(No Model.) 3 Sheets—Sheet 1.

J. I. THORNYCROFT.

SPEED INDICATOR FOR ROTATING SHAFTS.

No. 442,554. Patented Dec. 9, 1890.

Fig. 1.

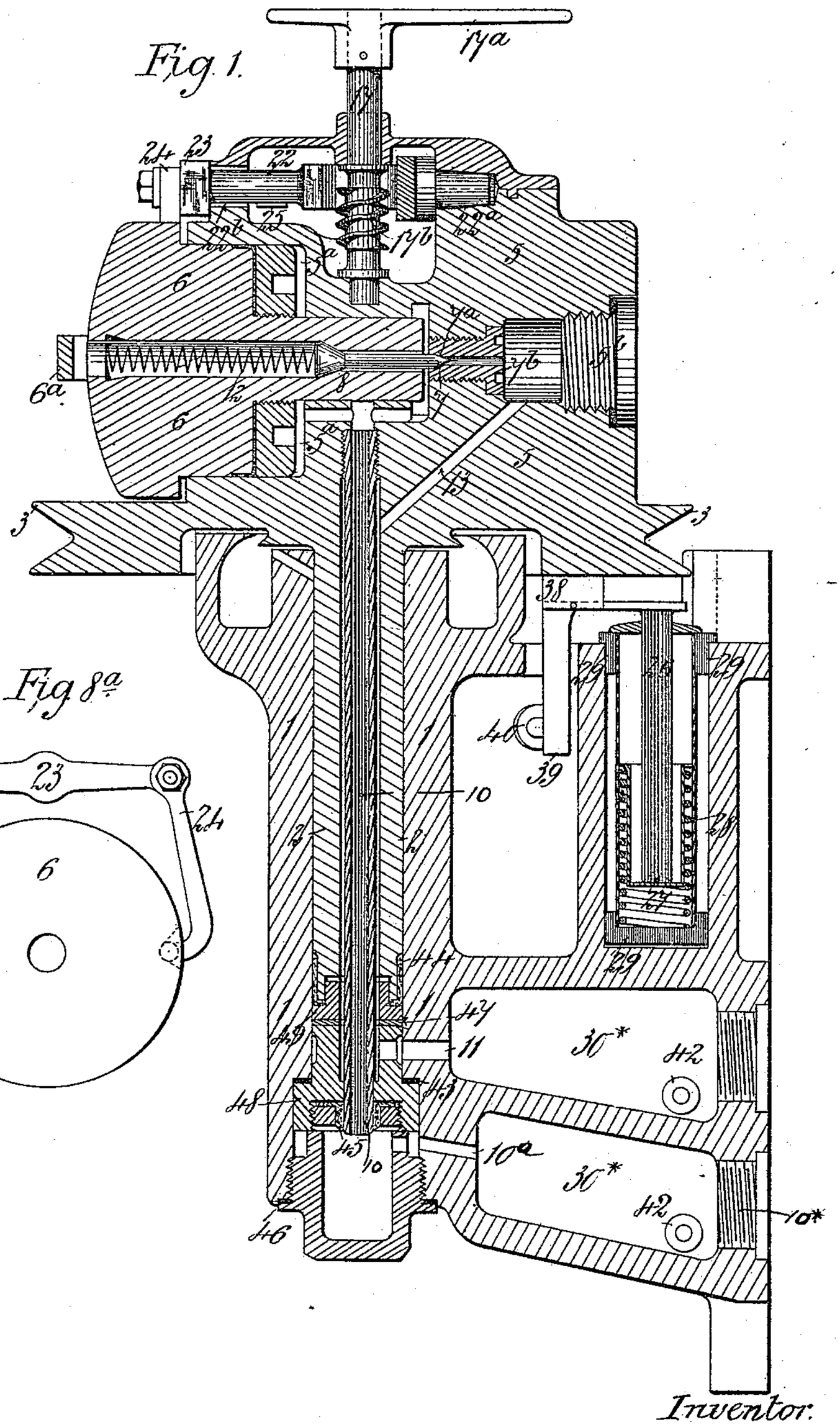

Fig 8a.

Witnesses

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C. M. Werle

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Attorney

(No Model.) 3 Sheets—Sheet 2.

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Fig. 2.

