J. C. BIRD.

VALVE MECHANISM FOR STEAM ENGINES.

APPLICATION FILED AUG. 24, 1909.

1,047,912.

Patented Dec. 24, 1912.

3 SHEETS—SHEET 1.

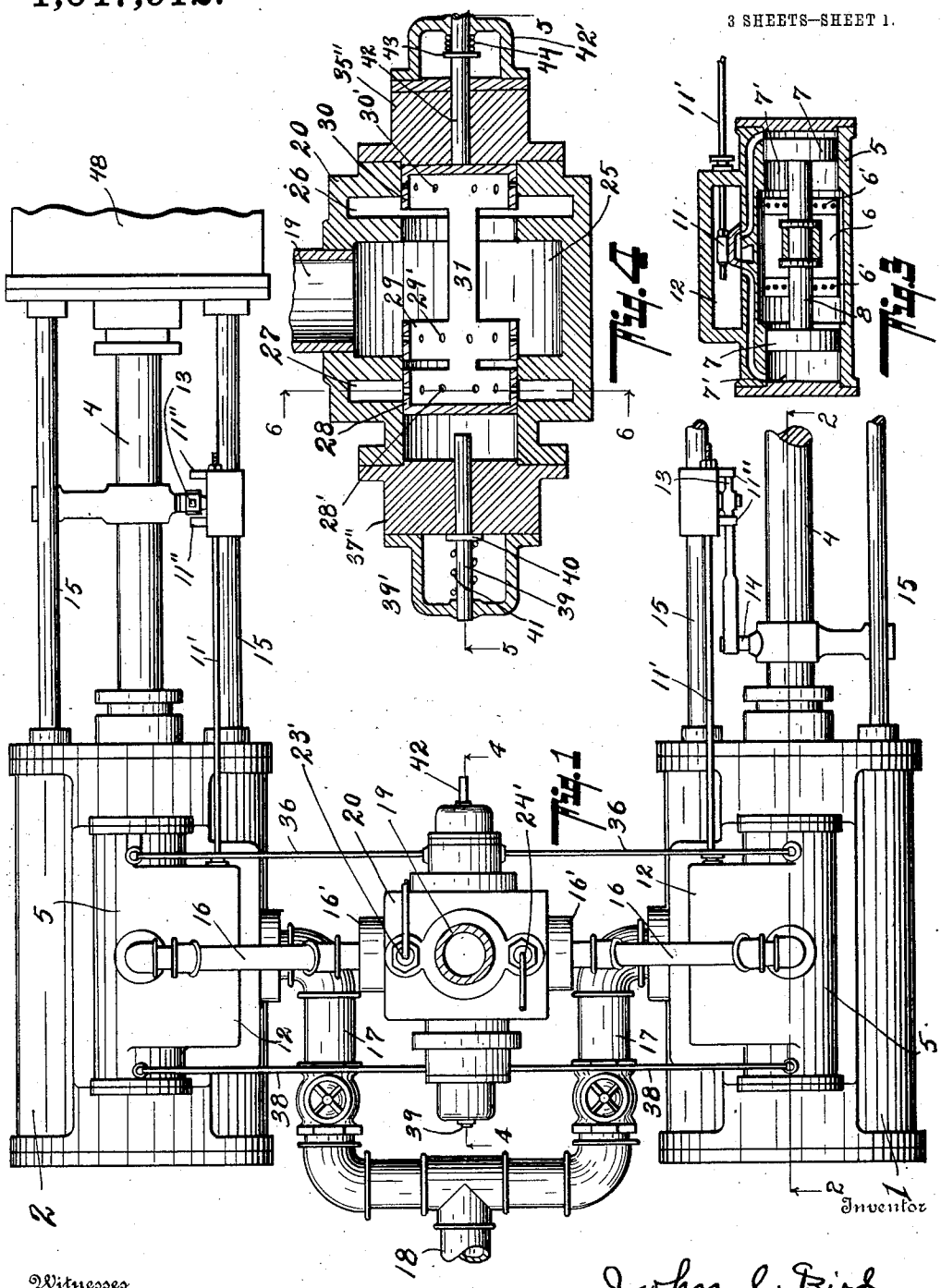

Fig. 1

Fig. 4

Fig. 3

Witnesses
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