(No Model.) 4 Sheets—Sheet 1.

F. W. HAGAR.

VALVE GEAR.

No. 527,691. Patented Oct. 16, 1894.

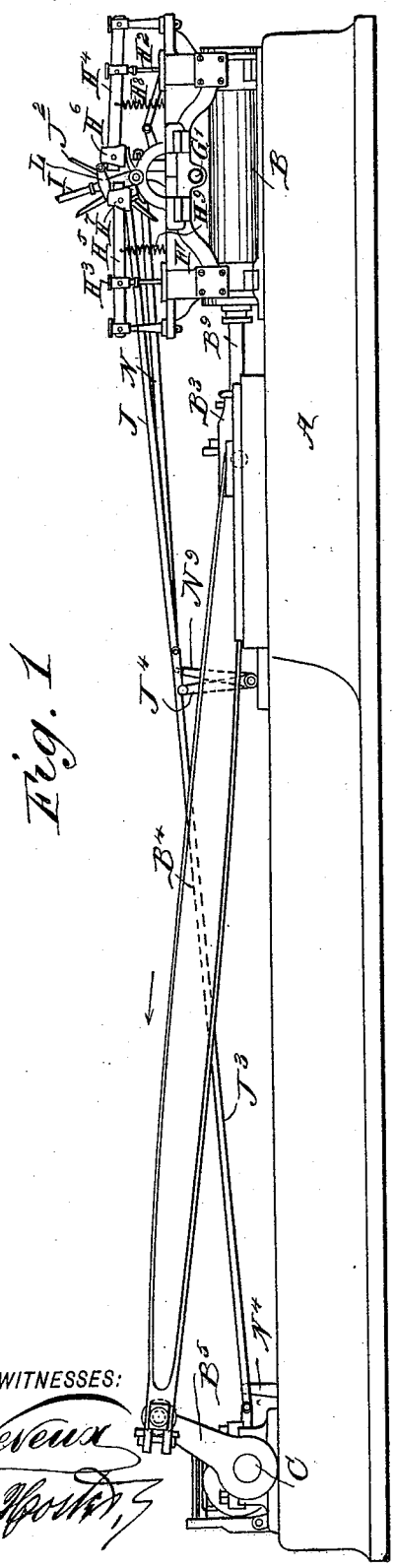

Fig. 1

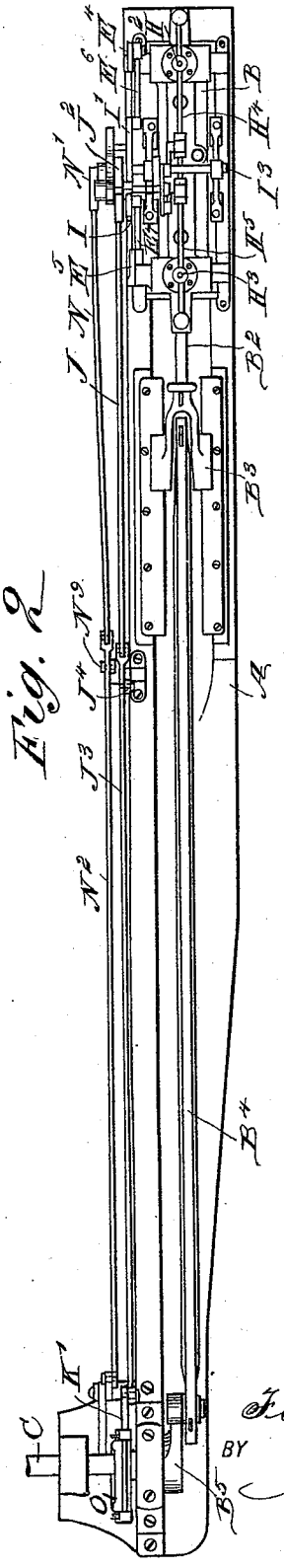

Fig. 2

WITNESSES:

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VALVE GEAR.

No. 527,691. Patented Oct. 16, 1894.

