

Dec. 9, 1952

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2,621,049

REVERSING VALVE AND CONTROL MEANS THEREFOR

Filed April 12, 1946

3 Sheets-Sheet 1

Fig. 4.

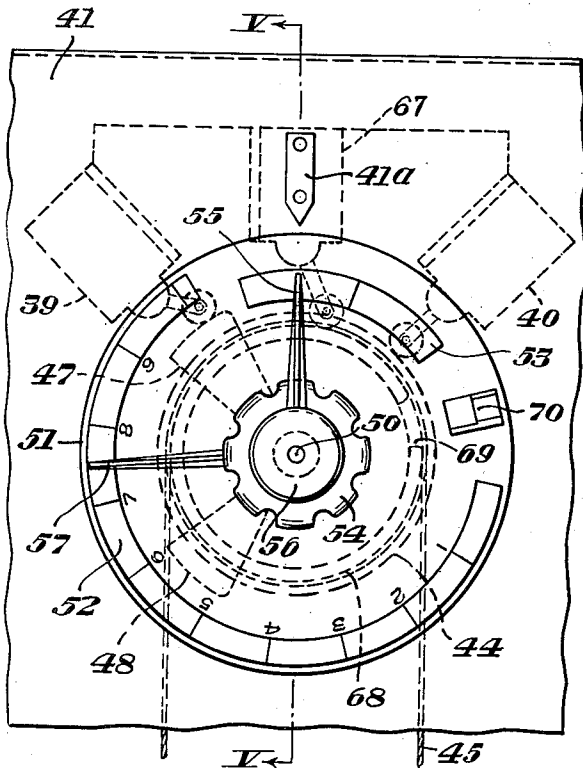


Fig. 5.

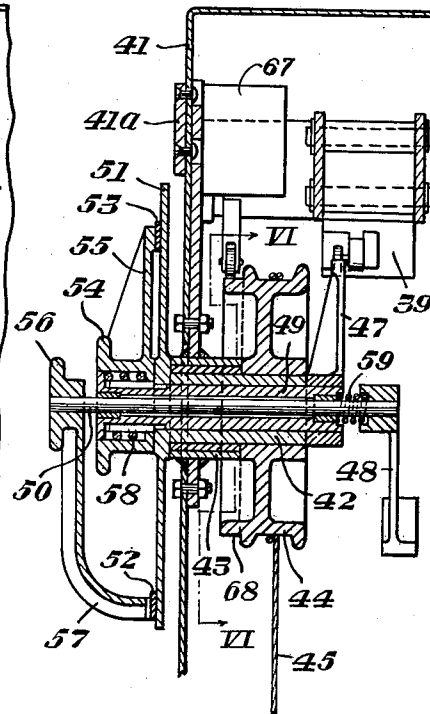


Fig. 6.

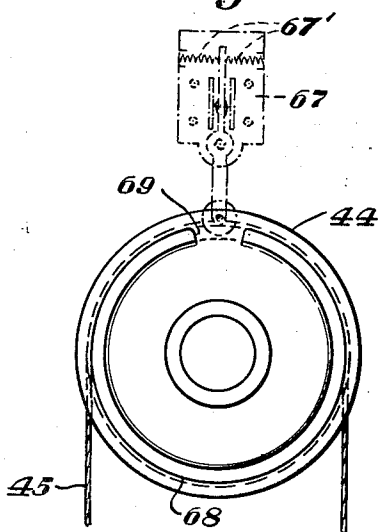
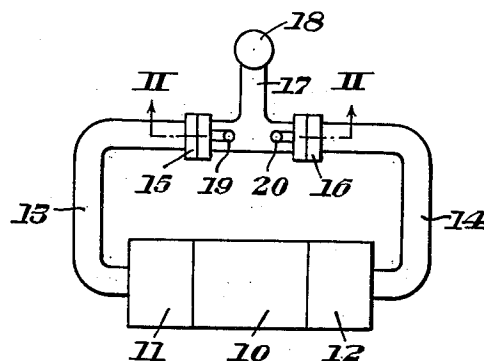


Fig. 1.