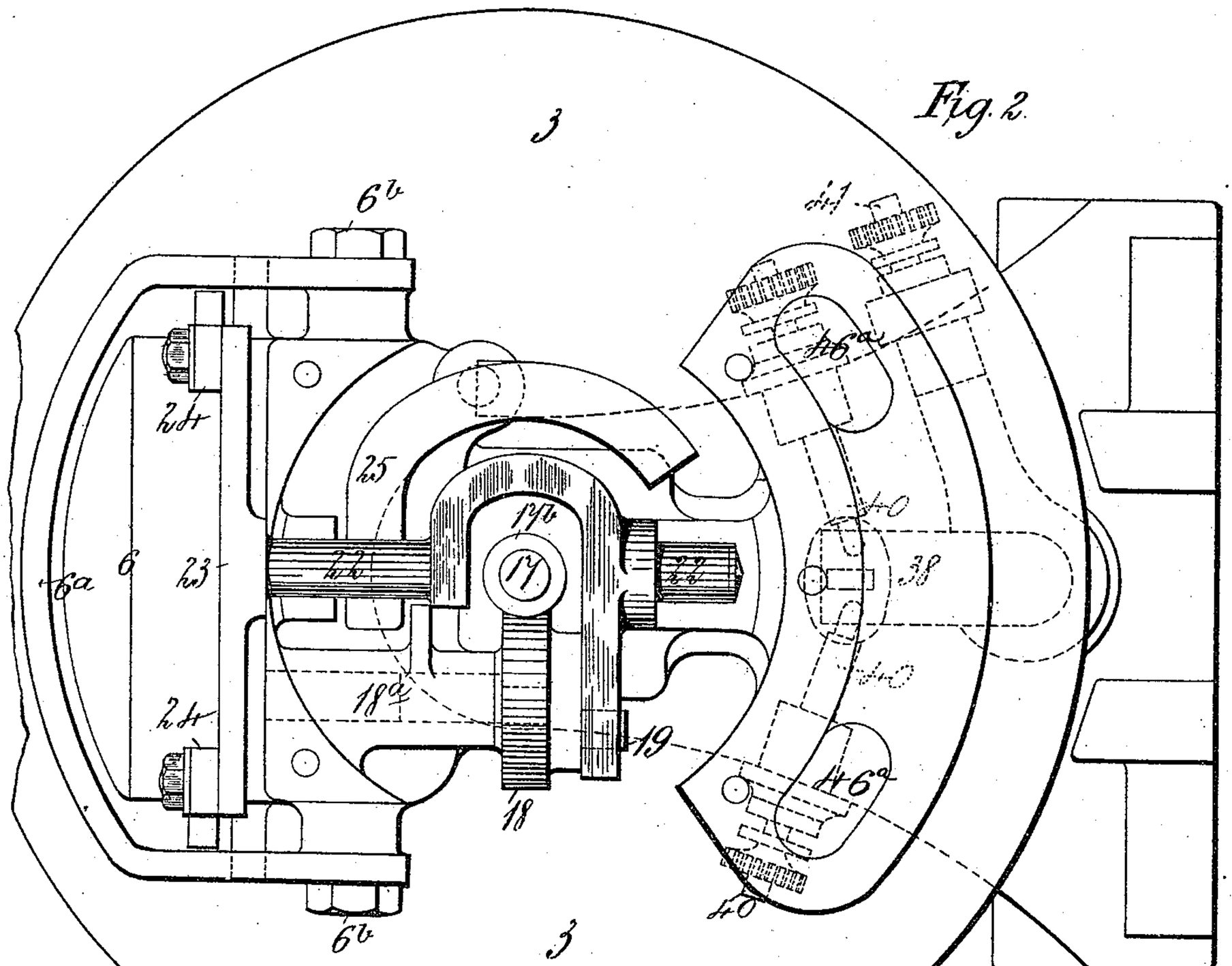


Fig. 5.