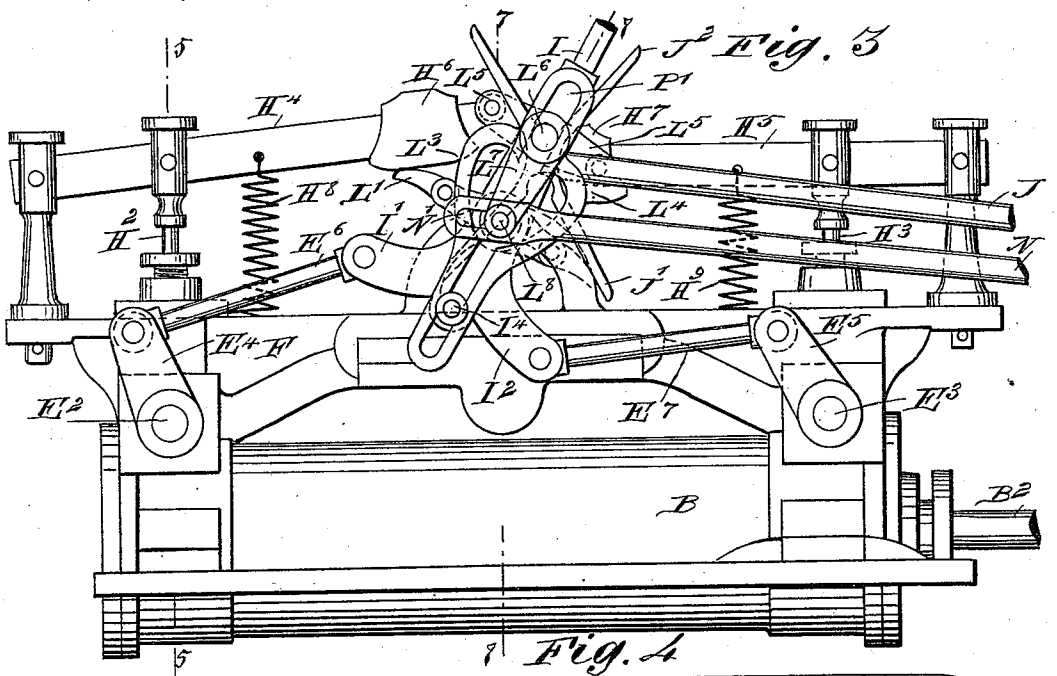

Fig. 3

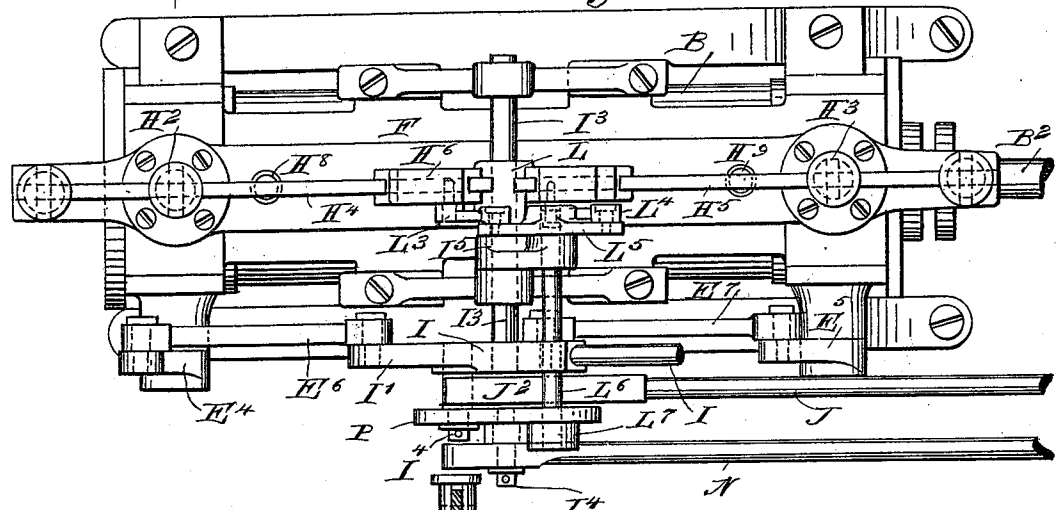

Fig. 4

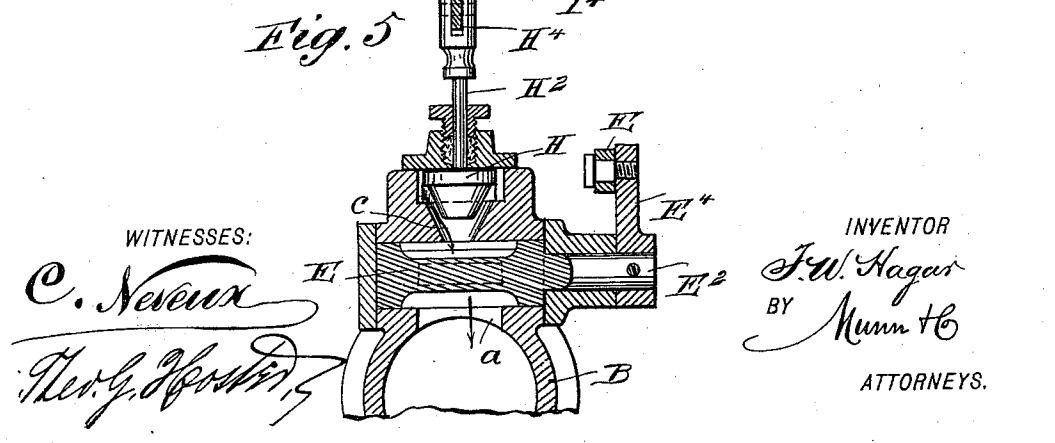

Fig. 5

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(No Model.) 4 Sheets—Sheet 3.

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VALVE GEAR.

No. 527,691. Patented Oct. 16, 1894.

