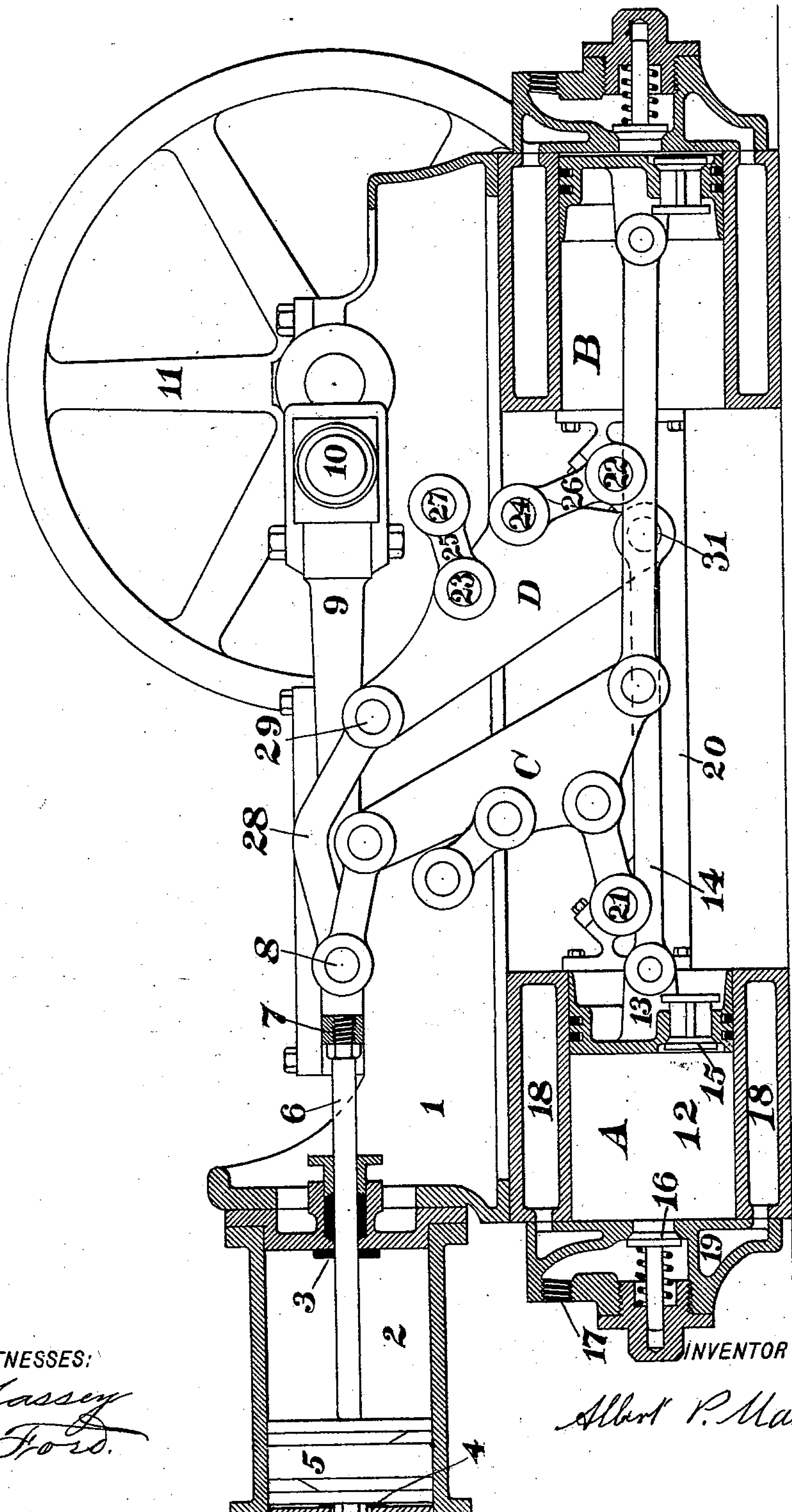
(No Model.) 2 Sheets—Sheet 1.