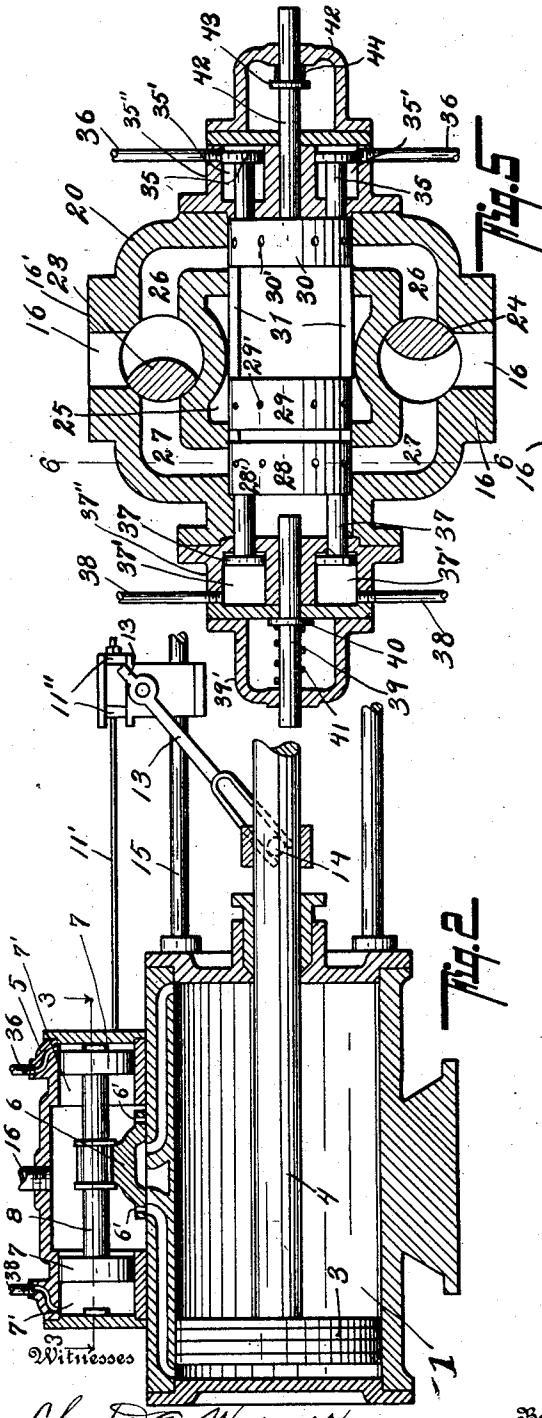

Fig. 2.

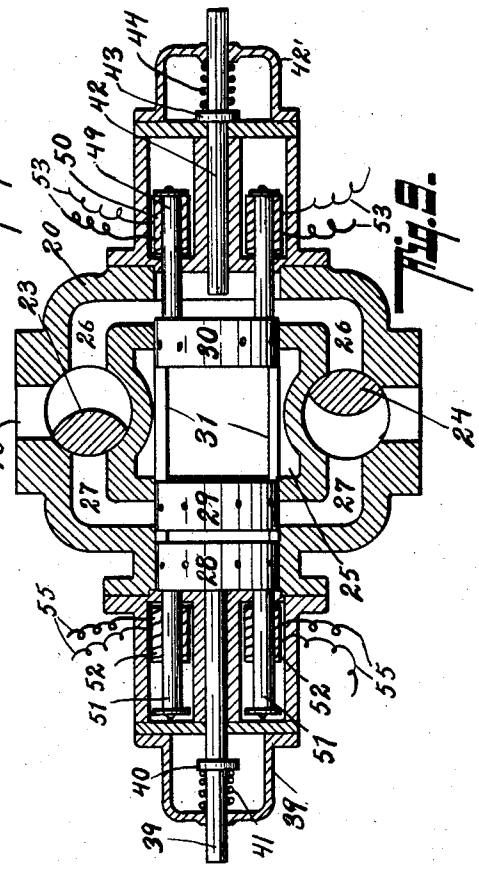

Fig. 5.

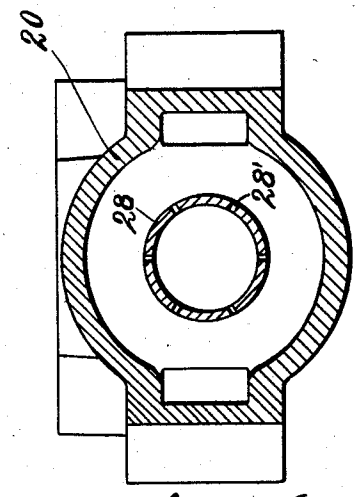

Fig. 8.

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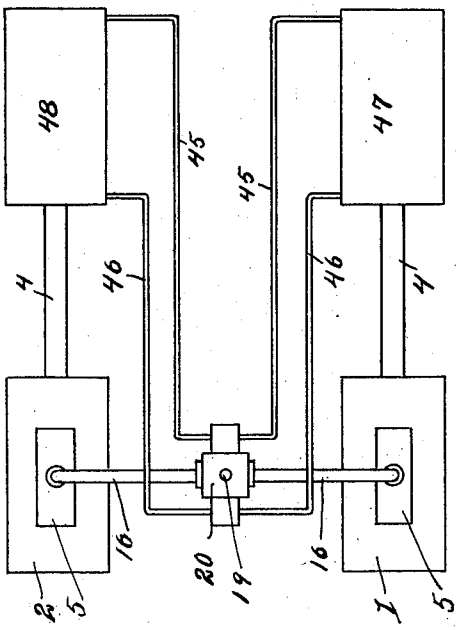

Fig. 8.

