May 30, 1933. T. C. KING ET AL 1,911,902

FURNACE VALVE REVERSING SYSTEM

Filed May 20, 1932 4 Sheets-Sheet 1

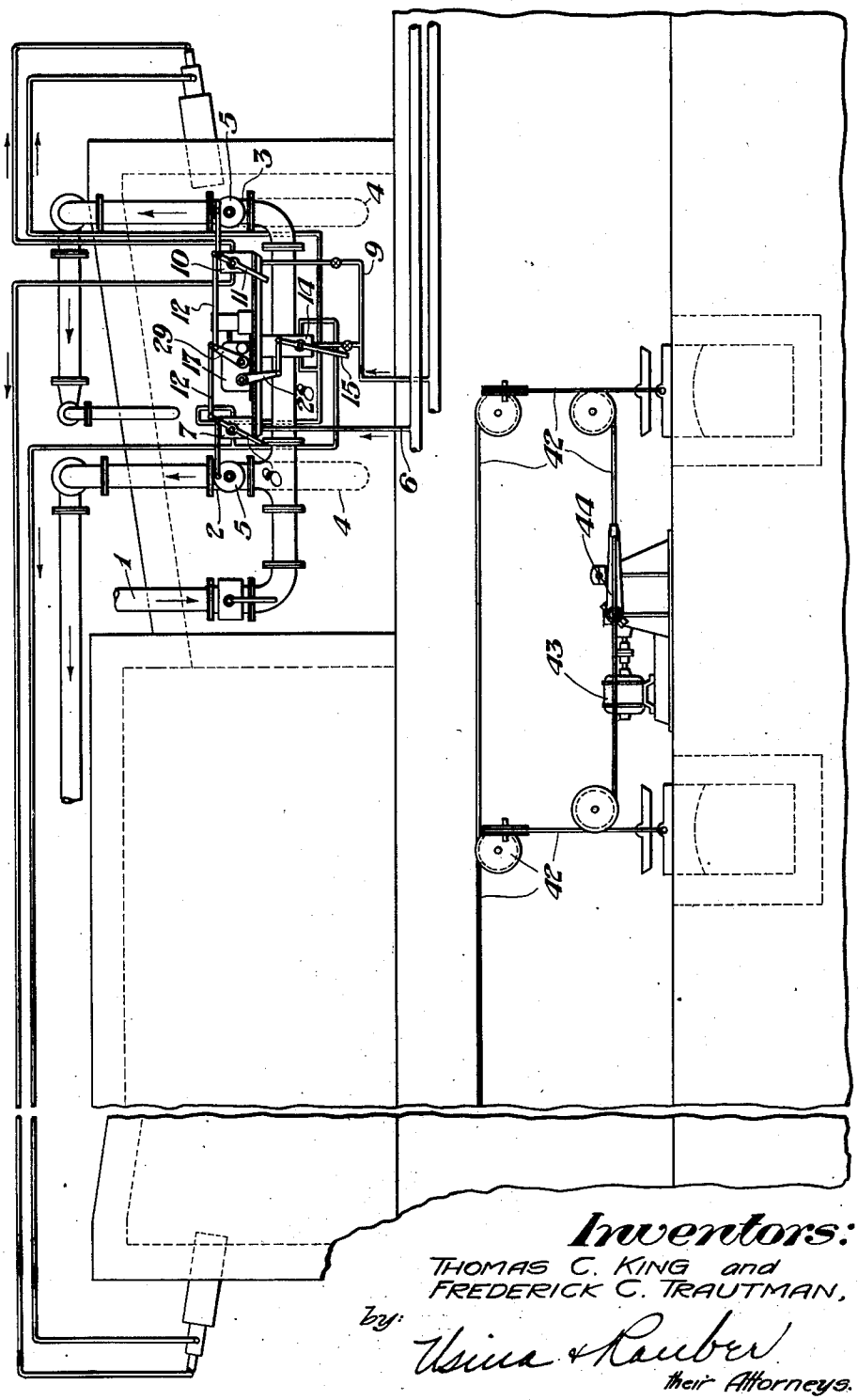


Fig. 1.

