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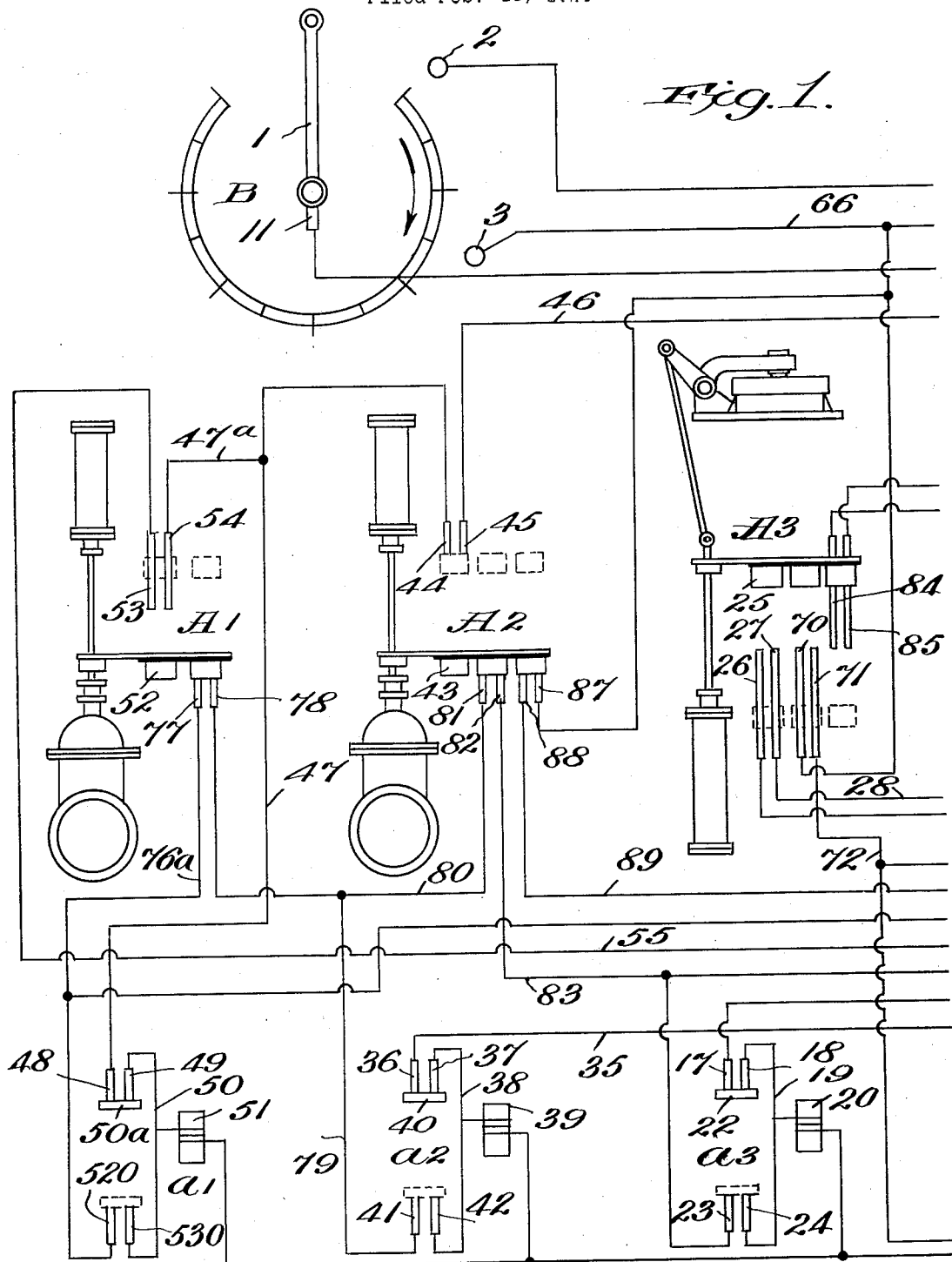
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J. S. KENNEDY