Fig. 6

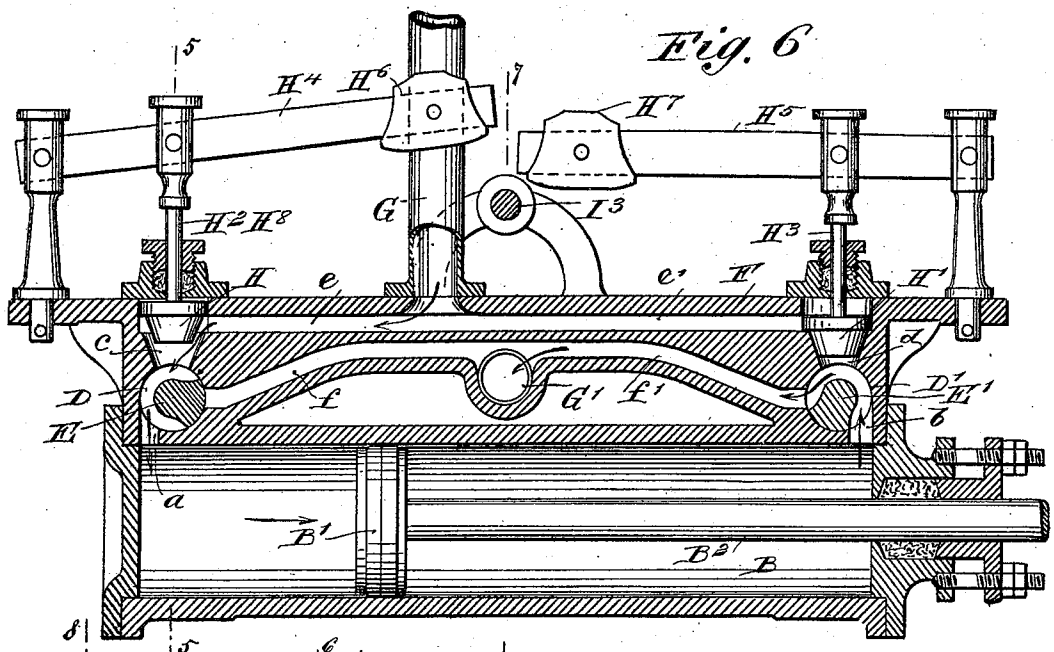


Fig. 7

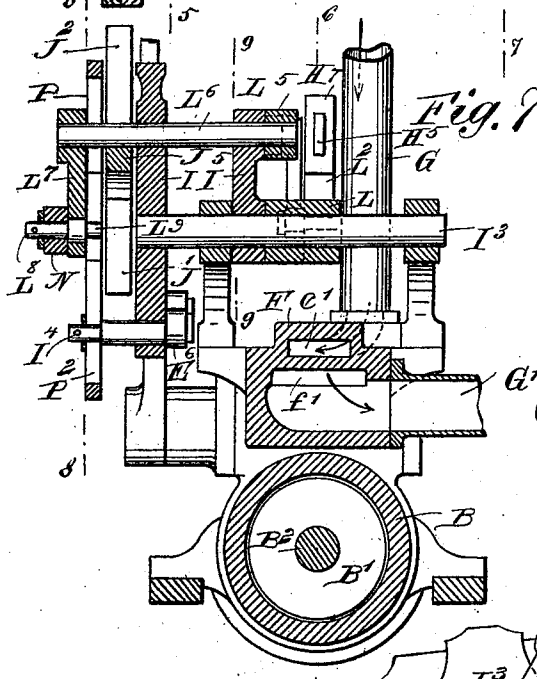


Fig. 8

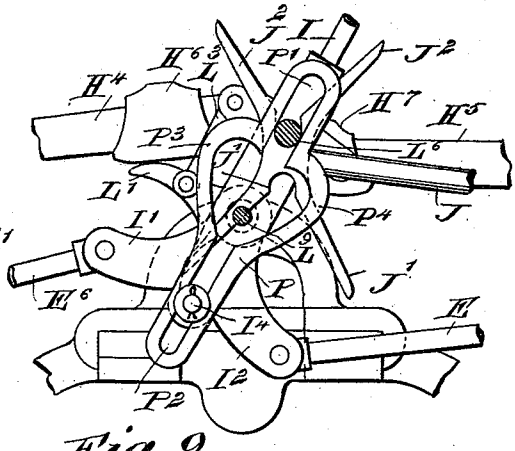
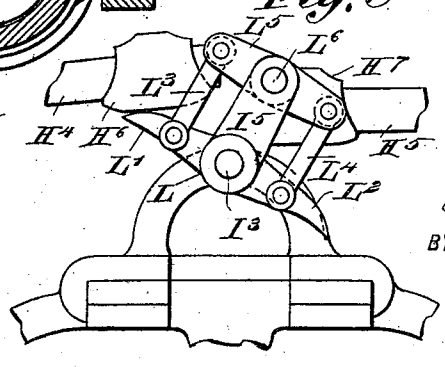


Fig. 9



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(No Model.) 4 Sheets—Sheet 4.

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VALVE GEAR.

No. 527,691. Patented Oct. 16, 1894.