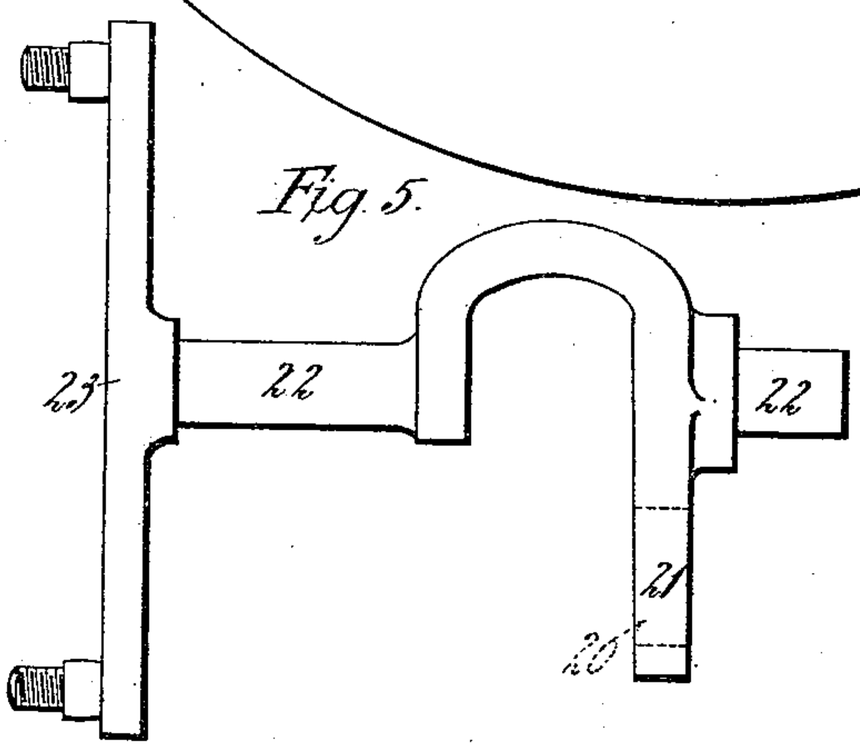


Fig. 3.

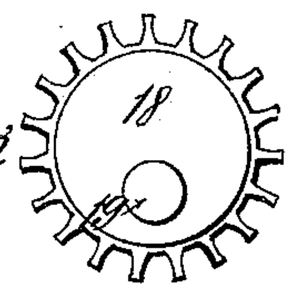


Fig. 4.

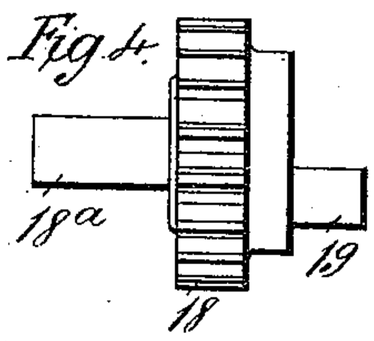
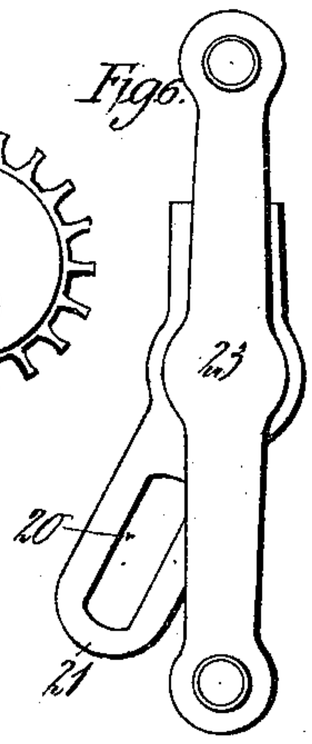


Fig. 6.



Witnesses.
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Fig. 11.

