(No Model.)

3 Sheets—Sheet 1.

G. A. BARNARD.

STEAM ENGINE.

No. 571,740. Patented Nov. 24, 1896.

FIG. 1.

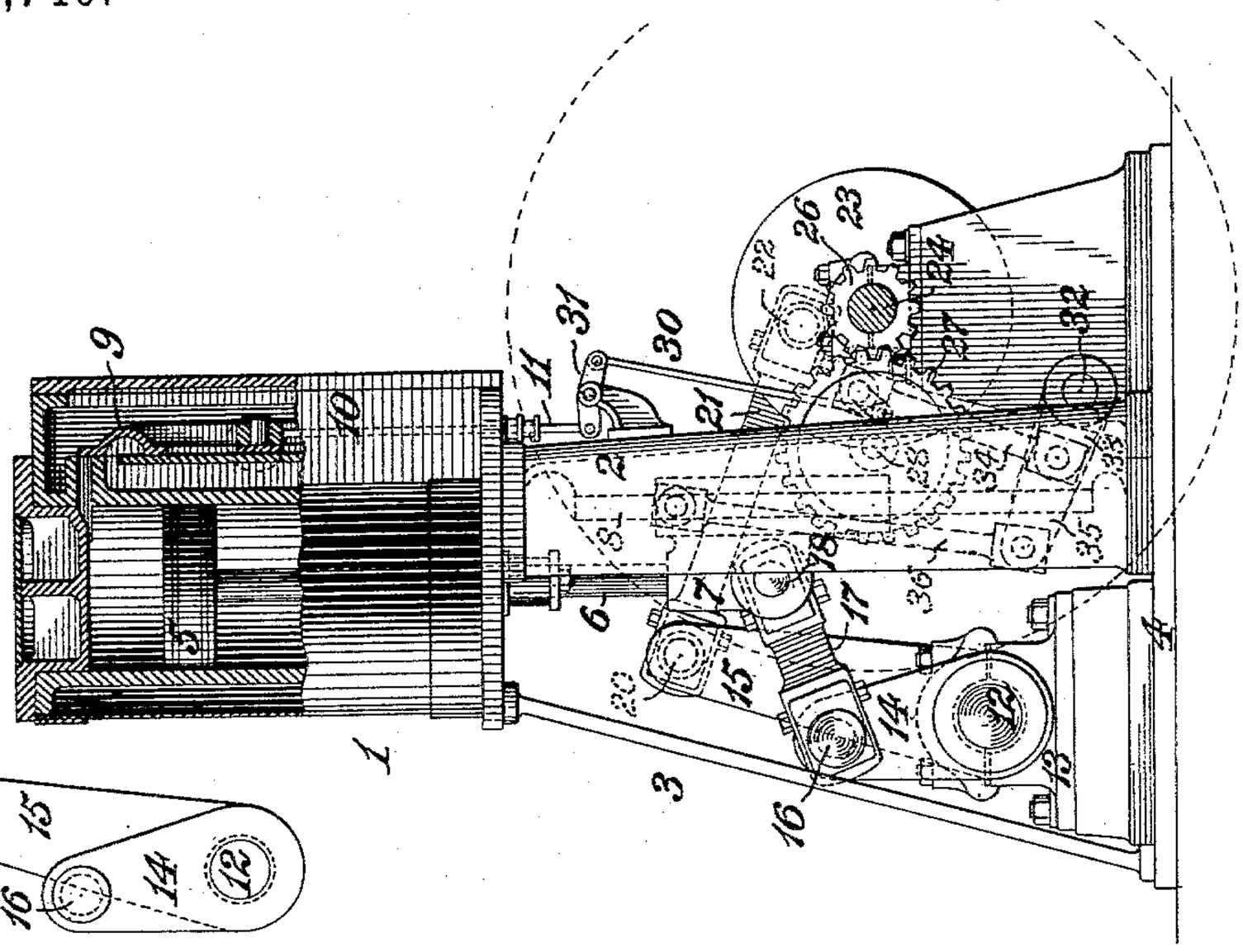

FIG. 4.

