No. 645,582. Patented Mar. 20, 1900.

J. WATSON.

COMPOUND ENGINE.

(Application filed June 16, 1899.)

(No Model.) 2 Sheets—Sheet 1.

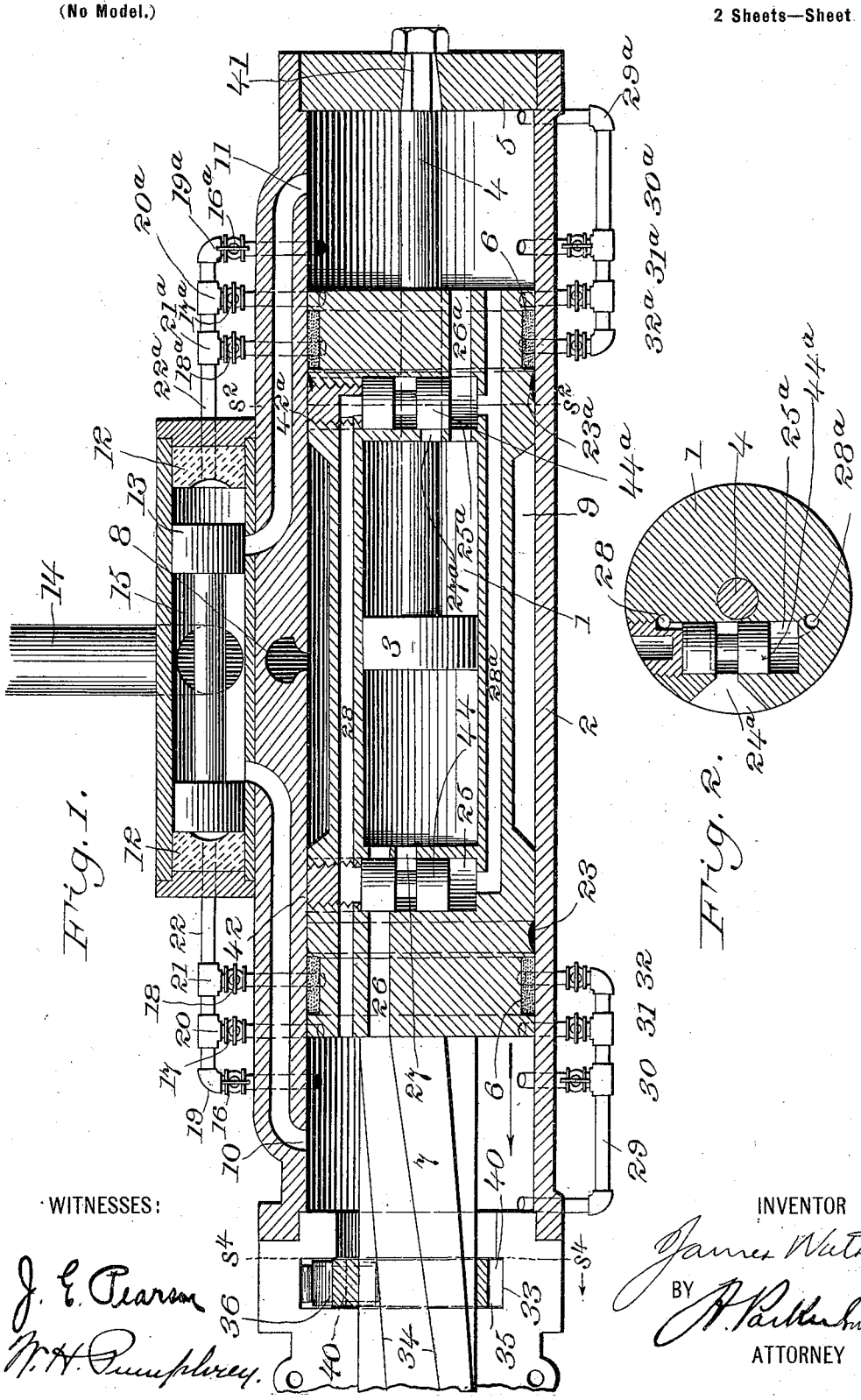


Fig. 1.

Fig. 2.

WITNESSES:

J. E. Pearson

W. A. Dumphrey.

INVENTOR

James Watson

BY Parker Smith

ATTORNEY

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 645,582. Patented Mar. 20, 1900.