Fig. 11

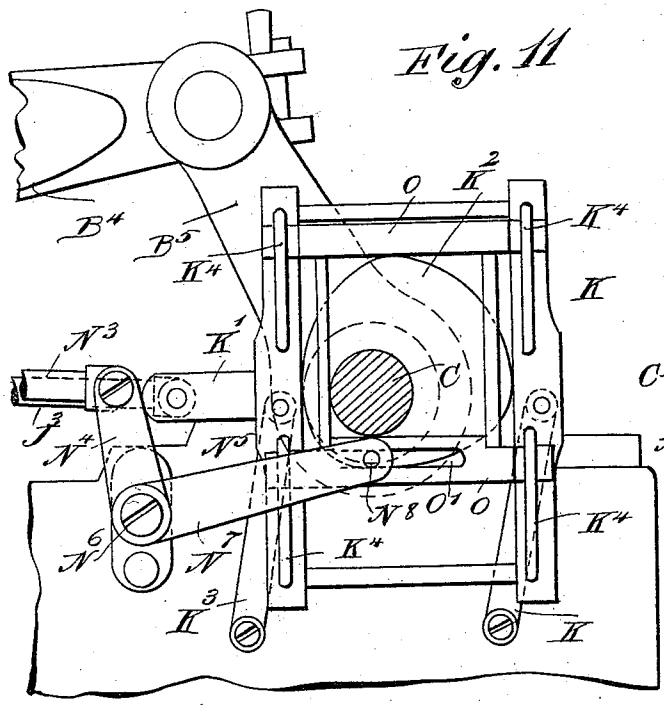


Fig. 12

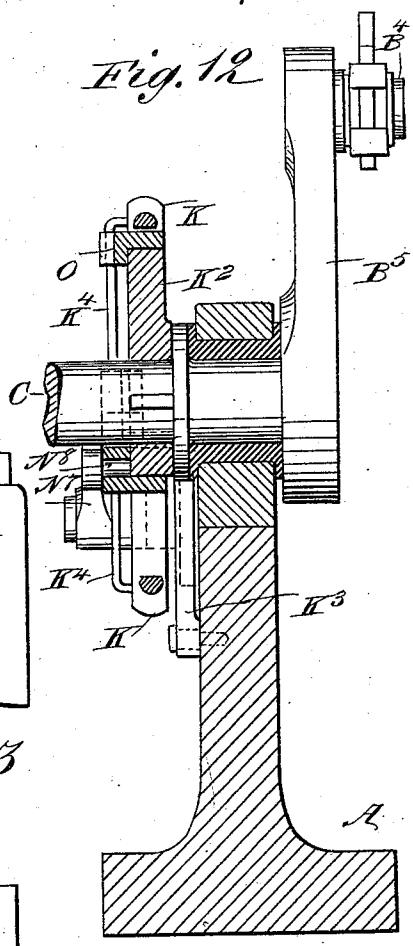


Fig. 13

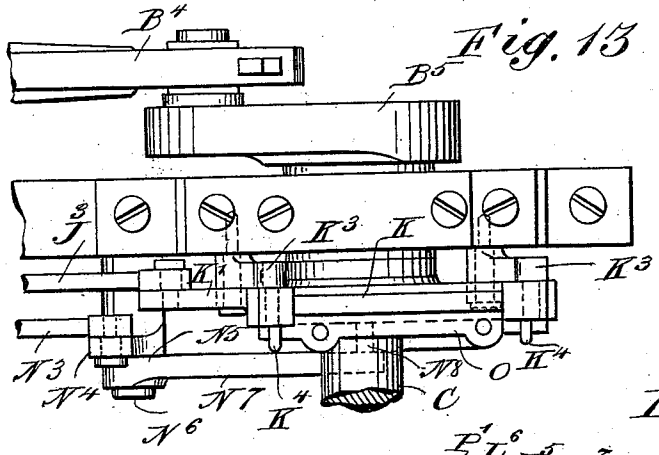
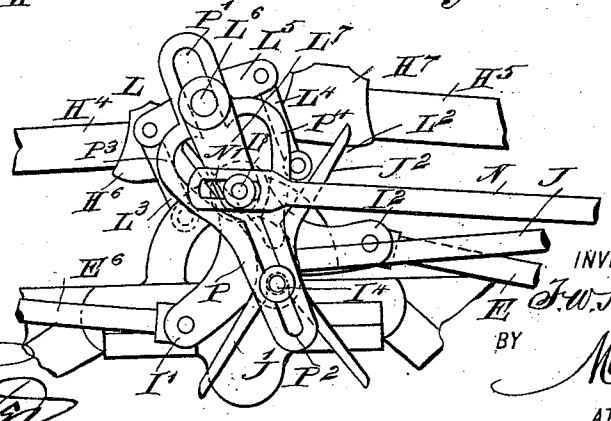


Fig. 10



WITNESSES:

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Rec'd. Goodwin

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UNITED STATES PATENT OFFICE.

FRANKLIN WOOD HAGAR, OF NASHVILLE, TENNESSEE.

VALVE-GEAR.

SPECIFICATION forming part of Letters Patent No. 527,691, dated October 16, 1894.

Application filed April 24, 1894. Serial No. 508,793. (No model.)

To all whom it may concern:

Be it known that I, FRANKLIN WOOD HAGAR, of Nashville, in the county of Davidson and State of Tennessee, have invented a new and Improved Valve-Gear for Steam-Engines, of which the following is a full, clear, and exact description.

The invention relates to marine engines, and its object is to provide a new and improved valve gear, which is simple and durable in construction, very effective in operation, and arranged to utilize the motive agent in the cylinder to the fullest advantage.

The invention consists of certain parts and details, and combinations of the same, as will be hereinafter described and then pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a side elevation of the improvement. Fig. 2 is a plan view of the same. Fig. 3 is an enlarged rear side