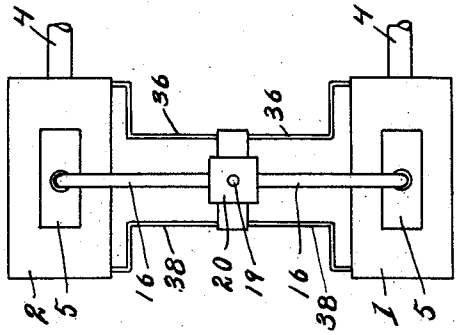

Fig. 7.

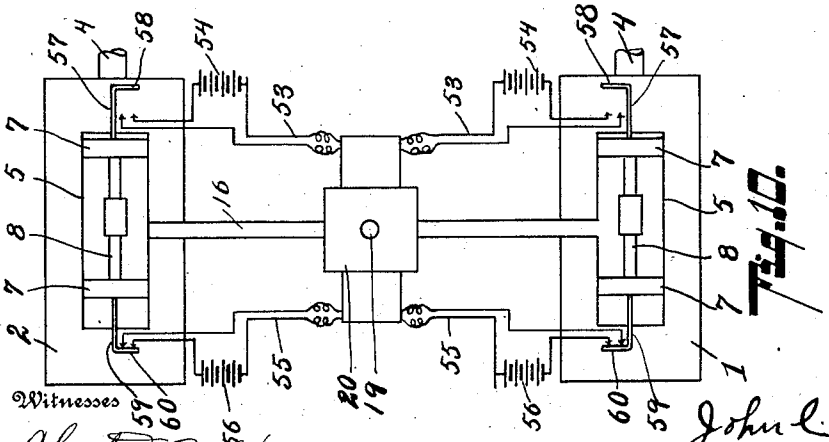

Fig. 10.

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UNITED STATES PATENT OFFICE.

JOHN C. BIRD, OF BATTLE CREEK, MICHIGAN, ASSIGNOR TO UNION STEAM PUMP COMPANY, OF BATTLE CREEK, MICHIGAN.

VALVE MECHANISM FOR STEAM-ENGINES.

1,047,912. Specification of Letters Patent. Patented Dec. 24, 1912.

Application filed August 24, 1909. Serial No. 514,383.

To all whom it may concern:

Be it known that I, JOHN C. BIRD, a citizen of the United States, residing at the city of Battle Creek, county of Calhoun, State of Michigan, have invented certain new and useful Improvements in Valve Mechanisms for Steam-Engines, of which the following is a specification.

This invention relates to improvements in valve mechanisms for steam engines.

The invention relates particularly to modifications and improvements in means for operating and means coacting with the valve illustrated in my Patent No. 933,952, issued September 14, 1909.

The objects of this invention are to provide means of controlling the said valve, which are other than direct mechanical connections between the pairs of engines, it having been found desirable in certain relations to so locate the engines that the mechanical means would not properly connect.

The improvements also here, in some instances, facilitate construction and economize in that particular.

The improved modified construction here reproduced is very effective in keeping the pumps in step, that being the main object, of course, of the entire structure, to keep two or more pumping engines in step in proper successive relation while they are at work. When I say in step in this specification I mean the properly timed successive action of the engines.

I accomplish the objects of my invention by the devices and means described in the following specification.

The structure described constitutes one effective embodiment of my invention.

Other embodiments would be readily devised by those skilled in the art.

The invention is clearly defined and pointed out in the claims.

A structure constituting an effective and preferred embodiment of the features of my invention is clearly illustrated in the accompanying drawing, forming a part of this specification, in which:—

Figure 1 is a plan view of a pair of pumping engines, with a pump illustrated in connection with one of them. Fig. 2 is a vertical longitudinal sectional view through one of the engines, taken on a line corresponding to line 2—2 of Fig. 1. Both engines are exactly similar. Fig. 3 is a detail horizontal sectional view, through the engine valve means, taken on a line corresponding to line 3—3 of Fig. 2, showing the auxiliary valve and its connecting rod as well. Fig. 4 is an enlarged detail vertical longitudinal sectional view of the synchronizing valve, taken on a line 4—4 of Fig. 1, through the synchronizing valve. Fig. 5 is a horizontal longitudinal detail sectional view of the synchronizing valve, taken on a line corresponding to line 5—5 of Fig. 4, showing details of construction of the parts. Fig. 6 is a transverse detail sectional view of the synchronizing valve, taken on a line corresponding to lines 6—6 of Figs. 4 and 5. Fig. 7 is a detail plan view of a modification of the connections for operating the synchronizing valve where the operating pipes are connected to the ends of the steam engine cylinder. Fig. 8 is a detail diagrammatic plan view of another modification in which the pipes for actuating the synchronizing valves are connected to the cylinders of the water ends of the pumps. Fig. 9 is a detail horizontal sectional view, through a modification, in which the synchronizing valve is operated by electric means, the same being taken on a line that would correspond to line 5—5 of Fig. 4. Fig. 10 is a diagrammatic plan view of the electrical connections, showing the various parts in conventional form.