FIG. 5.

FIG. 2.

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STEAM ENGINE.

No. 571,740. Patented Nov. 24, 1896.

FIG. 10.

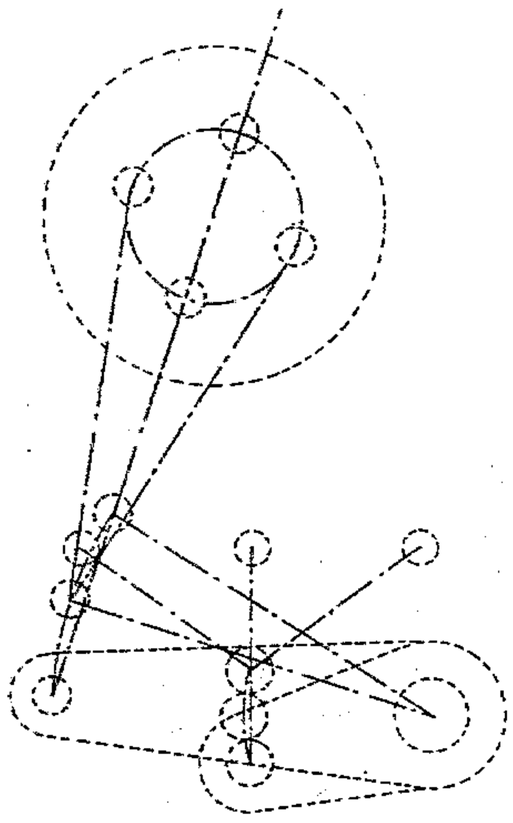


FIG. 6.

