3 Sheets. Sheet 1.

J. Robertson,

Direct Acting Engine.

No. 106,078. Patented Aug. 2. 1870.

Fig 7

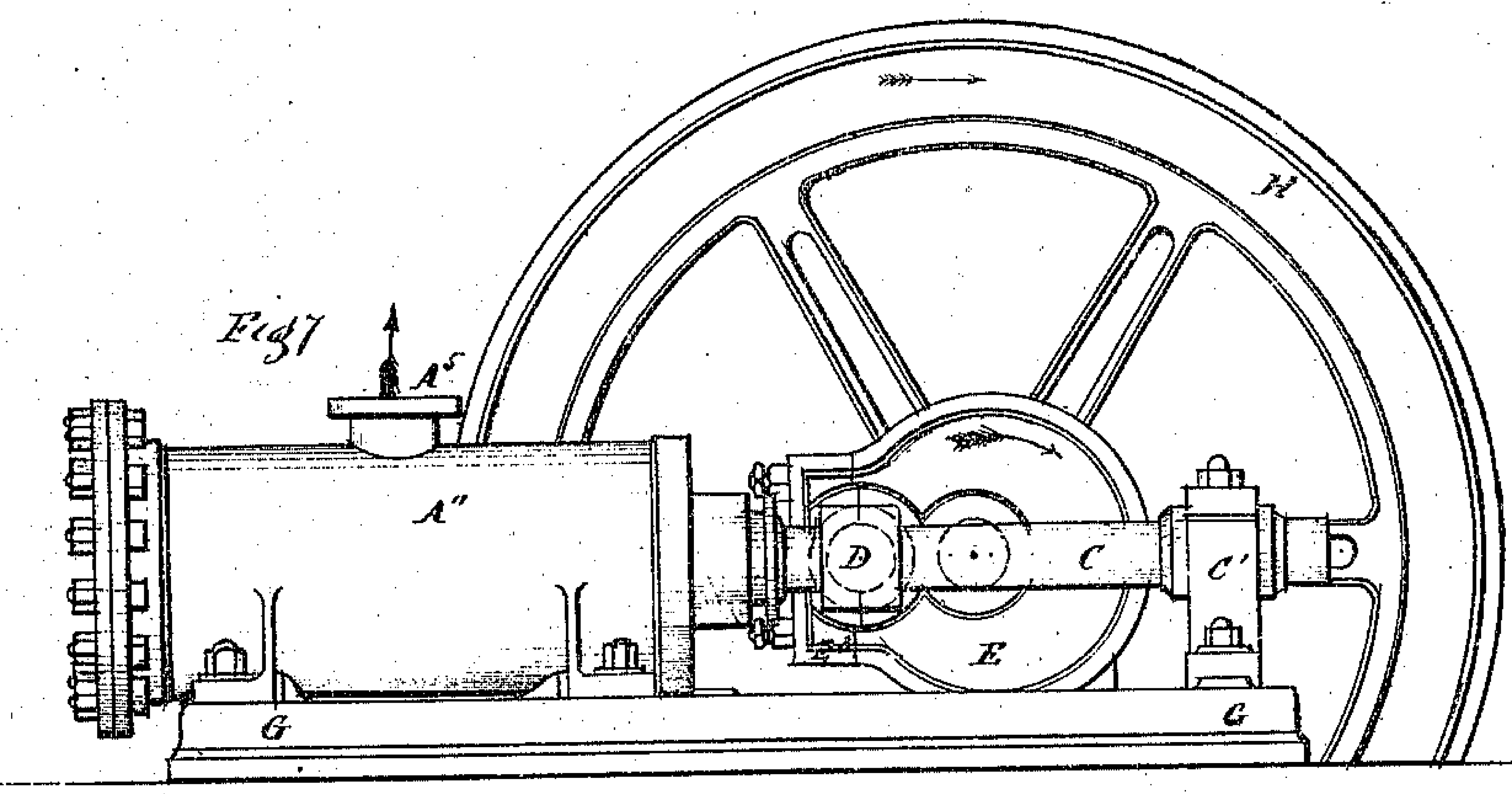
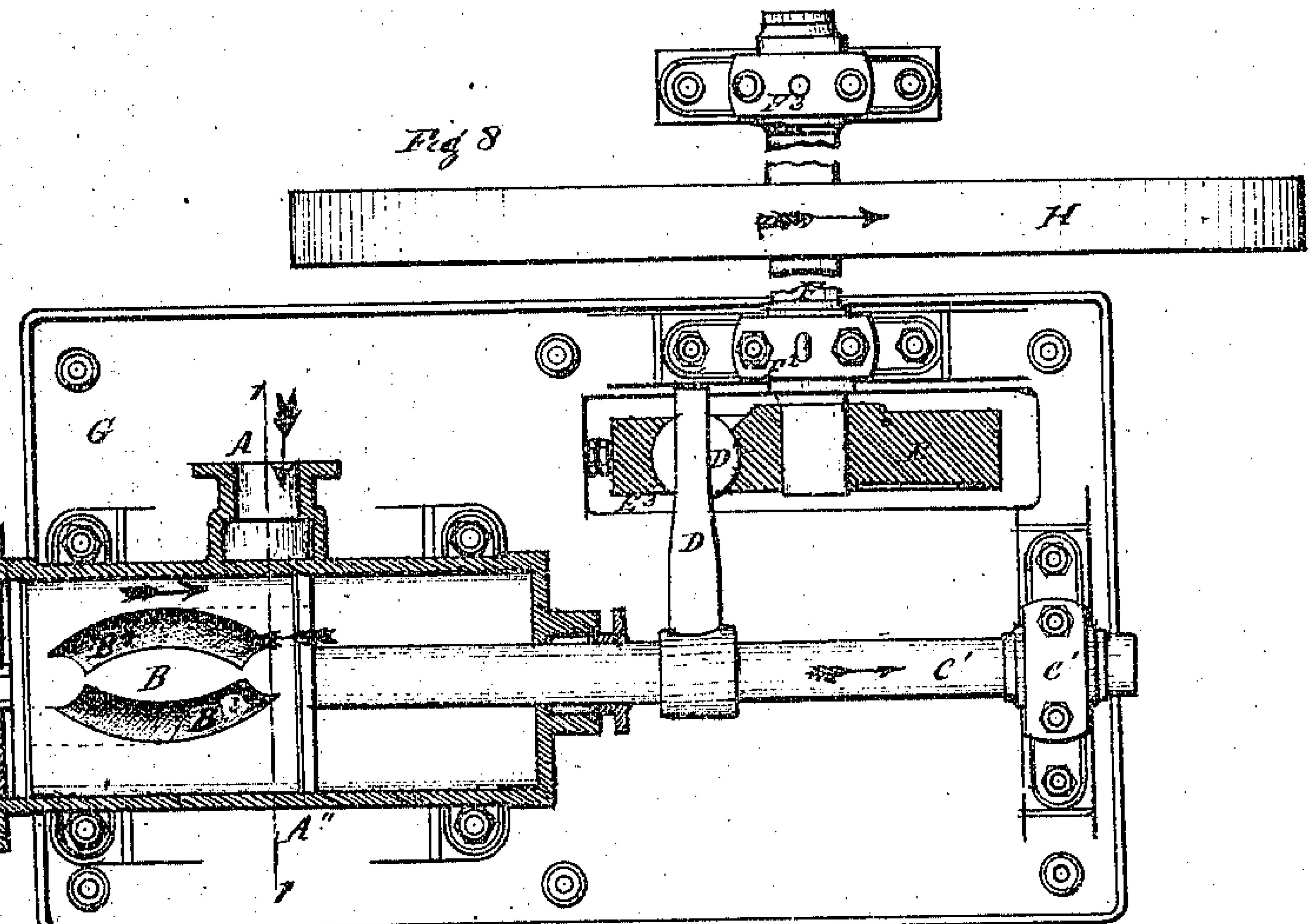