SEQUENCE INTERLOCK FOR AUTOMATIC VALVES

Filed Feb. 15, 1923

2 Sheets-Sheet 1



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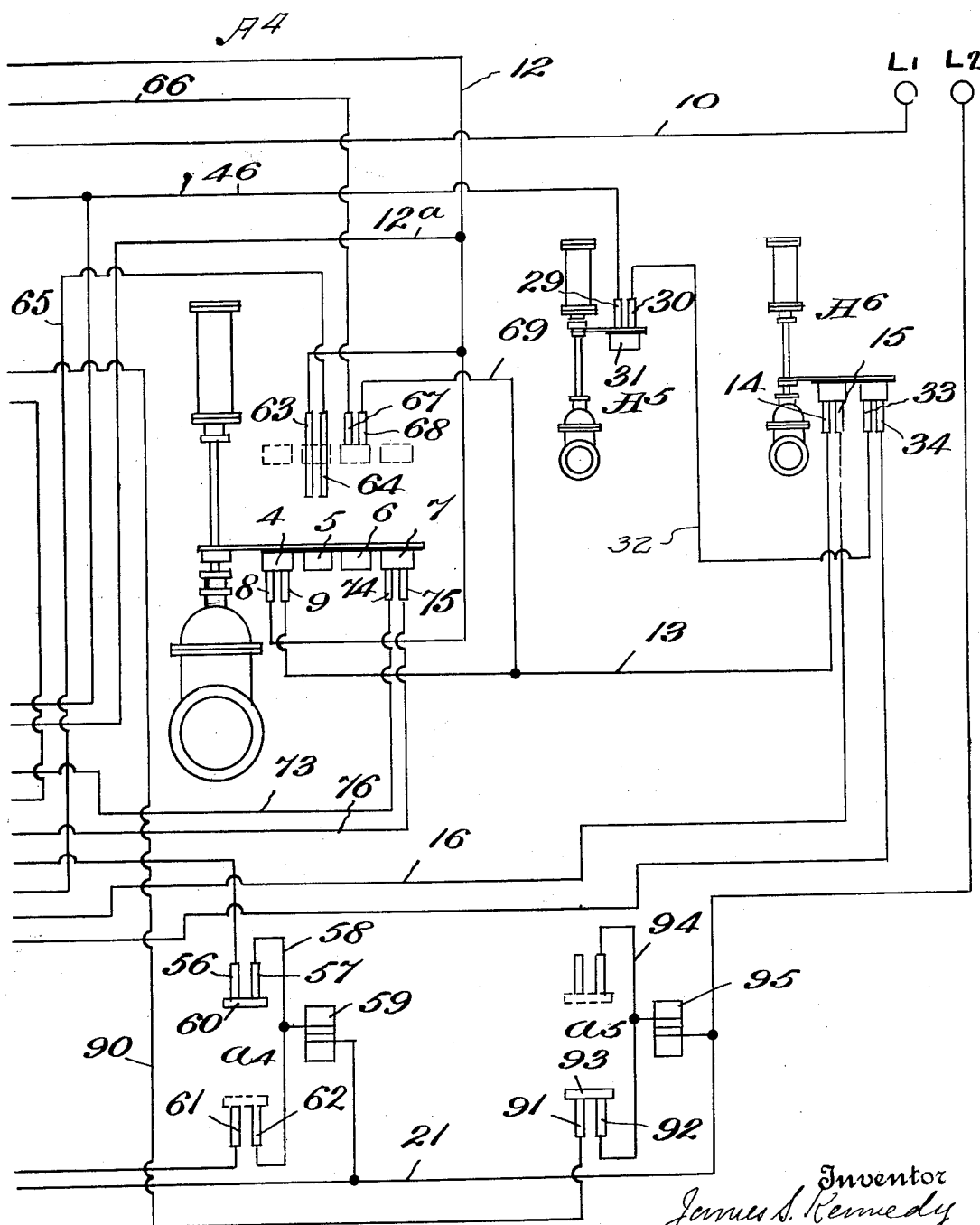
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2 Sheets-Sheet 2

Fig. 1a.



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UNITED STATES PATENT OFFICE.

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SEQUENCE INTERLOCK FOR AUTOMATIC VALVES.

Application filed February 15, 1923. Serial No. 619,257.

The present invention relates to an automatic controlling system whereby the various valves employed in the operation of gas generator sets are caused to operate with certainty in due order.

In gas generator sets most of the moving parts are so heavy that it is customary to actuate them by hydraulic engines (cylinders and pistons). These engines are controlled by suitable valves which cause the hydraulic pressure to act upon one side or the other of each hydraulic piston, according as the main valve to be actuated by each engine is to be opened or closed.

The valves which thus determine the direction of movement of the hydraulic engines may be called the "control" valves. All of the operations of a gas generator set may be suitably governed by hand; but it has been found advantageous to operate these control valves by automatic means governed from a suitable central timer or main controller, for instance, as described in my United States Patent No. 1,498,174.

The system set forth in said patent is operated electrically and includes interlocking means to insure the operation of the various valves in their proper order, inasmuch as accidental stoppage of certain valves followed by operation of certain others might lead to serious damage. For example, circuits acting to cause closure of the stack cap or "purge" pass through interlocking switches directly attached to and actuated by the generator blast valve and the carburetter blast valve, so that such circuits are not completed and the stack cap cannot be closed until after actual closing of the generator blast valve and the carburetter blast valve.