elevation of part of the improvement. Fig. 4 is a plan view of the same. Fig. 5 is a transverse section of the same on the lines 5—5 of Figs. 3 and 6. Fig. 6 is a longitudinal section of the same. Fig. 7 is a transverse section of the same, on the line 7—7 of Fig. 6. Fig. 8 is a rear sectional side elevation of the same on the line 8—8 of Fig. 7. Fig. 9 is a similar view of the same, on the line 9—9 of Fig. 7. Fig. 10 is a rear elevation of the valve-controlling mechanism with parts in a different position from that shown in Fig. 8. Fig 11 is a rear enlarged sectional side elevation of the main driving shaft, and the means for imparting motion to the valve rods. Fig. 12 is a transverse section of the same; and Fig. 13 is a plan view of the same.

The engine on which the improvement is applied is provided with the usual frame A, on one end of which is secured the cylinder B, in which reciprocates the piston B′, having a piston rod B^2, connected with a cross head B^3, connected by the pitman B^4, with the crank arm B^5, on the main driving shaft C, journaled in suitable bearings on the frame A. In the cylinder B are arranged the ports *a* and *b*, located near the ends of the cylinder and leading into valve chambers D and D′, containing the oscillating valves E and E′, respectively, arranged in such a manner as to, at all times, keep the said ports *a* and *b* open.