Fig 8



Witnesses: J. Dunig, R. Moss

Signature: James Robertson

Fig 9

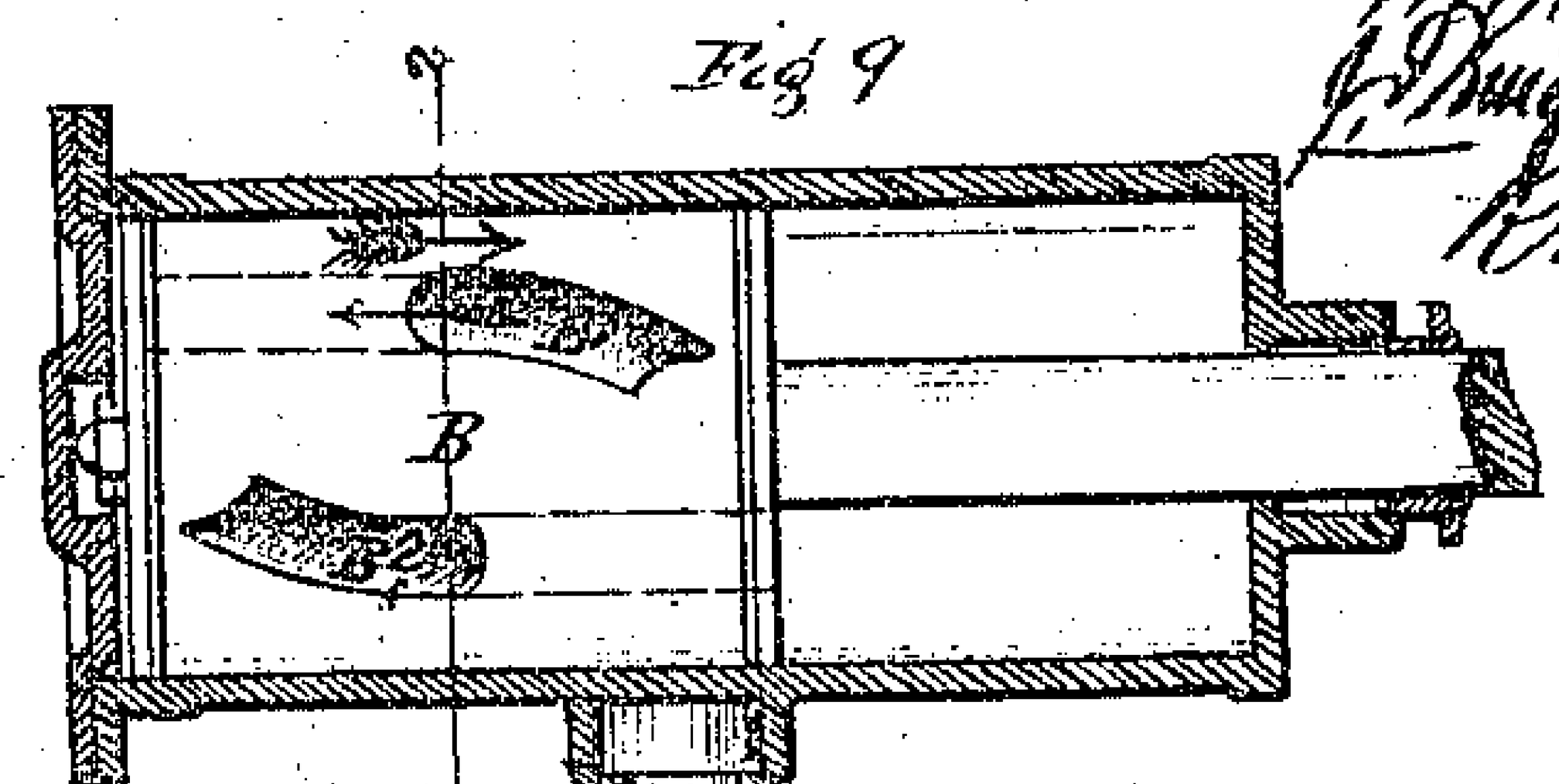


Fig 10

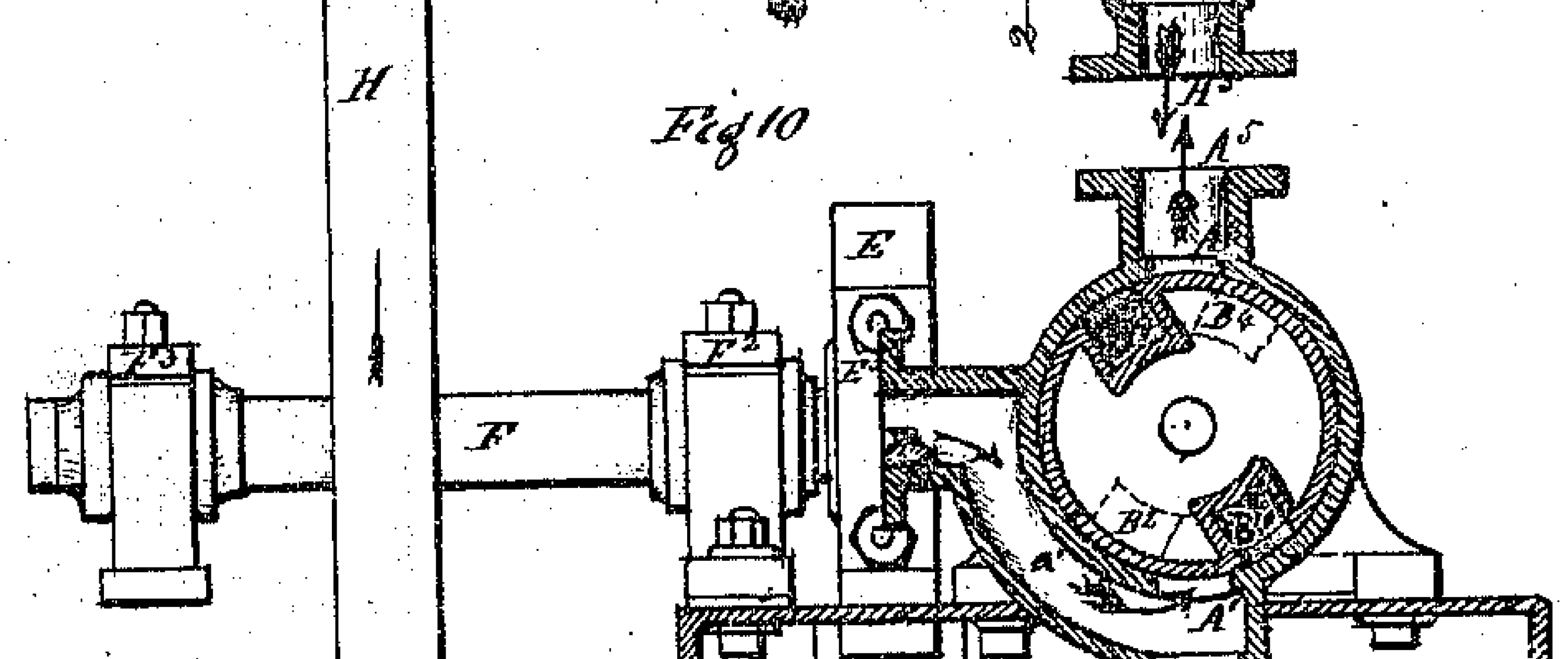
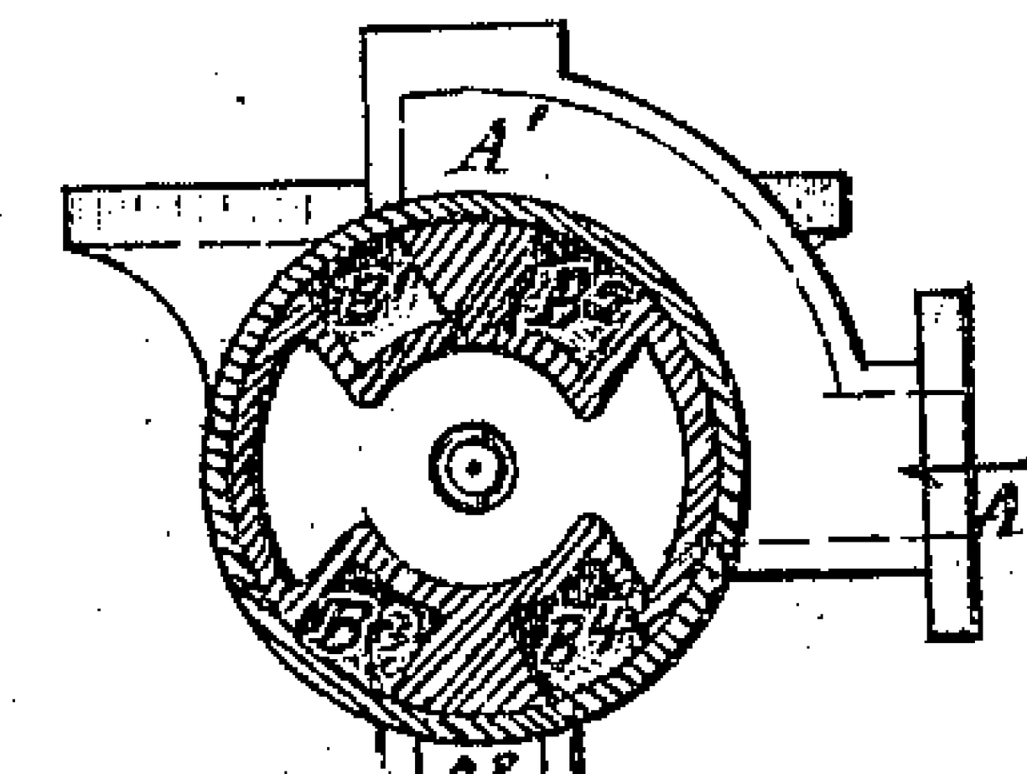