In the drawings, similar numerals of reference refer to similar parts throughout the several views, and the sectional views are taken looking in the direction of the little arrows at the ends of the section lines.

The engine cylinders with their steam-actuated engine valves and auxiliary valves are the same as those that appear in my former application above referred to. They will be here again described.

Referring to the numbered parts of the drawing, a pair of engines 1 at the right and 2 at the left are shown connected and controlled by my improved synchronizing valve mechanism. A piston 3 is in each engine cylinder, and a piston rod 4 projects through a suitable stuffing-box and connects to a pump or other driven part, the engine being especially adapted for use on pumps and direct work, although of course it may be desirable to control such engines for other purposes. Each engine cylinder 1 and 2 and corresponding pump cylinder 47 and 48 is coupled by rods 15. Each engine is provided with a steam-chest 5, which steam-chest is provided with a steam-actuated

valve controlled by pistons 7—7 of short steam cylinders 7′ 7′ at each end. A rod or stem 8 connects the two pistons together and connects them to a D-slide valve 6 containing perforations toward each end 6′ for the admission of steam.

Steam is admitted to actuate the pistons 7 by the auxiliary engine-valve 11 in the auxiliary steam-chest 12, which auxiliary valve is controlled by the valve-stem 11′ which is controlled by the action of the swinging arm 13 controlled from the piston rod by stop 14. The upper end of arm 13 contacts with the stops 11″, 11″, whereby the auxiliary valve is controlled and steam is admitted to actuate the pistons 7—7 in exactly the same manner that the piston of a steam engine is controlled. The swinging arm 13 is carried by one of the rods 15. This steam-actuated valve mechanism and means is identical on the two engines 1 and 2 referred to. A steam supply pipe 16 leads from the synchronizing valve casing 20 to each engine and the exhaust from the engine is through pipes 17 and 17 connected to pipe 18, as clearly appears in Fig. 1.

Midway between the two engines 1 and 2 is my improved synchronizing valve consisting of a casing 20 which receives steam through the pipe 19 and delivers to the engine through the pipes 16—16 which connect at bosses 16′ 16′, as clearly appears in Fig. 5.

Within the valve chamber 20 is a piston valve 31 controlled in the preferred construction by pairs of pistons, hereafter to be fully described. The valve chamber 20 has a central annular chamber 25 and annular chambers or ports 26 and 27 toward each end. Three-way valves or cocks 23 and 24 are provided at each side for controlling the connection of the chambers 26 and 27 to the supply-pipes 16—16, leading to the engines, so that either chamber 26 may be connected to either pipe or either pipe may be shut off, as the operation of the engine or engines may require.

The valves or three-way cocks 23 and 24 are provided with handles 23′ and 24′, respectively, which are bent at proper angles to indicate the position of the three-way cocks which control the discharge of steam from the synchronizing valve.

The piston-valve 31 is provided with sections 28, 29 and 30, for controlling the chambers or ports 26 and 27, there being a series of perforations 28′, 29′ and 30′, respectively, in each of the sections, to permit of the discharge of a restricted or limited amount of steam when the said ports 26 and 27 are closed by the said sections. This restriction of the steam is the means adopted for effectively controlling the engines and insuring that they move in step; and, if they start out of step, that they will vary their movement until they come into step. The sections 28, 29 and 30 are so spaced that the full ports may be uncovered and opened.

A pair of small pistons 35—35 are arranged to act on the right-hand end of the valve 20, and are in suitable small cylinder bores 35′— 35′, appearing in the casing 35″. On the left-hand end of the synchronizing valve is an exactly similar structure, consisting of the pair of pistons 37—37, in cylinder bores 37′, in the casing 37″. The pistons at the right-hand end are connected by small pipes 36—36 to the right-hand ends of the steam chest 5—5 at the corresponding side, and the cylinders 37′—37′ are connected by pipes 38—38, respectively, to the steam chests 5 and 5 at that end,—that is, to the left-hand end of the steam chest of the respective engine cylinders.

A spring loaded pin 39 is at the left-hand end of the synchronizing valve, pressure being applied by means of a spring 41 on a central collar 40, which stops against the outer part of the casing 37″, brackets or supports 39′ being provided for the spring loaded pin 39. A similar spring loaded pin 42 is at the right-hand end of the synchronizing valve, having the spring 44 acting against the collar 43, which is stopped at the outside, the same being supported by a suitable bracket 42′. These spring loaded pins extend into the valve casing 20 and contact against the opposite ends of the valve 31, locating and supporting the same in its central position. The tension of the spring is sufficient to overcome the frictional resistance of the pins 39 or 42 and the valve 31. When single pistons at opposite ends of the valve 31, for instance pistons 35 and 37, have fluid pressure admitted to them they will counter-balance each other because they act in opposite directions on the valve. The spring tension of the opposed springs 41 and 44 at the opposite ends of the valve will be sufficient to bring the valve 31 to a substantially central position. If, however, it occurs that the two small pistons 35 at the same end of the mechanism have fluid pressure on them, their force will be sufficiently powerful to overcome the tension of the single piston 37 at the opposite end and will compress the spring 44 at the opposite end of the valve 31 and thus throw the valve to the further limit of its travel in that direction. Should two small pistons 37 at the same end have fluid pressure, their force will be sufficient to overcome the single piston 35 at the opposite end and compress spring 39, and the reverse motion will occur. By the arrangement of the mechanism only two of the small pistons have fluid pressure on them at the same time.