Into the valve chambers D and D′ open the conical valve seats *c* and *d*, respectively, leading to channels *e* and *e′*, respectively, arranged in a chest F, forming part of the cylinder B and located on the top thereof, as plainly shown in the drawings. The channels *e* and *e′* connect with the steam supply pipe G leading to a boiler or other source of steam supply, so that live steam can pass from the said pipe G into the channels *e* and *e′* and alternately through the valve seats *c* and *d*, respectively, into the valve chambers D and D′ respectively, and from the same through the ports *a* and *b* into the opposite ends of the cylinder B to act on the piston B′ therein, so as to reciprocate the same, as hereinafter more fully described.

The valve seats *c* and *d* are adapted to be alternately closed and opened by puppet valves H and H′, respectively, so that live steam passes alternately through the ends of the cylinder B, as before mentioned. See Fig. 6. The valve chambers D and D′ also connect with the exhaust ports *f* and *f′* respectively, leading to the exhaust pipe G′ the said exhaust ports being controlled by the valves E and E′, respectively, so as to alternately open and close the said ports *f* and *f′* to the valve chambers D and D′, and consequently to the ports *a′* and *b′*, which are at all times open, and lead to the cylinder.

The valves E and E′ receive an oscillating motion from the main driving shaft C, and for this purpose the following device is provided: The valve stems E^2 and E^3 of the said oscillating valves E and E′ carry the crank arms E^4 and E^5, respectively, (see Figs. 3 and 4) connected by links E^6 and E^7, respectively, with arms I′ and I^2, respectively, extending in opposite directions from the rocking lever I having its fulcrum shaft I^3 journaled in suitable bearings arranged over the chest F.

From the rocking lever I, extends transversely a pin I^4 adapted to be engaged by either of the forked ends J′ and J^2 of the valve link J, pivotally connected with a valve rod J^3 extending longitudinally as plainly shown in Figs. 1 and 2, and pivotally con-

nected at its outer end with an arm K′ forming a rigid part of an open frame K hung on links K^3, fulcrumed on the main frame A. The open frame K is adapted to be engaged by a cam K^2 secured on the main driving shaft C (see Figs. 11, 12 and 13), so that on the rotating of the shaft C, a forward and backward sliding motion is given to the said frame K, to impart a forward and backward movement to the connected valve rod J^3 and valve link J, whereby the latter imparts a rocking motion to the lever I and by the links E^6 and E^7 and crank arms E^4 and E^5, to the oscillating valves E and E′ in the valve chambers D and D′, to alternately open and close the exhaust ports *f* and *f′*. Thus, when the several parts are in the position as shown in the drawings, then the puppet valve H is open (see Fig. 6), and the other puppet valve H′ is closed, while the valve E closes the exhaust port *f* and the other valve E′ establishes connection between the valve chamber D′ and the port *f′*. Now, live steam from the supply pipe G can pass through the channel *e*, the open valve seat *c*, into the valve chamber D, and from the latter through the port *a* into the outer end of the cylinder B, to exert its pressure against the piston B′ to send the latter on its inward stroke. The exhaust steam in front of the piston B′ now passes through the port *b* into the valve chamber D′ and then into the exhaust port *f′* and to the exhaust pipe G′ to the outer air. When the piston B′ nears the end of its inward stroke, then the position of the valves E, E′ and H, H′, is reversed; that is, the valve H closes the seat *c* to shut off the supply of live steam to this end of the cylinder, and the oscillating valve E opens the exhaust port *f* to establish connection between the ports *a* and *f*. The other puppet valve H′ opens to establish communication between the channels *e′*, the seat *d*, the valve chamber D′ and the port *b*, to permit the live steam to pass to this end of the cylinder. The valve E′ at that time, closes the exhaust port *f′* so that the live steam enters the inner end of the cylinder to act on the piston B′ and to send the same on its outward stroke. When the piston B′ nears the end of its outward stroke, then the valves again reverse to assume the position shown in Fig. 6, and the above described operation is again repeated.