Fig 11



J. Robertson,

3, Sheets, Sheet 2.

Direct Acting Engine.

No. 106,078. Patented Aug. 2, 1870.

Fig 12.

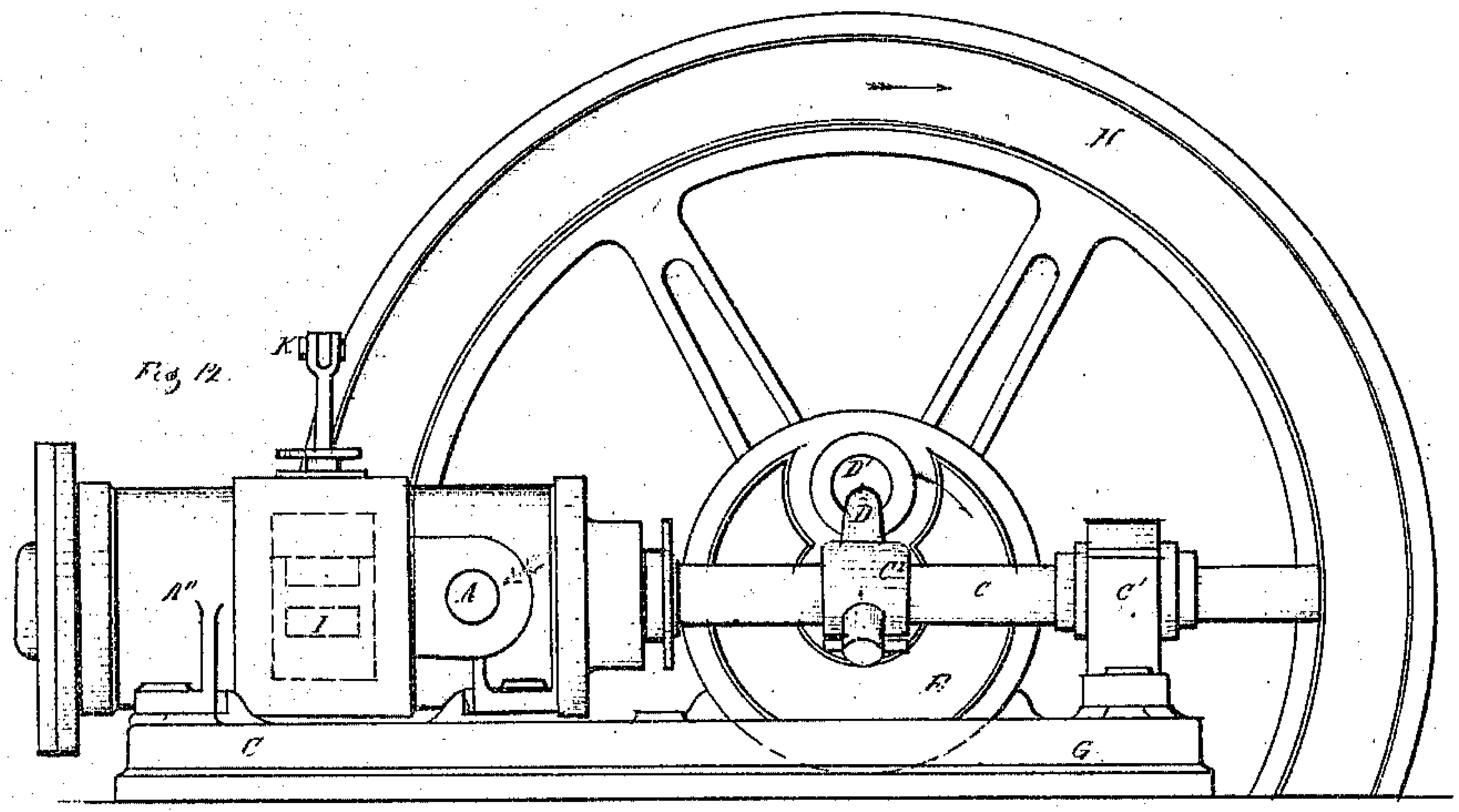
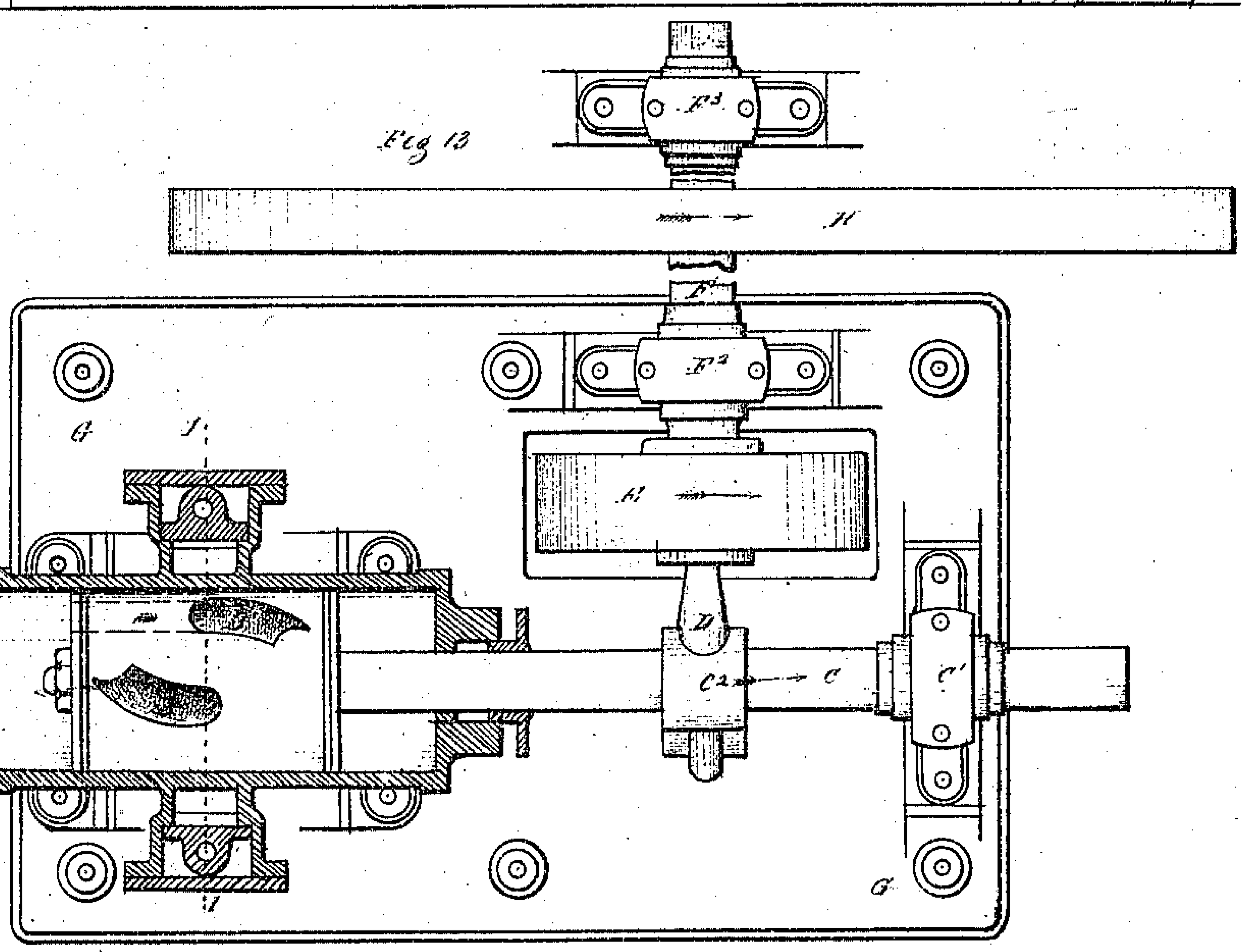