Having thus enumerated and described the various parts constituting my invention, I will now point out their operation and

their consequent purpose. In the first position of the mechanism, the piston engine 1 is on the point of reversing and the piston of engine 2 at its central position, moving toward the right. In this position, the steam is passing through the hollow piston-valve 31 out through the restricted perforations 28′ into the chamber 27 and thence through the pipe 16 to engine 1 where the valve is set for the steam to pass to the left-hand end of the cylinder. At the same time, steam is passing freely from the chamber 25 through the wide open ports to the chamber or port 26 through the pipe 16, without any obstruction, to the left-hand end of engine 2, which should be at about the center of its stroke. The pistons of both engines are thus moved in the same direction, and, when the piston of engine 2 reaches the end of its stroke, it will through swinging arm 13 actuate the auxiliary valve 11, which will operate the steam-actuated engine valve 6 of that engine, causing it to move to the reversing position. When the valve of engine 2 moves to the reversing position, it, of course, is actuated by steam pressure, which steam pressure, through the pipe 36 and the connected piston 35, reacts on the synchronizing valve, moving it to central position, where the section 30 will cover the port 26 and steam will pass thereto only through the restricted apertures 30′. The result is that the piston 3 of the engine 2 begins to move slowly toward the left. The same movement of the valve moves the section 28 from over the port 27 and admits the steam full head without restriction to port or chamber 27 which permits the steam to act upon the piston 3 of the engine 1 with full force until it reaches the end of its stroke when the piston 3 of the engine 2 will be at about midstroke. When the piston of engine 1 reaches the end of its stroke, it actuates its auxiliary valve and by it the main valve of the engine 1 is operated and moved instantly to the left. This admits steam to its right-hand end and steam passes through pipe 36 to actuate piston 35 connected thereto which acts to throw the piston valve 31 toward the left when the section 29 covers the port 27 and steam is admitted gradually through the apertures 29′ to the right-hand of the end of the cylinder of engine 1; and the same movement carries the section 30 from over the port 26 and admits the steam full head into the right-hand end of the cylinder 2. The movement then continues until the piston 3 of engine 2 reaches the end of its stroke toward the left, at which time the pistons of engine 1 will be about midstroke. When the piston 3 of engine 2 reaches the end of its stroke, it through swinging arm 13 actuates its auxiliary valve, which controls the steam-actuated engine valve which is thrown toward the right to the position indicated in Fig. 10. The steam is admitted at the left end of the cylinder to do this and the steam pressure actuates piston 37, connected by pipe 38, and tends to move the synchronizing valve to the right and moves it to position so that the port 27 is again opened and the port 26 is covered by the section 30 and the flow of the steam thereto is restricted through the perforations 30′ to the left-hand end of the cylinder of engine 2, and the port 27 is opened and the steam admitted full head to the right-hand of the cylinder of engine 1, when its piston 3 will be moved promptly to the left-hand end of its stroke. In engine 2 the piston 3 will be moved to the middle of its stroke toward the right-hand end, which brings the said pistons and valves to the position indicated in the beginning, when the cycle of movements would be complete. It will be seen from this that there can be no short stroke of either engine, because each controls its own valves, and any tendency for the engines to get out of step will result in retarding the movement of the engine which tends to move most rapidly, by restricting the flow of steam thereto and controlling the same in that way until the opposite engine finishes its stroke, the finish of the stroke in each instance being on a full head of steam and the supply of steam to the opposite engine being restricted until the full stroke of the other engine is completed in each instance,—which restriction, if there is a tendency for one engine to move in advance of the other and get out of step, is continued for more than half of the stroke, thereby compelling the piston thereof, due to the restricted passage, to move slowly while the other piston receives the full head of steam and promptly finishes its stroke. This is an improvement over the usual duplex arrangement of valves, where the pistons of one engine control the valves of the opposite engine, because, under such circumstances, the valves on one engine may be reversed by the opposite engine reaching the end of its stroke, causing one engine to short-stroke, thereby resulting in a great waste of steam and consequent loss, depending upon the extent of the defect in adjustment of the pump. This theoretically results in some loss at any point of the operation of such duplex pumps, because, theoretically, a perfect adjustment would be impossible and the loss would be in proportion to the defects of adjustment. Such pumps require constant attention to keep them in full stroke,—all of which is avoided by my improvements.

