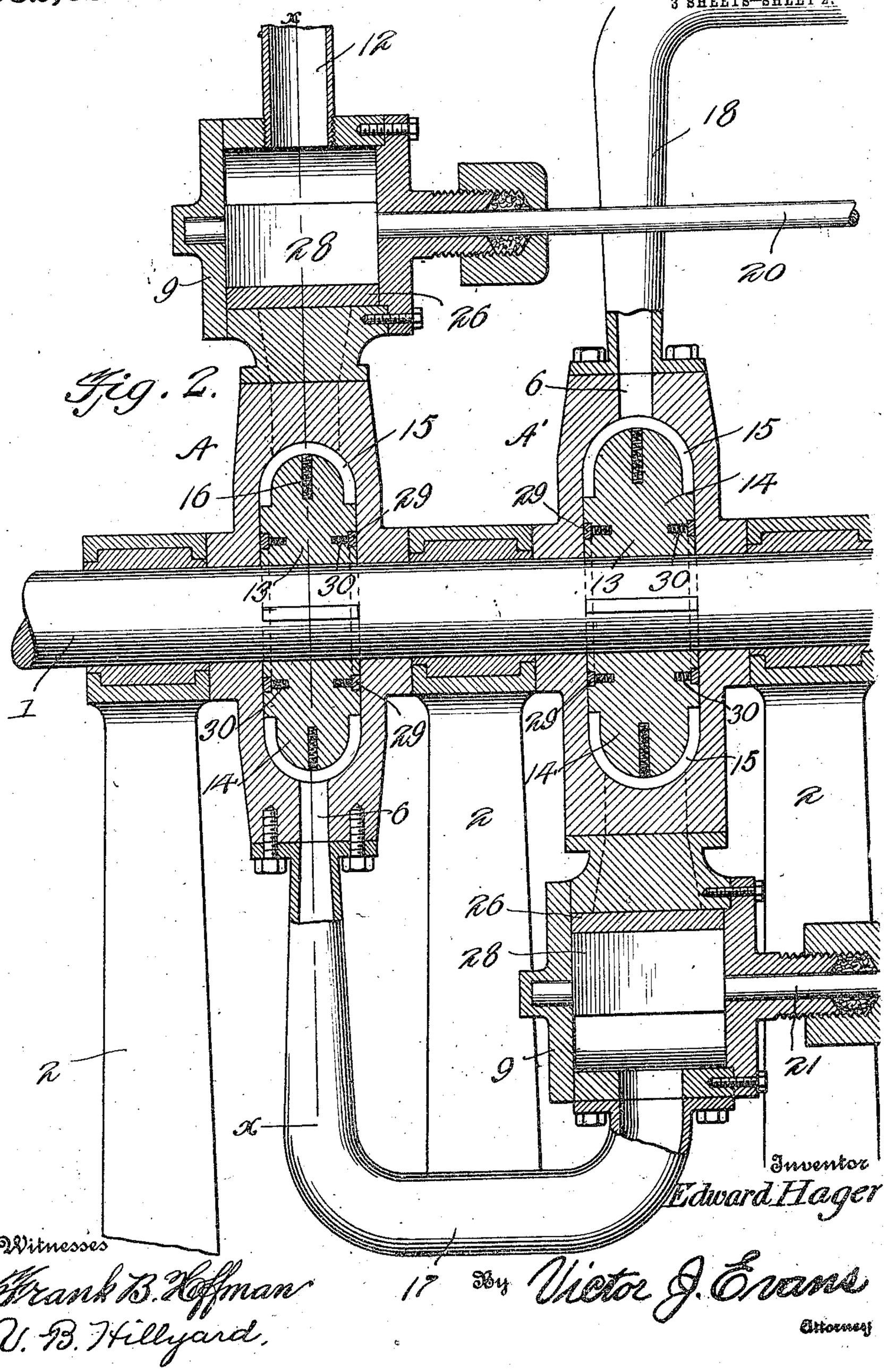

Fig. 2.