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FURNACE VALVE REVERSING SYSTEM

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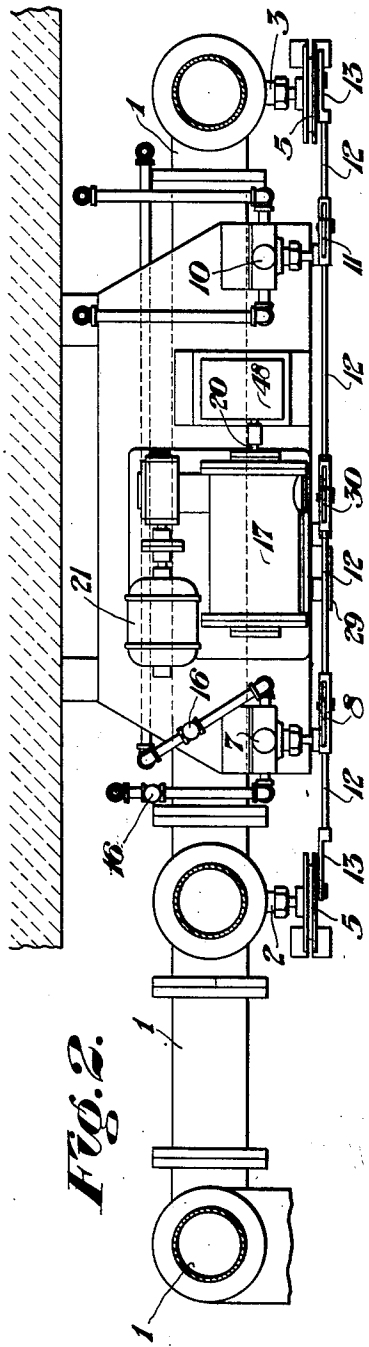


Fig. 2.

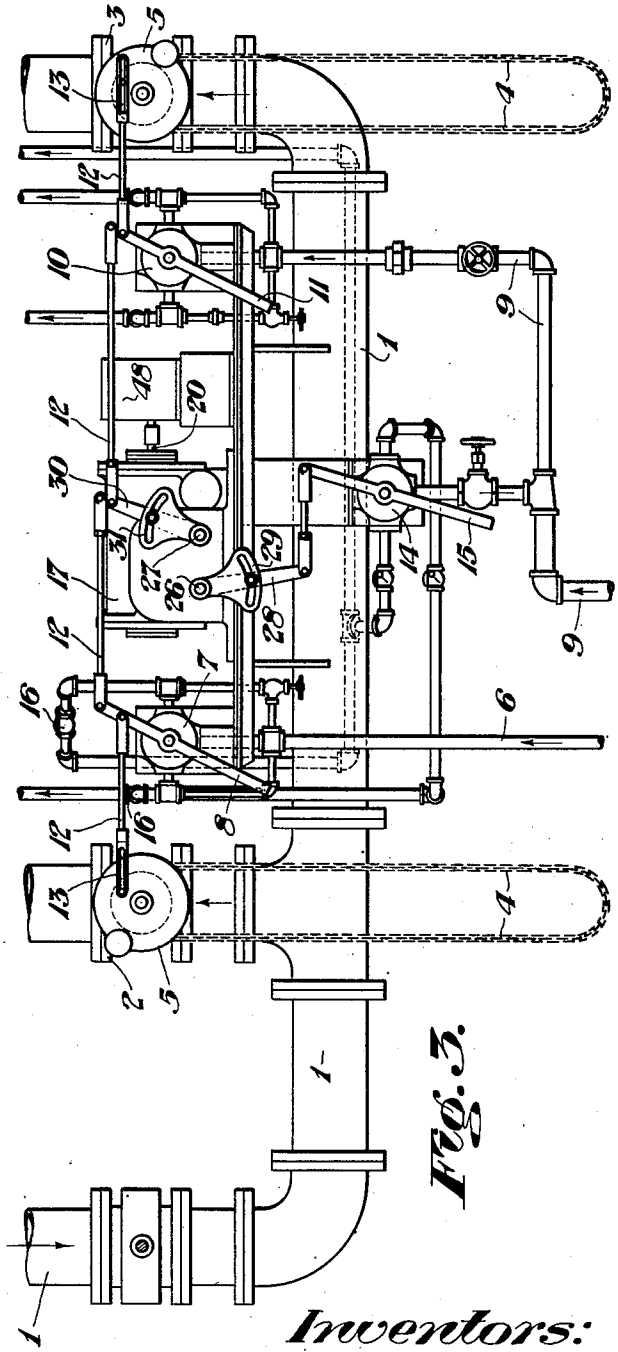


Fig. 3.