Now, in order to properly manipulate the puppet valves H and H′, the following device is provided: The valve stems H^2 and H^3 of the said puppet valves H and H′, respectively, extend upwardly and pass through suitable stuffing boxes arranged on the chest F, as plainly shown in Fig. 6. The outer ends of the said valve stems H^2 and H^3 are pivotally connected with levers H^4 and H^5, respectively, extending in opposite directions and fulcrumed at their outer ends in suitable brackets supported from the chest F. The inner ends of the said levers H^4 and H^5 carry cam heads H^6 and H^7, respectively, adapted to be engaged by the cam arms L′ and L^2, respectively, of a cam L, mounted to turn loosely, at its middle, on the fulcrum shaft I^3 for the rocking lever I. In order to hold the cam heads H^6 and H^7 in contact with the cam arms L′ and L^2, at all times, I provide the springs H^8 and H^9, respectively, attached at their lower ends to the chest F and at their upper ends to the said levers H^4 and H^5. The cam L is pivotally connected at its arms by links L^3 and L^4 with a rocking arm L^5 secured on a transversely-extending shaft L^6 journaled at one end in a bearing formed in an arm I^5 fastened to the fulcrum shaft I^3, as plainly shown in Fig. 9. The rear end of the said shaft L^6 is journaled in suitable bearings in the rocking arm I, so that the said shaft L^6 on the rocking of the rocking lever I is moved bodily forward and backward, and at the same time is free to turn in its bearings in the said rocking arm I, and the other arm I^5, likewise secured on the shaft I^3. The extreme rear end of the shaft L^6 carries a crank arm L^7 (see Fig. 10) having its wrist pin L^8 projecting into a longitudinally-extending slot N′ formed in a valve link N extending longitudinally, and pivotally connected with a valve rod N^3. (See Figs. 1, 2, 11, 12 and 13.) The outer end of this valve rod N^3 is pivotally connected with the arm N^4 of a bell crank lever N^5 fulcrumed at N^6 on the main frame A near the main driving shaft C, as illustrated in Fig. 11. The other arm N^7 of the said bell crank lever N^5, is provided with a transversely-extending pin N^8 engaging a longitudinally-extending slot O′ formed in a frame O fitted to slide vertically in suitable bearings K^4 arranged on the open frame K, and this frame O is adapted to be moved up and down by the cam K^2, which imparts a forward and backward swinging motion to the frame K, as previously described. Thus, the single cam K^2 actuates both frames K and O, and the rods and links connected therewith, to manipulate the oscillating valves E, E′, and the puppet valves H and H′, respectively. The wrist pin L^8 on the crank arm L^7 also projects forwardly (see Figs. 7 and 8) to extend into an open arm P formed with the aligned recesses or slots P′ and P^2 through the former of which extends the shaft L^6 and through the other P^2, the crank pin I^4 of the lever I. The open arm P is also provided with the curved side arms P^3 and P^4 for the purpose of shifting the position of the wrist pin L^8 as hereinafter more fully described.

Now, it will be seen that when a forward and backward swinging motion is given to the frame K, by the cam K^2, then the other frame O is at a standstill and when the latter frame O receives an up and down swinging motion from the said cam K^2, then the frame K is at a standstill. When the crank arm B^5 of the main driving shaft C is in the position shown in Figs. 1 and 2, then the frame O is in an uppermost position, as illustrated in Figs. 11 and 13, and the frame K is in its rear or outer-

most position, as indicated in the said figures. When these several parts are in the position described, then the valves E, E′ and H, H′, are in the position shown in Fig. 6, so that live steam passes to the outer end of the cylinder B, as previously described, to actuate the piston as before stated. Now, on the turning of the crank arm B^5 in a forward direction owing to the impulse given the piston B′, the cam K^2 acts on the frame O so as to cause the latter to slide downward in the now temporarily stationary frame K, whereby the bell crank lever N^5 receives a swinging motion and a pull is given to the rod N^3 and link N, whereby the slotted end of the link travels loosely along the pin I^4 until the latter reaches the end of the slot N′ and then on the further pulling of the said link N, a swinging motion is given to the crank arm L^7 to turn the shaft L^6 which, by the arm L^5 and links L^3, L^4, imparts a swinging motion to the cam L, so that the cam heads H^6 and H^7 are actuated; that is, the lever H^5, is raised, the lever H^4 is pulled downward by the action of its springs H^8, so that the puppet valve H closes, while the other lever H^5 is caused to swing upward to open the puppet valve H′. At this time the piston B′ is nearing the end of its innermost stroke, and the cam K^2 now acts on the frame K to swing the latter forward, whereby the rod J^3 and the link J are pushed so as to impart a rocking motion to the rocking lever I, to shift the oscillating valves E and E′ in such a manner that the port *f* is uncovered and the port *f′* is closed for the purpose previously described. Live steam now passes through the port *b′* into the inner end of the cylinder to force the piston B′ outward, while the steam in the front of the said piston exhausts through the port *a*, valve chamber D, port *f*, and exhaust pipe G′, to the outer air.