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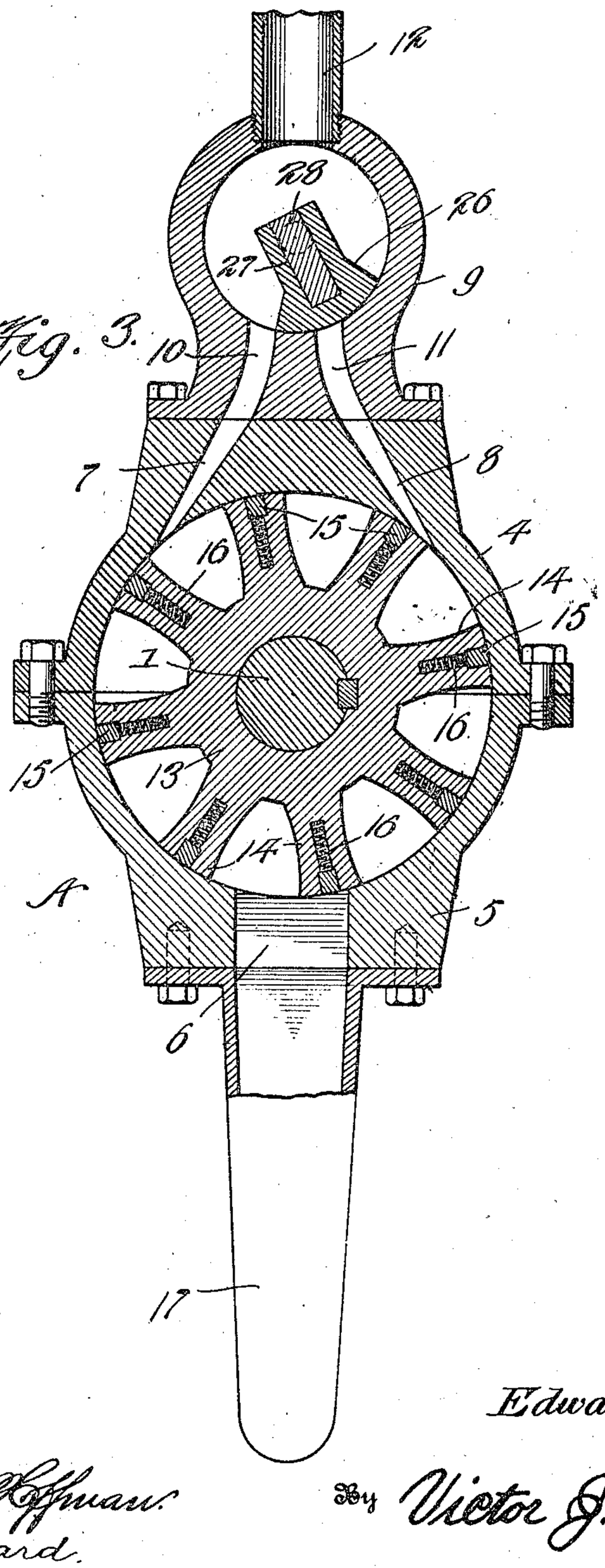
3 SHEETS—SHEET 3.

Fig. 3.



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UNITED STATES PATENT OFFICE.

EDWARD HAGER, OF BUFFALO, NEW YORK.

ROTARY ENGINE.

982,054. Specification of Letters Patent. **Patented Jan. 17, 1911.**

Application filed June 14, 1910. Serial No. 566,801.

To all whom it may concern:

Be it known that I, EDWARD HAGER, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented new and useful Improvements in Rotary Engines, of which the following is a specification.

The purpose of the invention is the provision of an engine of the rotary type designed for the economical use of steam by expansive force, the engine comprising a plurality of turbines arranged to use the steam expansively in series.

