No. 627,572. Patented June 27, 1899.

W. S. COLWELL.

ENGINE OR MOTOR.

(Application filed July 22, 1898.)

(No Model.) 6 Sheets—Sheet 1.

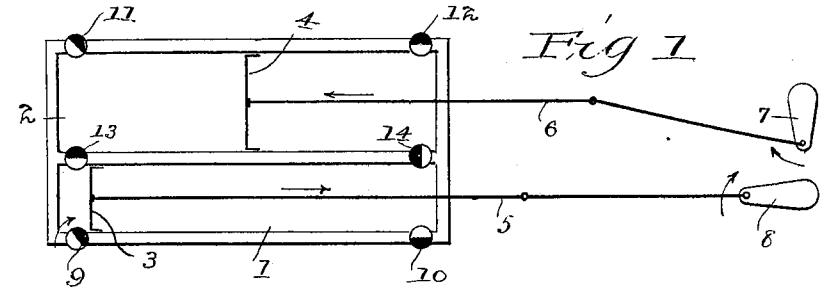

Fig 1

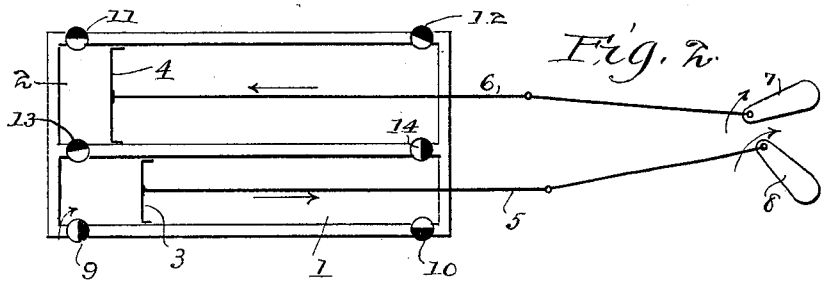

Fig. 2

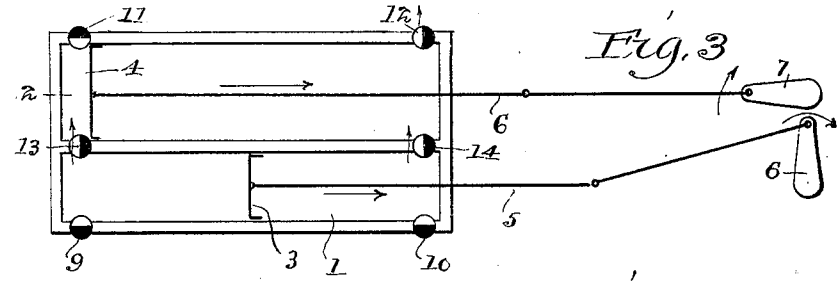

Fig. 3

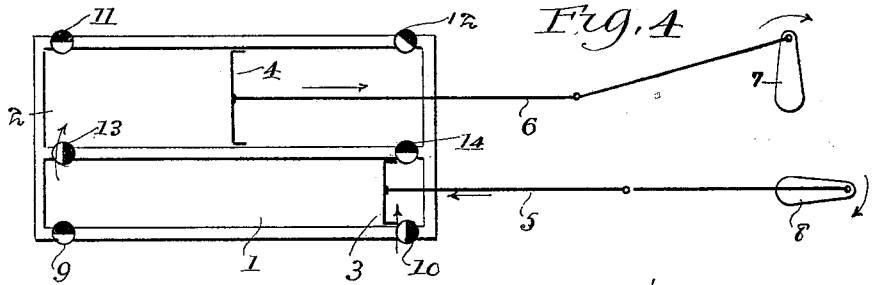