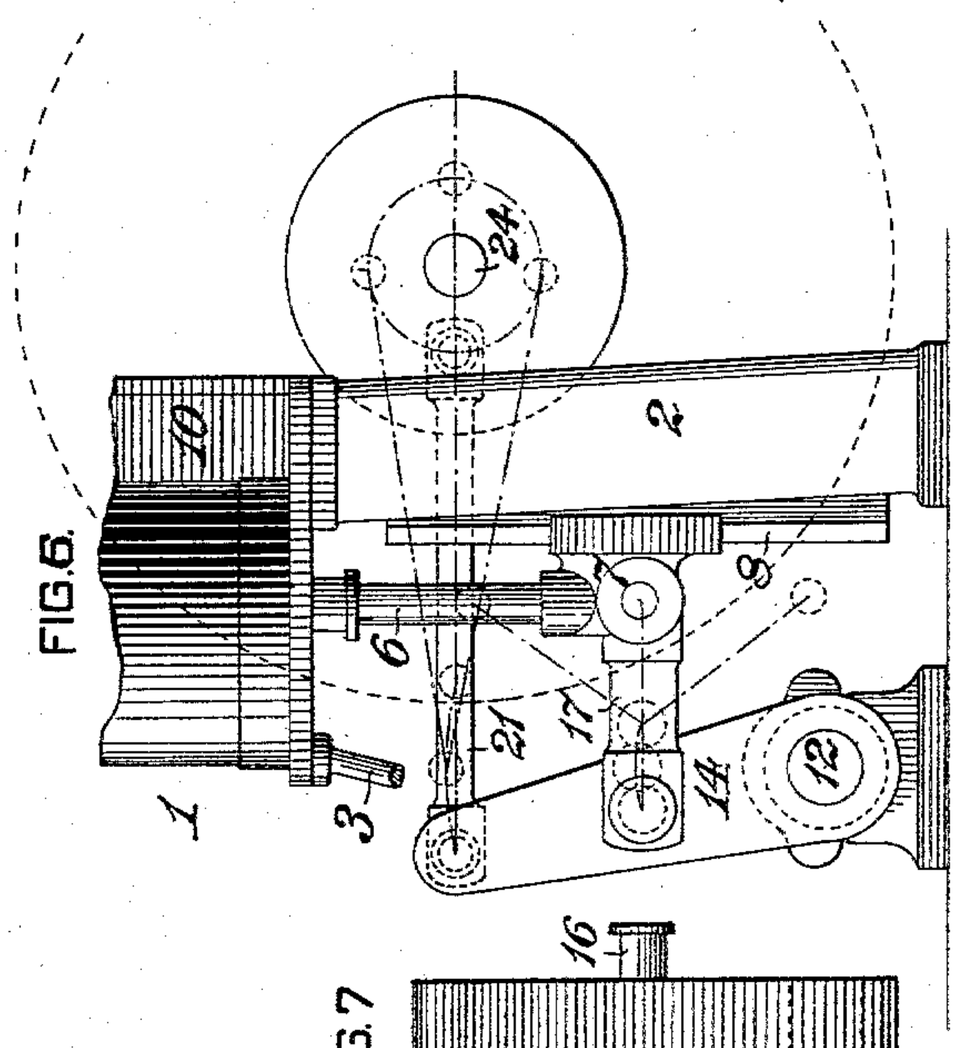
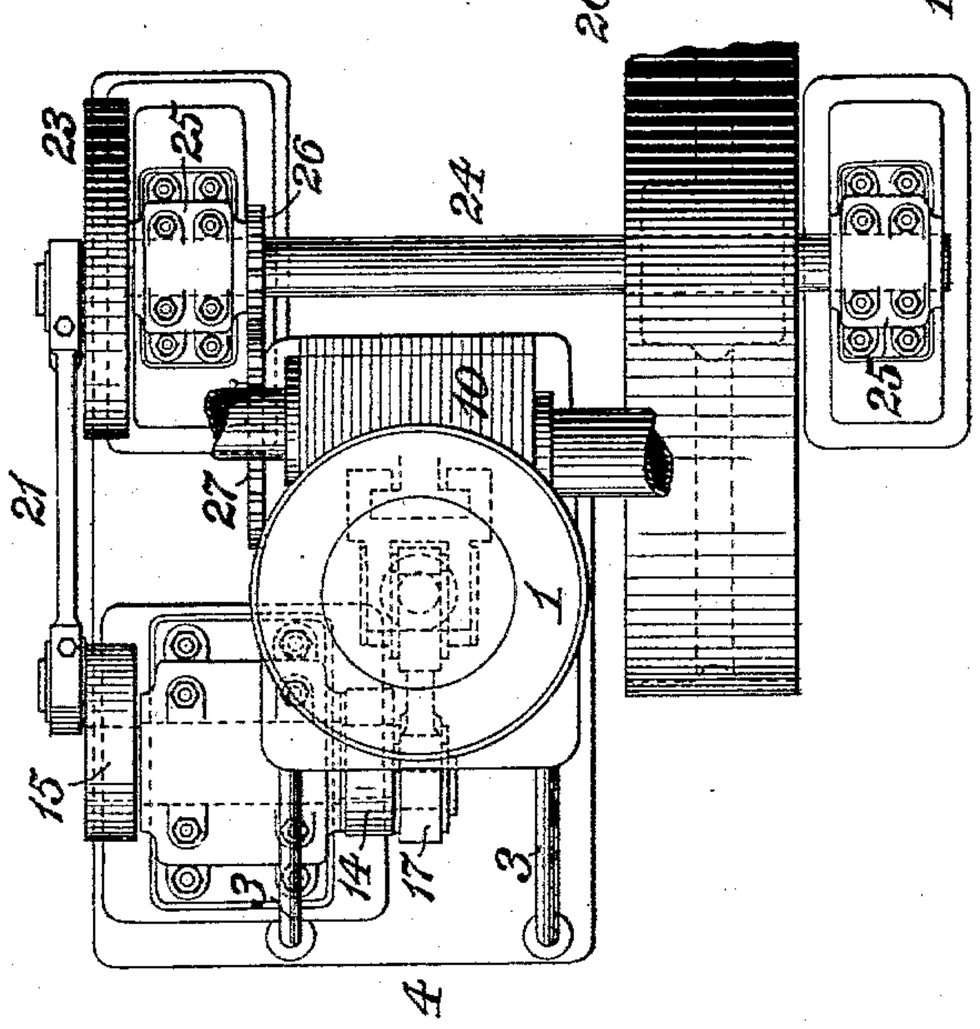