In the system described in the patent aforesaid there is a central timer or main controller switch whose movable member moves forward by jumps (preferably a quarter of a minute apart) and makes contact with a separate and distinct stationary contact member appropriated to each valve to be operated. The circuits through these contacts are routed or directed through the interlocking switches as above stated, for safety of operation. Such an arrangement involves a multiplicity of stationary or dial contacts, and a complication of circuits. The present invention has for its principal object the avoidance of these disadvantages

by providing a system that is simpler while quite as safe and certain as that above alluded to.

In practice the main valves of a gas generator set are operated through repeated cycles, each of which includes a "blow" followed by a "run". During the "blow" air is forced through the fuel bed to revive the combustion and restore the temperature impaired by the passage of steam through the glowing coal during the "run". It is during the run that the gas is actually produced.

In changing from the condition of "blow" to the condition of "run", or vice versa, a number of valves must be moved, and they must be operated in a certain order. Consequently, in the earlier system set forth in my said patent, the movable member of the central timer switch must perforce make contact with a number of separate stationary terminals simultaneously whenever the set is changed from the condition of "blow" to "run" or vice versa. In my present system only one stationary terminal makes contact with the movable member of the timer switch at such times. By this contact the circuit is closed which causes operation of that valve in the group to be actuated which should properly open first; movement of this first valve closes the circuit which causes operation of the second, and so on until all the valves of the group have been operated, and the change from "blow" to "run" or "run" to "blow" is completed.

Since group operation is thus carried out by making each valve in order act by its movement to cause operation of the next, the present system may be fitly called the "sequence interlocking" system.

After the "run" is started, certain other valves or valve pairs are operated individually before the "blow" again begins. For instance, the oil valve is opened, the "hot valves" are reversed and again reverse, the oil valve is closed and the steam valve for operating the blower is opened in proper order. These valves should be interlocked with others in the system (as set forth in the pending application aforesaid) but each valve is operated in turn, following contact with its corresponding stationary terminal in the central timer, and the "sequence interlock" does not apply to these.

The present invention is capable of use in systems variously constituted, and it is

independent of the specific construction of main and control valves and their operators. Such details have, therefore, not been shown or described herein.

5 In the accompanying drawings Figures 1 and 1^a are respectively the left hand and right hand sides of a complete diagram showing the preferred arrangement of circuits and switches for carrying out the present invention, as well as the relation of these
10 to the principal valves of one popular form of gas generator.

The specific arrangement which I have chosen as an example is one which includes a
15 "waste heat boiler". In this arrangement the hot gases passing away from the fuel body during the blow are not allowed to escape through the stack or "purge" to the air. They are diverted, instead, to a boiler where
20 their heat is utilized in generating steam for the various purposes of the plant.

The preferred arrangement shown herein is assumed to be applied to a system of the general character set forth in my patent
25 aforesaid in which there is a switch operated directly by movement of each main valve and another operated on movement of each "control" valve. These switches are shown
herein connected electrically in a manner to
30 carry out the purposes of the present invention. The switches operated by the main valves are preferably of a drum type, wherein insulated copper segments, cylindrical in shape, of varying angular length, are rotated
35 against the stationary contact fingers arranged tangentially to said segments. In the accompanying drawing the fingers are represented by narrow strips and the segments by bridging plates which may be brought into
40 and out of contact with said strips. For convenience the fingers are assumed to be of variable length in the drawing and the segments of a fixed length.

In the drawing the main valve switches
45 are indicated in a series from A¹ to A⁶ and the corresponding control valve switches and solenoids immediately below them. The main electric terminals are at L¹ and L², and the central timer or main controlling switch
50 is shown at B with enough of its terminals to elucidate the present invention. The rotating terminals of this timer switch is shown at 1, the mechanism for causing its clockwise movement by intermittent jumps
55 fifteen seconds apart being omitted.

At 2 is shown the stationary terminal by contact with which the "blow" is started, while at 3 is shown the terminal by contact with which the change from "blow" to "run"
60 is accomplished. The terminals corresponding to the valves which are operated singly are omitted as they have no reference to the present invention.

The switch at A¹ is operated by the carburetter blast valve; A² by the generator

blast valve; A³ by the "purge" or stack cap; A⁴ by the valve controlling admission of waste gases to the boiler; A⁵ by the throttle controlling the steam that drives the blower supplying the generator blast; and at A⁶ is
70 shown enough of the switch moved by the oil valve to show the safety interlock. This last named valve is not included in the "sequence interlock".