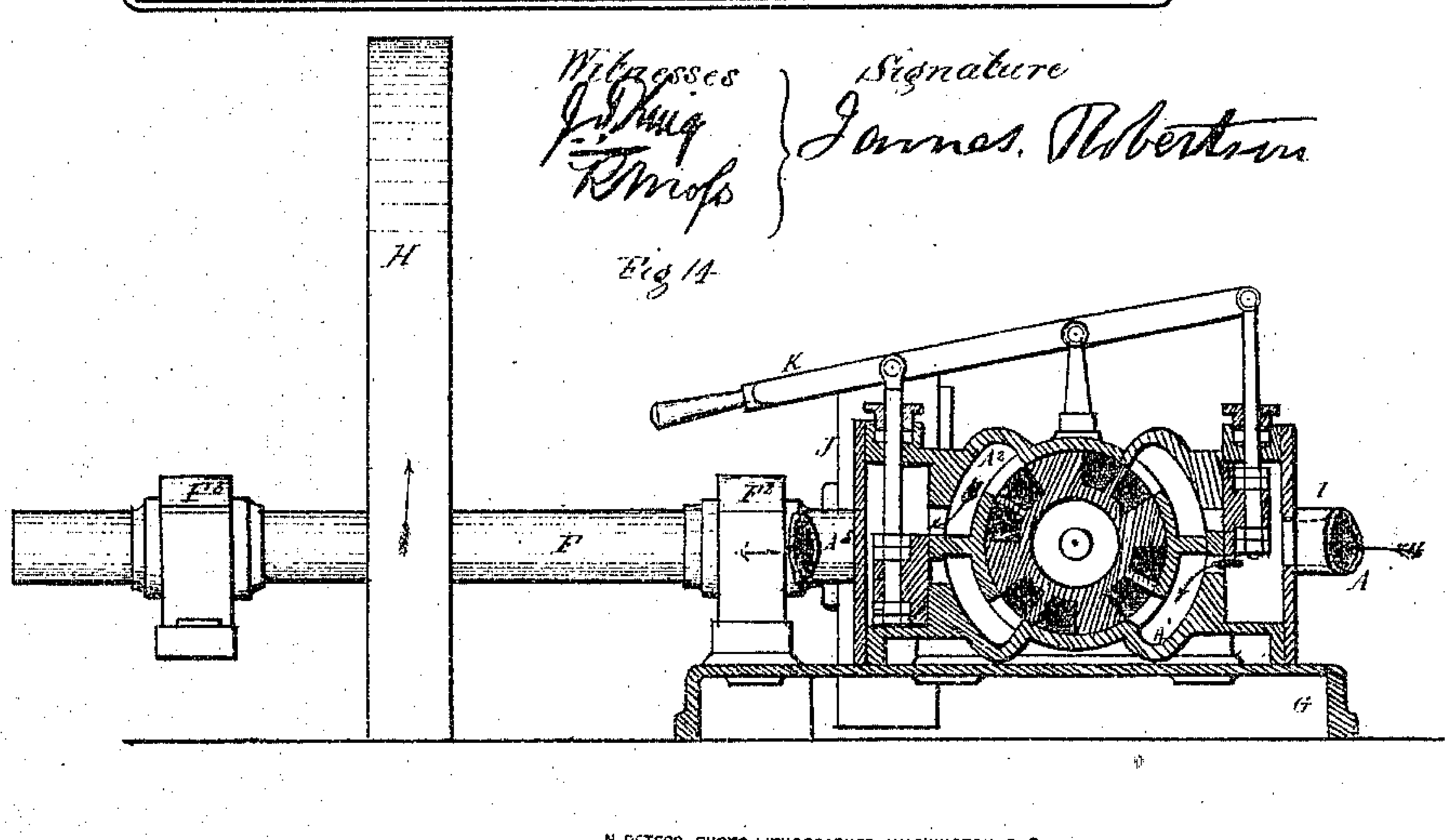
Fig 13



Witnesses
J. D. King
R. Moss

Signature
James. Robertson

Fig 14



N. PETERS, PHOTO-LITHOGRAPHER, WASHINGTON, D. C.

J. Robertson, 3. Sheets. Sheet 3.

Direct Acting Engine.