J. WATSON.

COMPOUND ENGINE.

(Application filed June 16, 1899.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 3.

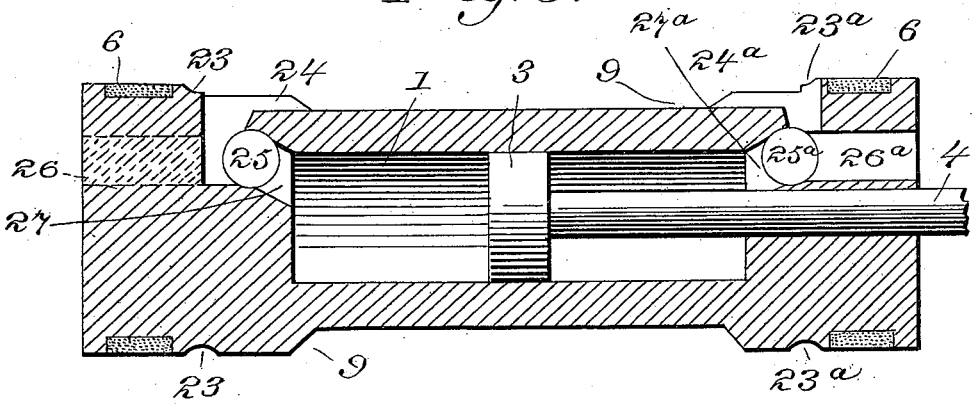
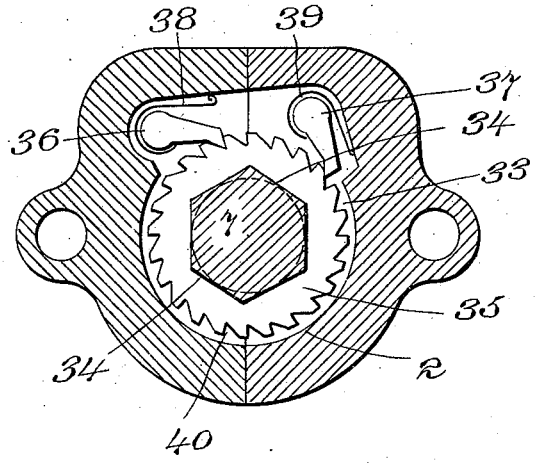


Fig. 4.



WITNESSES:

J. E. Pearson

W. H. Dumphrey.

INVENTOR

James Watson

BY A. Vanderwilt

ATTORNEY

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

JAMES WATSON, OF NEAR JOHANNESBURG, SOUTH AFRICAN REPUBLIC, ASSIGNOR TO BARRY SEARLE, OF MONTROSE, PENNSYLVANIA.

COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 645,582, dated March 20, 1900.

Application filed June 16, 1899. Serial No. 720,767. (No model.)

To all whom it may concern:

Be it known that I, JAMES WATSON, a subject of the Queen of Great Britain and Ireland, and a resident of the Crown Deep Gold Mining Company, near Johannesburg, in the South African Republic, have invented certain new and useful Improvements in Compound Engines, of which the following is a specification.

This invention relates to improvements in compound engines applicable to rock-drilling machines; and certain features of the invention are capable of use in other engines in which a reciprocating motion is required, the power employed being steam, compressed air, or other motive fluid.

The object of my invention is to provide a compound engine of simple and cheap construction and of a more compact nature than is possible with the type of compound engine which is at present in general use.

My invention consists of improvements in compound engines in which the high-pressure cylinder is arranged within and inclosed by the low-pressure cylinder, the piston of the high-pressure cylinder remaining stationary and the high-pressure cylinder, acting as the piston, working within the low-pressure cylinder and being connected with the reciprocating rod—*i. e.*, the drill-shaft or the piston-rod, as the case may be.

The preferred form of apparatus embodying my invention is illustrated in the accompanying two sheets of drawings, in which—

Figure 1 shows a central section of the apparatus, the plane of said section being shifted, however, at various points, so as to bring out certain of the parts more nearly in diagrammatic relation. Fig. 2 is a section of the combined low-pressure piston and high-pressure cylinder on line $s^2 s^2$ of Fig. 1. Fig. 3 is a horizontal central section of said low-pressure piston and high-pressure cylinder. Fig. 4 is a cross-section on line $s^4 s^4$ of Fig. 1 looking in the direction of the arrow.