Fig. 4

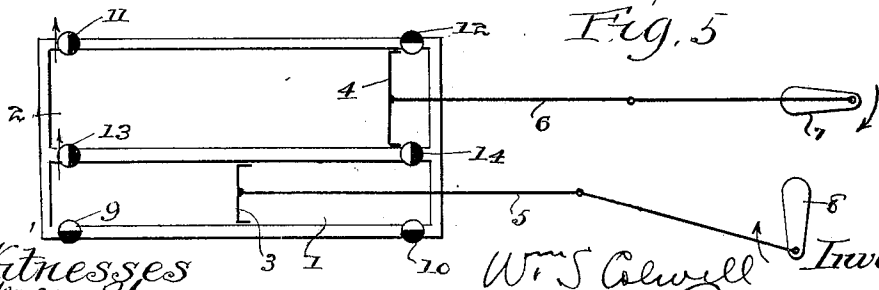

Fig. 5

Witnesses
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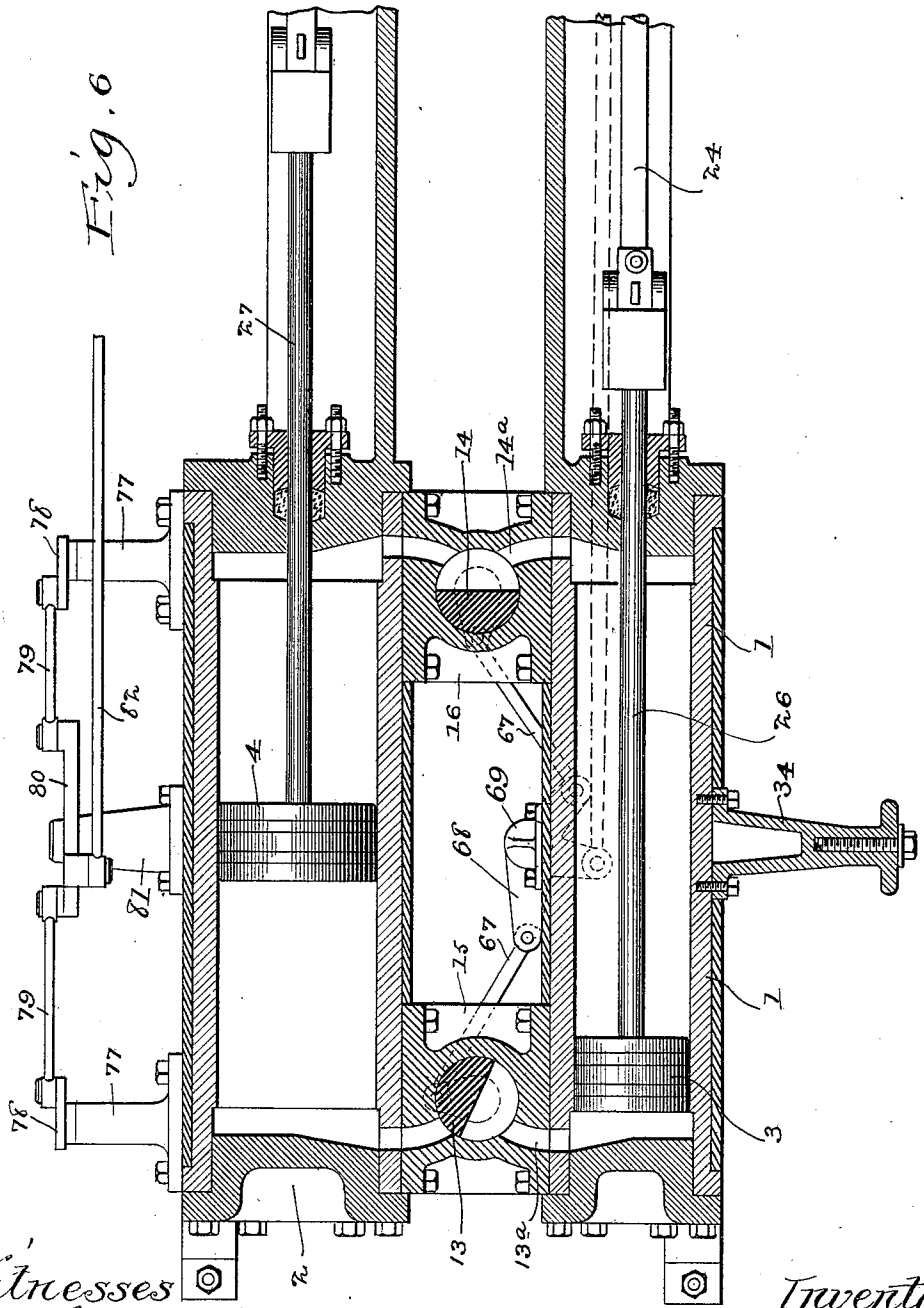
(No Model.) 6 Sheets—Sheet 2.

Fig. 6



Witnesses
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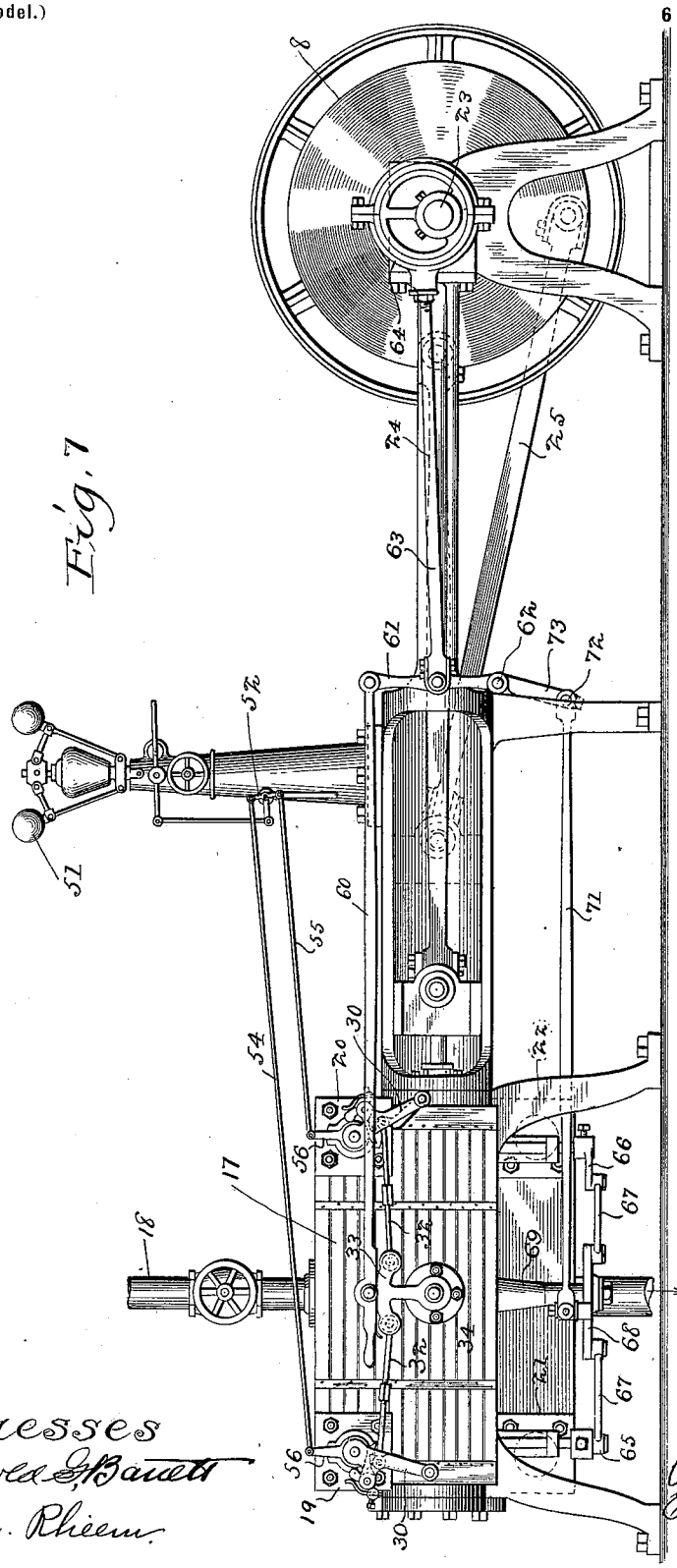
(No Model.) 6 Sheets—Sheet 3.