When it is desired to cut out either pump for any purpose, with my improved mechanism, one of the three-way cocks 23 or 24 is turned by its handle so that it shuts off the supply pipe 16 to the pump that is to be cut out, and the valve connects the chambers or ports 26 and 27; whereupon the

position of the synchronizing-valve is immaterial because it has no control of the supply of steam. It is best to effect this connection in cutting in this way, as it avoids a multiplicity of valves.

It will be noted that in the operation of this device the two engines are about half-stroke apart, the piston in engine 2 being in the lead about one-half stroke. This position could be reversed by reversing the position of the valves 23 and 24 when the piston of engine 1 would be about a half-stroke in the lead of the piston of engine 2. It does not matter, however, which piston is in the lead; the results from the operation of the synchronizing-valve are just the same. If the pistons of the engines are not in this position on starting they will quickly assume this position and relation from the control of my improved synchronizing-valve.

In Fig. 7 I have shown a modification of my device in that the steam pipes 36—36 and 38—38 are not connected to the opposite ends of the steam chests 5—5, in which are contained the steam-actuated engine valves, but to the opposite ends of the steam engine cylinders themselves.

From what I have already stated in describing the operation of the device, the operation of the synchronizing-valve will be understood in this behalf, because it will be the pressure of the steam in the engine cylinders themselves, as distinguished from the pressure of the steam in the steam chests 5—5 that operates the synchronizing valve and moves and holds it in the successive positions indicated.

In Fig. 8, I show a still further modification, in which pipes 45—45, corresponding to pipes 36—36, and pipes 46—46, corresponding to pipes 38—38, are connected to the opposite ends of the water cylinders, which are actuated by the steam pump. In this manner, the pistons 35—35 and 37—37 become hydraulic pistons, in place of steam pistons, which is the only difference.

In Figs. 9 and 10 I have shown a further modification in which pairs of plungers, operated by electro-magnets, are substituted for the piston plungers,—that is to say, at the right-hand end, there is an electro-magnetic core 49, extended into a plunger, which contacts with the end of the valve 31, which core and plunger is operated by a coil 50, which is in the circuit 53, which contains a battery, or source of electric supply 54. The left-hand end is provided with a pair of such plungers 51—51, which are operated by the electro-magnetic coils 52—52, which are in the circuits 55—55, respectively, which circuits each contains a source of electric supply and battery 56—56. The operation of the synchronizing valve is readily understood from the effect of these plungers, which is exactly the same as of the piston plungers in the other structure. These plungers are operated successively by providing extensions of the stems on the ends of the steam-actuated valves 6 of the engine cylinders 1 and 2. At the right-hand end of each valve a stem 57 extends, which has a lateral extension 58, which closes on to the terminals of the circuits 53, thereby closing the same and operating the synchronizing valve whenever the engine at that particular point is moved toward the left. On the opposite end of each valve is a stem 59, having a lateral extension 60, serving as a switch to close the circuits 55 at that side and actuate the electro-magnetic plungers at that side. The operation of the device will be readily understood from this description, these electro-magnetic plungers being operated successively by the contacting of the switches 58—58 and 60—60 respectively.

I have thus described my invention in various forms so that it will be readily seen that the synchronizing valve can be effectively operated by various means, although it is desired to remark that for ordinary purposes the mechanical connection appearing in my earlier application is desirable on account of its extreme simplicity.

The structures which I have shown here are of advantage in various relations where it is not expedient or possible to place the engines in the proper relation to react upon the synchronizing valve by means of the crossbar.

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

1. The combination of a pair of engines 1 and 2 each provided with a steam-actuated engine-valve consisting of a steam-chest 5 with cylindrical ends, pistons 7—7 in the ends, a D-slide valve 6 connecting by a stem 8 to the said piston-heads; an auxiliary valve 11 in a steam-chest 12 for controlling the supply of steam to the steam-actuated engine-valve; a valve-stem 11′ arranged to be actuated by a moving part of the engine, whereby each engine controls its own valve; a synchronizing-valve consisting of a casing 20 with a central port or chamber 25 and end-ports 26 and 27, with a supply leading thereto and supply pipes 16—16 leading therefrom to the steam-chests of the two engines, three-way cocks 23 and 24 for controlling the connections of the chambers 26 and 27 to the pipes 16—16, a piston-valve 31 within the valve-casing 20, consisting of sections 28, 29 and 30, containing restricted ports 28′, 29′ and 30′ respectively, for controlling the ports 26 and 27 and valves 23′ and 24 on the sides of the valve-casing 20 to regulate and reverse the same; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said

synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and spring-loaded pins extending inwardly at the opposite ends of said valve, the springs being of such tension and so arranged as to hold the synchronizing valve normally in the central position to be acted on successively by said plungers, all co-acting substantially as described and for the purpose specified.