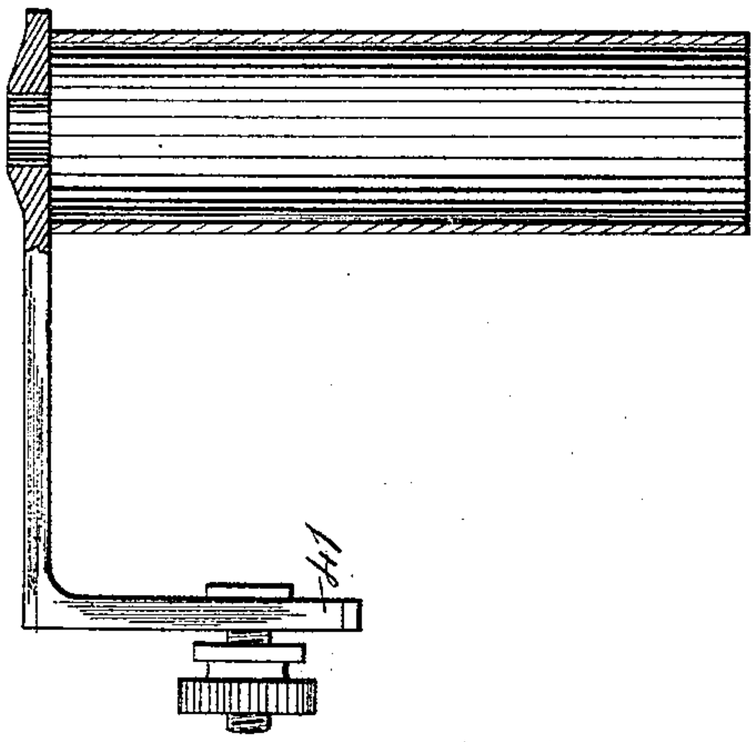

Fig. 9.

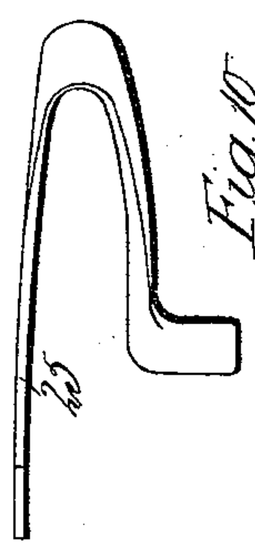

Fig. 10.

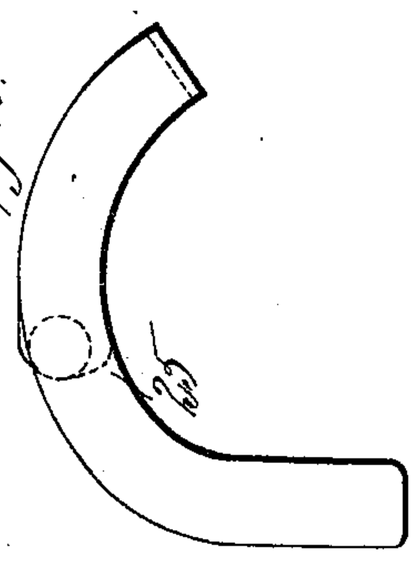

Fig. 7.

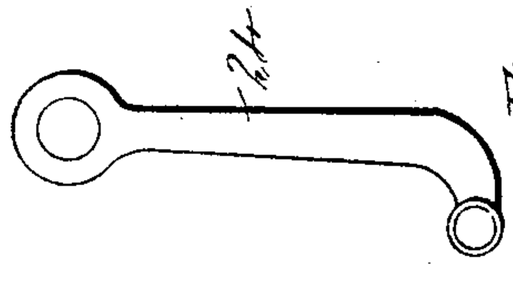

Fig. 8.

Witnesses
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C. M. Werle

Inventor
J. I. Thornycroft
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UNITED STATES PATENT OFFICE.

JOHN ISAAC THORNYCROFT, OF CHISWICK, ENGLAND.

SPEED-INDICATOR FOR ROTATING SHAFTS.

SPECIFICATION forming part of Letters Patent No. 442,554, dated December 9, 1890.

Application filed February 24, 1890. Serial No. 341,635. (No model.)

To all whom it may concern:

Be it known that I, JOHN ISAAC THORNYCROFT, a subject of the Queen of Great Britain and Ireland, residing at Chiswick, in the county of Middlesex, England, have invented Improvements in Apparatus for Controlling Pressure Applicable to Indicating the Speed of Rotating Shafts, of which the following is a specification.

This invention has reference to apparatus for controlling pressure, and which is applicable for indicating the speed of rotating shafts; and the particular kind of apparatus to which my present improvements relate is that described in the specification of a former patent granted to me under date the 20th day of August, 1889, No. 409,524.