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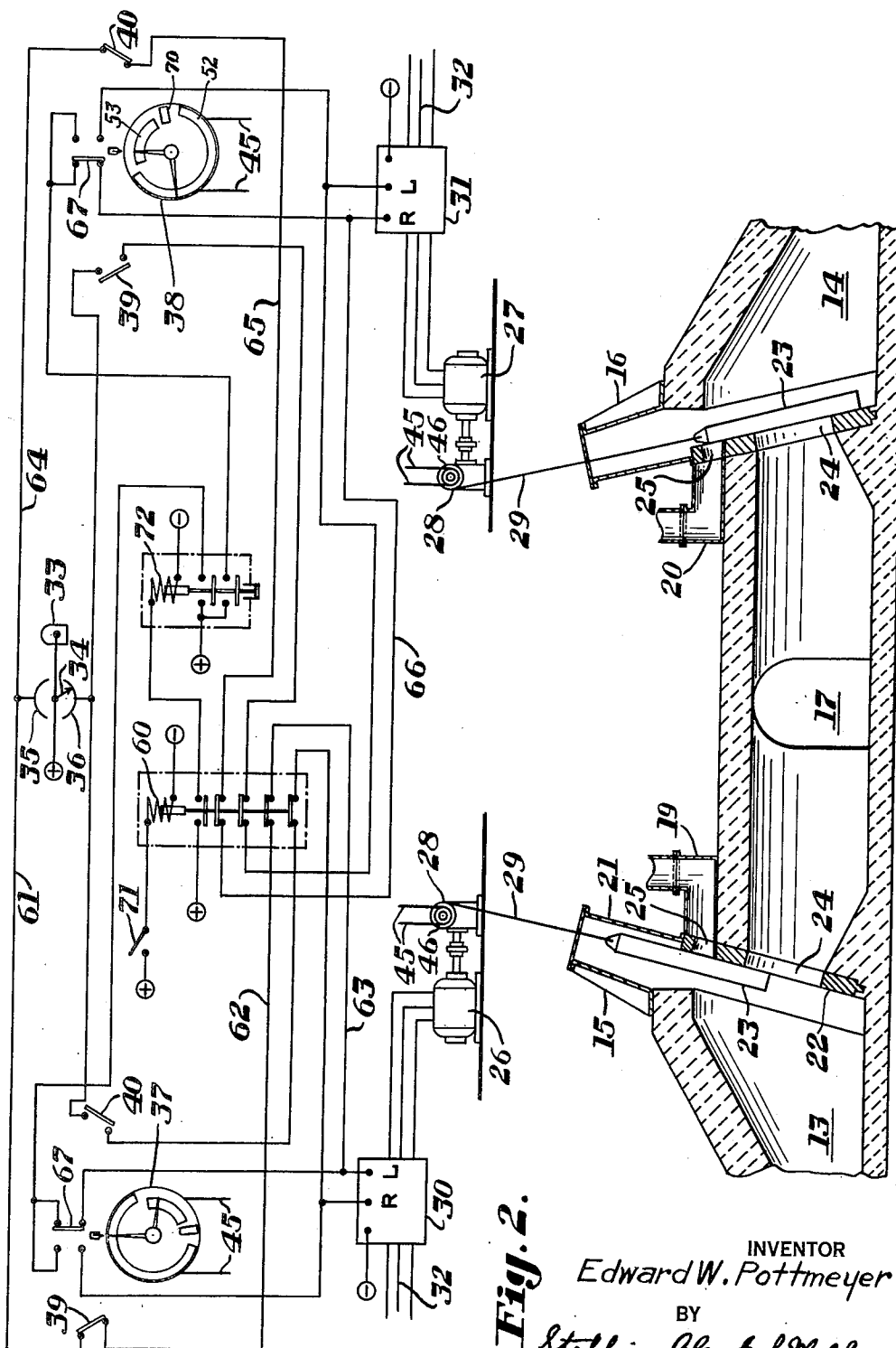


Fig. 2.