The invention contemplates a novel construction and arrangement of the turbines, the elements entering into the construction thereof and the means whereby the steam is controlled and directed from one turbine to the other in successive order, the engine being reversible so that it may be driven either forwardly or backwardly with equal facility.

The invention consists of the novel features, details of construction and combination of parts, which hereinafter will be more particularly set forth, illustrated in the accompanying drawings, and pointed out in the appended claims.

Referring to the drawings, forming a part of the application, Figure 1 is an elevation of a rotary engine or steam turbine embodying the invention. Fig. 2 is a vertical central longitudinal section of two of the turbines or elements of the series comprising the engine. Fig. 3 is a transverse section on the line *x*—*x* of Fig. 2. Fig. 4 is a detail perspective view of the valve and operating means therefor.

Corresponding and like parts are referred to in the following description, and indicated in all the views of the drawings, by the same reference characters.

The engine comprises a series of steam turbines A, A′ and A², which are mounted in line and have a shaft 1 common to the series. It is to be understood that there may be any number of steam turbines or engine elements and that they increase in size progressively from the receiving engine to the discharge engine. The receiving engine is the one having direct connection with the boiler or steam generator and receiving steam therefrom at boiler or high pressure. The discharging engine is the last of the series and exhausts the spent steam either into the atmosphere or into a hot well or other form of condensing chamber. The several engine elements or turbines are in communication so that the steam exhausted from one engine is admitted into the next engine to operate the same by expansive force and so on throughout the series until finally discharged into the air or condenser. The shaft 1 is mounted in bearings 2, which consist of standards or uprights of any construction, the bearings being provided in number so that an engine is supported between each two of the bearings, as indicated most clearly in Fig. 1. A fly wheel or band pulley 3 is secured to one end of the shaft 1.

The several engine elements or turbines are of like formation except as to size, the latter increasing in progressive order from the receiving to the discharging turbine in the manner herein stated. Because of the similarity of construction of the several turbines a detailed description of one will suffice for a clear understanding of each. Each turbine or engine element comprises a cylinder, which is formed in two parts or sections 4 and 5. These sections 4 and 5 have outer flanges which are apertured to receive bolts or other fastenings.

By forming the cylinder in the manner stated the interior is readily accessible for any purpose. The section or part 5 is formed with a port 6, whereas the section 4 has two ports 7 and 8, either one of which constitutes an inlet for the steam according to the direction of rotation of the engine, the port 6 forming an outlet or exhaust. A chest or valve casing 9 is secured to the section 4 and is provided with ports 10 and 11, which register respectively with the ports 7 and 8. The supply pipe 12 connects with the chest 9 of the turbine A. A rotary piston is arranged to operate in each of the cylinders and consists of a hub 13 and radial blades 14, the latter closely fitting the outer portion of the cylinder, which is made rounding. The rotary piston is keyed or otherwise secured to the shaft 1 so as to rotate therewith. Each of the radial blades 14 is provided with a packing to insure a steam-tight fit between the blades and the cylinder. The packing 15 is of substantially U-form and is fitted in a groove formed in

the end and sides of the blades. A spring 16 normally exerts an outward pressure upon the packing 15 to force the same in contact with the inner wall of the cylinder, said spring being located in an opening formed centrally of each blade 14. The packing 15 is of metal and its side members normally tend to spring outward so as to maintain a close fit against opposite sides of the cylinder. Packing rings 29 are fitted into annular grooves formed in the sides of the piston, said packing rings being pressed outward by means of springs 30 let into openings formed in the pistons. The packing rings 29 maintain a steam-tight joint between the side walls of the cylinder and the sides of the piston so as to prevent any escape of steam through the joint formed between the cylinder and the shaft 1.

