

No. 697,187.

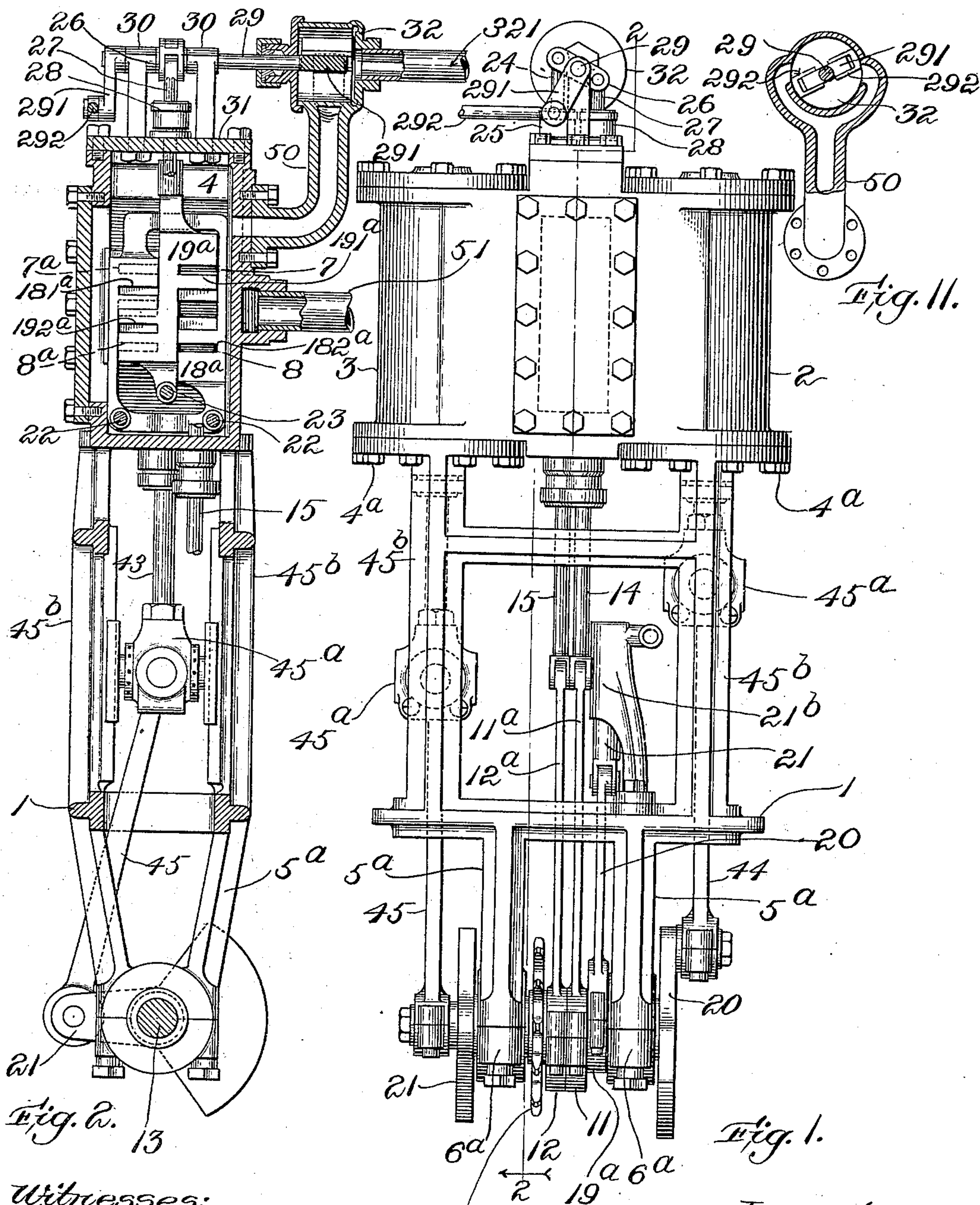
Patented Apr. 8, 1902.

P. B. WHITNEY.  
STEAM ENGINE.

(Application filed June 27, 1900.)

(No Model.)

3 Sheets—Sheet 1.



Witnesses:

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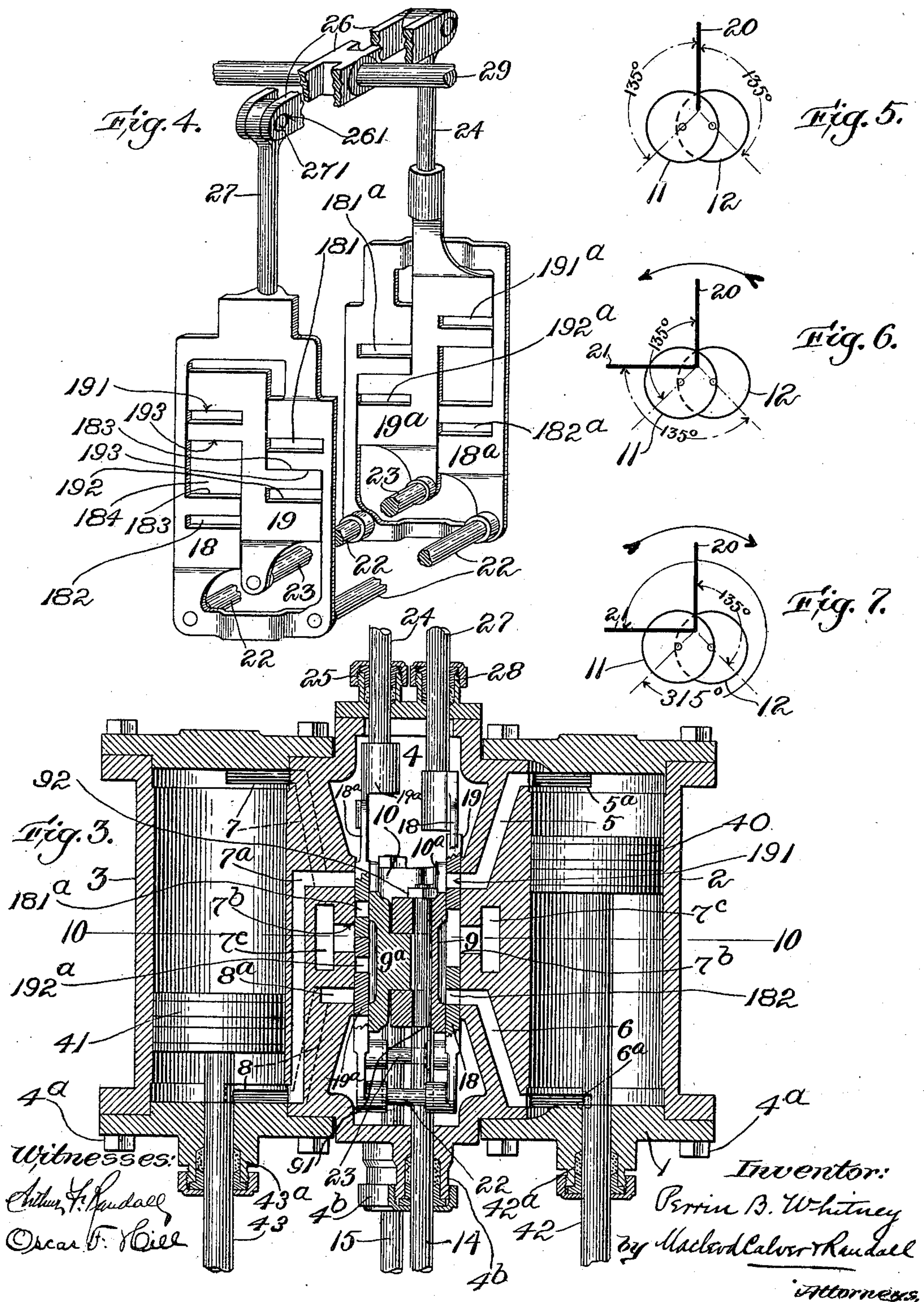