No. 106,078. Patented Aug. 2. 1870

Fig 20

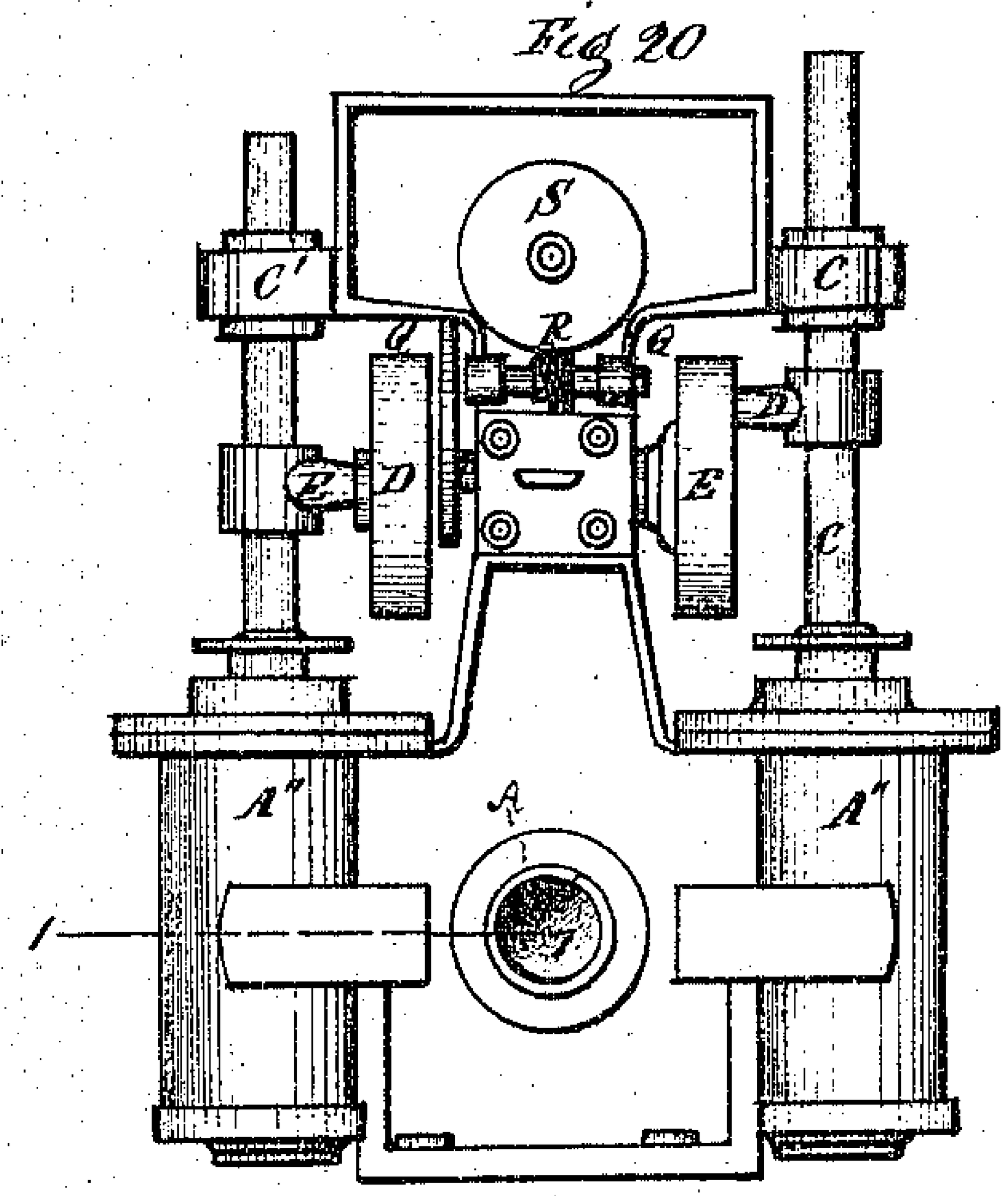


Fig 21

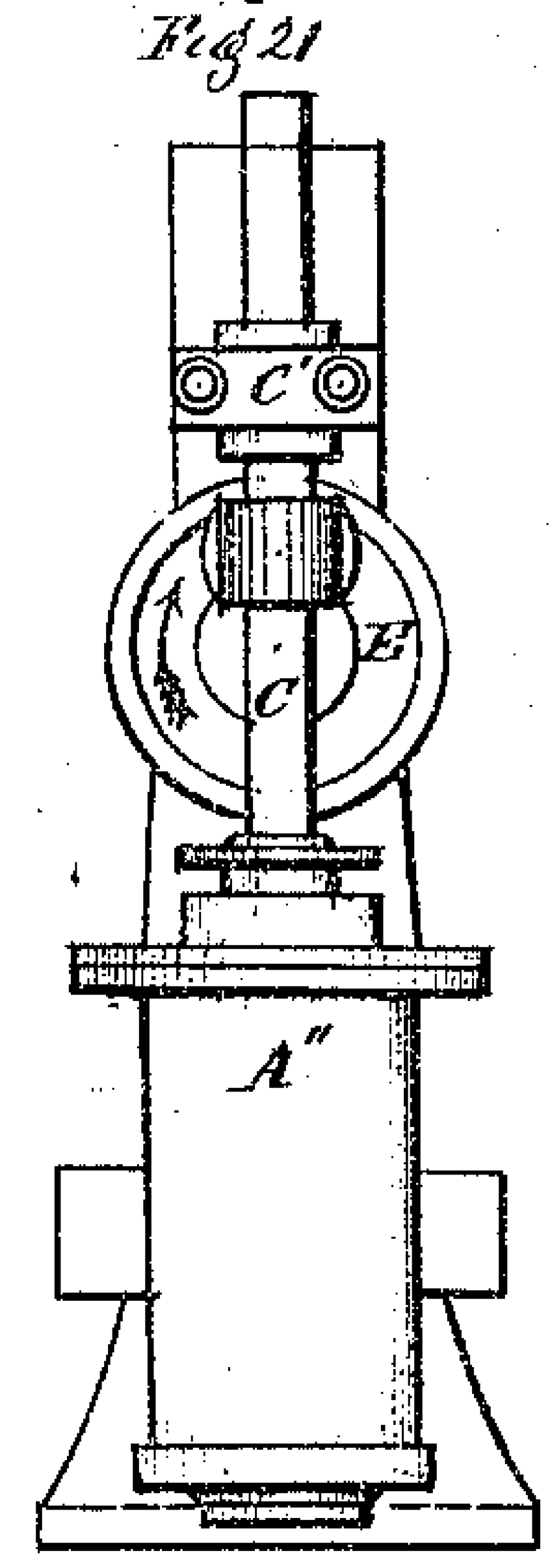


Fig 22

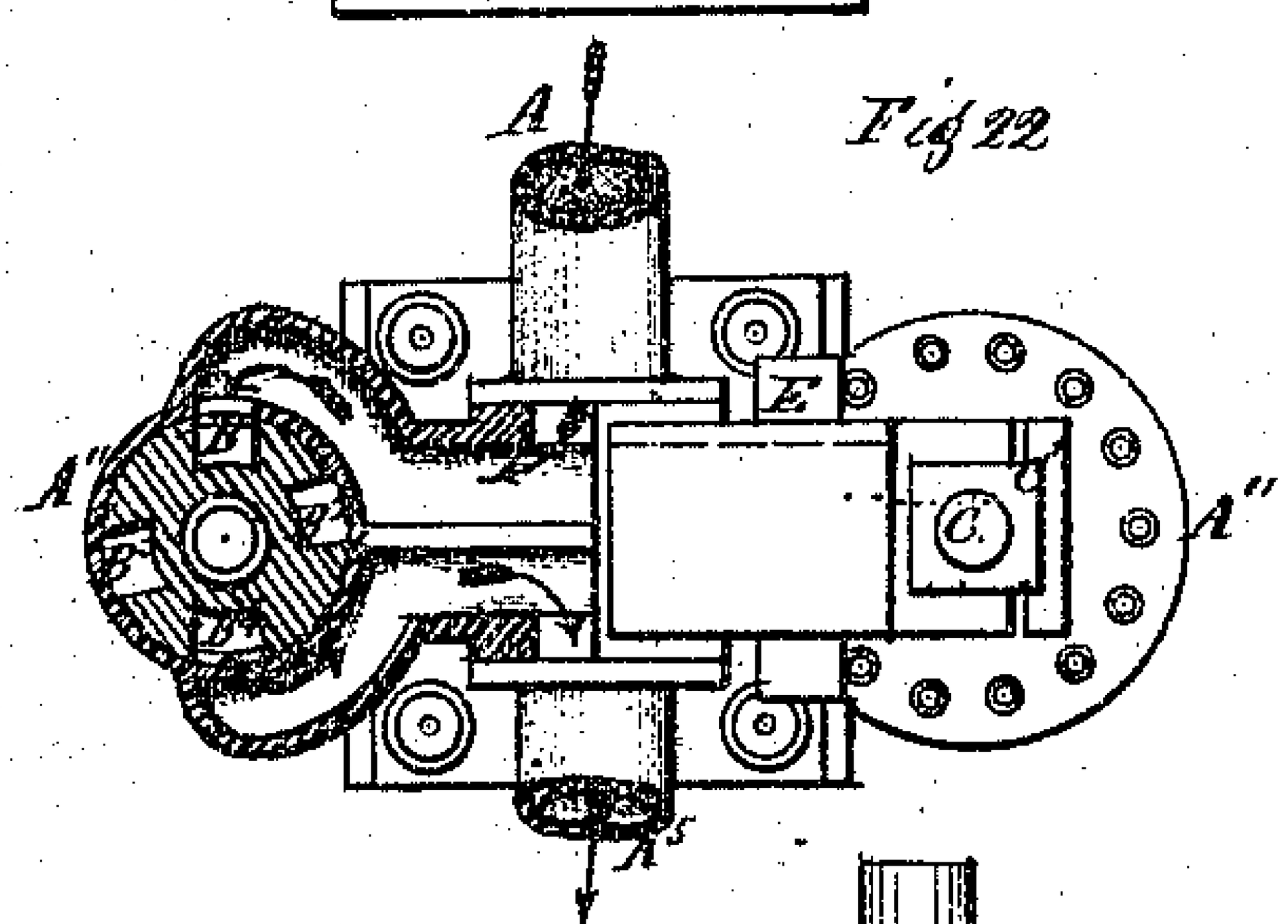


Fig 23

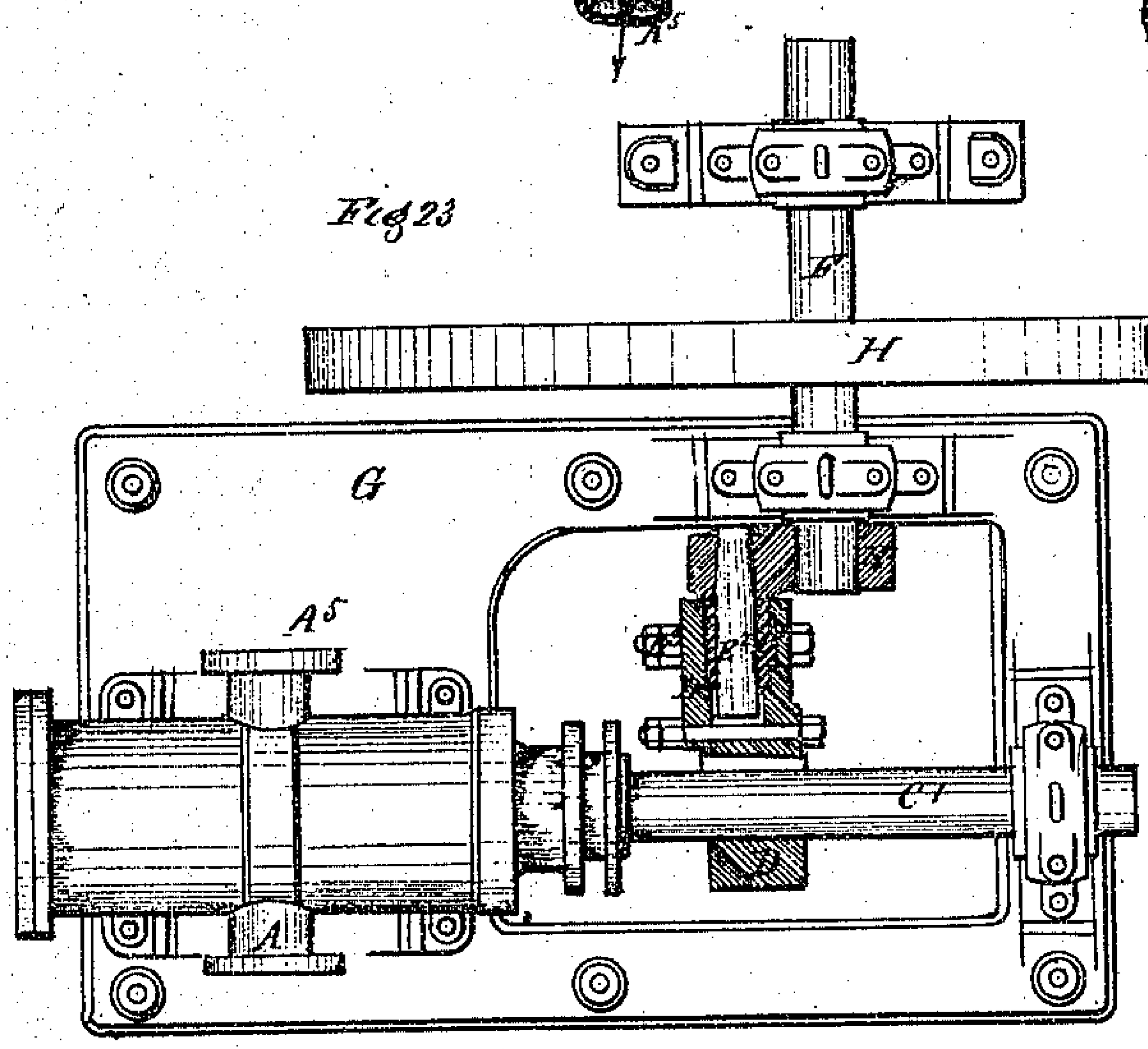


Fig 24

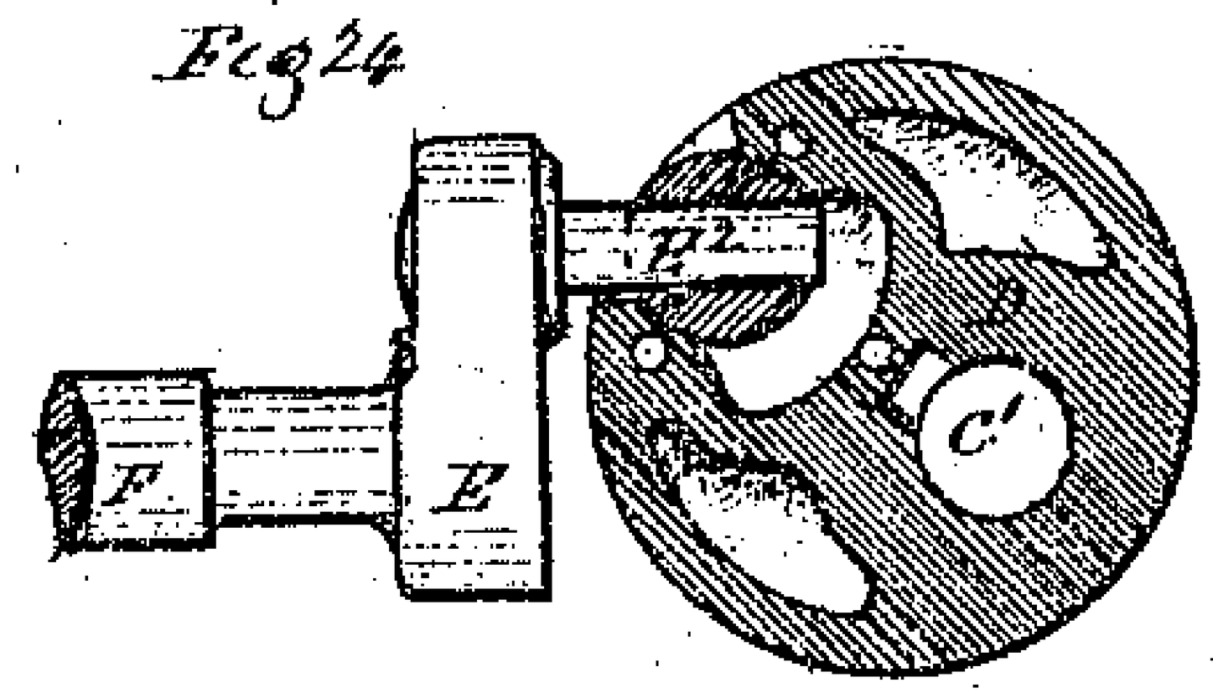


Fig 25

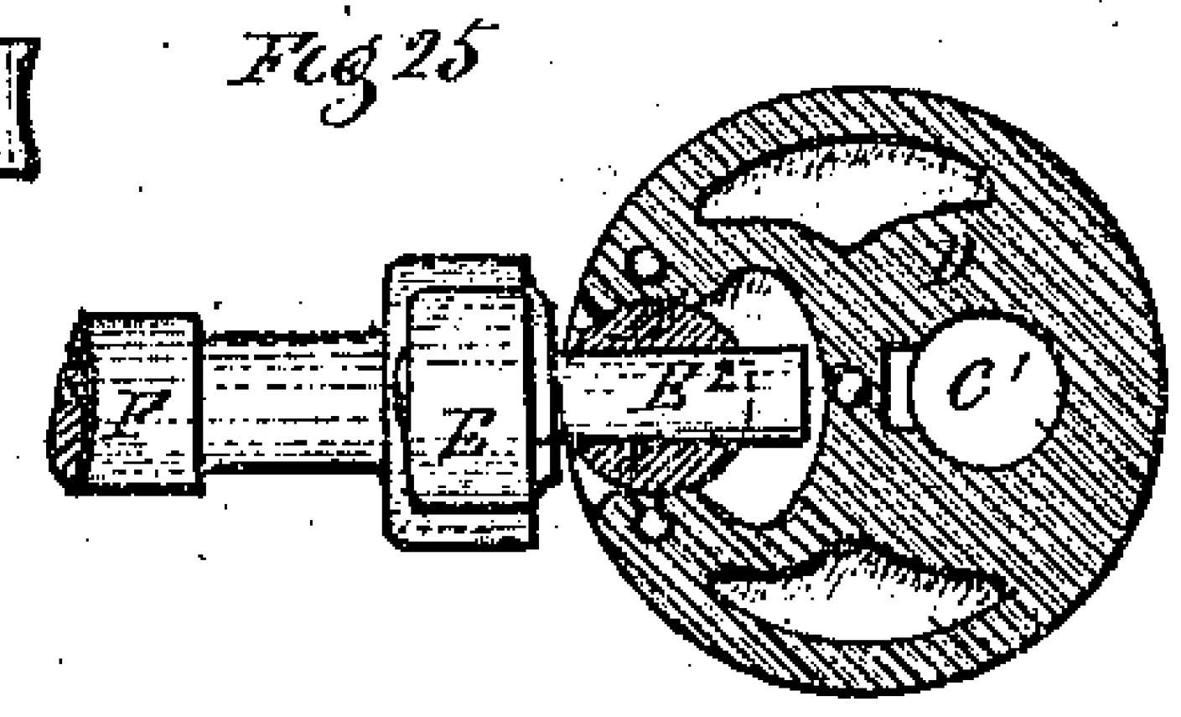
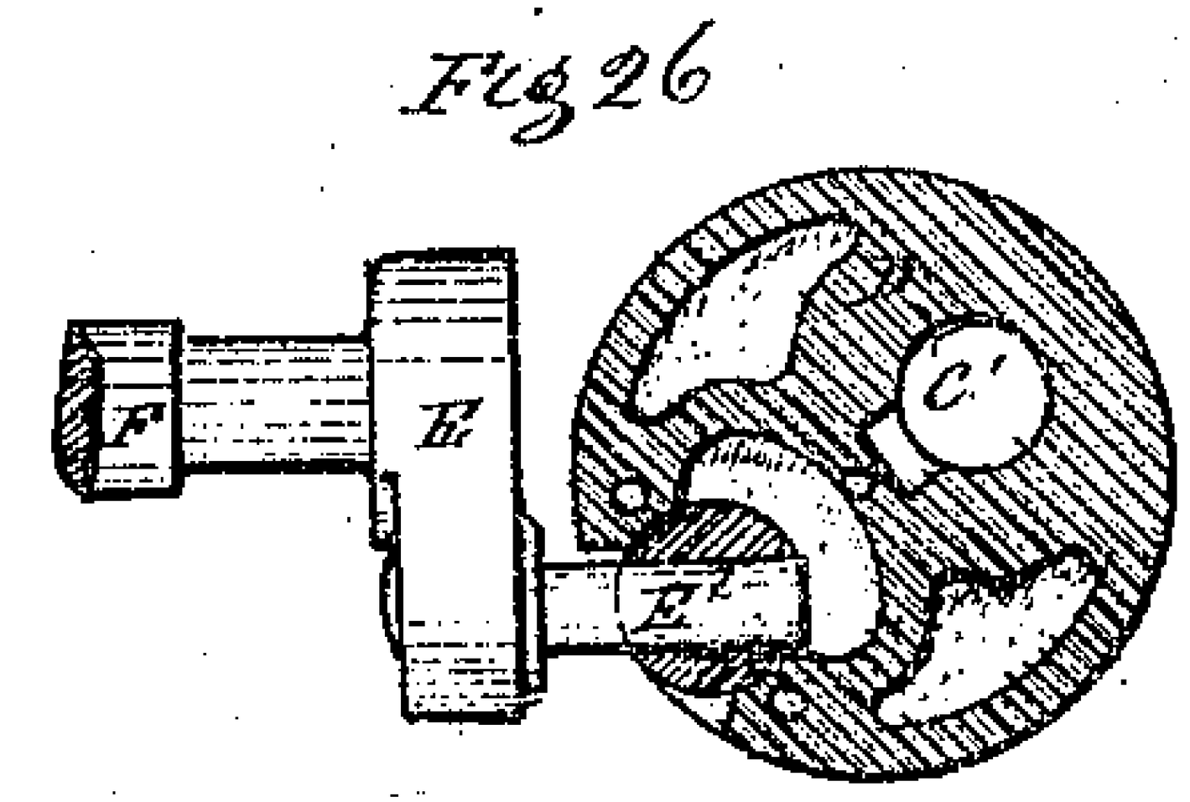


Fig 26



Witnesses } Signature.
J. D. King } James Robertson
R. W. Bishop }

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UNITED STATES PATENT OFFICE.

JAMES ROBERTSON, OF GLASGOW, SCOTLAND.

IMPROVEMENT IN MOTIVE-POWER ENGINES.

Specification forming part of Letters Patent No. **106,078,** dated August 2, 1870.

To all whom it may concern:

Be it known that I, JAMES ROBERTSON, engineer, of Glasgow, in the county of Lanark, Scotland, have invented certain new and useful Improvements in Motive-Power Engines; and I do hereby declare that the following is a full and ample description thereof, reference being had to the six sheets of illustrative drawings herewith, which form part of this specification, and to the letters and figures marked thereon—that is to say:

My invention relates to various novel motions, constructions, combinations, and arrangement of the parts of engines adapted to utilize power obtained from steam, water, or gas under pressure or from a vacuum.

I cause a piston, formed or constructed with passages therein, and fitted with a piston-rod, to partake of two motions, or a compound motion, within a cylinder, such cylinder being provided with induction and eduction ports, and a cover and stuffing-gland. The said two motions of which the piston partakes are, one a motion of reciprocation, and another a motion of rotation on its own axis. These motions are imparted to it simultaneously, and they serve to bring the passages in the piston opposite the induction and eduction ports in the cylinder in the proper sequential time; and by making the passages in the piston partly on the surface and partly within its interior, I can obtain any required degree of expansive working of the steam.