A. P. MASSEY.
PUMPING ENGINE.

No. 547,558. Patented Oct. 8, 1895.



WITNESSES:
F. L. Massey
W. H. Ford.

INVENTOR
Albert P. Massey

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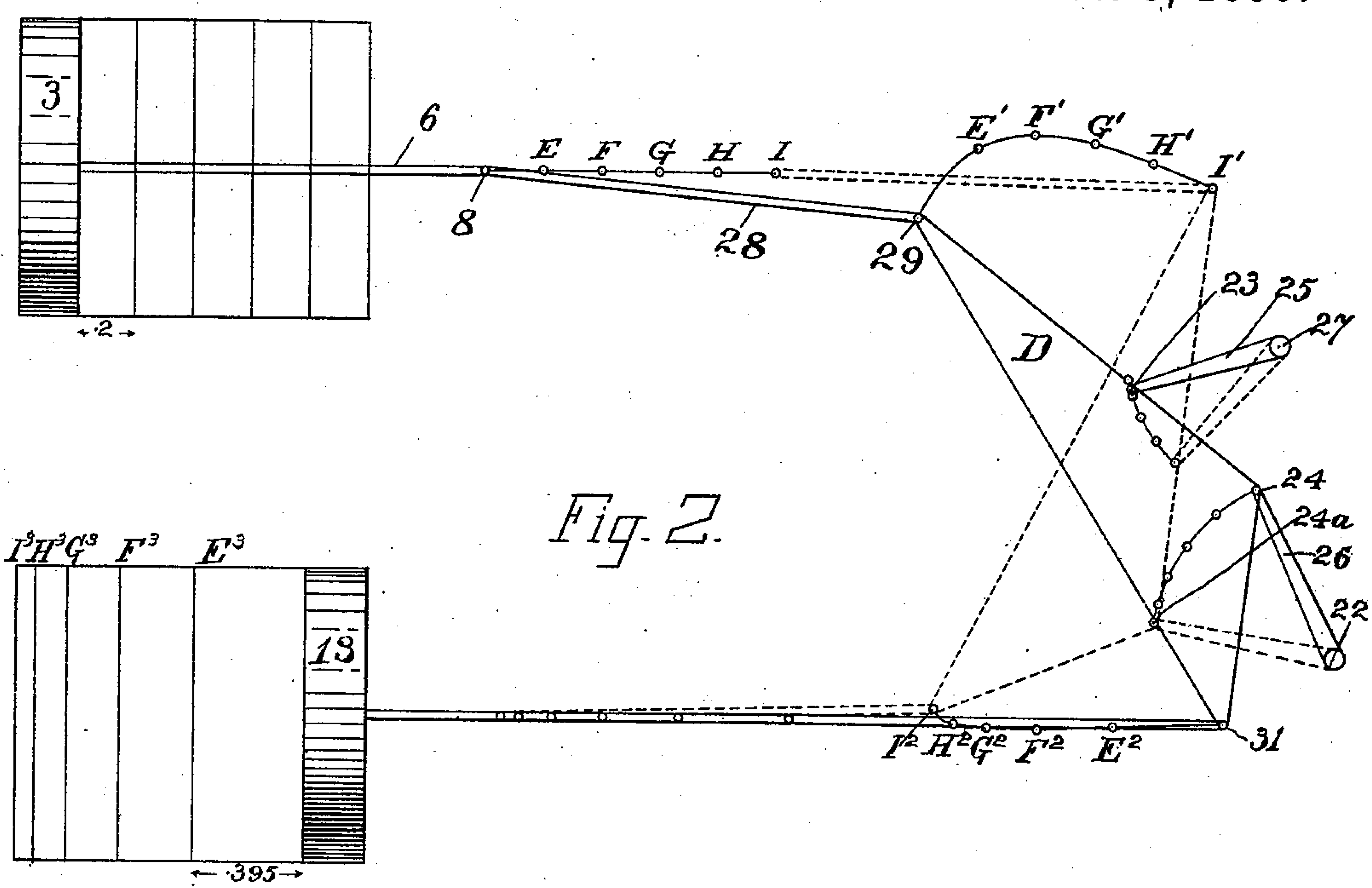

Fig. 2.