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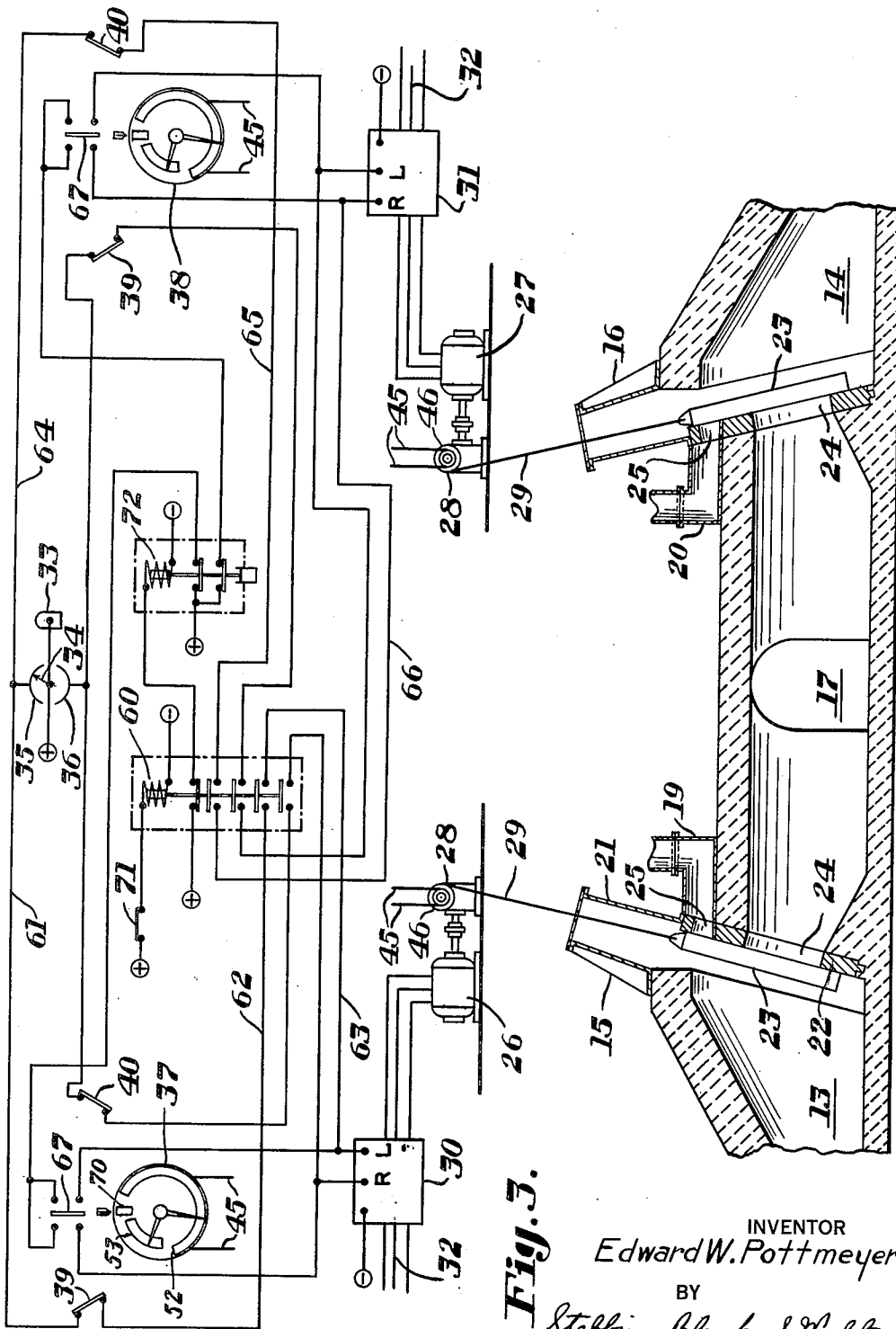


Fig. 3.

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2,621,049

REVERSING VALVE AND CONTROL MEANS THEREFOR

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Application April 12, 1946, Serial No. 661,560

8 Claims. (Cl. 277-6)

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This invention relates to reversing valves such as are used in pairs for controlling the supply of combustion air to one end of a regenerative furnace and the discharge of waste combustion gases from the other end. In particular, the invention concerns a novel form of valve and a control means for the motors operating the valves whereby the extent to which the air inlet and waste-gas outlet ports are opened on successive reversals of the furnace may be easily varied as desired, and the closures of both valves caused to occupy an intermediate position closing both the air inlet and the waste-gas outlet.