2. The combination of a pair of engines 1 and 2 each provided with a steam-actuated engine-valve consisting of a steam-chest 5 with cylindrical ends, pistons 7—7 in the ends, a D-slide valve 6 connecting by a stem 8 to the said piston-heads; an auxiliary valve 11 in a steam-chest 12 for controlling the supply of steam to the steam-actuated engine-valve; a valve-stem 11′ arranged to be actuated by a moving part of the engine, whereby each engine controls its own valve; a synchronizing-valve consisting of a casing 20 with a central port or chamber 25 and end-ports 26 and 27, with a supply leading thereto and supply pipes 16—16 leading therefrom to the steam-chests of the two engines, three-way cocks 23 and 24 for controlling the connections of the chambers 26 and 27 to the pipes 16—16, a piston valve 31 within the valve-casing 20, consisting of sections 28, 29 and 30, containing restricted ports 28′, 29′ and 30′ respectively, for controlling the ports 26 and 27 and valves 23′ and 24 on the sides of the valve-casing 20 to regulate and reverse the same; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and yielding means for returning said valve normally to the central position to be acted on successively by said plungers, all co-acting substantially as described and for the purpose specified.

3. The combination of a pair of engines 1 and 2 each provided with a steam-actuated engine-valve consisting of a steam-chest with cylindrical ends, pistons 7—7 in the ends, a D-slide valve 6 connecting by a stem 8 to the said piston-heads, an auxiliary valve 11 in a steam-chest 12 for controlling the supply of steam to the steam-actuated engine-valve; a valve-stem 11′ arranged to be actuated by a moving part of the engine, whereby each engine controls its own valve; a synchronizing-valve consisting of a casing 20 with a central port or chamber 25 and end-ports 26 and 27, with a supply leading thereto and supply pipes 16—16 leading therefrom to the steam-chests of the two engines, a piston-valve 31 within the valve-casing 20, consisting of sections 28, 29 and 30, containing restricted ports 28′, 29′ and 30′ respectively, for controlling the ports 26 and 27 and valves 23′ and 24 on the sides of the valve-casing 20 to regulate and reverse the same; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and spring-loaded pins extending inwardly at the opposite ends of said valve, the springs being of such tension and so arranged as to hold the valve normally in the central position to be acted on successively by said plungers for the purpose of controlling the said synchronizing-valve, all co-acting substantially as described and for the purpose specified.

4. The combination of a pair of engines 1 and 2 each provided with a steam-actuated engine-valve consisting of a steam-chest with cylindrical ends, pistons 7—7 in the ends, a D-slide valve 6 connecting by a stem 8 to the said piston-heads; an auxiliary valve 11 in a steam-chest 12 for controlling the supply of steam to the steam-actuated engine-valve; a valve-stem 11′ arranged to be actuated by a moving part of the engine, whereby each engine controls its own valve; a synchronizing-valve consisting of a casing 20 with a central port or chamber 25 and end-ports 26 and 27, with a supply leading thereto and supply pipes 16—16 leading therefrom to the steam-chests of the two engines, a piston-valve 31 within the valve-casing 20, consisting of sections 28, 29, and 30, containing restricted ports 28′, 29′ and 30′ respectively for controlling the ports 26 and 27 and valves 23′ and 24 on the sides of the valve-casing 20 to regulate and reverse the same; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and yielding means for returning said valve normally to the central position to be acted on successively by said plungers, all co-acting substantially as described and for the purpose specified.

5. The combination of a pair of direct acting steam engines, each containing a steam-actuated valve and an auxiliary valve controlled from the piston of each of said engines for controlling the said steam-actuated valve thereof whereby each engine controls its own valve; a synchronizing-valve; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing-valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; spring-loaded pins extending inwardly at the oppo-

site ends of said valve, the springs being of such tension and so arranged as to hold the valve normally in the central position to be acted on successively by said plungers for the purpose of controlling the said synchronizing-valve; restricting passages in said synchronizing-valve controlling the ports of said valve to restrict the initial flow of steam to the said engines; a supply-pipe to the synchronizing-valve; and supply-pipes from the synchronizing-valve to the steam-chests of the engines, whereby the actuation of the steam-actuated valve controls and regulates the supply of steam to the said steam-chests of said engines, substantially as described and for the purpose specified.

6. The combination of a pair of direct acting steam engines, each containing a steam-actuated valve and an auxiliary valve controlled from the piston of each of said engines for controlling the said steam-actuated valve thereof whereby each engine controls its own valve; a synchronizing-valve; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing-valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; yielding means for returning said valve normally to the central position to be acted on successively by said plungers; restricting passages in said synchronizing-valve controlling the ports of said valve to restrict the initial flow of steam to the said engines; a supply-pipe to the synchronizing-valve; and supply-pipes from the synchronizing-valve to the steam-chests of the engines, whereby the actuation of the steam-actuated valve controls and regulates the supply of steam to the said steam-chests of said engines, substantially as described and for the purpose specified.