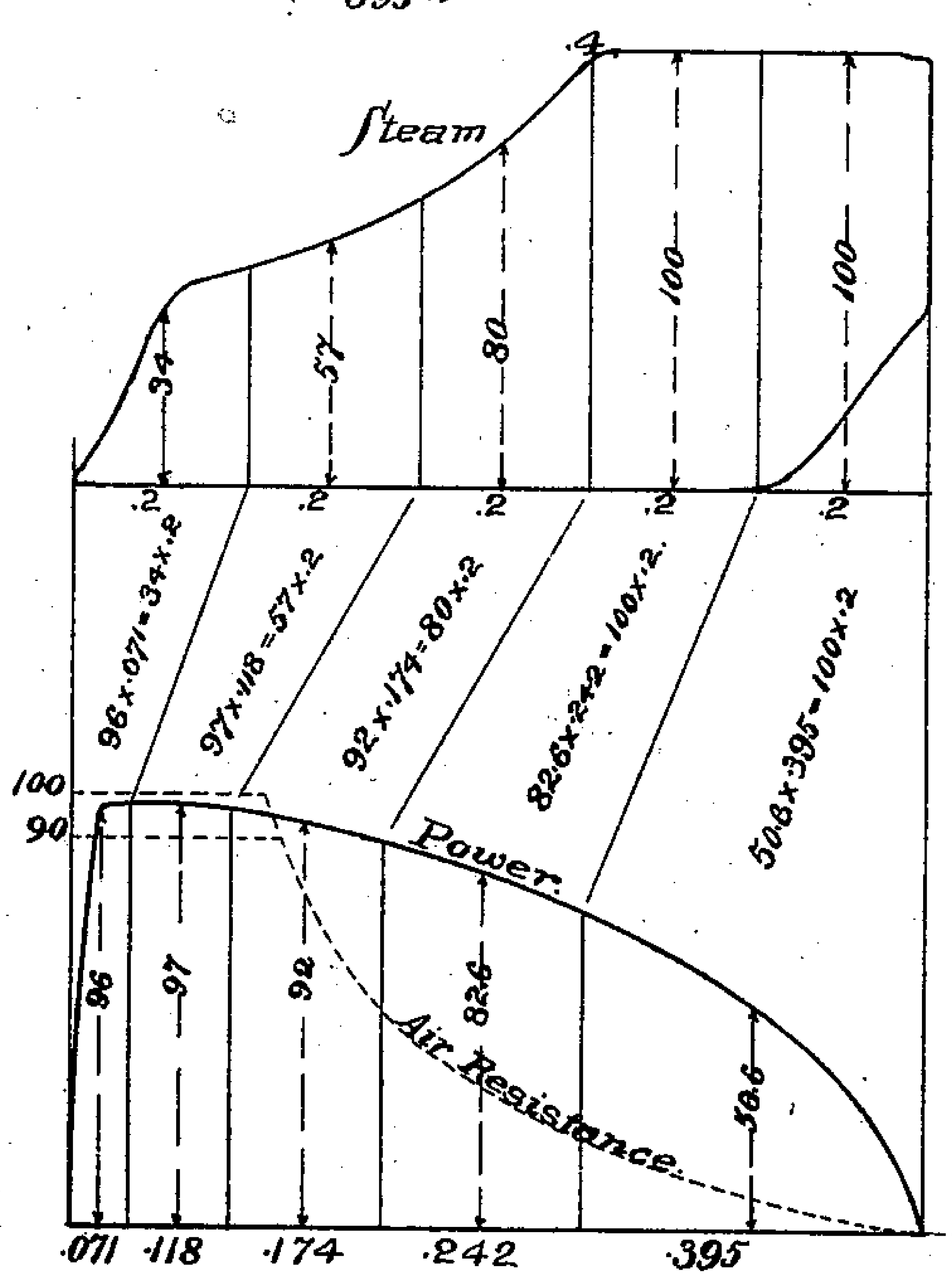

Fig. 3.