Fig. 7



Witnesses
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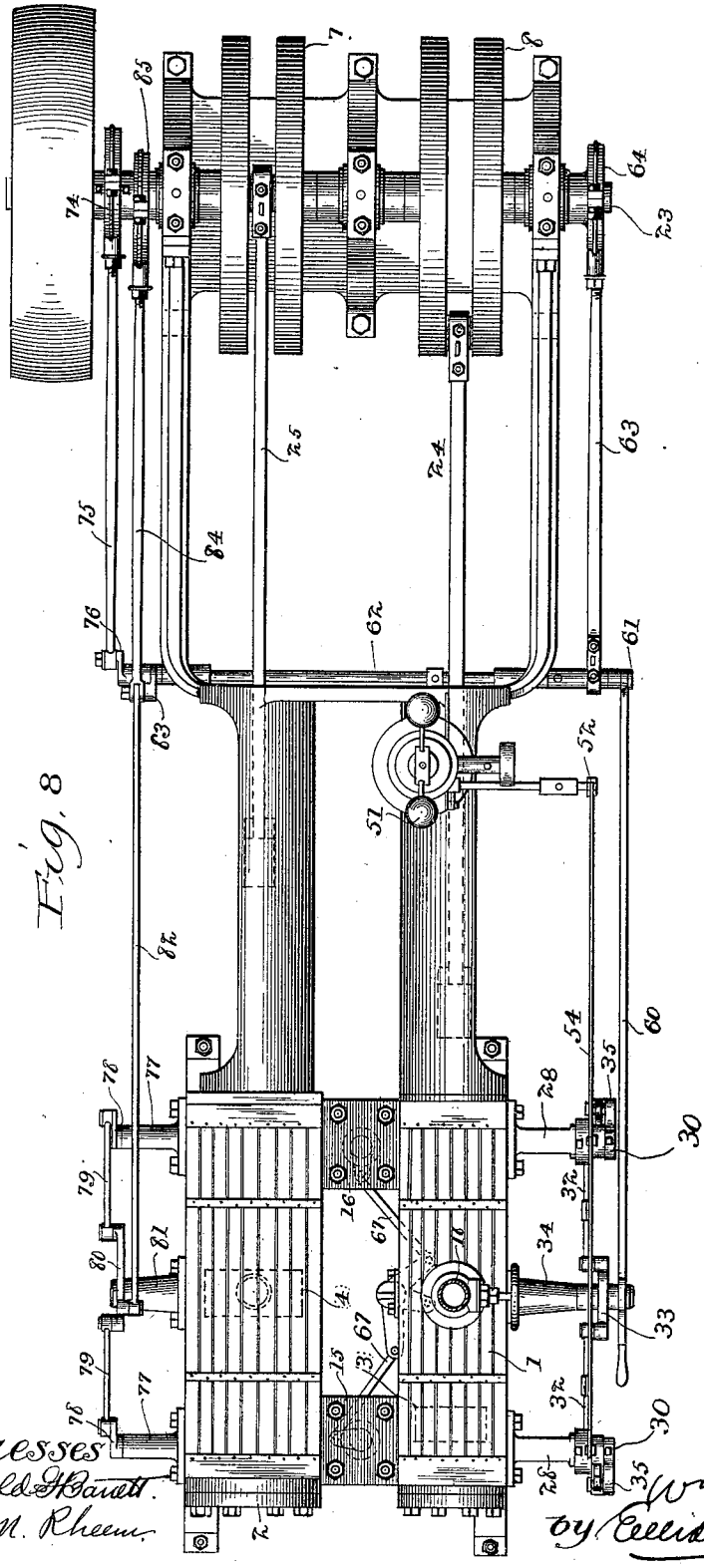