Second. In the mechanism for imparting motion of rotation to the piston. The piston carries a hollow cylindrical casing, which incloses a corresponding bush, in which latter is fitted a crank-pin, fixed firmly on a revolving shaft. This revolving shaft is the main or crank shaft, free to rotate. The crank-pin must have room to play lengthwise in the bush.

The importance of these features will become apparent in the following description of engines, which are constructed in accordance with my invention, and illustrated on the drawing.

These several modifications have been appended that others may be enabled to carry my improvements into beneficial effect.

The accompanying drawing forms a part of this specification, and, with the descriptive references hereafter contained, mechanicians will be enabled to build and work my said motive-power engines.

Similar letters of reference indicate corresponding parts in all the figures.

Figure 7, Sheet C, is an external elevation of one modification of my engine; Fig. 8, a plan, showing the steam-cylinder in section, Fig. 9 showing another and inverted vertical plan of the cylinder; Fig. 10, an end elevation, showing the cylinder in section through the line 1 1 in Fig. 8; Fig. 11, a corresponding inverted sectional elevation through the line 2 2 in Fig. 9, but arranged to work the steam expansively.

This arrangement of ports is such as affords ready facility to form them, to cut off the steam at any desired point of the stroke, from about one-tenth of the stroke to any greater fractional part thereof. The steam in this modification is admitted by the branch pipe A, round the passage a^1 to the port A^1, underneath the cylinder, (seen in section in Fig. 10,) and exhaust from the top side of the cylinder by the exhaust-port A^2 and exhaust branch pipe A^5, the exhaust-port in the cylinder and exhaust-passages B^1 B^2 in the piston bearing on the top side.

The form of the exhaust-passages B^3 and B^4 is seen in the plan (see Fig. 8) of the cylinder, which are formed the full length of the stroke of the engine, and, therefore, give for nearly the full stroke a free exhaust for the steam, the inverted sectional plan of the cylinder and and external plan of the piston B, Fig. 9, showing the length and form of the steam-ports longitudinally, and the corresponding inverted sectional elevation showing the ports in the cylinder and passages in the piston in section through the line 2 2 in Fig. 9.

As will be seen by Fig. 9, the steam-passages in the piston are only left open toward the port or ports about one-half of the length of the stroke. The steam thereafter, in its passage to the cylinder, is cut off to this extent, and the steam-passage continued underneath the surface of the piston, as indicated by the dotted lines and partly-dotted arrow shown in port B^1. In this way, as will be readily seen, by shortening the opening or open part of the steam-passages B^1 and B^2 in the piston out to the port in the cylinder, the steam cut off will

be proportionately shortened, so that, within about the limits stated, any degree of cut-off in the length of the stroke can be effected. The motion of the steam is as indicated by the arrows.

The connection of the arm D to the crank on the revolving shaft, here represented, is perfectly practicable, and is clearly represented as one of the modifications which will allow the benefit of some parts of my invention; but I prefer a different connection, as will be shown farther on.

Fig. 12, Sheet D, is an external side elevation; Fig. 13, a plan, with the cylinder shown in section, and showing an external plan of the piston. Fig. 14 is an end elevation, showing the cylinder, with its steam ports and passages in section through the line 1 1 in Fig. 13.

The form of the steam-ports in this engine is entirely similar to those described in connection with Figs. 7, 8, 9, 10, and 11; but there are two sets of passages formed in the piston B, and in a reverse way, to give reversing action. As these parts are the same, and the same letters of reference refer to like parts, they need not be again described, the ports in the cylinder and passages in the piston, shown out of action, being left without letters of reference. Those shown in action have the same letters on like parts as in Figs. 7, 8, 9, 10, and 11, and the courses of the currents and motion indicated by arrows, as before.

In reversing the currents, the cylinder is provided with two slide-valves, as represented, the slide-valve seen in section in Fig. 14 having the steam-port A^1 open to the casing, and the slide-valve J having the exhaust-port A^2 open, giving motion to the engine accordingly. On the handle *k* being raised, and the slide-valves I and J moved to the opposite ends of their casings, the other set of ports and passages shown comes into action, and the motion of the engine will be reversed.

All of the modifications of my engines are, by making the ports or piston-passages without cut-off of the actuating-current suitable for being wrought or actuated by water or other liquids, as well as by elastic fluids, and it is intended to so operate them.

Fig. 20, Sheet H, is a front external elevation; Fig. 21, a side external elevation; Fig. 22, in part an external plan, and in part a sectional plan, of a pair of these oscillating and reciprocating cylinders, combined and connected to one crank-shaft, to act as a water-engine or water-meter, whereby when at work the water passing can be measured. The form of the ports and passages in the pistons used is the same as described in connection with Figs. 15 and 16. The same letters of reference refer to the same parts in these figures as in this combination, and do not require to be otherwise further described.

The water enters by the branch pipe A, and, passing through the channels and ports indicated by the arrows, passes out by the exhaust-pipe A^5, the capacity of the cylinders being made to any desired aliquot part or understood quantity, as indicated by an ordinary liquid-index through the small wheel P on the crank-shaft gearing into the wheel Q, which has formed on its spindle the small worm R, gearing with the worm-wheel S, to which an ordinary index can be geared, and forming thereby a complete water engine and meter. Two cylinders can be coupled in various ways, as a coupled engine, and this also illustrates one way of doing so.

Figs. 23, 24, 25, and 26 illustrate what I consider the best form of universal joint or crank connection for coupling the arm from piston-rod to the crank-shaft. I propose to employ it in connection with all the forms of my engine. In this bush-joint the oscillating bush D^1 is placed in the arm D, fixed on piston-rod C′, and worked upon the pin E^2, which is fixed in the crank E, keyed upon the crank-shaft F. The arm D, in this example, is made in a circular form, like an eccentric, for convenience in finishing, and to give space for the bush D^1, with its cover D^2 and its fixing-bolts D^3. When the oscillating bush D^1 is placed in the arm D, as in this example, it only requires to oscillate in one plane or direction, as the axis of the crank-pin E^2, on which it works, remains parallel to the axis of the crank-shaft F at every point of the circle which it is caused to describe. Hence, the oscillating bush D^1, in this modification, is not formed spherical, as shown in Figs. 7 and 8, but of a cylindrical form, with flat ends, its axis lying parallel to the axis of the piston-rod C′. It is formed in halves to receive the crank-pin E^2, which passes through or into it at a right angle to the axis of the piston-rod C′ when the piston is at the end of the stroke, as seen in section in Figs. 23 and 25. When the piston is at mid-stroke, the arm or bush holder D is oscillated to the one side the full radius of the crank E. Fig. 24 shows in section the position of the arm D, bush D^1, crank E, and pin E^2, at mid-forward stroke, and Fig. 26 shows the positions assumed by these parts when the crank-pin E is at the opposite point of the circle. The seat of the bush D^1 is turned out. All the parts are easily made, are adjustable for wear, and work smoothly.

Having now described the nature of my said invention, and particularized the same by the several modifications herein referred to and delineated on the drawing, I would have it understood that I do not confine myself to the exact details set forth, as many modifications may be made without departing from the leading features of my improvements. Many of the parts shown are common to other, and some to all, engines, pumps, and analogous machines now in use.

What I do claim is—

1. The within-described piston, constructed with passages B^1, &c., formed partly on the surface and partly under the surface, and so connected and operated that it partakes simul-

taneously, when at work, of a motion of reciprocation and a motion of rotation on its own axis, to receive, direct, and cut off the impelling fluid without a necessity for valves, all as herein set forth.

2. In connection with the above, the bush D^1, free to oscillate in the disk or arm D, secured to the piston-rod, in combination with the crank or eccentric stud E^2, and arranged as represented, so as to serve as means both for transmitting motive power to or from the crank shaft or mechanism, and for insuring a motion of rotation in the piston, all substantially as described, and shown in the drawing.

JAMES ROBERTSON.

Witnesses:
J. S. KING,
R. MOSS.