Reversing valves of various types have been used heretofore for controlling the direction of firing in regenerative furnaces. In some types, separate valve seats and closures therefor are provided in the air inlet and waste-gas outlet. In another type, a single valve seat has an air-inlet port and a waste-gas outlet port therein adapted to be closed alternately by a door slidable on the seat. Valves of this type have been constructed so that the door, in addition to cutting off the flow through either of the ports, may also serve as a damper for the outflowing waste gases (Loxterman Patent 2,306,069). I have invented a novel form of reversing valve capable of serving as a damper to control not only the outflowing waste gases but also the entering combustion air, and control means whereby the extent to which either the waste-gas port or the air-inlet port is opened may be easily varied by a simple manual operation in accordance with the conditions existing at any given time. In addition, the valve of my invention includes a closure dimensioned to close both the air-inlet port and waste-gas port when in an intermediate position, which is desirable in furnaces of certain types, particularly soaking-pit furnaces. I also provide control means for automatically causing the valve closures to move to intermediate position under certain conditions.

In a preferred embodiment of the invention, I provide a pair of valves, each including a seat and a closure movable thereon. The valve seat has an air-inlet port and a waste-gas outlet port therein. The closure is adapted to overlie one of the ports and a portion of the other in opposite extreme positions but is also dimensioned to close both ports when in an intermediate position. The seat is adapted, furthermore, to permit the movement of the closure necessary to effect regulation of the flow of entering air as well as outgoing combustion gases. The closures are operated by motors through suitable driving

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mechanism, and I provide manually adjustable control devices whereby the extreme positions of the closures may be chosen at will and varied from time to time to effect the desired regulation. In addition, I provide control means for the motor effective to move the closures to intermediate position when desired.

A complete understanding of the invention may be obtained from the following detailed description and explanation which refer to the accompanying drawings illustrating a present preferred embodiment. In the drawings,

Figure 1 is a diagrammatic plan view or layout of a simple form of regenerative furnace showing the location of the reversing valves;

Figure 2 is a partial vertical section through the valves taken along the plane of line II—II of Figure 1, including also a circuit diagram for the valve operating motors and their control devices;

Figure 3 is a view similar to Figure 2 showing the various elements in alternate positions;

Figure 4 is a partial elevation of the control device by which the degree of opening of the posts is adjustable;

Figure 5 is a vertical section therethrough taken along the plane of line V—V of Figure 4 with certain parts in altered positions; and

Figure 6 is a section taken along the plane of line VI—VI of Figure 5 with parts shown diagrammatically.

Referring in detail to the drawings and for the present to Figure 1, a reversing furnace such as a soaking-pit furnace, for example, indicated diagrammatically at 10 has regenerators 11 and 12 at opposite ends thereof. Flues 13 and 14 extending from the regenerators have reversing valves 15 and 16 therein for controlling the flow of waste combustion gases through a junction flue 17 to a stack 18. Air inlet connections for the flues 13 and 14 are indicated at 19 and 20.

Referring more particularly to Figure 2, the valves 15 and 16 are identical, each including a pocket or housing 21 offset from the flue, an inclined seat 22 and a closure or door 23 slidable upwardly and downwardly thereon. Each seat has a waste-gas port 24 and an air-inlet port 25.

The closure 23 of each valve is normally moved between extreme positions at each reversal of the direction of firing through the furnace 10. The valve closures are adapted to overlie one of the ports 24 and 25 in each position and are dimensioned so that they may partially overlie the other port at the same time, as clearly shown in Figure 2. By appropriately determining the extreme positions of the closures, the flow of the entering

combustion air and the outgoing waste gases may be suitably controlled. The closures 23, furthermore, are so dimensioned as to overlie both the ports 24 and 25 at the same time, as shown in Figure 3, when desired as will be further explained hereinafter.