Fig. 8

Witnesses
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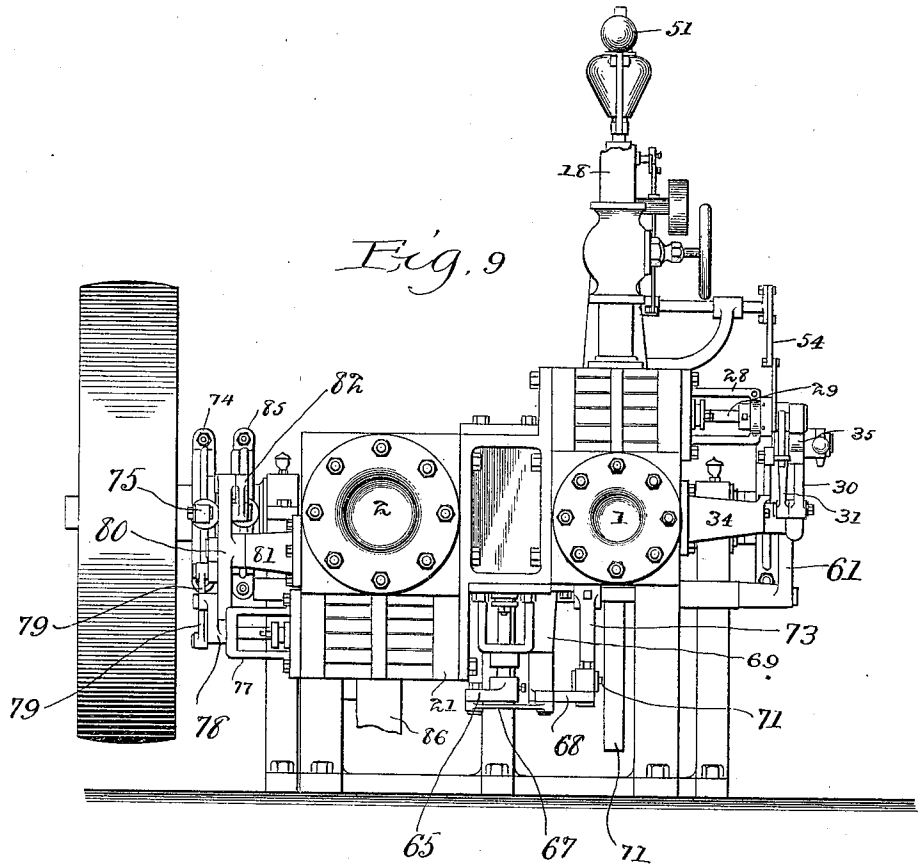
ENGINE OR MOTOR.

(Application filed July 22, 1898.)

(No Model.) 6 Sheets—Sheet 5.

Fig. 9



Witnesses
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ENGINE OR MOTOR.

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(No Model.) 6 Sheets—Sheet 6.

Fig. 10

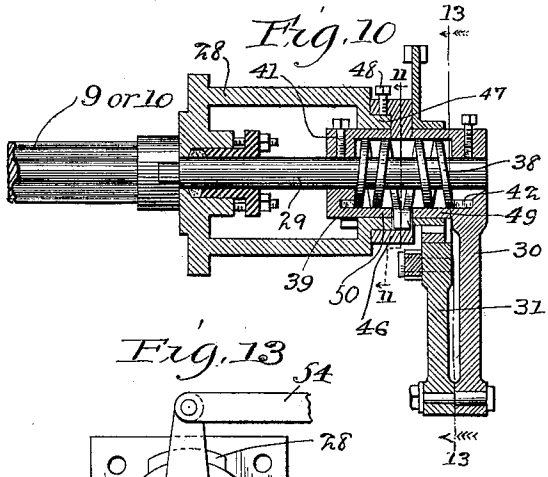


Fig. 11

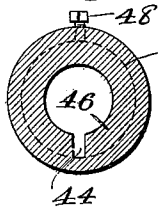


Fig. 12

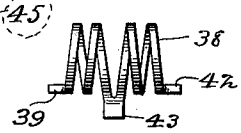


Fig. 13

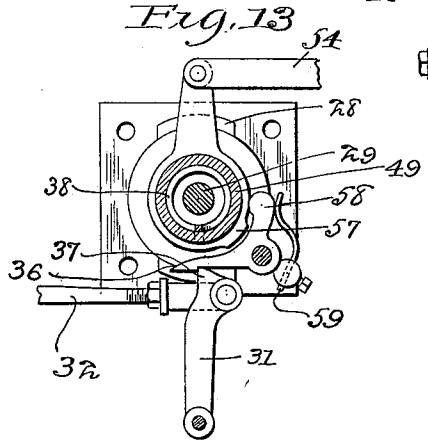


Fig. 14

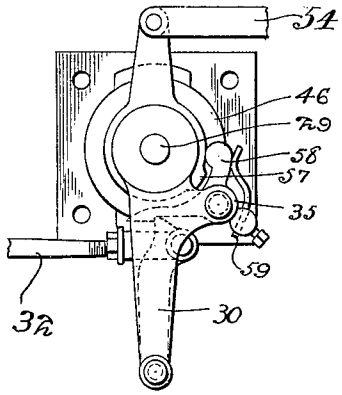


Fig. 15

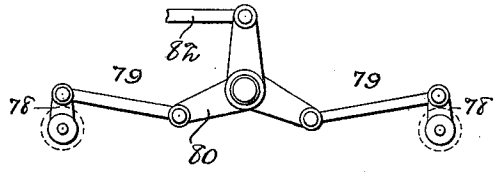
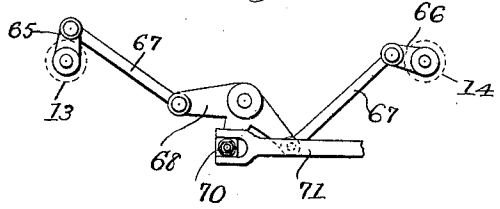


Fig. 16



Witnesses
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Wm. M. Rheem.