Throughout the drawings like reference-figures refer to like parts.

A high-pressure cylinder 1 is arranged within and completely inclosed by a low-pressure cylinder 2. The said high-pressure cylinder 1 also constitutes the piston of the low-pressure cylinder 2. The piston 3 of the high-pressure cylinder is rigidly mounted on one end of a piston-rod 4, which passes through a stuffing-box (not shown) in the right-hand head of the high-pressure clyinder 1, and has its other end rigidly screwed in the head 5 of the low-pressure cylinder. The said piston-rod is prevented from turning in the head 5 by means of the feather 41 or any other equivalent construction. Packing-rings 6 6 are fitted in the grooves turned on either end of the high-pressure cylinder 1, so as to render the same a steam-tight piston for the low-pressure cylinder 2. A drill bar or shaft 7 or other working piston-rod is secured to the left-hand head of the high-pressure cylinder 1 and works through a stuffing-box fitted in the left-hand end of the low-pressure cylinder 2. (Not shown in the drawings.) An inlet-port 8 for high-pressure steam is situated approximately in the center of the low-pressure cylinder 2, through which steam, compressed air, or other motive fluid under pressure may be admitted to drive the engine, said inlet-port being connected to any ordinary supply-pipe. (Not shown in the drawings.)

The high-pressure cylinder 1 is turned down to a reduced diameter about its central portion inside of the packing-ring 6 6, so as to form an annular chamber 9, which constitutes the high-pressure steam-chest of the engine. This recess 9 is of such length as to always leave it in communication with the inlet-port 8, even at the extremes of stroke of the low-pressure piston 1. The low-pressure cylinder 2 is provided at either end with exhaust-ports 10 and 11, which lead to the exhaust-valve chest 15, in which is mounted the piston exhaust-valve 13.

14 is an exhaust-pipe connecting with the exhaust-chest 15, and 12 12 represent cushions of rubber or other material calculated to take the shock of the blow of the valve 13 and cushion the same.

From either end of the exhaust-valve chest 15 run pipes or other forms of passage-ways 22 22^a, which have a series of branches 19 20 21 19^a 20^a 21^a communicating with the interior of the low-pressure cylinder at various points in the length of the latter. These various branches are controlled by valves 16 17 18 16^a 17^a 18^a or other equivalent means.

These branches, however, all connect with the low-pressure cylinder at points nearer its center than the openings of the exhaust passage-ways 10 11.

23 23ª are annular grooves cut in the cylinder-heads of the high-pressure cylinder 1 inside of the packing-rings 6 6. These annular grooves are connected by longitudinal grooves 24 24ª with the high-pressure chest 9, so that the ports of the branches 19 20 21 19ª 20ª 21ª are respectively placed in communication with the high-pressure chest 9 whenever one of the annular grooves 23 23ª come opposite said ports.

In each head of the high-pressure cylinder 1 are mounted valves 44 44ª, preferably made in the form of double piston-valves, as shown, which move in valve-chest 25 25ª along lines at right angles to the line of motion of the combined high-pressure cylinder and low-pressure piston 1. These valves perform the double function of opening and closing the exhaust passage-ways 26 26ª, affording communication between the high and low pressure cylinders at either end and also controlling the admission of high-pressure steam or air to the high-pressure cylinder from the chest 9 through the passage-ways 24 24ª and 27 27ª, respectively. Passage-ways are also cored out in the high-pressure cylinder, as shown at 28 28ª, which afford communication from one end of the low-pressure cylinder to one end of the valve-chambers 25 25ª and from the other end of the low-pressure cylinder to the other ends of said valve-chests 25 25ª. Passage-ways are also provided from the extreme ends of the low-pressure cylinders, preferably in the form of pipes 29 29ª, which have a series of valve-controlled branches 30 31 32 30ª 31ª 32ª communicating with the low-pressure cylinder at points at the same corresponding distances from the heads as the branches 19 20 21 19ª 20ª 21ª.