FIG. 7

FIG. 3.



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STEAM ENGINE.

No. 571,740. Patented Nov. 24, 1896.

FIG. 8.

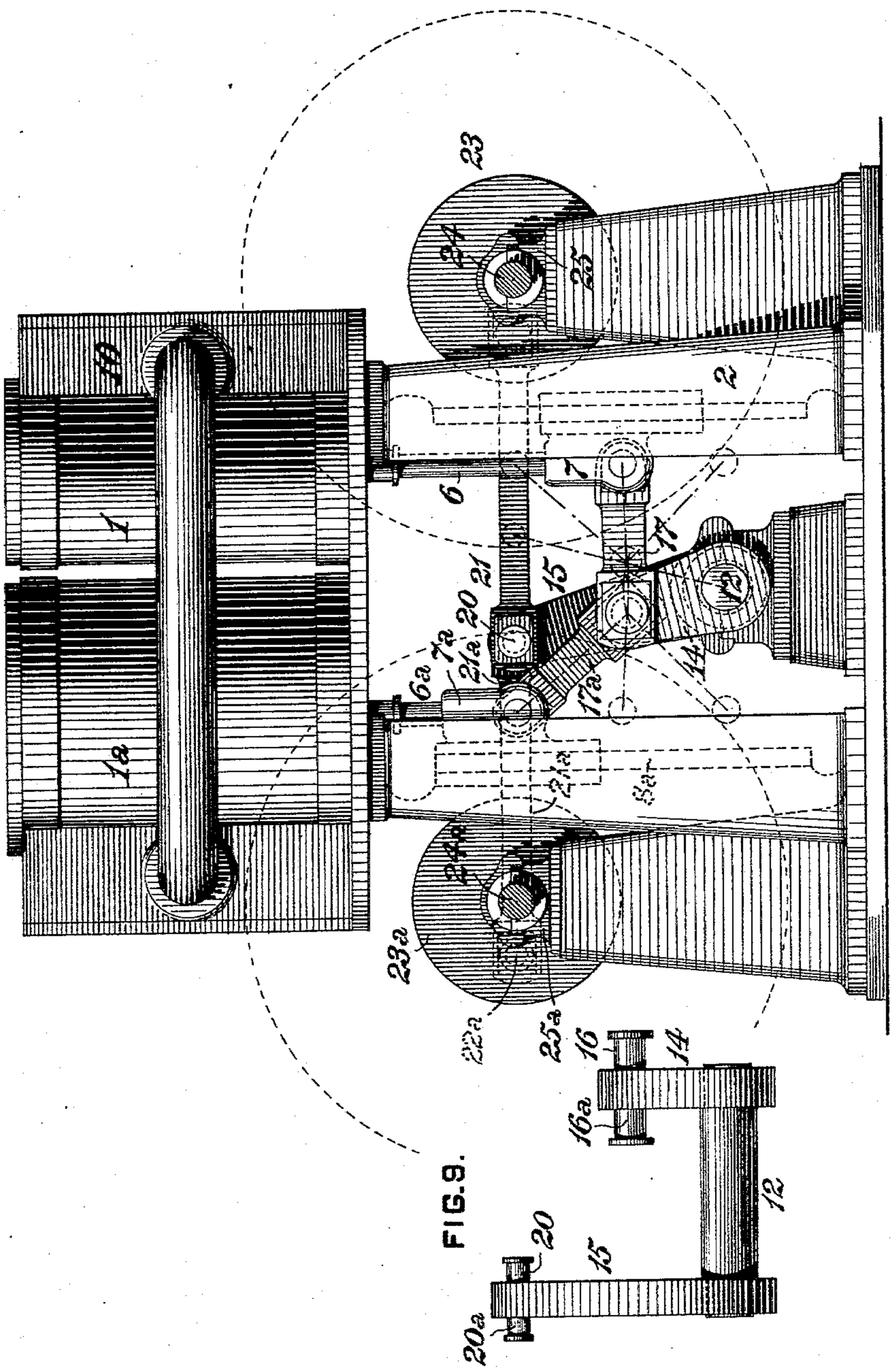

FIG. 9.

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UNITED STATES PATENT OFFICE.

GEORGE A. BARNARD, OF NEW YORK, N. Y.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 571,740, dated November 24, 1896.

Application filed November 13, 1895. Serial No. 568,754. (No model.)

To all whom it may concern:

Be it known that I, GEORGE A. BARNARD, of the city, county, and State of New York, have invented a certain new and useful Improvement in Steam-Engines, of which improvement the following is a specification.

My invention relates to steam or other fluid-pressure engines of the various types in which a reciprocating piston imparts, through intermediate connections, rotary motion to a shaft.

The object of my invention is to provide an engine which shall be of simple and compact construction and in which a complete revolution of the crank-shaft will be effected in and by each single stroke of the piston, thereby doubling the number of revolutions of the crank-shaft relatively to the ordinary construction without increase of piston-stroke or piston-speed.

To this end my invention generally stated consists in the combination of a fluid-pressure cylinder, a piston working therein, a cross-head fixed to the rod of the piston, a member or connecting part vibratory in a direction transverse to the traverse of the cross-head, and links coupling said vibratory member with the cross-head and with a crank-pin on a rotatable shaft.

The improvement claimed is hereinafter fully set forth.