Inventor
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UNITED STATES PATENT OFFICE.

WILLIAM SAMUEL COLWELL, OF CHICAGO, ILLINOIS.

ENGINE OR MOTOR.

SPECIFICATION forming part of Letters Patent No. 627,572, dated June 27, 1899.

Application filed July 22, 1898. Serial No. 686,592. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM SAMUEL COLWELL, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Engines or Motors, of which the following is a full, clear, and exact specification.

The invention relates more particularly to overcoming dead-center in steam and other fluid-pressure engines or motors; and it has for its primary object to compel the fluid-pressure which has acted on the shaft or other rotary member until the point of dead-center is or about to be reached to continue to act on such shaft or member at another point of the cycle, and thus cause a single engulf of fluid-pressure after carrying the wrist-pin completely to the point of dead-center to return it or carry it around past such point and to continually act rotatively on the crank-shaft until the time of exhausting without back pressure.

I have shown my invention embodied in the form of a reciprocating engine, and in accomplishing its main object I employ two cylinders or other chambers, each containing a piston or other movable abutment for the fluid-pressure to act on, and the two cylinders or abutment-chambers are connected together at opposite ends by valved crossover-passages, while one of the cylinders (the primary cylinder) is provided at each end with an inlet and the other or secondary cylinder at each end with an exhaust. These pistons or abutments are operatively connected together by any suitable means, such as piston-rods and a crank-shaft, so that the action of one coöperates with the other in the work to be performed, and where this operative connection consists of a shaft and cranks the points of connection between the cranks and the pistons are arranged on the quarter, and this arrangement, it is also seen, sets one piston or abutment a half-stroke in advance of the other. As a consequence by a proper manipulation of the valves the pressure may be admitted to the primary cylinder while the secondary piston is at an intermediate point in its stroke and the cross-over valve may be opened at the same end while the primary piston is at an intermediate point, thus permitting pressure in the primary cylinder to rush into the secondary cylinder and also act on the secondary piston throughout its entire stroke while the primary piston is finishing one stroke and beginning another. In short, the fluid-pressure admitted to the primary cylinder also acts on the secondary piston during the time that the primary piston is approaching and receding from the dead-point or point where its motion reverses, and live pressure or steam being admitted to the opposite side of the primary piston as soon as the dead-center is passed it follows that the continuous column of pressure then extending throughout the entire length of the primary cylinder and half the length of the secondary cylinder will be pushed backward, as it were, by the returning primary piston and forced around into the secondary cylinder, impelling the secondary piston on its way throughout the balance or remaining half of its stroke, and continues to thus actuate the secondary piston until its stroke is finished, whereupon the single engulf of steam or pressure having been fully utilized for making one complete stroke of both pistons is allowed to exhaust from the advancing side of both pistons at once before there is any opportunity for either piston to compress it or reduce its volume from that volume to which it has expanded in driving the pistons.

With the described objects in view my invention consists in the features of novelty by which the said objects and certain other objects, hereinafter appearing, are attained and which I will now more specifically describe, reference being had to the accompanying drawings, in which—

Figure 1 is a diagrammatic view of my improved engine, illustrating the primary cylinder in the act of taking steam in its left-hand inlet-port. Fig. 2 is a similar view illustrating the pistons advanced a half-stroke from the position illustrated in Fig. 1, the cranks being advanced a quarter-stroke of the cycle from the latter position, fluid-pressure being admitted from the primary cylinder through the crossover-passage on the left. Fig. 3 is a similar view showing the cranks advanced an eighth of a stroke farther than shown in Fig. 2, the supply being shut off and the exhaust open and both pistons working

by expansion alone. Fig. 4 is a similar view illustrating the cranks on the next or second quarter from that illustrated in Fig. 1, the crossover-valve on the left remaining open and the primary cylinder being in the act of taking fluid-pressure on the right. Fig. 5 is a similar view illustrating the cranks on the third quarter from that illustrated in Fig. 1, fluid-pressure being admitted from the primary cylinder to the secondary cylinder through the crossover-valve on the right, crossover-valve on the left and exhaust-valve on the left of secondary cylinder being open, allowing both cylinders to exhaust on the left, each piston having made one and a half strokes. Fig. 6 is a plan section of a reciprocating engine embodying the invention. Fig. 7 is a side elevation thereof. Fig. 8 is a full plan. Fig. 9 is a rear end view or view looking from the cylinder end. Fig. 10 is an enlarged detail sectional view of the valve-operating mechanism hereinafter described. Fig. 11 is a transverse sectional view thereof, taken on the line 11 11, Fig. 10. Fig. 12 is a detail view of the valve-actuating spring hereinafter described. Fig. 13 is a sectional view taken on the line 13 13, Fig. 10. Fig. 14 is an end elevation of the valve-operating mechanism, looking from the right in Fig. 10. Fig. 15 is a plan view of the mechanism for operating the crossover-valves, and Fig. 16 is a side elevation of the mechanism for operating the exhaust-valves.