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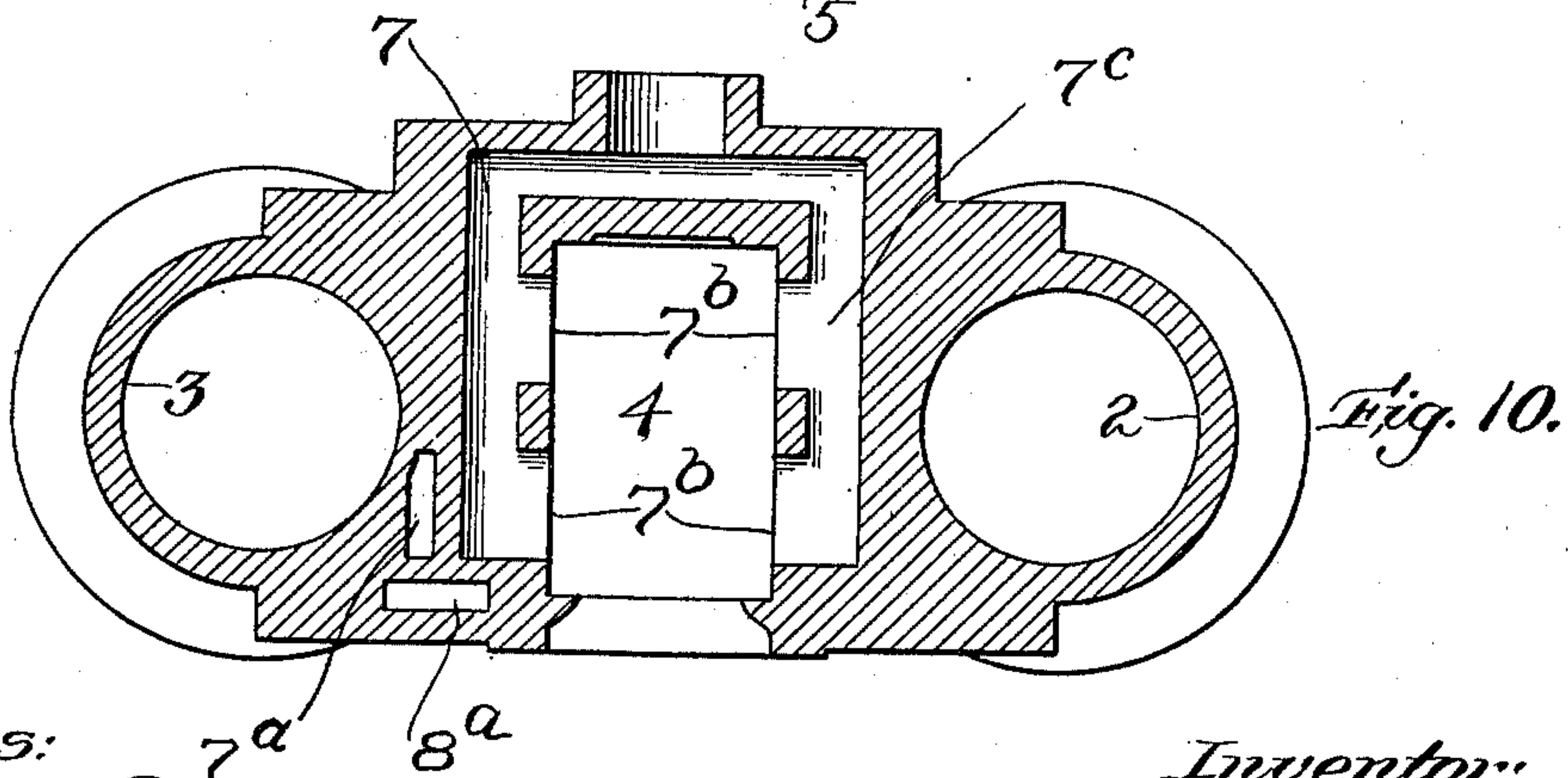
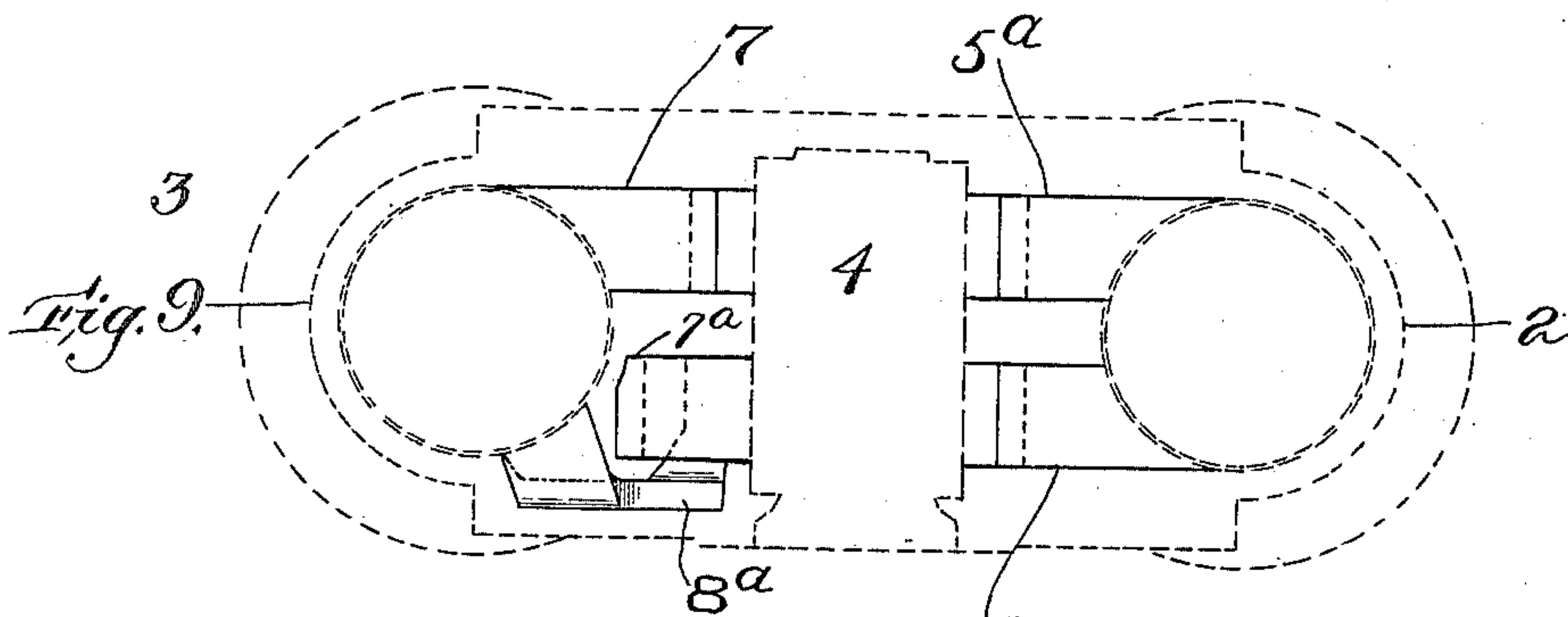
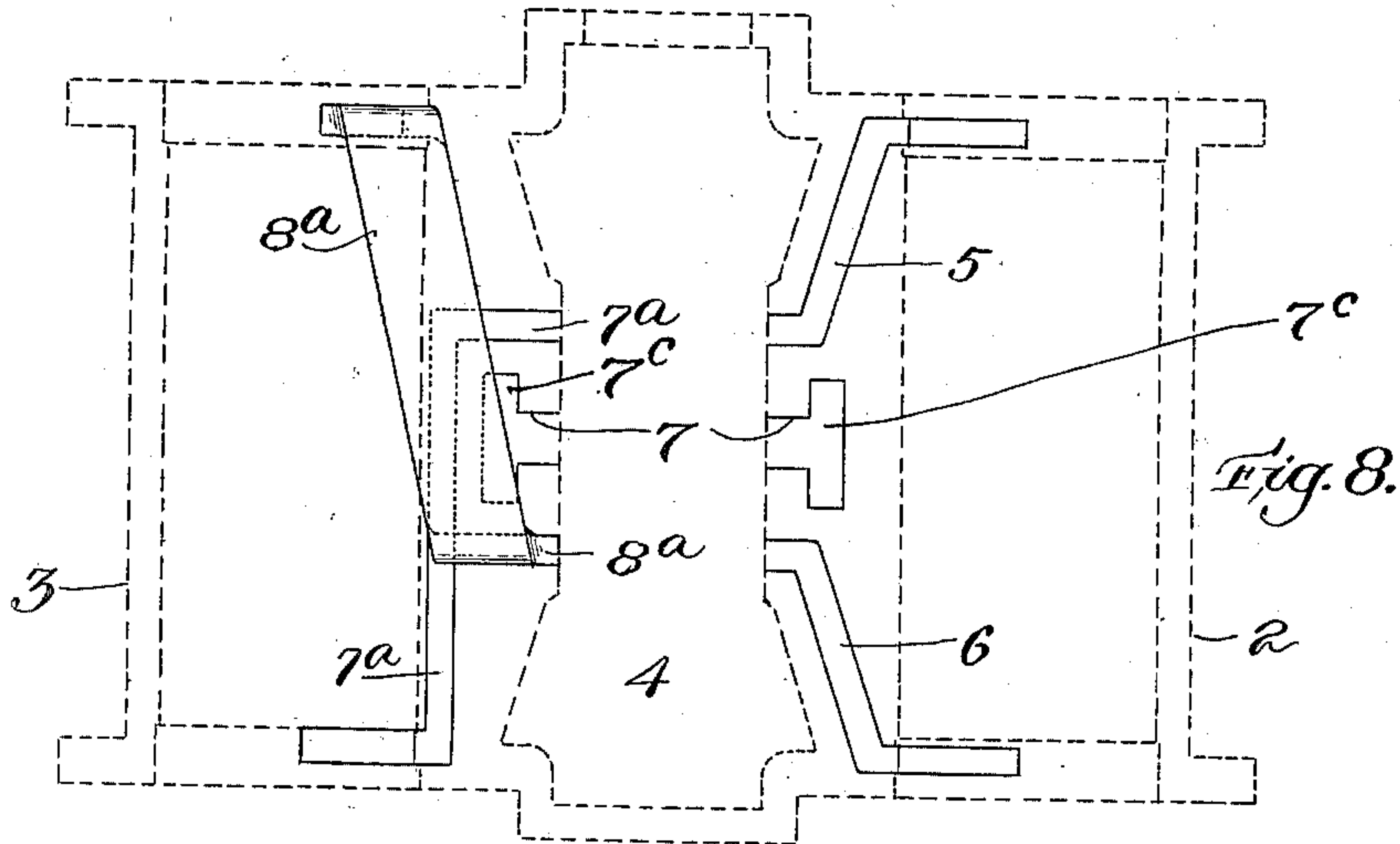
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# UNITED STATES PATENT OFFICE.