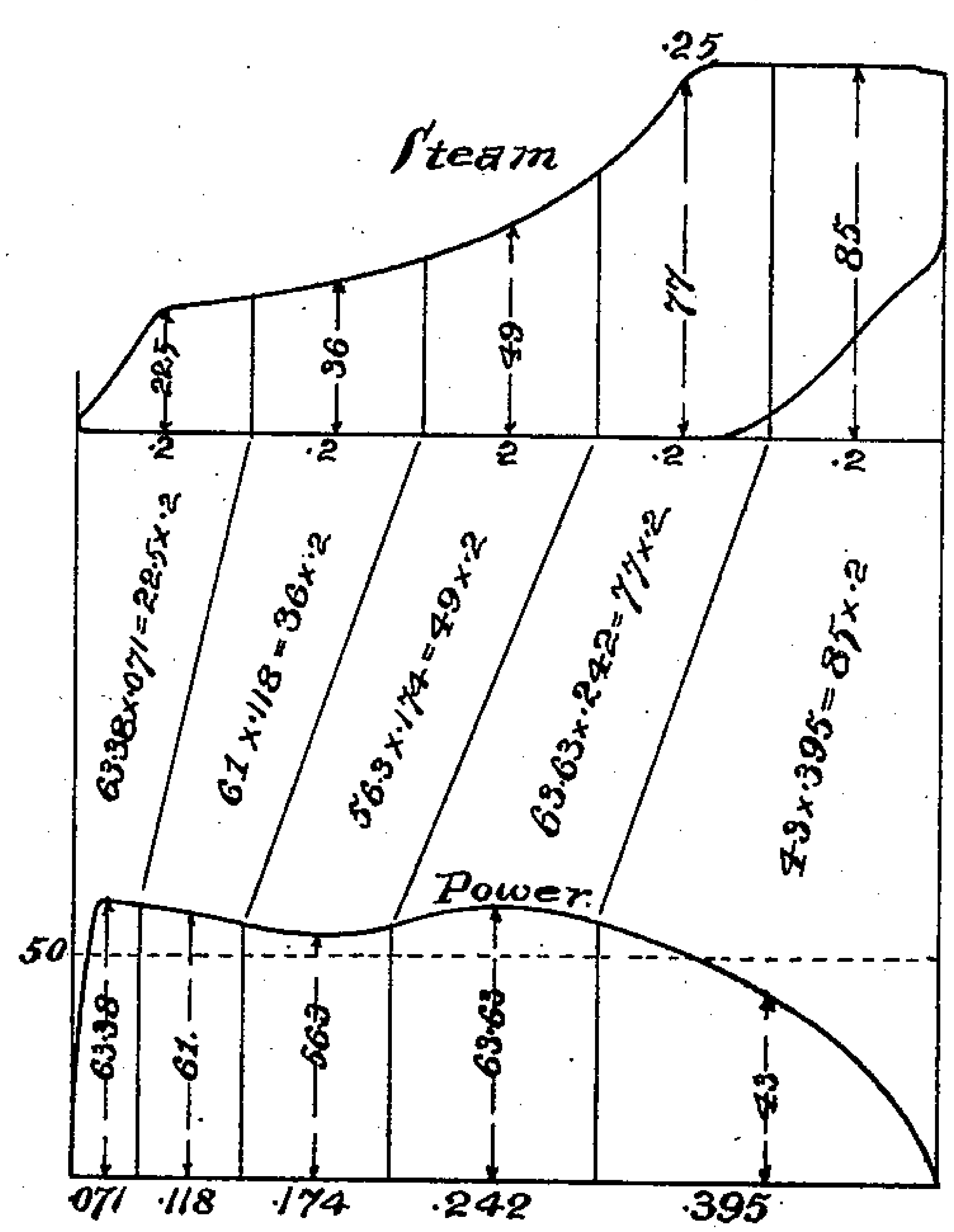

Fig. 4.

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UNITED STATES PATENT OFFICE.