In describing the invention reference will first be made to the diagrammatic views, Figs. 1 to 5, which illustrate the principle of the invention and which when understood might be embodied in various forms of mechanism without departing from the invention in its generic sense.

1 represents the primary cylinder or abutment-chamber, and 2 the secondary cylinder or abutment-chamber. Each of these contains a movable abutment or piston, the primary piston or abutment being shown at 3 and the secondary at 4, which are provided, respectively, with piston-rods 5 6, having suitable operative connection with the shaft or other member to be driven, which has been omitted from the diagrammatic views for the sake of clearness. For the sake of illustration, however, it may be assumed that an ordinary crank-shaft is employed and has secured to it a pair of cranks, one of which, 7, is connected with the secondary piston 4, and the other, 8, with the primary piston 3, both cranks being secured to the same shaft. These cranks are set on the quarter or ninety degrees apart.

The primary cylinder 1 is provided at each end with an inlet-valve 9 10 and the secondary cylinder 2 at each end with an exhaust-valve 11 12, and the two cylinders are provided at each end with crossover-passages having valves 13 14, respectively, whereby communication may be opened between the cylinders at either end. This arrangement of the cranks on the quarter, it will be seen, also sets one of the pistons less than a whole stroke, or, to be accurate, a half-stroke, in advance of the other, and hence when the primary piston is at the limit of the stroke, as indicated in Fig. 1, and the valve 9 is about to admit pressure to the primary cylinder the secondary piston is at an intermediate point of its stroke about midway between its ends.

When the primary piston 3 is at the beginning of its stroke on the left, as shown in Fig. 1, the inlet-valve 9 is opened by the automatic valve-gear, hereinafter described, or by any other suitable mechanism and remains open for a greater or less time, according to the condition of the cut-off mechanism, and the piston 3 is driven toward the right by the pressure thus admitted. In this position of the parts the crossover-valve 13 is closed, so as to confine the pressure at first to the primary cylinder 1; but by the time the parts are in the position shown in Fig. 3 the secondary piston has completed its stroke toward the left and is about to commence its return stroke toward the right and the crossover-valve 13 will open and admit pressure from the primary cylinder 1 to the left-hand end of the secondary cylinder 2. If the pressure fluid be elastic or expansible and the inlet-valve 9 be closed, it will act upon both pistons by its expansive force alone and drive them in the same direction, or if the condition of the cut-off mechanism be such that the valve 9 is still open when the valve 13 opens the secondary cylinder will also receive direct pressure from the source of supply. This pressure, whether it be expansible or direct, or both, will drive the two pistons to the right until primary piston 3 reaches the limit of its stroke on the right, when the parts will be in the position as shown in Fig. 4, (or, if going toward the left, in the reverse position shown in Fig. 1,) the piston 4 in the secondary cylinder being about midway of its stroke. At about this position the inlet-valve 10 admits new pressure to the primary cylinder 1 on the right of piston 3, crossover-valve 14 being closed so as to confine the new pressure at first to the primary cylinder on the right of piston 3. In this position of the parts the pressure on the left of piston 4 in secondary cylinder 2 continues to drive said piston 4 to the right, carrying crank 8 of the primary cylinder past its dead-center, whereupon the new pressure admitted to the right of piston 3 becomes effective and drives piston 3 toward the left, driving the volume of fluid-pressure on the left of piston 3 toward the left in the primary cylinder through crossover-valve 13 and thence toward the right in cylinder 2 against secondary piston 4, piston 3 in the primary cylinder being driven toward the left and piston 4 being driven toward the right until piston 4 in the secondary cylinder has reached the limit of its stroke, when the parts will be in the position shown in Fig. 5. At this time exhaust-valve 11 opens, allowing both cylinders to ex-

haust the fluid-pressure on the left of pistons 3 4 through valve 13 and exhaust-valve 11. When piston 4 in the secondary cylinder is at the end of its stroke on the right and about to return toward the left, as shown in Fig. 5, crossover-valve 14 opens to admit pressure from the primary cylinder, and the pressure which is now on the right of both pistons will continue to drive them toward the left until they are again in the position shown in Fig. 1. It is of course understood that as soon as the secondary piston arrives at substantially the limit of its stroke at either end of the cylinder and the expansive force of the pressure can no longer be utilized thereon the exhaust-valve 11 or 12 at the opposite end of the cylinder will open to permit both cylinders to exhaust. When the pistons arrive at the positions shown in Fig. 4 and the live steam admitted to piston 3 through the valve 10 begins to drive said piston 3 to the left, the steam on the left of piston 3 is not compressed by that action, but passes through valve 13 into secondary cylinder 2 and follows and keeps up the motion of the secondary piston 4 to the end of its stroke toward the right, whereupon all pressure on the left side of the pistons is exhausted. It is also seen that when the pistons are in the position shown in Fig. 4 the greater leverage of the secondary crank 7, it being at the point of greatest efficiency, gives the secondary piston 4 a decided advantage over the primary piston 3, and hence would still continue the rotation of the shaft and carry the primary crank past the dead-center, even though the pistons were not of differential area, but were subjected to the same pressure; but by being of differential area this advantage of the secondary piston 4 is greatly augmented. It is further seen that should the pressure fluid employed be not of an expansible character, such as water under ordinary temperature, the pressure on the right of the primary piston when in the position shown in Fig. 4 would force the column of fluid contained in the two cylinders around through the valve 13 and against the secondary piston, giving the latter more power on the shaft than the primary piston would possess, owing to the greater leverage of the secondary crank.