PERRIN B. WHITNEY, OF WALPOLE, MASSACHUSETTS, ASSIGNOR OF ONE-HALF TO J. EDWARD PLIMPTON, OF NORWOOD, MASSACHUSETTS.

## STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 697,187, dated April 8, 1902.

Application filed June 27, 1900. Serial No. 21,799. (No model.)

*To all whom it may concern:*

Be it known that I, PERRIN B. WHITNEY, a citizen of the United States, residing at Walpole, in the county of Norfolk, State of Massachusetts, have invented a certain new and useful Improvement in Steam-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention has for its object to produce an improved steam-engine, and more particularly an engine of comparatively small size, which may be employed in propelling road-vehicles or automobiles.

The nature and character of my invention are fully set forth in the following description, taken in connection with the accompanying drawings, and the novel features thereof are pointed out and clearly defined in the claims at the close of this specification.

Having reference to the drawings, Figure 1 is a front elevation of one form of my improved steam-engine. Fig. 2 is a section on line 2 2 of Fig. 1 looking in the direction of the arrow adjacent such line. Fig. 3 is a sectional view of a portion of the steam-engine shown in Fig. 1, showing the interior of the cylinders and the steam-chest. Fig. 4 is a perspective view of the two pairs of slides hereinafter described and their actuating connections. Figs. 5, 6, and 7 are diagrams hereinafter referred to. Figs. 8 and 9 are diagrams illustrating the construction and arrangement of the cylinder-ports. Fig. 10 is a section on line 10 10 of Fig. 3 with the valves and slides removed and showing the cylinder exhaust-ports. Fig. 11 is a detail sectional view of the throttle-valve.