ALBERT P. MASSEY, OF WATERTOWN, NEW YORK.

PUMPING-ENGINE.

SPECIFICATION forming part of Letters Patent No. 547,558, dated October 8, 1895.

Application filed February 14, 1895. Serial No. 538,409. (No model.)

To all whom it may concern:

Be it known that I, ALBERT P. MASSEY, a citizen of the United States, and a resident of the city of Watertown, county of Jefferson, State of New York, have invented a new and useful Improvement in Pumping-Engines, of which the following is a specification.

In an ordinary pump for liquids or gases operated by a piston actuated by steam the resistance in the latter part of each stroke is as great or greater than at the beginning of the stroke, whereas in the steam-cylinder the power decreases in the latter part of the stroke unless steam is admitted to the cylinder during the whole stroke.

The object of my invention is to use steam expansively by cutting off the admission of steam at an early part of the stroke and distribute the power to the pump-piston nearly in proportion to the resistance of the pump-piston. This I accomplish by means of compensating levers introduced between the steam-piston and the pump-piston.

Figure 1 is a sectional view of a pumping-engine with the pump-cylinders designed for compressing air. Fig. 2 is a diagram showing the travel of one pump-piston relative to that of the steam-piston when modified by a compensating lever. Fig. 3 is a steam-diagram cutting off at four-tenths stroke, compared with a diagram from an air-compressing cylinder in which the power developed for each one-fifth of the stroke of the steam-piston is transferred to a corresponding power-diagram superposed on the air or resistance diagram. Fig. 4 is a steam-diagram cutting off at one-fourth stroke, compared with a diagram from a water-cylinder in which the power developed for each one-fifth of the stroke of the steam-piston is transferred to a corresponding power-diagram superposed on the water-resistance diagram.

The steam-engine may be of any ordinary type of steam-engine, and the pumps, as regards valves, &c., may be of any type of liquid or gas-pump, it being only necessary to introduce the compensating levers between the steam-piston and the pump-pistons in order to get the highest efficiency of the steam-engine transferred to the pump-piston with such uniformity of power and resistance at each portion of the stroke as to require only a fly-wheel of moderate weight to maintain a uniform speed.

For purposes of illustration I have taken an air-pumping engine, (see Fig. 1;) but this can be converted into a liquid-pump by merely changing the inlet-valves to the cylinder-heads, so that a pipe might connect them to a supply of the liquid to be pumped; or suitable cylinders and plunger-pistons with proper valves might be substituted for the air-cylinders without changing any other detail of the apparatus.

In the drawings, 1 is the bed-plate or frame of a steam-engine.

2 is the steam-cylinder, with ports 3 and 4, which lead to a valve, (not shown,) which controls the admission and exhaust of steam from the cylinder.

5 is the steam-piston.

6 is the piston-rod.

7 is a cross-head.

8 is the cross-head pin.

9 is a connecting-rod.

10 is a crank.

11 is a fly-wheel.

The above parts are suitably arranged to make a steam-engine of common type.

In the foundation of the engine proper are located two single-acting air-pumps A and B, which are duplicates and compress air into the reservoir alternately.

12 is an air-cylinder.

13 is a piston, and 14 a connecting-rod.

15 is an inlet-valve.

16 is a discharge-valve.

17 is a duct leading to a reservoir.

18 18 is a water-jacket surrounding the cylinder and connected by passages with 19, a water-jacket in the cylinder-head.

20 is one of a pair of rigid tie-bars connecting the two air-cylinders and supporting the bearings 21 and 22.

The steam-piston is operatively connected to the air-pistons by the compensating levers C and D. The lever D is suspended at two points 23 and 24 by the links 25 and 26. Link 25 is attached to the frame or rigid structure by pin 27, about which it is free to revolve. Link 26 is attached to the frame or rigid structure by the pin 22, about which 26 is free to revolve. The upper end of lever D is connected to the cross-head pin 8 by the connecting-rod 28 and pin 29. It is connected to the air-piston 13 by the connecting-rod 14 and pin 31. Lever C is connected in a similar manner to transmit power from cross-head pin 8 to the piston of air-pump B.