With an engine constructed on this principle it will be seen that each engulf of pressure not only produces the stroke and continues the motion beyond the dead-center and dead-point, but produces a complete stroke of each piston and carries the shaft throughout three-fourths of a revolution before it exhausts and the same engulf of pressure acts rotatively throughout its entire period of confinement. It is also seen that there is at no time any more back pressure than may be especially provided if needed by the adjustment of the eccentric, because as soon as the secondary piston ceases to move under the pressure to which corresponding sides of both pistons are subjected, such pressure is relieved through the exhaust.

The drawings illustrate the cylinders or abutment-chambers as being of different diameters and the pistons or abutments accordingly of different areas, the primary cylinder and abutment being the smaller; but this differential area is preferable rather than essential, for it is obvious that while this increased area of the secondary piston renders it more effective under a given pressure the invention nevertheless comprehends cylinders and pistons of the same diameter, as the latter construction is eminently effective.

The invention will now be described with reference to Figs. 6 to 16 of the drawings, which show its practical embodiment. The cylinders 1 and 2 are connected together by a pair of blocks 15 16, which constitute the valve-housings for the crossover-passages 13^a 14^a, which communicate with registering ports or passages formed in the opposed sides of the cylinders 1 2. The upper side of the primary cylinder 1 is provided with a steam-chest 17, to which leads the supply-pipe 18, and in each end of which chest is formed a valve-housing 19 20 for the accommodation of the inlet-valves 9 10, which extend transversely of the cylinder 1 and are preferably of the elongated cylindrical type shown in Fig. 10. The exhaust-valves 11 12 are preferably arranged under the secondary cylinder 2 transversely thereof and are of the cylindrical form similar to the valves 9 10, the under side of the secondary cylinder being provided with depending housings 21 22, as shown in Figs. 7 to 9, for their accommodation.

23 represents the shaft, having thereon the two cranks 7 8, shown in the drawings as crank-disks, which are rigidly secured in any suitable manner to the shaft 23 and each connected by a pitman 24 25 with the piston-rods 26 27 of the pistons or abutments 3 4, thus operatively connecting such pitmen or abutments together, so that they will have a coöperative effect on the shaft 23.

On the outer end of each of the valve-housings 19 20 is arranged a hood 28, in which is journaled a valve-stem 29, (see Fig. 10,) whose inner end is socketed in the end of the inlet-valve. On the outer end of this stem 29 is secured a crank-arm 30, which has pivoted to its lower end another crank-arm 31. Each of these crank-arms 31 is pivoted at its upper end to a connecting-rod 32, and these two connecting-rods are pivoted at their contiguous ends to a rocking lever 33, which is in turn pivoted to a bracket 34, projecting from the side of the cylinder 1. The crank-arm 30 carries a supplemental arm 35, to which is pivoted a dog or catch 36, which engages with a tooth or lug 37, formed on the upper end of the arm 31, when the latter arm moves toward the arm 30, and when the parts are thus engaged it will be seen that the oscillation of the arm 31 will also cause the oscillation of

the arm 30, and consequently actuate the inlet-valve, to which the stem 29 is attached, this motion of the arm 31 being preferably utilized for opening the valve. The valve is closed by means of a spring or cushion which is employed in preference to other devices for the sake of avoiding objectionable noise and cost and will economize space and be of efficient construction. The spring referred to for this purpose is the spring 38. (Shown in Fig. 12.) It surrounds the stem 29, as shown in Fig. 10, and has its bent end 39 engaged in a collar 40, secured to the stem 29 by a set-screw 41, while its bent end 42 is inserted in the crank 30. The intermediate convolutions of the spring 38 are carried downwardly in a V-shaped formation 43 and engaged in a notch 44, formed in a collar 45, which has a flange 46 surrounding a hub or flange 47, formed on the end of the hood 28 and being secured to such flange 47 by a set-screw 48. Thus it will be seen that both ends of the spring 38 are secured to the stem 29, while its mid-length is held against rotation by means of the collar 45, and the collar 45 being adjustable on the hood 28 the tension of the spring may be varied at will. When the valve is opened by a pull on the crank-arm 31, the spring 38 is contracted, and when the dog 36 releases its hold on the arm 31 the spring instantly returns the valve to its closed position. Now in order that the return movement of the valve may be positive and its resting position accurately determined, so that the valve will be free from vibratory movement when closing, the spring is provided with an inclosure which comes in contact with the circumference of its convolutions and limits its recoil or expansion. This inclosure preferably consists of a sleeve, and this may be formed partly on the crank-arm 30 and partly on the collar 40. The part of the sleeve on the crank-arm 30 is shown at 49 and the part on the collar 40 at 50. Thus it will be seen that the valve will be actuated to close with the desired rapidity, and at the same time the checking of the valve in its closing movement will be free from the noise resulting from the use of a dash-pot.