My invention employs an ordinary steam-cylinder fixed to or upon a suitable bed-plate or base and provided with the usual piston, piston-rod, cross-head, and cross-head guides. The reciprocating parts are actuated in the ordinary manner, and by means of a link or connection coupled to the cross-head and to a lever-arm, cross-head, or other vibratory or reciprocating member a vibrating or oscillatory movement is imparted to the lever-arm, cross-head, or other vibratory or reciprocating member in a direction transverse to the axis of the cylinder, the vibratory lever-arm or member making a double traverse or cycle during each single stroke of the piston in either direction. A connecting-rod coupled at one end to a pin on the lever-arm or vibratory member or to a pin on an independent arm fixed to the shaft thereof, and coupled at its opposite end to a crank-pin on a main or driving shaft, effects a complete revolution of said shaft during each single stroke of the piston.

The transmitting mechanism is of a character which admits of material structural variation, as may be required under different conditions of application, without variation of operative principle. Thus, for example, two or more cylinders, either simple or multiple expansion, may be employed, their cross-heads being connected by links to the vibratory member. By the use of two connecting-rods leading in opposite directions two crank-shafts may be driven, and by making the connections of the cross-head and crank-shaft to independent lever-arms, set at an angle upon a common vibratory shaft, the crank-shafts may be located as desired relatively to the cylinder and independent of the position of its axis. The cylinders may be either vertical, horizontal, or inclined, as preferred, the use of two vibratory arms set at an angle, or, equivalently, of a crank-disk having two pins in different positions circumferentially, permitting the crank-shaft to be located at any desired radius from the center of motion of the vibratory lever-arm.