7. The combination of a plurality of steam engines; steam-actuated engine-valves for each of said engines; an auxiliary valve controlled by a moving part of each engine for admitting steam to actuate the steam-actuated engine-valve thereof whereby said engine controls its own valve; a synchronizing-valve having restricted and also full ports for controlling the flow of steam to the engine valves of each engine; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and spring-loaded pins extending inwardly at the opposite ends of said valve, the springs being of such tension and so arranged as to hold the synchronizing valve normally in the central position to be acted on successively by said plungers as specified.

8. The combination of a plurality of steam engines; steam-actuated engine-valves for each of said engines; an auxiliary valve controlled by a moving part of each engine for admitting steam to actuate the steam-actuated engine-valve thereof whereby said engine controls its own valve; a synchronizing-valve having restricted and also full ports for controlling the flow of steam to the engine valves of each engine; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and yielding means for returning said valve normally to the central position to be acted on successively by said plungers, as specified.

9. The combination of a plurality of steam engines; steam-actuated engine-valves for each of said engines; an auxiliary valve controlled by a moving part of each engine, for admitting steam to actuate the steam-actuated engine-valve thereof whereby each engine controls its own valve; a synchronizing-valve for controlling the flow of steam to the engine-valve of each engine; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and spring-loaded pins extending inwardly at the opposite ends of said valve, the springs being of such tension and so arranged as to hold the valve normally in the central position to be acted on successively by said plungers, as specified.

10. The combination of a plurality of steam engines; steam-actuated engine-valves for each of said engines; an auxiliary valve controlled by a moving part of each engine, for admitting steam to actuate the steam-actuated engine-valve thereof whereby each engine controls its own valve; a synchronizing-valve for controlling the flow of steam to the engine-valve of each engine; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and yielding means for returning said valve normally to the central position to be acted on successively by said plungers, as specified.

11. The combination of a plurality of steam engines; steam-actuated engine-valves for each of said engines; a synchronizing valve arranged in the supply passage to said engines with ports for controlling the delivery of steam to said engine valves; a controlling means consisting of pairs of op-

positely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and spring-loaded pins extending inwardly at the opposite ends of said valve, the springs being of such tension and so arranged as to hold the valve normally in the central position to be acted on successively by said plungers, coacting for the purpose specified.

12. The combination of a plurality of steam engines; steam-actuated engine-valves for each of said engines; a synchronizing valve arranged in the supply passage to said engines with ports for controlling the delivery of steam to said engine valves; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and yielding means for returning said valve normally to the central position to be acted on successively by said plungers, coacting for the purpose specified.

13. The combination of a plurality of steam engines; steam actuated valves for each of said engines, a synchronizing valve arranged in the supply passage to said engines with ports for controlling the delivery of steam to said engine valves; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and spring-loaded pins extending inwardly at the opposite ends of said valve, the springs being of such tension and so arranged as to hold the valve normally in the central position to be acted on successively by said plungers, coacting for the purpose specified.

14. The combination of a plurality of steam engines, steam actuated valves for each of said engines, a synchronizing valve arranged in the supply passage to said engines with ports for controlling the delivery of steam to said engine valves; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and yielding means for returning said valve normally to the central position to be acted on successively by said plungers, coacting for the purpose specified.

15. The combination of a plurality of steam engines; steam-actuated valves for each of said engines, a synchronizing valve to control the operation of said engines; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and spring-loaded pins extending inwardly at the opposite ends of said valve, the springs being of such tension and so arranged as to hold the valve normally in the central position to be acted on successively by said plungers, for the purpose specified.

16. The combination of a plurality of steam engines; steam-actuated valves for each of said engines, a synchronizing valve to control the operation of said engines; a controlling means consisting of pairs of oppositely-facing plungers at the opposite ends of the said synchronizing valve with connections to corresponding ends of said engines to operate the said plungers of said pairs yieldingly and successively; and yielding means for returning said valve normally to the central position to be acted on successively by said plungers, for the purpose specified.

17. In a synchronizing valve and means of actuating the same, the combination with a plurality of engine cylinders, of a synchronizing valve through which steam is delivered to actuate said engines, said synchronizing valve being provided with open ports and restricted ports; means for holding said valve yieldingly in position of the restricted portage; and a connection for the said synchronizing valve to both ends of both engine cylinders for actuating the same, the combination of the actuating means of both engine cylinders being required to move the valve to the full portage, coacting as specified.

18. In a synchronizing valve and means actuating the same, the combination with a plurality of engine cylinders, of a synchronizing valve through which steam is delivered to actuate said engines; means for holding said valve yieldingly in a position of restricted portage; and a connection for the said synchronizing valve to both ends of both engine cylinders for actuating the same, the combination of the actuating means of both engine cylinders being required to move the valve to the full portage, coacting as specified.

In witness whereof, I have hereunto set my hand and seal in the presence of two witnesses.

JOHN C. BIRD. [L. S.]

Witnesses:
H. VAN WAGNER,
EDWARD REEVES.