In operation the reciprocating motion of the steam-piston 5 produces a corresponding motion in the pistons of the air-pumps A and B; but, by reason of the compensating levers, the motions of the air-pistons vary in their speed relative to the steam-piston. This may be seen more readily by reference to Fig. 2, which is a diagram illustrating the action of one air-piston in relation to the movement of the steam-piston when the motion is communicated through the lever D. The total stroke of the air-piston is the same as the steam-piston; but the lever is combined with the links in such manner that a uniform horizontal motion of the upper end of the lever to the right will give a constantly-decreasing motion to the lower end of the lever to the left. In the beginning of the stroke the virtual fulcrum of the lever is at 23, and link 26 serves merely as a guide. In the latter portion of the stroke the pin 24^a is the fulcrum and link 25 is a guide. In intermediate positions the virtual fulcrum is a point somewhere between the pins 23 and 24. The paths described by the two ends of the lever are indicated on the drawings; also, the position of the centers for each fifth of the stroke of the steam-piston. When the steam-piston has moved one-fifth of its stroke, the cross-head pin will be at E, the pin 29 will be at E', the pin 31 at E^2, and the edge of piston 13 at E^3. When the steam-piston has moved the second fifth, the points will be at F F' F^2 F^3, respectively, and so on. The successive equal movements of the steam-piston result in a constantly-decreasing movement of the air-piston, as follows: .395, .242, .174, .118, .071, the average speed during the last fifth of the stroke being .18 of the speed during the first fifth. The spaces into which the cylinders are divided show the volumes swept by the air-piston compared with the volumes swept by the steam-piston during each one-fifth of its stroke. If steam were admitted to the steam-cylinder full stroke, the pressure per square inch would be uniform, and the pressure per square inch of the air-piston would be inversely as the volumes swept by the air-piston at any part of the stroke. This would give a much higher terminal pressure than is required to compress air to the steam-pressure. This provision is made in order to use steam expansively.

Fig. 3 contains an indicator-diagram taken from a steam-cylinder with the valve set to cut off at four-tenths the stroke compared with a diagram from an air-cylinder on which the power developed in the steam-cylinder during each one-fifth stroke is transferred to a corresponding power-diagram superposed on the air-diagram. In this power-diagram the successive pressures are obtained from the pressure in the steam-cylinder and the relative volumes swept by the steam and air pistons. For instance, the pressure in the steam-cylinder for the first .2 stroke is one hundred pounds per square inch. As the air-piston moves .395 during this movement of the steam-piston, the average power on the air-piston would be one hundred multiplied by .2 and divided by .395 or 50.6 pounds. The diagrams show that there is a surplus of power in the early part of the stroke, and the power is about equal to the resistance during the latter part of the stroke. As quite a portion of the surplus in the early part of the stroke is needed to overcome the inertia of the reciprocating parts, a fly-wheel of moderate weight is sufficient to distribute the slight variation between power and resistance and produce even turning.

Fig. 4 shows graphically the proper cut-off in the steam-cylinder when the apparatus is used as a liquid-pump. In this case the resistance is uniform throughout the stroke of the pump-piston, as shown by the dotted line. The steam-diagram is one taken with the valve set to cut-off at one-fourth stroke. The relative pressures are transferred, as before, in proportion to the respective traverses of the steam and pump pistons and give a resultant power-line that is so near a uniform pressure that a fly-wheel of moderate weight will insure even turning.

What I claim, and desire to secure by Letters Patent, is—

In a pumping engine operated by a reciprocating motor the combination of such motor with the pump piston by means of a lever suspended by and oscillating on two links which swing on stationary bearings located so that one link forms the fulcrum of the lever during the early part of the stroke, and the movement of the lever shifts the virtual fulcrum gradually from one link to the other during the traverse of the piston, substantially as set forth.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 11th day of February, 1895.

ALBERT P. MASSEY.

Witnesses:
H. D. MORGAN,
M. J. MORKIN.