In the accompanying drawings, Figure 1 is a side view, partly in section, of a steam-engine, illustrating an application of my invention; Fig. 2, a front view of the same; Fig. 3, a plan or top view; Fig. 4, an end view of the vibratory shaft and its lever-arms; Fig. 5, a side view of the same; Fig. 6, a partial side view of an engine having a single vibratory lever-arm; Fig. 7, a side view of the lever-arm of Fig. 6; Fig. 8, a side view in elevation of a two-cylinder engine embodying my invention; Fig. 9, a similar view of the vibratory shaft and its lever-arms, and Fig. 10 a diagram illustrating the movements of the transmitting elements in the construction of Fig. 1.

Referring first to Figs. 1 to 5, inclusive, and Fig. 10, my invention is exemplified in an engine of the vertical double-acting type, having a steam or other fluid pressure cylinder 1, which is supported by a framing composed of a vertical casting 2 at the rear and inclined rods or standards 3 at the front of the engine, these being connected at their lower ends to a bed-plate 4 and at their upper ends to the cylinder. A piston 5, of the ordinary

construction, is fitted to reciprocate in the cylinder 1 and is secured to a piston-rod 6, the lower end of which is secured to a cross-head 7, which is fitted to slide on guides 8, fixed to the rear casting 2 of the frame. Motive fluid is admitted to and exhausted from the cylinder by a distribution-valve 9, controlling induction and eduction ports at opposite ends of the cylinder and reciprocating in a valve-chest 10, movement being imparted to the distribution-valve by a valve-stem 11, actuated, through intermediate connections, by the main or driving shaft of the engine, as presently to be described.

A vibratory shaft 12, which is journaled in bearings 13 on the bed-plate, exterior to the axial line of the cylinder, has fixed upon one of its ends a lever-arm 14, and another lever-arm 15, of greater length, is fixed upon its opposite end. The arms 14 and 15 are vibratory in a direction transverse to the traverse of the piston and cross-head, and their center lines are in this instance set at an angle one to the other; but their center lines may, if preferred, be in the same plane, as in the construction shown in Fig. 8. A pin 16 on the arm 14 is coupled by a link or connecting-rod 17 to a pin 18 on the cross-head 7, the relation of the cross-head and lever-arm pins being such that when the cross-head is at the middle of its traverse the lever-arm will be at the extremity of its traverse farthest from the cross-head, and when the cross-head is at either the upper or the lower extremity of its traverse the lever-arm will be at the extremity of its traverse nearest the cross-head.

By reference to the diagram, Fig. 10, it will be seen that the lever-arm 14 moves from the nearer to the farther extremity of its traverse while the cross-head is moving in either direction from one end to the middle of its traverse, and moves in the reverse direction, from the farther to the nearer extremity of its traverse, while the cross-head is moving through the remainder of the stroke of the piston, that is to say, from the middle to the extremity of its traverse in either direction.

The longer lever-arm 15, which is fixed on the opposite end of the vibratory shaft 12, carries, near its outer end, a pin 20, the distance of the axis of which from the axis of the shaft is in this instance, although not necessarily, equal to twice the distance of the axis of the pin 16 of the arm 14 from the axis of the shaft. The pin 20 is coupled by a link or connecting-rod 21 to a pin 22 on a crank-arm, or, as shown, a crank-disk 23, fixed on a main or crank shaft 24, journaled in bearings 25 on the bed-plate 4. A spur-pinion 26 on the crank-shaft engages a corresponding gear 27, the pitch-circle of which is double the diameter of that of the pinion 26 and which is fixed on a counter-shaft 28. A crank-pin or eccentric 29 on the counter-shaft 28 is connected by a rod or link 30 with the stem 11 of the distribution-valve 10, the connection being in this instance made, for convenience, through a double-armed lever or rocker 31.