In the drawings, 2 3 are two cylinders located side by side, and 4 is a steam-chest located between the said cylinders and ordinarily cast in one piece therewith.

1, Figs. 1, 2, and 3, is an open framework affixed by bolts 4<sup>a</sup> 4<sup>a</sup>, &c., to the lower ends of the cylinders, and 5<sup>a</sup> 5<sup>a</sup> are brackets depending from the lower end of the framework 1. The said brackets are furnished with bearings at 6<sup>a</sup> 6<sup>a</sup> for the crank-shaft 13, Fig. 2.

20 21 are counterbalanced cranks located at opposite ends of the said crank-shaft outside the bearings 6<sup>a</sup> 6<sup>a</sup>, and 44 45 are connect-

ing-rods, by which power is transmitted to the said cranks from the cross-heads 45<sup>a</sup> 45<sup>a</sup>. The said cross-heads are attached to the piston-rods 42 43 and slide on the guide-bars 45<sup>b</sup> 45<sup>b</sup>, with which framework 1 is furnished. Piston-rods 42 43 work in stuffing-boxes 42<sup>a</sup> 43<sup>a</sup>, applied to the cylinder-heads on the upper end of framework 1.

40 41 are the respective pistons working in the cylinders 2 3.

Upon the crank-shaft 13 between the bearings 6<sup>a</sup> 6<sup>a</sup> are made fast the valve-operating eccentrics at 11 12, having applied thereto straps and connecting-rods 11<sup>a</sup> 12<sup>a</sup>, which last are connected pivotally with the lower ends of the valve-stems 14 15. The said valve-stems enter the steam-chest 4 through stuffing-boxes at 4<sup>b</sup> 4<sup>b</sup>.

18<sup>a</sup> is a sprocket-gear fast on crank-shaft 13 and by means of which power may be transmitted from the said crank-shaft for driving purposes, the said sprocket-gear being located at one side of and closely adjacent the eccentrics 11 12 between the latter and one of the bearings 6<sup>a</sup> 6<sup>a</sup>. An eccentric 19<sup>a</sup> is made fast on the crank-shaft between eccentrics 11 12 and the other bearing 6<sup>a</sup>, the said eccentric 19<sup>a</sup> having fitted thereto the strap and connecting-rod 20<sup>a</sup>, the latter being connected with the plunger 21<sup>a</sup>, working in the cylinder 21<sup>b</sup> of a feed-pump, the said cylinder being bolted in convenient manner to framework 1.

I have been thus particular in describing the foregoing features to aid in explaining the invention itself, although it should be understood that the said features themselves form no part of the invention. The illustrated construction and arrangement of the said features are advantageous in practice on account of the simplicity, convenience, and compactness thereof.

The illustrated engine is of the locomotive type—that is to say, the cranks 20 21 are set at ninety degrees apart with relation to each other and the valve-operating eccentrics 11 12 are set with an “angular advance” of forty-five degrees, as it is termed in steam-engineering, by which is meant that each of the said eccentrics leads or precedes the corresponding crank by one hundred and thirty-five de-



grees in the direction of rotation when the engine is running forward. (See Fig. 6.) My invention comprises, primarily, an improved and novel form of valve and reversing gear, which is designed more especially for employment in connection with an engine of the said type.

In accordance with my invention I furnish each cylinder with two pairs of steam-passages leading from the steam-chest to the cylinder-bore. In the case of one of the cylinders, as 2, the two pairs 5 6 and 5<sup>a</sup> 6<sup>a</sup> are duplicates of each other, each pair corresponding generally in disposition, &c., with the steam-passages which usually are provided in steam-engines. The steam-passages 5 5<sup>a</sup> communicate by ports with the upper end of the bore of the said cylinder 2, as indicated in Figs. 3 and 9, and the ports through which they communicate with the steam-chest 4 are located side by side, as indicated in Fig. 9. The steam-passages 6 6<sup>a</sup> likewise communicate by ports with the lower end of the bore of the said cylinder 2, and the ports through which they communicate with the steam-chest are located side by side. In the case of the other cylinder, as 3, the pair of steam-passages 7 and 8, communicating with the opposite ends of the bore of the said cylinder, are arranged as usual, as indicated by dotted lines in Fig. 3; but the other pair of steam-passages 7<sup>a</sup> and 8<sup>a</sup> is crossed for a purpose which is explained hereinafter, the inner ends of the respective steam-passages 7<sup>a</sup> and 8<sup>a</sup> being continued, so that they overlap or extend past each other, as indicated in Figs. 3 and 8, thus locating the port through which steam-passage 7<sup>a</sup> (leading from the lower end of the bore of cylinder 3) communicates with the steam-chest 4 above the corresponding port of steam-passage 8<sup>a</sup>, (leading from the upper end of the said bore.) At 7<sup>b</sup> 7<sup>b</sup>, Figs. 3 and 10, are indicated exhaust-ports at the opposite sides of the steam-chest, through which ports communication is had with the exhaust-passage 7<sup>c</sup>, from which the exhaust-pipe 51 extends.