The essential features of apparatus of the kind referred to are (when the pressure to be controlled is less than that of the atmosphere) a hollow revolving body or valve-case (hereinafter called a "valve-case") connected at one part to an apparatus capable of exerting a constant exhausting action, at a second part to the pipe or vessel in which the pressure is to be controlled, and at a third part to the atmosphere. The first and third connections are each provided with a valve, the two valves being on one spindle and moving together. The third inlet or opening to the valve-case is located in a plunger, piston, or diaphragm, subject to centrifugal force. It is this force which determines the pressure maintained in the valve-case and in the pipe or vessel connected with it. If the motion which causes this centrifugal force is derived from the motion of a rotating shaft then the pressure in the exhausted pipe or vessel will be a function of the speed of the rotating shaft, and may be made to operate a gage or gages upon which the speed of the shaft may be read; and in order that my present improvements in the above-mentioned apparatus may be clearly understood, I will, in referring to certain parts of the original arrangement, distinguish them by the reference-numerals with which they are described in the drawings annexed to the specification of my before-mentioned patent.

To simplify the construction and render the apparatus more efficient and reliable, I dispense with the dish or cup 4, heretofore used for carrying the valve-case 5, and construct the apparatus with a combined valve-case, cylinder for plunger, and driving-spindle, all formed in one piece and provided with a driving-pulley that may be of the same piece or a separate part, the arrangement being such as to dispense with the packing-ring 16 and with the packing-ring applied between the valve-case and the top of the tube 10 in my original apparatus; also, I make the valve-seat in the valve-case separate from the main casting, for convenience of manufacture, and to permit of its being easily renewed.

For the purpose of reducing the friction of the plunger in a longitudinal direction and to make the same more sensitive to changes of pressure, I provide means for imparting a constant rocking motion to it. I likewise provide a spring, whereby the weight of the plunger is supported to keep it exactly central in its cylinder; and in this way, also, to reduce its friction, I provide a fixed safety-band to prevent the plunger accidentally flying out of its cylinder.

In order that the apparatus shall indicate the direction of rotation as well as the speed, I arrange a movable electric contact or terminal in rubbing contact with a moving part of the apparatus, so that the said contact or terminal is pressed against one of two fixed electric contacts or terminals. One of these contacts is fixed at each side of a movable contact and connects with an indicator which shows the direction of motion.

To facilitate the comprehension of my present improvements, reference is made to the accompanying sheets of drawings, in which—

Figure 1 is a vertical central section of the improved apparatus. Fig. 2 is a plan. Figs. 3 to 8 show details of the rocking apparatus. Fig. 8ª is an end view of the plunger and the links and lever for imparting a to-and-fro rotary motion thereto. Figs. 9 and 10 show the spring. Fig. 11 is a detail of the electric device.

5 is a valve-case formed with a bored part 5ª, constituting a cylinder, within which works a plunger 6 capable of endwise movement.

This valve-case and cylinder is, for the purposes hereinbefore mentioned, made in one piece with the vertical driving-spindle 2, which is mounted to rotate within a fixed bearing 1. The driving-pulley 3 is, in the example shown, also made in one piece with the driving-spindle. A central hole is bored through the plunger, and at one part of it there is formed a valve-seat, against which there normally rests the valve 8. Against one side of this valve 8 bears one end of a spring 12, the other end of which bears against a shoulder in the plunger 6. This spring should be so constructed and arranged as to exert only a small force against the valve 8. The valve 8 is connected by a rod or stem to a second valve 7, which normally rests against a seat 7^a, formed in a removable bush 7^b, which is screwed into a recess prepared for it in the valve-case 5. This opening through which the bush is introduced is closed by a plug 5^b. The plunger 6 is capable of a small endwise movement in either direction from the position in which it is shown. To prevent it being accidentally thrown out of its cylinder by the centrifugal force, it is partly surrounded by a safety band or bridle 6^a, which is attached to the valve-case by screws 6^b 6^b.