In order to impart a rotary motion to the drill-bar, any one of a number of devices may be used; but I prefer to employ the construction illustrated in Fig. 4, in which a ratchet-wheel 35 is located in a recess 33 in the left-hand head of the low-pressure cylinder. Said ratchet-wheel has preferably a polygonal central opening, which fits over and slides on the correspondingly-shaped drill-bar 7. The said drill-bar is given a helical twist, so that the edges 34 34 thereof form rifle-bars or other equivalent helical guides.

Mounted in the casing or cylinder-head are two pawls 36 37, taking into the ratchet-teeth 40 of the ratchet-wheel 35, said pawls being normally held in engagement by springs 38 39 or equivalent apparatus.

42 42ª represent radial openings in the high-pressure-cylinder heads closed by screw-plugs, as shown, through which openings the valves 44 44ª may be introduced or removed.

The mode of operation of my invention is as follows: The parts being in the position shown in Fig. 1, high-pressure air or steam is entering through the induction-port 8 to the chest 9, from which it is passing through the passage-way 24 and valve-port 27 to the left-hand end of the high-pressure cylinder. The piston 3 being held stationary, the high-pressure cylinder will evidently be driven to the left in the direction of the arrow in Fig. 1. At the same time the air or steam left in the right-hand end of the high-psessure cylinder at the close of the preceding stroke is escaping through the passage-way 26ª to the right-hand end of the low-pressure cylinder and acting upon the right-hand head of the high-pressure cylinder to also drive said cylinder to the left as a piston. This forces the drill down into the hole being drilled and rotates the ralchet-wheel 35 a distance proportionate to the length of stroke of the apparatus. As shown in Fig. 1, when the valves 17 18 17ª 18ª are turned so as to close the passage-ways 20 21 20ª 21ª and the valves 16 16ª to be open, so as to leave the passage-ways 19 19ª open, the engine will make its complete stroke—that is to say, the high-pressure cylinder and low-pressure piston will travel in the direction of the arrow nearly if not quite to the end of the cylinder or until the groove 23 comes opposite the port connecting with the passage-ways 19 30. Live steam will then be admitted through the pipe 22 to the left-hand end of the exhaust-chest 15 and force the exhaust-valve 13 to the right, closing the exhaust-passage 10 of the low-pressure cylinder and opening exhaust-port 11 from the other end. At the same time the high-pressure steam or air will pass through the connections 30 and 29 to the left-hand end of the low-pressure cylinder (cushioning the high-pressure piston) and, passing through the passage-way 28, will force down the valves 25 25ª. This reversal of the high-pressure-cylinder valves will close the port 27 and open the port 27ª, admitting the high-pressure steam from the chest 9 to the other end of the high-pressure cylinder. The same motion of said valve 25 25ª will close the exhaust-port 26ª from that end of the high-pressure cylinder and open that 26 from the other end of the high-pressure cylinder to the left-hand end of the low-pressure cylinder. The high-pressure cylinder will therefore be driven back to the other end of the low-pressure cylinder, where a similar operation of the valves in opposite directions in each case will again reverse the connections, and thus the engine will be continuously reciprocated. When the drill-bar 7 is drawn to the right on its upstroke from the hole being drilled, it will tend to rotate the ratchet-wheel 35 in the opposite direction to which said ratchet-wheel was rotated on the forward or down stroke. One or the other of the pawls 36 37 will, however, catch in the teeth 40 and prevent such rotation of the ratchet-wheel. As a result the drill-bar and high-pressure cylinder 1 must themselves take a partial rotation on their axes during this back stroke, and thus the drill will be

given the necessary fraction of a rotation to cause it to strike in a new place at the bottom of the hole being drilled.

The above-described operation is repeated when the apparatus is set to work at one-third or two-thirds of its full stroke. This shortening of the stroke to two-thirds is produced by closing the valves 16 16ª 30 30ª and opening the valves 17 17ª and 31 31ª. The operation is then as before described, except that the reversal will occur when the grooves 23 23ª come under the ports communicating with said valves 17 17ª or 31 31ª. To cut the stroke down to one-third, the valves 16 17 and the corresponding valves of the other sets are closed and valves 18 18ª 32 32ª opened.