In connection with each cylinder I employ two valves, each of the said valves coöperating with the ports of one pair of the steam-passages. Thus in the case of cylinder 2 a valve 9 is arranged in the steam-chest in connection with steam-passages 5 and 6, and a second valve 10<sup>a</sup> is arranged alongside valve 9 in connection with steam-passages 5<sup>a</sup> 6<sup>a</sup>. In the case of cylinder 3 a valve 10 is arranged in connection with steam-passages 7 8, and a valve 9<sup>a</sup> is arranged alongside valve 10 in connection with steam-passages 7<sup>a</sup> 8<sup>a</sup>. The valves 9 9<sup>a</sup> (see Fig. 3) are operated in unison through being connected with the valve-stem 14, which is operated from eccentric 11, while the valves 10 10<sup>a</sup> are operated in unison through being connected with the valve-stem 15, operated from eccentric 12. Only one pair of steam-passages in connection with each cylinder is in use at a time. Thus for

rotation of the crank-shaft 13 in one direction—say forwardly—steam-passages 5 6 of cylinder 2 are used and steam-passages 7 8 of cylinder 3, while for rotation of the crank-shaft in the reverse direction the said steam-passages are placed out of service and steam-passages 5<sup>a</sup> 6<sup>a</sup> of cylinder 2 and 7<sup>a</sup> 8<sup>a</sup> of cylinder 3 are used. The respective pairs of steam-passages are placed in and out of service at will by means presently to be described. In the former instance the flow of steam into and out of cylinder 2 through steam-passages 5 6 will be controlled by the valve 9, which is operated, as aforesaid, from eccentric 11, and the flow into and out of cylinder 3 through steam-passages 7 8 will be controlled by valve 10, which is operated, as aforesaid, from eccentric 12. In the other instance, steam-passages 5, 6, 7, and 8 having been placed out of use, the flow of steam into and out of the cylinder 2 through steam-passages 5<sup>a</sup> 6<sup>a</sup> will be controlled by the valve 10<sup>a</sup>, operated, as aforesaid, from the eccentric 12, and the flow of steam into and out of cylinder 3 through steam-passages 7<sup>a</sup> 8<sup>a</sup> will be controlled by valve 9<sup>a</sup>, operated, as aforesaid, from eccentric 11.

The employment of two valves actuated to move alternately in connection with the two pairs of steam-passages for each cylinder and in combination with means permitting either pair of steam-passages to be placed in service and the other pair out of service at will enables me to substitute a very simple and reliable form of reversing-gear in the place of the forms heretofore employed in practice.

In the case of an engine having the cranks set at an angle of ninety degrees apart with relation to each other and the valve-operating eccentrics set to lead or precede their respective cranks by one hundred and thirty-five degrees in the direction of forward rotation the relative arrangement of cranks and eccentrics may be represented as in Fig. 6, where the cranks 20 and 21 are represented by the heavy lines and the lines of greatest throw of the eccentrics are indicated by dotted lines. It will be perceived, especially with the aid of Fig. 5, that the two eccentrics 11 12 are disposed symmetrically with relation to crank 20, and consequently the eccentric 12 in the case of reverse rotation of the crank-shaft 13 will have the right amount of advance relatively to said crank 20 to enable it to work the valve 10<sup>a</sup> properly. In the case of eccentric 11, however, such eccentric will have an advance of three hundred and fifteen degrees relatively to crank 21. (See Fig. 7.) This would be just one hundred and eighty degrees more than is required in order to enable eccentric 11 to work valve 9<sup>a</sup> properly were it not for the crossing of ports 7<sup>a</sup> 8<sup>a</sup>. This crossing of the said ports compensates for the said excess of one hundred and eighty degrees.

I will now describe the means by which I



control the use of the respective pairs of steam-passages pertaining to the two cylinders, so as to bring either the set 5 6 7 8 into service for running the engine in one direction or the set 5<sup>a</sup> 6<sup>a</sup> 7<sup>a</sup> 8<sup>a</sup> for running the same in the opposite direction. Reference will be had more especially to Figs. 2, 3, and 4.