The closures 23 of the valves 15 and 16 are raised and lowered by motors 26 and 27, respectively. Each motor drives a winch 28 through reducing gear. A hoisting cable 29 is secured to each closure and is trained around the winch drum. Operation of the motors 26 and 27 to effect up and down movement of the valve closures is controlled by reversing panels 30 and 31 provided with the necessary relays and contactors whereby electric current may be supplied from a connection 32 to a suitable distribution system. The details of the reversing panels or controllers are well known. For the purpose of explaining the present invention, it is sufficient to state that each controller has a relay circuit for causing the operation of the motor in such direction as to raise the closure and a similar circuit for causing the operation of the motor in the other direction. These circuits are connected, as shown on the drawings, to terminals marked R and L, respectively. It will be understood that operation of either motor continues only so long as one of these relay circuits remains energized.

Normal reversal of the valve closures at periodic intervals may be controlled by a timer 33 which may simply be a continuously energized motor driving rotating contact finger 34 adapted to engage fixed contacts 35 and 36 successively. By this device, circuits are set up to energize the aforementioned relay circuits on the reversing controller panels 30 and 31 to cause successive reversals of the positions of the valve closures 23.

The points in the paths of the closures at which they are stopped after each reversal, i. e., the extreme positions of the valve closures, are determined by manually adjustable control and indicating devices 37 and 38. Each device comprises a dial so driven that it turns in accordance with the movement of the valve closure from raised to lowered position and vice versa. The position of the dial relative to a fixed index indicates the position of the closure at all times. Pointers adjustable relative to scales on the dial control cams for operating limit switches which stop the valve closures in selected positions. The positions of the pointers show the degree of opening of the air and waste-gas ports for the extreme positions of the closure. The construction of the control devices is illustrated in Figures 4 through 6. Figure 4 shows the device with the ports in positions as indicated at the right in Figure 2. As there illustrated, each device includes normally closed limit switches 39 and 40 mounted on a supporting panel 41. A hollow shaft 42 is journaled in a bearing hub 43 secured to the panel. A drum 44 on the shaft is actuated in accordance with the movement of the winch 28 driven by one of the valve-operating motors through a cable 45. The cable makes several turns about the drum 44 and similar drum 45 on the shaft of the winch 28. Any other suitable driving means may be employed, of course, for actuating the shaft 42 in accordance with the movement of the winch 28. The ratio of the drive, in any case, should be such that the shaft 42 turns through an angle of somewhat less than 360° on movement of the valve closure from its lowermost to its uppermost position, i. e., from the position in which the air inlet is fully opened

to the position in which the waste-gas outlet is fully opened.

The limit switches 39 and 40 are of conventional construction and are illustrated only diagrammatically for that reason. They are actuated by cams 47 and 48. The cam 47 is mounted on a hollow shaft 49 extending through the hollow shaft 42 and rotatable therein. The cam 48 is mounted on a shaft 50 extending through the hollow shaft 49 and rotatable therein. A dial 51 is mounted on the shaft 42 in front of the panel 41. The dial is provided with scales 52 and 53 to indicate the setting of the cams 47 and 48 and thus the positions in which the valve closures will stop, for any given setting of the cams. A knob 54 on the outer end of the shaft 49 has a pointer 55 cooperating with the scales 53. A knob 56 on the outer end of shaft 50 likewise has a pointer 57 cooperating with scale 52. A compression spring 58 seated within a bore in the knob 54 tends to force the latter toward the dial so that the end of the pointer 55 makes frictional contact with the scale 53. A spring 59 on the shaft 50 between the cam 48 and the shaft 49 likewise urges the knob 56 and the pointer 57 toward the dial so that the pointer has frictional engagement with the scale 52. By pulling out on the knobs 54 and 56, the cams may be set to various positions. When the knobs are released, the springs cause re-engagement of the contacting surfaces of the pointers and dial. The positions of the pointers relative to the scales always show the relative positions of the cams.

It will be apparent that rotation of the drum 44 and shaft 42 will cause rotation of the shafts 49 and 50 by virtue of the frictional engagement between the contacting surfaces of the pointers 55 and 57 and the dial 51, thus causing the cams 47 and 48 to operate the limit switches 39 and 40 at the proper times. Preferably, the contacting surfaces of the pointers and scales are toothed or corrugated to provide a more positive drive from the dial to the cam shafts.