As shown in Fig. 4, the pawls 36 37 are so placed that where one engages the teeth 40 the other is midway between two teeth. Consequently when the drill makes one-third of a stroke the rifle-bars are so designed as to give the ratchet-wheel 35 a fraction of a revolution corresponding to half a tooth, and pawl 36 will catch on one stroke and pawl 37 on the alternate stroke, so as to give the drill at each stroke a fraction of a revolution corresponding to half a tooth. When the apparatus is so set as to give the drill a two-thirds stroke, then the ratchet-wheel 35 will be given a rotation equal to one tooth at each stroke, and one or the other of the pawls 36 37 will always engage, the other remaining idle. When the apparatus is set for a full stroke, the ratchet-wheel 35 will be given a revolution equal to one and a half teeth and the pawls 36 37 will operate alternately, as before described.

The principle of operation of the automatically-adjustable drill-rotating or twist-feed apparatus above described depends on the fact that while a plurality of pawls are used they do not engage the ratchet-teeth simultaneously. This renders their alternative action possible and so permits the ratchet-wheel to be checked against backward rotation at a point of half-tooth or one-and-a-half-tooth travel. Thus a twist-feed may be obtained equal to a fraction of a revolution smaller than that which could be obtained with the same number of ratchet-teeth if only one pawl were used or several pawls operating simultaneously. Thus in Fig. 4 a ratchet-wheel with twenty-four teeth is shown. From this, however, a twist-feed of one forty-eighth of a revolution at one-third stroke is obtainable, because one or the other pawl catches at every half-tooth advance. At two-thirds stroke a twist-feed of one twenty-fourth of a revolution is obtained at every reciprocation, and at full stroke a twist-feed of one-sixteenth of a revolution is given at every reciprocation. Thus a wide range of variation from fine to course feed is obtainable without increasing the number of ratchet-teeth to a degree that would render them each too small to stand the great strain to which they must be subjected. Moreover, if the teeth are many in number and so necessarily small in size the possibility of the pawl slipping over and failing to engage them is increased. Of course a different number of pawls from that shown might be employed so long as there is a plurality of pawls.

The advantages of my invention consist in the simple means for varying the stroke, in the compact form of combined engine shown, in the sure and prompt action of the high-pressure valves, arising from the fact that their motion is at right angles to that of the high-pressure cylinder 1, so that the momentum of the latter will not interfere with the said valves, and also due to the fact that full high pressure is promptly admitted to either end of said valves to drive them back and forth in their respective chambers.

A further advantage consists in the apparatus described, by which the degree of twist given to the drill corresponds to the length of its stroke.

Of course various changes could be made in the details of the apparatus described without departing from the spirit and scope of my invention so long as the relative arrangement of parts or the principle of operation disclosed is preserved. Other forms of valves with communicating passage-ways might be substituted for those shown and other forms of apparatus for giving the drill its necessary amount of twist might be substituted; but these and similar variations I should consider matters of form and not of substance and as still leaving the resulting construction within the broad principle of my invention.

Having therefore described my invention, what I claim as new, and desire to protect by Letters Patent, is—

1. In a compound reciprocating engine the combination of the exterior low-pressure cylinder, the high-pressure cylinder movable therein, the high-pressure piston mounted on one end of a piston-rod, the other end of which is rigidly fastened in one head of the low-pressure cylinder, passage-ways in the high-pressure cylinder connecting its interior with the low-pressure cylinder, and with the high-pressure steam-chest, and valves controlling said passage-ways movable only at right angles to the line of travel of said high-pressure cylinder, an exhaust-valve connected with the low-pressure cylinder at either end, means whereby high-pressure steam may be caused to move said exhaust-valve, and a pipe for conducting said high-pressure steam, having a plurality of valve-controlled connections to the high-pressure steam-chest, whereby the stroke of the engine may be regulated.

2. In a compound reciprocating engine the combination of the exterior low-pressure cylinder, the high-pressure cylinder movable therein, the high-pressure piston mounted on one end of a piston-rod, the other end of which is rigidly fastened in one head of the low-pressure cylinder, passage-ways in the high-pressure cylinder connecting its interior with the low-pressure cylinder, and with the high-

pressure steam-chest, and valves controlling said passage-ways movable only at right angles to the line of travel of said high-pressure cylinder, together with the working piston-rod extending through the other head of the low-pressure cylinder and connected to the high-pressure cylinder.