The plunger 6 receives a to-and-fro oscillating motion to reduce its friction in its cylinder. This motion is imparted as follows: In the axial line of the rotary valve-case is a spindle 17, held stationary by an arm 17^a, which is attached to some fixed object. On the spindle 17 is a worm 17^b, with which there engages a worm-wheel 18 on the spindle 18^a. In the face of the worm-wheel is a crank-pin 19, which works in a slot 20 in a lever 21 formed in one with the shaft 22. On the extremity of the shaft is a double-armed lever 23, to each end of which is pivoted a link 24. Each of these links is pivoted at its other extremity to the plunger 6. (See Fig. 8^a.) The links are so pivoted to the lever and to the plunger as to permit, when necessary, of a small movement of the plunger in the direction of its axis without its becoming disconnected from the lower ends of the links. For this purpose the bearing-surfaces between the links and the lever and plunger may be made slightly spherical or barrel-shaped. When the valve-case is in rotation, the worm-wheel revolves about the room 17^b, and at the same time it rotates on its axis. The crank-pin working in the slot 20 gives a to-and-fro oscillating motion to the shaft 22, and this motion is transferred to the plunger 6. It is well known that if a plunger or piston is kept in rotary motion it can be moved endwise with little friction, and, further, that it is prevented from sticking or becoming fast in its cylinder. The spindle 22 at its inner end runs in a bearing 22^a, and near its outer end, which works through a guide 22^b, is supported by a spring 25, which keeps the links 24 always in tension, in such a manner as to take the weight of the plunger 6 and thereby reduce its friction in the cylinder. For this purpose the bearing 22^a is made conical or sufficiently large to permit of the outer end of the spindle making, when necessary, a slight upward turning movement about the bearing 22^a as a center.

In order that the direction of motion, as well as the rate of revolution, may be indicated, an electrical device is added to the apparatus. Within the framing there is mounted a spindle 26, standing on a footstep 27, constantly pressed upward by a spring 28. This spring is soldered to its abutment at its end, as it also serves for an electric conductor. This spindle is insulated from the frame by non-conducting packings 29. Connected to the spindle 26 is an arm 38, covered or partially covered with insulating material. This arm is kept in rubbing contact with the under side of the pulley 3 by the spring 28. When the pulley revolves in one direction it carries the arm with it as far as it is permitted to go, and when it revolves in the other direction it does similarly. From the arm 38 there depends a finger 39, capable of moving within the limits defined by two stops 40 40. These stops are the terminals of two electric circuits, which have a common return through the terminal 41, which is in metallic contact with the footstep-bearing of the spindle 26, through the spring 28. If the two terminals 40 40 be connected to the two poles of an electric battery, and if the terminal 41 be connected to the center of the same battery, then the current will flow through the conductor connecting the terminal 41 to the battery in one direction when the pulley 3 rotates to the right and in the opposite direction when it rotates to the left. An instrument such as a galvanoscope interposed in the circuit will thus show the direction of motion of the pulley.

The connections to the pipe in which the pressure is to be controlled and to the exhausting apparatus now form part of the frame at 10* and 11, respectively. Cavities 30* are formed leading to these orifices, and are employed to catch the lubricant which leaks down the spindle. This can be drawn off by cocks at 42 42. To prevent communication between the pipe in which the pressure is to be controlled, the exhausting apparatus and the atmosphere packing is employed around the spindle 2. This consists of a leather ring 43 and a cupped leather 44, and a smaller cupped leather 45.

46 is a packing-ring to prevent entry of air to the lower cavity 30*.

47 is a steel ring that serves to lessen friction between the fixed plug 48 and a collar 49 that may revolve with the spindle 2, and which serves to hold the packing-ring 44 in place.

In order to prevent variation in the velocity ratio of the driving-pulley (the velocity of which is to be indicated) and the pulley 3 driven thereby should the driving-cord be-

come reduced in diameter due to wear or other cause, the angle of the V-shaped groove of each pulley should be such that the distances between the center of the cord and the bottoms of the grooves of the two pulleys when the cord is in place in the grooves will be in the ratio of the diameters of the two pulleys, measuring from the bottoms of the grooves.

To enable the revolving part to be readily balanced, holes 46ª 46ª are cast in it for the reception of lead weights.