As indicated by the diagram, Fig. 10, the crank-shaft 24 makes a half-revolution during each traverse of the lever-arm 15, and, as before explained, two traverses, in opposite directions, of the vibratory shaft 12 and its lever-arms 14 and 15 are effected by and during each single stroke of the piston and cross-head. A revolution of the crank-shaft will be made by and during each said single stroke, thus doubling the number of revolutions relatively to an engine of the ordinary construction.

In order to insure the maintenance of the normal relation of the speed of the piston and cross-head and that of the vibratory shaft and connected crank-shaft, which might otherwise be disturbed by the momentum of the fly-wheel when steam is shut off from the cylinder or from other causes, the cross-head may be connected with the crank independently of the vibratory lever-arm and its connecting-rod. A construction suited to this end is shown in Figs. 1 and 2, in which a vibratory shaft 32 is journaled in bearings on the bed-plate and carries a short arm 33, which is coupled by a link or connecting-rod 34 with a pin on the gear 27 of the counter-shaft, and also carries a longer arm 35, which is coupled by a link or connecting-rod 36 with a pin on the cross-head 7. The cross-head will thus be reciprocated by and in time with the revolutions of the crank-shaft when steam is shut off and the source of motion is the fly-wheel, and during the working of the engine will impart rotation to the crank-shaft of the engine through the connections above described and the gearing, as well as through the lever-arms and their connections. The independent connections afford means for driving a valve-actuating shaft at proper speed independently of the gearing and provide for the conditions of quick stoppage and reversing when required.

As shown in Figs. 6 and 7, the lever-arm 14 is prolonged sufficiently to carry the pin 20 of the connecting-rod 21, and the second lever-arm 15, before described, is dispensed with. The operation is, however, identical with that of the construction shown in Figs. 1 to 5, inclusive.

Fig. 8 illustrates an application of my invention in connection with a two-cylinder compound engine, and, further, as employed to rotate two independent crank-shafts. The high-pressure cylinder 1 and the connections of its cross-head 7 to the crank-shaft are similar to the construction first described. The piston-rod 6^a of the low-pressure cylinder 1^a is fixed to a cross-head 7^a, fitted to slide on guides 8^a and coupled by a link 17^a to a pin 16^a on the arm 14, the cross-heads 7 and 7^a of the high and low pressure cylinders being set so that when one is at the middle of its traverse the other will be at one end of its trav-

erse. The arm 15 is coupled, as in the instance first described, to a crank-shaft 24, and also carries a pin 20^a, which is coupled by a connecting-rod 21^a to a pin 22^a on a crank-disk 23^a, fixed on an independent crank-shaft 24^a, which is journaled in bearings 25^a on the bed-plate, on the opposite side of the engine from the crank-shaft 24.

While the double-cylinder engine has been shown as of the compound type, two single-expansion cylinders may be similarly employed, and it is also to be noted that two crank-shafts are not an essential of the double-cylinder construction, as the pistons of two cylinders, either in a single-expansion or a compound engine, may be connected, in the manner substantially as described and shown, with a single crank-shaft and effect the rotation of the same under the same operative principle exemplified in the instances having a single cylinder.

Among the structural features of my invention may be noted that the vibratory shaft, whether provided with one or with two lever-arms, may have any desired relation to the axis of the crank-shaft. The extended throw of the longer lever-arm or of the pin farther from the axis of vibration when only one lever-arm is employed is provided for the purpose of fixing the length of the crank as may be desired. In the instances shown the crank is one-quarter the length of the piston-stroke instead of one-half, as in ordinary constructions. This length, however, is not an essential one and may be varied in the discretion of the constructor.

By the employment of two lever-arms set at proper angles on the vibratory shaft the crank-shaft may be located in any desired angular relation to a plane passing through the axis of the vibratory shaft and wholly independent of relation to the axial line of the cylinder. This capability is of advantage under frequent conditions, as, for example, in driving an overhead line-shaft directly, and thus dispensing with belts, &c.