Between the valves 9 10<sup>a</sup> and the adjacent wall of the steam-chest I interpose a pair of slides 18 19 in the form of thin plates. Slide 18 has an irregular elongated opening, within which slide 19 is placed, the slide 19 being free to move in said opening independently of slide 18. A substantially similar pair of slides 18<sup>a</sup> 19<sup>a</sup> is interposed between the valves 10 9<sup>a</sup> and the other wall of the steam-chest. Slides 18 18<sup>a</sup> are connected to move in unison by rods 22 22, extending from one to the other at their lower ends. Slides 19 and 19<sup>a</sup> are similarly connected to each other by a rod 23. For the purpose of enabling slides 18 and 18<sup>a</sup> to be moved at will one of them, as 18, has connected therewith a stem, as 27, passing upward through a stuffing-box 28, with which the cover of the steam-chest is provided, the said stem being connected pivotally with one arm of a walking-beam 26, mounted on a rock-shaft 29. The connection between said stem and said arm is effected by means of a pin 271, carried by the stem and having its ends placed within slots 261 in the forked end of the arm, the said slots being made large enough to permit play of the pin therein, thereby compensating for the fact that the stem is confined to a right line in its movement, while the movement of the arm is curvilinear. In like manner one of the other pair of slides, as 19<sup>a</sup>, has connected therewith a similar stem, as 24, passing upwardly through a stuffing-box 25, with which the cover of the steam-chest is provided, the said stem being loosely connected pivotally with the other arm of said walking-beam. It will be observed that when rock-shaft 29 is turned in either direction the respective slides of each pair will be moved in opposite directions with relation to each other. Rock-shaft 29 is intended to be moved by hand in practice. For this purpose an arm 291, Figs. 1 and 2, may be affixed thereto, and a rod 292 may be connected to the said arm and extended to any convenient point, where an actuating-lever or the like may be connected therewith.

The slide 18 has an upper transverse slot 181, Fig. 4, corresponding in form and area with the entrance-port of the steam-passage 5<sup>a</sup> of cylinder 2 and intended to cooperate with said entrance-port, and also has a lower port 182, intended to cooperate with the entrance-port of steam-passage 6 of cylinder 2. (See also Fig. 3.) Slide 19 has similar upper and lower ports 191 and 192, Fig. 4, cooperating, respectively, with the entrance-ports of steam-passages 5 and 6<sup>a</sup> of said cylinder 2. (See also Fig. 3.) The valves 9 and 10<sup>a</sup> coact more immediately with the ports 181

182 191 192 of the slides 18 and 19, while the said slides and their ports constitute an auxiliary means for controlling or determining the flow of steam into and out of steam-passages 5 5<sup>a</sup> 6 6<sup>a</sup> during the play of the said valves. When one of said ports 181, &c., registers with the entrance-port of the corresponding steam-passage, steam is free to flow into and out of the said steam-passage in accordance with the position of the corresponding valve. When, however, such port is moved out of register with the said entrance-port, the steam-passage is closed by the corresponding slide against the flow of steam in either direction. Similarly, as indicated in Figs. 2, 3, and 4, slide 18<sup>a</sup> is furnished with upper port 181<sup>a</sup> and lower port 182<sup>a</sup>, cooperating with the entrance-ports of steam-passages 7<sup>a</sup> and 8, respectively, of cylinder 3, and slide 19<sup>a</sup> is furnished with ports 191<sup>a</sup> and 192<sup>a</sup>, cooperating with the entrance-ports of steam-passages 7 and 8<sup>a</sup>, respectively, of cylinder 3. Valves 9<sup>a</sup> and 10 cooperate more immediately with ports 181<sup>a</sup>, 182<sup>a</sup>, 191<sup>a</sup>, and 192<sup>a</sup> of the slides 18<sup>a</sup> and 19<sup>a</sup>. It will be observed that each slide has two ports and that the upper one of these ports controls the entrance-port of a steam-passage pertaining to one pair of steam-passages of a given cylinder, (see Fig. 2,) while the lower one thereof controls the entrance-port of a steam-passage pertaining to the other pair of such steam-passages; also, that the position of the two ports in each slide is such that when one thereof, as 191<sup>a</sup>, Fig. 2, registers with the entrance-port of the corresponding steam-passages, as 7, the other thereof, as 192<sup>a</sup>, is out of register with the entrance-port of its steam-passage, as 8<sup>a</sup>, and the latter is closed by the slide. Hence movement of the two slides of a pair oppositely with relation to each other, effected, for instance, through means such as described, causes the entrance-ports of one pair of steam-passages pertaining to a given cylinder to be opened, as in the case of steam-passages 7 8, Fig. 2, and those of the other pair to be closed, as in the case of steam-passages 7<sup>a</sup> 8<sup>a</sup>, and vice versa.

Adjacent each port 181, &c., each slide 18, &c., is furnished with an exhaust-lip 183, &c. When the exhaust-lips 183 193 at one side of a pair of slides are brought together, which is the case where the entrance-ports pertaining to one pair of the steam-passages of a given cylinder are closed, as at the left-hand side in Fig. 2, the exhaust-port between such steam-passages also is closed, as shown. The exhaust-lips at the other side of such slides are separated, however, thereby producing an exhaust-port 184, with which the steam-passages of the other pair pertaining to such cylinder may communicate through the open entrance-ports above and below such exhaust-port, as at the right-hand side in Fig. 2.