Referring again to Figure 2, it will be observed that the circuits from the moving finger 34 of the timer 33 extend through the contacts of the limit switches of the devices 37 and 38 and through back (normally closed) contacts of a relay 59. Considering the conditions illustrated, the finger 34 has just engaged contact 36 energizing the raising relay circuit for the motor of valve 15 and the lowering relay circuit of the motor operating valve 16, whereupon the closures 23 were shifted to the positions in which they are illustrated. The raising of the closure of valve 15 to the position in which it is illustrated caused the opening of limit switch 40 of control device 37 and the lowering of the closure of valve 16 caused the opening of limit switch 39 of control device 38 when the closure reached the position in which it is illustrated. As above explained, these limit switches open at points in the travel of the closures of the respective valves, depending on the setting of the pointers 55 and 57 on the respective control and indicating devices 37 and 38. The pointer settings shown in Figure 4 correspond to the positions of the closures shown in Figure 2, i. e., the pointer 55 is set about the half-way point on the scale 53 and the pointer 57 is set at about the three-quarter point on the scale 52.

It will be apparent that, when the pointers have been set to position the cams properly relative to the limit switches, energization of the proper relay circuits of the reversing controllers

30 and 31 through the contacts 35 and 36 of the timer 33 causes operation of the valve closures until the limit switches operate to open the relay circuits. The timer 33, of course, is constructed so that the finger 34 maintains engagement with the fixed contacts 35 and 36 for a time longer than that required for operation of the valve closures from one extreme position to the other. A reversal of the valve closures takes place every time the finger 34 engages one of the fixed contacts 35 and 36.

The dials 51 and the pointers 55 and 57 of the two control devices 37 and 38 move in opposite directions. Both the dials turn clockwise when the valve closure controlled thereby moves downwardly and counterclockwise when the closure is being raised. The cables 45 are suitably reeved from the drum 44 to the drum 46 to produce rotation of the dials in the directions just stated. The drums need not be proximately disposed and suitable guide pulleys may be used as necessary. The two closures, of course, move in opposite directions on all reversals. A fixed index 41a is mounted on the panel of each control device in such position that one of the pointers 55 and 57 is in alinement therewith when its limit switch is open. It is thus possible, by looking at the dials to tell which valve closure is in raised position and which in its lower position. The positions of the dials also indicate which closure will be raised and which lowered on the next reversal, and the points at which the closures will stop.

When the moving contact finger 34 of the timer 33 engages the fixed contact 35, a circuit is completed through a conductor 61, limit switch 39 of control device 37, a conductor 62, the third back contact of relay 60 and a conductor 63 to the relay terminal L of controller 30. At the same time, a circuit is completed through a conductor 64, the limit switch 40 of control device 38, a conductor 65, the first back contact of relay 60 and a conductor 66 to the terminal R of controller 31. The closures 23 of the valves 15 and 16 are then moved to reverse their relative positions, and are stopped at points determined by the settings of the pointers of the control devices 37 and 38. The next reversal is similarly effected when the finger 34 again engages the contact 36.

It will be understood that fuel is supplied to suitable burners at opposite ends of the furnace in accordance with the direction of firing and appropriately controlled in the known manner simultaneously with the reversal of the valves 15 and 16.

As pointed out above, the closures 23 of the valves 15 and 16 are dimensioned to overlie both the air-inlet port 25 and the waste-gas outlet port 24 as shown in Figure 3. This arrangement is desirable in order to permit the furnace to be entirely closed off at both ends under certain conditions, for example, when a predetermined temperature therein has been attained and it is desired merely to maintain the temperature for an extended period to permit soaking of the charge. It will be apparent that the closures 23 as shown in Figure 3 occupy an intermediate position between the two extreme positions illustrated in Figure 2. In order to cause the closures to be moved to this intermediate position, I provide each of the control devices 37 and 38 with a third limit switch 67. I also provide means for operating the centering limit switches 67 so that they bridge one or the other of two pairs of contacts at all times except when the closures are in the positions shown in Figure 3. Thus, as the

closures pass through their intermediate positions, these limit switches prepare circuits for returning the closures to the intermediate positions when this is called for, as by a rise in the furnace temperature to a predetermined value. Referring to Figure 6, it will be seen that each limit switch 67 is actuated by a cam 68 formed on the drum 44. The cam has a gap 69 and when it is in alignment with the roller of the limit switch, the contacts thereof are centered by suitable opposing springs 67'. The drum 44 is so positioned on the shaft 42 relative to the dial 51 that the gap of the cam is in alinement with the roller of the limit switch 67 when the valve closures occupy the positions shown in Figure 3. At this time, a marker 70 on the dial is in alinement with the index 41a. The marker 70 is positioned on the dial in alinement with the gap 69 in the cam.