It is to be understood that the stack cap is
75 connected in a well known manner with the valve controlling admission of the generator steam to the fuel mass. This connection is such that when the stack cap is opened the generator steam valve is closed, and vice
80 versa (with one exception hereinafter noted).

In the accompanying diagram the various switches are shown in the positions corresponding to the end of a "run", the movable terminal of the timer being about to jump
85 forward to make contact with the stationary terminals 2. At this time all of the valves corresponding to the switches A¹ to A⁶ are closed except that at A⁵. This last corresponds to the throttle governing admission
90 of motive steam to the blower, which has been opened in order that the generator blast may be ready as soon as its valve is opened at A². The generator steam valve is also
95 open, of course, but, as before explained, this valve is automatically operated by connection with the stack cap. All this is well known in the art, and requires no illustration here.

The "sequence interlock" mode of operation can now be described with reference to the drawing, as it is carried out for changing
100 from "run" to "blow".

As soon as the movable contact 1 of the timer B touches (and rests awhile) on the
105 terminal 2, the following circuit is closed. From main terminal L¹, by wire 10, brush 11, contact 1, terminal 2, wire 12, terminals 8 and 9 and plate 4 of the closed boiler valve at A⁴, terminals 14 and 15 of the switch at
110 the closed oil valve, wire 16, terminals 17, 18 and plate 22 of the "preparing switch" at A³, wire 19, solenoid 20, and wire 21 to main terminal L².

The solenoid 20, being thus energized, operates the control valve which opens the
115 stack cap or "purge"; and as this moves the switch 25 at A³ closes or prepares circuits at 26, 27 and at 70, 71, while opening the interlocking switch at 84, 85 (see dotted line
120 position of plates 25).

The switch 25, thus actuated by the opening of the stack cap closes the following circuit for opening the generator blast valve.
125 From wire 12 (as before) wire 12^a, terminals 26, 27, wire 28, terminals 29, 30 and plate 31 at the open motive steam throttle, wire 32, terminals 33, 34 at the closed oil valve, terminals 36, 37 and plate 40 at A², wire 38, solenoid 39 and wire 21 to the main terminal L².
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The solenoid 39 opens the generator blast valve, by whose motion the switch 43 at A² closes circuit at 44, 45 and opens circuit at 81, 82 and 87, 88.

5 The switch 43, thus actuated, establishes the following circuit for opening the carburetter blast valve. From wire 12 and 12^a, terminals 26, 27 and plate 25, wire 46, terminals 44, 45 and plate 43, wire 47, terminals 48, 49 and plate 50^a at A¹, wire 50, solenoid 51 and wire 21 to terminal L².

The solenoid 51 opens the carburetter blast valve, by whose motion the switch 52 at A¹ closes circuit at 53, 54 and opens it at 77, 78; and this switch operation causes the opening of the boiler valve at A⁴, as follows. From wire 12 to terminal 44 as above traced, thence by wire 47^a, terminals 53, 54 and plate 52, wire 55, terminals 56 and 57 and plate 60 at A⁴, wire 58, solenoid 59 to wire 21 and terminal L².

The solenoid 59 opens the boiler valve by whose motion the switch at A⁴ is operated to bring the plates 4, 5, 6 and 7 into the dotted line position. The closure of circuits thus effected is to re-close the stack cap, so that all the hot gases leaving the fuel bed will pass through the boiler valve just opened. The circuit for accomplishing this is as follows.

From wire 12, wire 12^b, terminals 63, 64 and plate 5, wire 65, terminals 23 and 24 and plate 22 (which moved into dotted line position when the solenoid 20 was energized) thence to solenoid 20 and out by wire 21 to L².

This completes the change to the condition of "blow", all of the actions described taking place while the timer terminals 1 and 2 are in contact. It is to be noted that automatic opening of the generator steam valves does not take place when the stack cap is closed at the beginning of the blow. This is because automatic means are employed to prevent the opening of said generator steam valve whenever the boiler valve is opened. These details form no part of the present invention.

When further progress of the timer switch brings the terminal 1 into contact with the terminal 3, the valves are operated to change back from "blow" to "run" by the "sequence interlock" as follows.

The first operation is the opening of the stack cap, as follows—from L¹, by 10 and 11 to terminals 1 and 3, wire 66, terminals 67, 68 and plate 6 at A⁴, wire 69, terminals 14 and 15 at the closed oil valve, wire 16, terminals 17, 18 and plate 22 (which returned to the position shown at A³ when the stack cap was last closed) by wire 19, solenoid 20 and wire 21 to L².