By the arrangement described positive motion is given to the valves E, E′, and puppet valves H, H′, to control the inlet and exhaust of the steam in the manner described, the said valves being all contained in a single chest F having steam and exhaust ports and channels, as described.

When the arm P is pushed up against its stop it holds the pin L^8 in the center line of the shaft L^9 to allow the puppet valve to work full stroke with the link J. (See Fig. 8.) When the arm P is pushed down against its stop then the curved side arms P^3 and P^4 should not come in contact with the pin L^8, but be under the complete control of the link I^2 (see Fig. 10) to produce a cut-off by the auxiliary movement of the link I^3. The link J, when raised to the shaft L^9, reverses the valve motion, that is, opposite from what it is on the lower pin I^4, and in either case the rocker arm I works full stroke. It is understood that each link is governed by different mechanism for shifting from one position to another. When the engine is reversed then it cuts off in the same manner as above described. The link J is thrown in either of its two positions by any suitable mechanism, not shown in the drawings, and the said cut-off is very prompt, yet the movement is of such a nature that it easily seats the valves, requiring therefore no dash pots or cushions to prevent slamming or knocking of the valves.

It is understood that a compound motion is given to the top shaft L^6 from the lever I, and the crank arm L^7 connected by the link N and rod N^2 with the crank lever L^4 controlled from the frame O. The valves E and E′ for the exhaust are of the Corliss type and they diminish the clearance to about two and one-half per cent. of the cubic contents of the cylinder B, while the stroke is four times the diameter of the cylinder. By this arrangement of valves the most perfect distribution of the lubricant is obtained.

The engine cuts off at half stroke but the cut-off is not adjustable and is not desirable, as engines are easily worked to full-stroke in order to obtain the maximum power, and on application of the indicator usually the fact is revealed that the exhaust port is entirely too small to handle the enormous terminal pressure, and the back pressure neutralizes all the gain of power due to a late cut off, while the exhaust port would be ample for cutting off at half stroke.

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

1. A valve gear for steam engines, comprising a cylinder having ports at its ends open at all times, a chest containing valve chambers into which open the said ports, the said chests also containing exhaust ports leading from the said chambers and inlet channels for the live steam leading to valve seats opening into the said valve chambers, oscillating valves in the said valve chambers, puppet valves in the said seats, and means, substantially as described, for actuating the said oscillating valves and the said puppet valves in the manner set forth.

2. A valve gear for steam engines, comprising a rocking lever for the oscillating exhaust valves, and a rocking shaft journaled in the said first named rocking lever, and having an independent turning motion to control the puppet valves for the admission of steam, substantially as shown and described.

3. A valve gear for steam engines, comprising a rocking lever for the oscillating exhaust valves, a rocking shaft journaled in the said first named rocking lever, and having an independent turning motion to control the puppet valves for the admission of steam, and a valve link adapted to be operated from the main driving shaft and adapted to engage either a pin on the said lever or the said shaft, substantially as shown and described.

4. A valve gear for steam engines, comprising puppet valves for the admission of the live steam, oscillating exhaust valves for controlling the exhaust, a rocking lever connected

with the said exhaust valves, a rocking shaft journaled in the said rocking lever, and a connection between the said rocking lever and the said puppet valves to actuate the latter, substantially as shown and described.

5. A valve gear for steam engines, comprising puppet valves for the admission of the live steam, oscillating exhaust valves for controlling the exhaust, a rocking lever connected with the said exhaust valve, a rocking shaft journaled in the said rocking lever, and a connection between the said rocking lever and the said puppet valves to actuate the latter, a valve link for the said rocking lever and operated from the main driving shaft and adapted to engage either a pin on the rocking lever or the said shaft, and a second valve link likewise operated from the main driving shaft and connected with a crank arm on the said shaft, substantially as shown and described.

6. In a valve gear for steam engines, the combination with a cam on the main driving shaft, of a frame mounted to swing forward and backward and actuated by the said cam, the said frame being connected with the oscillating exhaust valves, and a second frame mounted to slide vertically in the said swinging frame, and likewise operated from the said cam, the said second frame being connected with puppet valves for controlling the live steam to the cylinder, substantially as shown and described.

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