In order to cause the closures 23 to move to the position shown in Figure 3, it is necessary to render the timer 33 and limit switches 39 and 40 ineffective and to substitute the limit switches 67 therefor. This is accomplished by relay 60. The relay may be controlled in any convenient manner. As an example, I have shown a contact 71 in circuit with the operating coil of the relay which may be closed by means responsive to the temperature in the furnace. If the furnace is being brought up to temperature, the contact 71 will close when the temperature reaches the desired value. The resulting operation of relay 60 closes an energizing circuit at its front (normally open) contact for a relay 72. The relay 60 also opens its back contacts, thus disconnecting the limit switches 39 and 40 from the controllers 30 and 31. The relay 72 closes its front contacts after a predetermined time and connects the limit switches 67 in circuit with the controllers 30 and 31. These conditions are illustrated in Figure 3. It will be apparent that the moving contacts of one limit switch 67 will be in engagement with one pair of its fixed contacts while the moving contact of the other limit switch will be in engagement with the other pair of fixed contacts, thus causing the closure which is in raised position to be lowered and the closure which is in lowered position to be raised until they reach the position shown in Figure 3, whereupon limit switches 67 are opened as the low points of the cams 68 come into alinement with the limit switches. The motors 26 and 27 are thereby stopped, leaving the valve closures overlying both the air-inlet and waste-gas outlet ports.

It will be understood that the supply of fuel to the furnace is automatically terminated by means not shown before the closures of both valves are moved to the positions shown in Figure 3. The time delay relay 72 is provided to delay movement of the closures until the fuel has been shut off.

When the temperature in the furnace has fallen to an extent such as to make renewed firing desirable, the contact 71 opens deenergizing the relay 60. This causes the relay 72 to be deenergized and it opens its contacts without any time delay. As soon as the relay 60 closes its back contacts, the closures are immediately actuated to the position shown in Figure 2 in accordance with the setting of the control devices 37 and 38, depending on which of the fixed contacts 35 and 36 of the timer is at the moment engaged by the moving contact finger 34 thereof. Normal reversals of the valve positions then fol-

low, in the manner already described under the control of the timer.

It will be apparent from the foregoing that the invention is characterized by numerous advantages over reversing valves and control systems thereof previously known. In the first place, the invention provides means for easily changing the positions at which the valve closures stop in raised or lowered position, in order to control the entering combustion air and the outgoing exhaust gases. This contributes to a flexibility of control which is important from the standpoint of efficient combustion and maintenance of the desired temperature in the furnace. In addition, there is the further advantage that the closures are so dimensioned as to be capable not only of regulating the degree of opening of the air inlet or waste-gas outlet, but also to close both ports simultaneously when it is desired to close off the furnace entirely at both ends. The automatic means provided for accomplishing this, furthermore, may easily be made responsive to the temperature in the furnace and the transfer relay renders the establishment of these conditions entirely compatible with the normal periodic reversal of the valve closures while the furnace is being actively fired.

Although I have illustrated and described but a present preferred embodiment of the invention, it will be recognized that changes in the construction and arrangement may be made without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. In a regenerative furnace, the combination with a pair of reversing valves each including a seat having spaced air and waste-gas ports and a closure movable to extreme positions to close said ports alternately and dimensioned to close both ports simultaneously in an intermediate position, a motor for operating each valve, and means for causing the motors periodically to shift the closures from one extreme position to the other, of means for removing the motors from the control of said means and causing the motors to move both the closures to said intermediate position.