It is observed that the inlet and the exhaust ports are located at diametrically opposite points of the cylinders and for simplicity of construction and arrangement the cylinders have an alternate arrangement in successive order, so that the inlet of the first turbine is at the top and the exhaust at the bottom, and the inlet of the second turbine is at the bottom and the exhaust at the top and the inlet of the third turbine is at the top and the exhaust at the bottom and so on throughout the series. This arrangement results in an alternate disposition of the steam chests, as indicated most clearly in Fig. 1. The steam from the boiler, generator or other source is supplied to the turbine A by means of the pipe 12 and the steam exhausted from the turbine A is supplied to the turbine A′ by means of a pipe 17, which connects the exhaust port of the turbine A with the chest 9 of the turbine A′. A pipe 18 connects the exhaust of the turbine A′ with the chest of the turbine A^2 and an exhaust pipe 19 carries off the steam from the turbine or the discharging engine element.

A shaft 20 is mounted in the heads of the upper series of steam chests and the controlling valves operated thereby for connection with said shaft. A shaft 21 is mounted in the heads of the lower chest or chests and has the valve or valves arranged to operate in the chest or chests connected therewith. The two shafts 20 and 21 are connected for simultaneous operation at a like speed. While any means may be employed for connecting the two shafts 20 and 21 it is preferred to provide the shaft 20 with a sprocket wheel 22 and the shaft 21 with a sprocket wheel 23, both sprocket wheels being of like diameter and connected by means of a sprocket chain 24. A hand wheel 25 is applied to one of the shafts, as 21, for turning the same to fix the relative position of the valves. Each of the chests 9 has a valve 26, which is provided with a slot or opening 27 to receive a head 28 provided upon the shaft. The valve 26 has its face made rounding to conform to the curved wall of the chest 9, said valve having a shank portion in which the slot or opening 27 is formed. The head 28 is of rectangular formation and is adapted to have play in the slot or opening 27, thereby admitting of the parts readily adapting themselves when placing them together and at the same time admitting of inserting or removing the shaft by an endwise movement, the head 28 sliding into or out of the slot or opening 27, as will be readily understood. By moving the valves 26 into one position one or both of the ports 10 or 11 may be closed, thereby shutting off the steam or admitting the same into either one of the ports according to the direction of rotation of the engine. If the valve is turned to close both ports 10 and 11 steam is cut off from the engine. By turning the valve to admit steam into the port 10 only the engine is driven to the left or by turning the valve to admit steam into the port 11 only the engine is driven to the right. It will thus be understood that the valve is used both in the capacity of a throttle and for reversing the engine and for regulating the amount of steam to be supplied to the engine according to the load. The series of valves are so arranged and connected that by operating the hand wheel 25 all the valves have a like movement and coöperate to control the steam to the respective cylinders or turbines.

From the foregoing description, taken in connection with the accompanying drawings, the advantages of the construction and of the method of operation will be readily apparent to those skilled in the art to which the invention appertains, and while I have described the principle of operation of the invention, together with the device which I now consider to be the embodiment thereof, I desire to have it understood that the device shown is merely illustrative, and that such changes may be made when desired as are within the scope of the claims appended hereto.

Having thus described the invention what is claimed as new, is:—

1. A rotary engine comprising a cylinder having its outer and side walls of integral formation and made rounding, a rotary piston having a blade, the outer end of which is made rounding to conform to the curved wall of the cylinder, a U-shaped spring packing fitted in a groove formed in the outer end and sides of the blade of the piston, and a spring interposed between the U-shaped packing and blade to press the packing outward.

2. A rotary engine comprising a cylinder having its outer walls made rounding, a rotary piston arranged to operate in the cylinder and comprising a hub and a series of

radially disposed blades having grooves in their ends and sides and having annular grooves in the sides of the hub, spring metal packing of U-form fitted in the grooved ends of the blades, springs interposed between the packing and blades to press the packing outward, packing rings fitted in the annular grooves in the sides of the piston, and springs for forcing the packing rings outward.

In testimony whereof I affix my signature in presence of two witnesses.

EDWARD HAGER.

Witnesses:

LENA THOMPSON,

LEONA MAGER.