Let it be assumed that the spindle is rotating with a uniform velocity and that the exhausting apparatus is in operation. The plunger 6 will be urged outward by centrifugal force, and this force will be balanced by the excess of pressure on its outer end over that on its inner end. Any outwardly-acting centrifugal force in the coupled valves 7 and 8 is resisted by the spring 12. Now should the speed of rotation of the spindle increase, the plunger will move outward and the valve 7 will leave its seat. Air will then be drawn from the external indicator-tube through the tube connected to the frame at 10*, the passage 10ª, and the tube 10 past the valve 7 into the passage 13 and down the annular passage in the spindle to the chamber at the bottom of it, and thence by the outlet 11 to the exhausting apparatus. When the pressure has been reduced sufficiently to balance the centrifugal force of the plunger, the latter returns to its former position and the valve 7 closes the passage 13. Thus the pressure in the external indicator-tube, on which is or are mounted one or more vacuum-gages, will vary with the speed of revolution of the shaft from which the pulley 3 is driven, and this speed will be indicated by the said gage or gages, as in the apparatus described in the said former specification. Should the speed of the shaft be decreased the plunger will move inward and the external air will pass the valve 8 until the partial vacuum existing below the plunger and in the indicator-pipe is so far reduced that the plunger moves back to its normal position and closes the valve 8.

What I claim is—

1. In apparatus for indicating the speed of rotating shafts, a rotating valve-case with plunger-cylinder formed in one with the spindle on which it is mounted, and connected at one part to an apparatus for increasing or reducing fluid-pressure, such as an exhauster, at another part to the pipe in which pressure is to be varied, and at a third part to a source of constant pressure, such as the atmosphere, in combination with a body, such as a plunger, arranged to rotate with said valve-case and itself subjected to the direct action of centrifugal force, and a valve or valves controlling two of the connections to the said valve-case, substantially as described, for the purposes specified.

2. In apparatus for indicating the speed of rotating shafts, a rotating valve-case with plunger-cylinder formed in one with the spindle on which it is mounted and connected at one part to an apparatus for increasing or reducing fluid-pressure, such as an exhauster, at another part to the pipe in which pressure is to be varied, and at a third part to a source of constant pressure, such as the atmosphere, a plunger arranged to be rotated with said valve-case and to be subjected to the direct action of centrifugal force, and two valves, of which one is seated in the said plunger, substantially as described, for the purpose specified.

3. In apparatus for indicating the speed of rotating shafts, a rotating valve-case formed in one with the spindle on which it is mounted, and connected at one part to an apparatus for increasing or reducing fluid-pressure, such as an exhauster, at another part to the pipe in which pressure is to be varied, and at a third part to a source of constant pressure, such as the atmosphere, a plunger arranged to be rotated with said valve-case and to be subjected to the direct action of centrifugal force, and two valves, of which one is seated in the said plunger, while the other commands a connection between the apparatus for increasing or reducing fluid-pressure and the space in which the pressure is to be varied, substantially as described.

4. In apparatus for indicating the speed of rotating shafts, the combination, with a rotating valve-case with plunger-cylinder and a plunger subject to centrifugal force, of a safety-band arranged to prevent the plunger accidentally flying out of said cylinder, substantially as described.

5. In apparatus for indicating the speed of rotating shafts, a plunger having a constant oscillating motion and subject to centrifugal force, to a fluid-pressure which is capable of being varied, and to a constant fluid-pressure, such as the atmosphere, substantially as herein described, for the purposes set forth.

6. In apparatus for indicating the speed of rotating shafts, the combination, with a plunger subject to centrifugal force, to a fluid-pressure which is capable of being varied, and to a constant fluid-pressure, such as the atmosphere, of the links 24, lever 23, spindle 22, with slotted arm 21, worm-wheel 18, with crank-pin 19, and fixed worm 17ᵇ, substantially as described, for the purpose set forth.

7. In apparatus for indicating the speed of rotating shafts, the combination, with a plunger subject to centrifugal force, to a fluid-pressure which is capable of being varied, and to a constant fluid-pressure, such as the atmosphere, of the links 24, lever 23, spindle 22, with slotted arm 21, worm-wheel 18, with crank-pin 19, fixed worm 17ᵇ, and spring 25, arranged to support said plunger, substantially as described, for the purpose set forth.

8. In apparatus for indicating the speed of rotating shafts, the combination, with a driving-pulley 3, of a spindle supported by a footstep constantly pressed upward by a spring,

an arm carried by said spindle and in rubbing contact with, but electrically insulated from, said pulley, a movable electric terminal carried by said arm, two fixed terminals between which said terminal can move, and electrical connections, substantially as herein described, for the purpose set forth.

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

JOHN ISAAC THORNYCROFT.

Witnesses:

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WM. THOS. MARSHALL,

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