The dog 36 is caused to release its hold on the arm 31 sooner or later, according to the speed of the engine, by the operation of the usual governor 51. The governor is connected to a double lever 52 by rod 53, and each arm of this lever 52 is connected to one of a pair of rods 54 55, which are connected, respectively, with an arm 56, journaled on each of the sleeves 49 and having a cam 57, as more clearly shown in Fig. 13, against which rubs a tailpiece 58, formed on the dog 36 and held in contact with the cam 57 by a spring 59, secured to the supplemental arm 35 of the arm 30. Hence it will be seen that as the governor moves up or down with the varying speed of the engine the rods 54 55 will be moved in opposite directions and the position of the cams 57, carried by each of the arms 56, will be changed with relation to the stroke of the tailpiece 58 on each of the dogs, and consequently the dog will be forced out of engagement with the arm 31 sooner or later after effecting the cut-off, according to the speed of the engine.

The lever 33 receives its motion from a connecting-rod 60, having one end pivoted to a lever 61, mounted loosely upon a shaft 62 and being in turn connected by eccentric-rod 63 to an eccentric 64 on the shaft 23.

The lower end of each of the crossover-valves 13 14 is provided with a crank-arm 65 66, each of which is connected by a rod 67 to one of the arms of a bell-crank lever 68, pivoted on the lower end of a hanger 69 and being also provided with a third arm having universal-joint connection 70 with one end of a connecting-rod 71, whose other end is connected by a universal joint 72 to a crank-arm 73 on the rocker-shaft 62. (See Fig. 7.) This shaft 62 receives a rocking movement from an eccentric 74 on the shaft 23, connected by eccentric-rod 75 to a crank-arm 76 on the end of the shaft 62. Thus when the shaft 62 is rocked back and forth the crossover-valves 13 14 will be alternately opened and closed.

The stems of the exhaust-valves, which valves are similar in construction to the inlet-valves before described, are mounted in bearings 77, secured to the side of the valve-housings 21, and each of such stems is provided with a crank-arm 78, and each of these crank-arms 78 is pivoted to the outer end of one of a pair of connecting-rods 79, whose inner ends are pivoted to a tri-armed bell-crank lever 80, pivotally supported on bracket 81 and having its third arm pivoted to one end of a connecting-rod 82, whose other end is pivotally supported by a crank arm or standard 83, loosely journaled on the shaft 62 and connected by eccentric-rod 84 to an eccentric 85 on the shaft 23, so that at each rotation of the eccentric 85 the exhaust-valves will be opened and closed, 86 being the exhaust-discharge pipe.

The particular form of valve-gear for opening and closing the valves and regulating the cut-off, though very appropriate for this engine, is not essential and may have many substitutes so far as this engine is concerned, and while I have shown and fully described it as an example of valve-gear I have not claimed it herein, as it forms the subject-matter of a contemporaneous application.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. In an engine the combination of primary and secondary cylinders, a piston in each of said cylinders, two cranks connected with said pistons respectively and being set on the quarter, means for admitting pressure to the left-hand end of the primary cylinder when the primary piston is at that end, means for opening communication between said cylinders at the same end after the secondary pis-

ton has completed its stroke toward that end, means for admitting pressure to the primary cylinder at the right-hand end when the primary piston is at that end and opening communication between the cylinders at the right-hand end after the secondary piston has completed its right-hand stroke and means for exhausting the pressure from the advance side of both pistons at once, substantially as set forth.

2. In an engine the combination of primary and secondary cylinders, two pistons in said cylinders respectively, two cranks connected with said pistons respectively and being set on the quarter, means for admitting pressure to the left-hand end of the primary cylinder when the primary piston is at that end, means for opening communication between said cylinders at the same end after the secondary piston has completed its stroke toward that end and maintaining said communication until said secondary piston has completed its return stroke toward the right, means for admitting pressure to the primary cylinder at the right-hand end when the primary piston is at that end and opening communication between the cylinders at the right-hand end after the secondary piston has completed its right-hand stroke, and means for exhausting the pressure from the advance side of both pistons at once, substantially as set forth.

3. In an engine the combination of primary and secondary cylinders, two pistons in said cylinders respectively, two cranks connected to said pistons and being set on the quarter, means for admitting pressure to the left-hand end of the primary cylinder when the primary piston is at that end, means for opening communication between the cylinders at the same end when the secondary piston has completed its left-hand stroke, and maintaining said communication until the primary piston has completed its right-hand stroke and again returned to the left-hand end of the cylinder, means for opening the exhaust at the left-hand end of the cylinders when the secondary piston reaches the end of its right-hand stroke, means for admitting pressure to the primary cylinder at the right-hand end when the primary piston is at the right-hand end of its stroke, means for opening communication between the cylinders at the right-hand end when the secondary piston has completed its right-hand stroke and maintaining said communication until the secondary piston has completed its left-hand stroke and means for opening the exhaust at the right-hand end of the cylinders when the secondary piston has completed its left-hand stroke, substantially as set forth.

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Witnesses:
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