I am aware that various mechanisms have been heretofore proposed, as intermediate connections from a piston to a crank-shaft, for the purpose of increasing the number of revolutions of the latter relatively to the strokes of the former, and I do not therefore broadly claim a mechanism for effecting such result.

I claim as my invention and desire to secure by Letters Patent—

1. The combination, substantially as set forth, of a fluid-pressure cylinder, a piston working therein, a cross-head fixed to the rod of the piston, an arm or connection adapted to vibrate in a direction transverse to the traverse of the piston, and to effect two traverses, in opposite direction, during each stroke thereof, a link coupling said vibratory member directly to the cross-head, a rotatable crank-shaft, and a connection coupling said crank-shaft with the vibratory member.

2. The combination, substantially as set forth, of a fluid-pressure cylinder, a piston working therein, a cross-head fixed to the rod of the piston, an arm or connection adapted to vibrate in a direction transverse to the traverse of the piston, and to effect two traverses, in opposite direction, during each stroke thereof, a link coupling said vibratory arm or connection directly to the cross-head, a rotatable crank-shaft, and a connection coupling said crank-shaft with the vibratory member, at a greater distance from the axis thereof than the cross-head connection.

3. The combination, substantially as set forth, of a fluid-pressure cylinder, a piston working therein, a cross-head fixed to the rod of the piston, a shaft journaled to vibrate at right angles to the traverse of the piston, and to effect two traverses, in opposite direction, during each stroke thereof, lever-arms fixed upon the vibratory shaft, a rotatable crank-shaft, a connection coupling one of the lever-arms with the cross-head, and a connection coupling the other lever-arm with the crank-shaft.

4. The combination, substantially as set forth, of a fluid-pressure cylinder, a piston working therein, a cross-head fixed to the rod of the piston, a shaft journaled to vibrate at right angles to the traverse of the piston, and to effect two traverses, in opposite direction, during each stroke thereof, lever-arms fixed, at an angle one to the other, upon the vibratory shaft, a rotatable crank-shaft, a connection coupling one of the lever-arms directly to the cross-head, and a connection coupling the other lever-arm with the crank-shaft.

5. The combination, substantially as set forth, of two fluid-pressure cylinders, pistons working in said cylinders, cross-heads fixed to the rods of said pistons, a shaft journaled to vibrate at right angles to the traverse of said pistons, and to effect two traverses, in opposite direction, during each stroke thereof, connections coupling said vibratory shaft directly to the cross-heads, a rotatable crank-shaft, and a connection coupling said crank-shaft with the vibratory shaft.

6. The combination, substantially as set forth, of two fluid-pressure cylinders, pistons working in said cylinders, cross-heads fixed to the rods of said pistons, a shaft journaled to vibrate at right angles to the traverse of said pistons, and to effect two traverses, in opposite direction, during each stroke thereof, connections coupling said vibratory shaft directly to the cross-heads, two rotatable crank-shafts, and connections coupling said crank-shafts with the vibratory shaft.

7. The combination, substantially as set forth, of a fluid-pressure cylinder, a piston working therein, a cross-head fixed to the rod of the piston, a shaft journaled to vibrate at right angles to the traverse of the piston, a connection coupling said vibratory shaft with the cross-head, a rotatable crank-shaft, a connection coupling said crank-shaft with the

vibratory shaft, a counter-shaft geared to the crank-shaft, and independent connections coupling the cross-head with the counter-shaft.

8. The combination, substantially as set forth, of a fluid-pressure cylinder, a piston working therein, a distribution-valve controlling the supply and exhaust of the cylinder, a cross-head fixed to the rod of the piston, a shaft journaled to vibrate at right angles to the traverse of the piston, a connection coupling said vibratory shaft with the cross-head, a rotatable crank-shaft, a connection coupling said crank-shaft with the vibratory shaft, a counter-shaft geared to the crank-shaft, independent connections coupling the cross-head with the counter-shaft, and connections for actuating the distribution-valve by the movement of the counter-shaft.

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