The invention includes also a novel arrangement of throttle in connection with the



valve and reversing gear. The throttle-valve comprises a casing 32, to which a feed-pipe 321 leads, and from it a passage 50 extends to steam-chest 4. Passage 50 is branched or  
 5 forked, as shown in Fig. 11, the respective branches thereof communicating with the interior space of casing 32 at opposite points. Within casing 32 is a plate 291, made fast on  
 10 rock-shaft 29 and provided on its opposite wings with slides 292 292 to make close contact with the interior of the casing. These slides serve to close the openings leading to the branches of passage 50. When rock-shaft 29 is turned in one direction or the other in  
 15 shifting the slides, the throttle-valve is operated at the same time as the valves. As will be perceived, the slides may be moved to various points to vary the cut-off, as desired, while the throttle-valve will be simultane-  
 20 ously adjusted proportionately to vary the amount of steam supplied to the engine. This is true in whichever direction the engine may be run. The described arrangement, &c., of throttle in connection with the reversing-  
 25 gear enables the engine always to be supplied with steam at boiler-pressure. This results from the fact that in proportion as the throttle is opened the area of its openings is always greater at any given instant than the  
 30 openings of the ports in the steam-chest. In other words, in consequence of operating the reversing-gear and throttle in unison any movement of the reversing-gear always is accompanied by movement of the throttle, and  
 35 thereby they are retained in definite relationship with each other. These things are not true of the ordinary engine having the usual link motion or other customary reversing-gear. In the case of such an engine there  
 40 ordinarily is no connection between the throttle and the link or reversing gear, and hence the two require to be adjusted independently. It usually occurs that the link or reversing gear is set to make the required change in the working of the engine, and then the throt-  
 45 tle is moved to give the required amount of opening.

The pair of slides 18 19 is placed loosely between the pair of valves 9 10<sup>a</sup> and the ad-  
 50 jacent wall of the steam-chest, and the pair of slides 18<sup>a</sup> 19<sup>a</sup> is similarly placed between the pair of valves 10 9<sup>a</sup> and the opposite wall of the steam-chest. As shown in Fig. 3 in the case of the valves 9 9<sup>a</sup>, each pair of the  
 55 said valves is applied loosely to the corresponding valve-stem 14 or 15, so as to allow free play sufficient to enable the steam-pressure within the steam-chest to press the valves outwardly against the slides and also press  
 60 the said slides against the said walls of the steam-chest. Thus the steam-pressure is enabled to hold the parts firmly in contact with one another and leakage of steam is prevented. One of the valves of each pair, as  
 65 9, Fig. 3, has at the back thereof two projecting lugs, through which are formed the holes

which receive the valve-stem 14. The other valve of the pair, as 9<sup>a</sup>, Fig. 3, has a single lug fitting between those of the first-mentioned valve and grooved lengthwise to partly  
 70 receive the said valve-stem. The first-mentioned valve, 9, is confined between a shoulder 91 on the valve-stem and a nut 92 thereon. In order that the slides at one side of the steam-chest may be free to move transversely  
 75 with relation to the other pair thereof, the rods 22 22 23, which cause slides 18 and 18<sup>a</sup> to move in unison vertically and slides 19 and 19<sup>a</sup> to move in unison vertically, are fixed to one pair of the said slides, as 18 19, and  
 80 simply fitted to work through sockets in the other pair of said slides, as 18<sup>a</sup> 19<sup>a</sup>.

What I claim is—

1. A steam-engine having a cylinder provided with two sets of steam-passages, a valve  
 85 for each set of passages, a pair of slides intermediate the said valves and said passages, and means for operating said valves and said slides to close either set of said passages, for the purposes and substantially as described.  
 90

2. In a steam-engine, in combination, a cylinder having two sets of steam-passages, two valves, one coöperating with one set of passages, and the other coöperating with the  
 95 other set of passages, a pair of movable slides located between said valves and said passages for closing one set of passages and opening the other set when in one position, and for reversing the condition of the passages when in  
 100 another position, and means for operating the said valves alternately, substantially as described.

3. In a steam-engine, in combination, two cylinders, each having two sets of steam-passages, with one set of passages of one cylinder  
 105 crossed as described, two valves, one for controlling one set of passages of one cylinder and the other for controlling one set of passages of the other cylinder, and both connected to move in unison, two other valves,  
 110 one for controlling the other set of passages of the first cylinder and the other for controlling the other set of passages of the second cylinder, and both connected to move in unison, and two pairs of slides, one pair located  
 115 between the valves and passages of one cylinder and the other pair located between the valves and passages of the other cylinder, for the purposes and substantially as described.

4. In a steam-engine, in combination, a cylinder provided with two sets of steam-passages, a valve for each set of passages, a pair of slides intermediate the said valves and said passages, substantially as set forth, a throttle, and means connected with said throttle  
 120 and said slides by which the action of the engine and the steam-supply to the latter are controlled and varied simultaneously.

5. In a steam-engine, in combination, the two cylinders and the steam-chest, the said  
 130 cylinders having each the two pairs of steam-passages opening into the steam-chest, the



slides located at the opposite walls of the said steam-chest, means to move the said slides to control the flow of steam through the respective pairs of passages of each steam-cylinder  
5 whereby the said pairs are placed in and out of service alternately with each other, the valves working against the inner sides of the said slides and loosely connected in pairs, and

means for actuating said pairs of valves alternately, substantially as described. 10

In testimony whereof I affix my signature in presence of two witnesses.

PERRIN B. WHITNEY.

Witnesses:

WILLIAM A. COPELAND,  
ALICE H. MORRISON.