2. In a regenerative furnace, the combination with a pair of reversing valves each including a seat having spaced air and waste-gas ports and a closure movable to extreme positions to close said ports alternately and dimensioned to close both ports simultaneously in an intermediate position, a motor for operating each valve, a reversing controller for each motor, of a timer adapted to actuate said controllers periodically to cause the closures to be shifted from one extreme position to the other, means adapted to actuate said controllers to cause both the closures to move to said intermediate position, and means for rendering said timer and said last-mentioned means effective alternately.

3. In a regenerative furnace, the combination with a pair of reversing valves each including a seat having spaced air and waste-gas ports and a closure movable to extreme positions to close said ports alternately and dimensioned to close both ports simultaneously in an intermediate position, a motor for operating each valve, a reversing controller for each motor, of a timer and limit switches adapted to actuate the controllers periodically to cause reversal of the positions of the closures, centering switches adapted to actuate the controllers to cause both the closures to move to said intermediate posi-

tion, and means for transferring the controllers from said timer and limit switches to said centering switches and vice versa.

4. In a regenerative furnace, the combination with a pair of reversing valves each including a seat having spaced air and waste-gas ports and a closure movable to extreme positions to close said ports alternately and dimensioned to close both ports simultaneously in an intermediate position, a motor for operating each valve, a reversing controller for each motor, of an automatic control means governing said controllers to cause periodic reversal of the extreme positions of the closures, centering switches adapted to govern said controllers to cause both closures to move to said intermediate position, and means for disconnecting the automatic control means from the controllers and connecting the centering switches to the controllers, and vice versa.

5. In a regenerative furnace or the like, in combination, a valve closure movable between preselected extreme positions, a reversible motor for moving said valve closure in opposite directions between said positions, a reversing electrical circuit for said motor, a limit switch in a fixed location in each part of said circuit controlling one of the two directions of rotation of said motor, a rotatable cam mounted on a shaft for operating each of said limit switches, a proportional driving connection between said cams and said motor to rotate said cams in preselected angular relation to each other, and means for adjusting each of said cams to vary the location of the one of said extreme positions controlled thereby.

6. In a regenerative furnace or the like, in combination, a valve closure movable between extreme positions, at least one motor for moving said valve closure between said positions, an electrical circuit for each direction of movement of said valve closure, a limit switch for each of said positions, each such limit switch being in the corresponding one of said electrical circuits, an intermediate positioning switch circuit interconnected between said circuits, respective members movable in relation to the extent and direction of movement of said closure for operating each of said limit switches and said intermediate positioning switch, said members being in adjustable fixed relation to one another respectively, a driving connection for said members, and means automatically responsive to furnace conditions for making a selection between said limit switches and said intermediate positioning switch as a control for the movement and positioning of said valve closure.

7. In a regenerative furnace or the like, in combination, a valve closure movable between extreme positions, a reversible motor for moving said valve closure in opposite directions between said positions, an electrical circuit for each direction of rotation of said motor, a timer and reversing controller in said respective circuits for periodically reversing the movement of said valve closure between said positions, a limit switch in each of said circuits for fixing the respective locations of said extreme positions of said valve closure, an intermediate positioning switch circuit interconnected between said circuits, coaxially mounted cam members for respectively operating said limit switches and said intermediate positioning switch, a proportional driving connection between said cam members and said motor, and means for making a selection between said timer, reversing controller and limit switches, and said intermediate positioning switch circuit

to control the movement and positioning of said valve closure.

8. In a regenerative furnace or the like, in combination, a valve closure movable between extreme positions, a reversible motor for moving said valve closure in opposite directions between said positions, an electrical circuit for each direction of rotation of said motor, a timer and reversing controller in said respective circuits for periodically reversing the movement of said valve closure between said positions, a limit switch in each of said circuits for fixing the respective locations of said extreme positions of said valve closure, an intermediate positioning switch circuit interconnected between said circuits, a time delay relay in said circuit of said intermediate positioning switch adapted to delay upon energization of said intermediate positioning switch circuit, coaxially mounted cam members for respectively operating said limit switches and said intermediate positioning switch, a proportional driving connection between said cam members and said motor, and means for making a selection between said timer, reversing controller and

limit switches, and said intermediate positioning switch circuit to control the movement and positioning of said valve closure.

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