The solenoid 20 again opens the stack cap, and the switch 25 closes circuit through 70 and 71 (see dotted lines at A³) and the boiler

valve is closed as follows—by wire 66^a, terminals 70, 71 and plate 25 at A⁴, wire 72, terminals 61 and 62 and plate 60 (which is in dotted line position) at A⁴, solenoid 59 and wire 21 to L².

When the boiler valve is closed, the switch position is restored as illustrated at A⁴ and the following circuit is established to close the carburetter blast valve. From terminal 71, wires 72 and 73, terminals 74, 75 and plate 7 at A⁴, wire 76, terminals 520, 530 and plate 50^a (now in dotted line position at A¹) solenoid 51 and by wire 21 to L².

When the carburetter blast valve is closed the switch at A¹ returns to the position illustrated, and the generator blast valve is closed as follows—from wire 76, branch 76^a, terminals 77 and 78 and plate 52 at A¹, wire 79, terminals 41, 42 and plate 40 at A² (now in dotted line position) solenoid 39 and by wire 21 to L². This closes the generator blast valve.

The closing of the generator blast valve restores the switch at A² to the position illustrated and the stack cap is again closed as follows—Current passes from wire 80, terminals 81 and 82 and plate 43 at A², wire 83, terminals 23 and 24 and plate 22 at A³ (now in dotted line position) solenoid 20, branch wire 21 to L². This closes the stack cap, and with it, of course, the generator steam valve, since the boiler valve is now closed.

Closure of the stack cap restores the switch at A³ to the position illustrated and this closes the blower steam throttle as follows: From wire 66^a, wire 86, terminals 87 and 88 at A², wire 89, terminals 84 and 85 and plate 25 at A³, wire 90, terminals 91 and 92 and plate 93 and at A⁵, solenoid 95.

The change from "blow" to "run" is now completed. As heretofore explained, certain valves will be automatically operated from the central timer B one or two at a time, during the progress of the run. These operations are independent of the present invention, and are fully explained in the application aforesaid. In said application is also fully described automatic and manual means for shutting down the set, as well as other features not connected necessarily with the present invention, and therefore not necessary to describe here. It may be well, however, to note certain details of the drawing as follows.

In describing the first sequence (beginning the blow) the circuit for opening the stack cap at the start can only be established through the terminals 14 and 15, and therefore when the oil valve is closed. Similarly in opening the generator blast valve, the current must pass from 29 to 30 at A⁵ and from 33 to 34 at A⁶, and therefore it cannot open unless the blower is running and the oil valve is closed.

Certain interlock switch terminals are

made so long that circuit between them is closed before the movement of the corresponding valve is completed. For instance circuit is closed through 70 and 71 at A³ before the stack cap is fully open. This permits the boiler valve to begin to close when the stack cap is about half open. As these valves have to move comparatively slowly, this overlapping of operations saves time. Similar arrangements are elsewhere shown. The present invention will be seen to be of a nature such that it may be embodied in a variety of constructions, and it is not limited to the details herein shown and described.

What is claimed is—

1. In apparatus of the character described, a plurality of valves intended for operation in sequence, separate motive means for each valve, a controlling device for each motive means, and means directly and immediately actuated by the movement of a valve intended for earlier operation, adapted to initiate operation of the motive means for the next later valve in sequence.

2. In apparatus of the character described a plurality of valves intended for operation in sequence, an electrically operated controlling device for each valve, and switches operated by the movements of the various valves adapted to close the immediate operating circuit of each valve after movement of the preceding valve in the sequence.

3. Apparatus as in claim 2 wherein a

switch operated by movement of a valve comprises circuit closing terminals connected in series with those of the switches connected with the next earlier and the next later valve in the sequence, whereby operation of two successive valves in the sequence is necessary to operation of the third.

4. Apparatus as in claim 2 in combination with a central timing switch having a contact closing terminal connected with one main terminal and a stationary contact closing terminal connected permanently with one or more of the valve operated switches in the system.

5. Apparatus as in claim 2 in combination with a central timing switch having a movable contact closing terminal connected with one main terminal and two stationary contact closing terminals connected permanently with different portions respectively of one or more of the valve operated switches.

6. In apparatus of the character described a plurality of valves intended for operation in sequence, separate motive means for each valve, and means independent of said motive means adapted to be actuated directly and immediately by the movement of a valve intended for earlier operation and adapted to control the supply of power to the next later valve motive means in sequence.

In testimony whereof I have hereto set my hand on this 9th day of February, 1923.

JAMES S. KENNEDY