3. In a compound reciprocating engine the combination of the exterior low-pressure cylinder, the high-pressure cylinder movable therein, the high-pressure piston mounted on one end of a piston-rod, the other end of which is rigidly fastened in one head of the low-pressure cylinder, passage-ways in the high-pressure cylinder connecting its interior with the low-pressure cylinder, and with the high-pressure steam-chest, and valves controlling said passage-ways movable only at right angles to the line of travel of said high-pressure cylinder, together with the working piston-rod extending through the other head of the low-pressure cylinder and connected to the high-pressure cylinder, and means for partially rotating said working piston during one of its strokes.

4. In a compound reciprocating engine the combination of the exterior low-pressure cylinder, the high-pressure cylinder movable therein, the high-pressure piston mounted on one end of a piston-rod, the other end of which is rigidly fastened in one head of the low-pressure cylinder, passage-ways in the high-pressure cylinder connecting its interior with the low-pressure cylinder, and with the high-pressure steam-chest, and valve controlling said passage-ways, an exhaust-valve connected with the low-pressure cylinder at either end, means whereby high-pressure steam may be caused to move said exhaust-valve, and a pipe for conducting said high-pressure steam, having a plurality of valve-controlled connections to the high-pressure steam-chest, whereby the stroke of the engine may be regulated.

5. A combined high-pressure cylinder and low-pressure piston having its central portion of reduced diameter to form a steam-chest, annular grooves on its heads inside of the packing-rings, and a passage-way connecting each of said grooves with said steam-chest.

6. A combined high-pressure cylinder and low-pressure piston having its central portion of reduced diameter to form a steam-chest, annular grooves on its heads inside of the packing-rings, and a passage-way connecting each of said grooves with said steam-chest, together with valve-chambers and coöperating valves located in the piston-heads, and passage-ways connecting the steam-chest with said valve-chambers, one set of the ports of said valve-chambers opening into the high-pressure cylinder, and another set opening communication from the low-pressure cylinder to the high-pressure cylinder.

7. In a reciprocating engine, the combination of the cylinder and piston therein, an exhaust-valve therefor, a recess in the piston continuously supplied with motive fluid, passage-ways in the cylinder adapted to convey fluid from said piston-recess to reverse the exhaust-valve, said passage-ways having valve-controlled branches adapted to communicate with the piston-recess at different points in its stroke, whereby the length of stroke may be varied.

8. In a reciprocating engine, the combination of the cylinder and piston therein, an exhaust-valve therefor, a recess in the piston continuously supplied with motive fluid, passage-ways in the cylinder adapted to convey fluid from said piston-recess to reverse the exhaust-valve, said passage-ways having valve-controlled branches adapted to communicate with the piston-recess at different points in its stroke, whereby the length of stroke may be varied, together with inlet-valves for said cylinder, and means reversing them simultaneously with the reversals of the exhaust-valve.

9. In a reciprocating engine, the combination of the cylinder and piston therein, an exhaust-valve therefor, a recess in the piston continuously supplied with motive fluid, passage-ways in the cylinder adapted to convey fluid from said piston-recess to reverse the exhaust-valve, said passage-ways having valve-controlled branches adapted to communicate with the piston-recess at different points in its stroke, whereby the length of the stroke may be varied, together with inlet-valves for said cylinder, and passage-ways adapted to convey fluid from said piston-recess to reverse said inlet-valves, said passage-ways having corresponding valve-controlled branches adapted to communicate with the piston-recess at corresponding different points of its stroke.

10. In a compound reciprocating engine the combination of the exterior low-pressure cylinder, the high-pressure cylinder movable therein, the high-pressure piston mounted on one end of the piston-rod, the other end of which is rigidly fastened in one head of the low-pressure cylinder, passage-ways in the high-pressure cylinder connecting its interior with the low-pressure cylinder, and with the high-pressure-steam chest, and valves controlling said passage-ways, an exhaust-valve connected with the low-pressure cylinder at either end, means whereby high-pressure steam may be caused to move said exhaust-valve, and a pipe for conducting said high-pressure steam, having a plurality of valve-controlled connections to the high-pressure-steam chest, whereby the stroke of the engine may be regulated, together with means for rotating said high-pressure cylinder at a rate varying as the length of the stroke given to it.

In witness whereof I have hereunto set my hand in presence of two witnesses.

JAMES WATSON.

Witnesses:
WILLIAM JOHN ROLSON,
DAVID LEWIS WOOLF.