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FURNACE VALVE REVERSING SYSTEM

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Fig. 4.

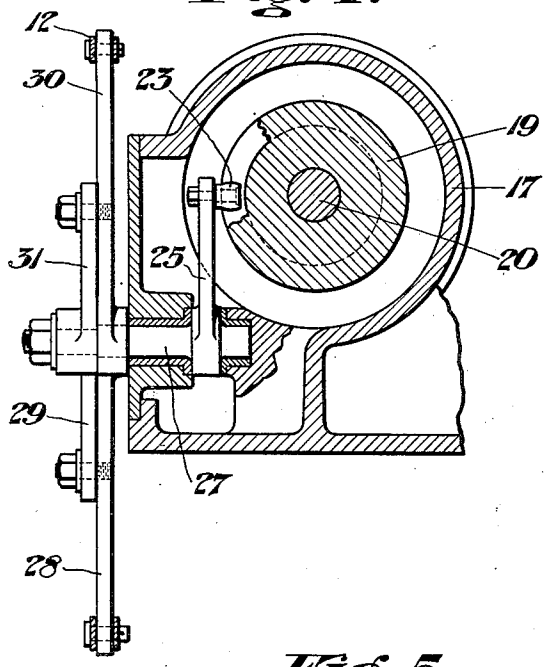


Fig. 6.

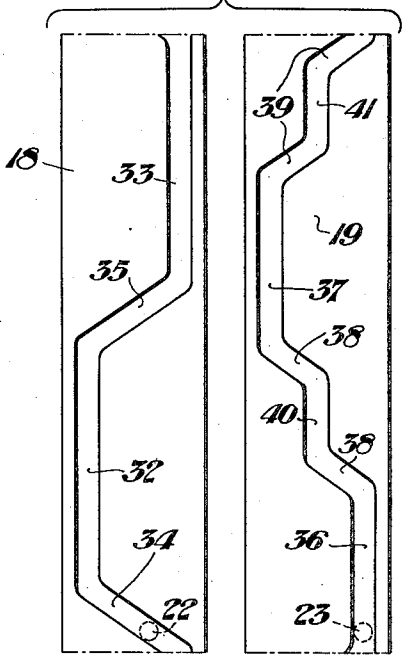
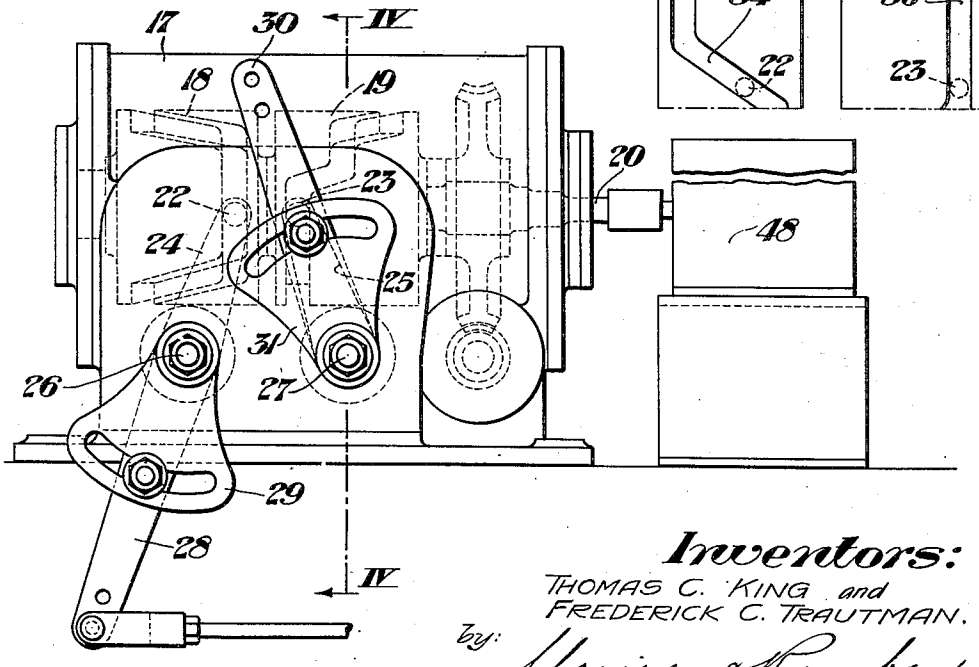


Fig. 5.



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FURNACE VALVE REVERSING SYSTEM

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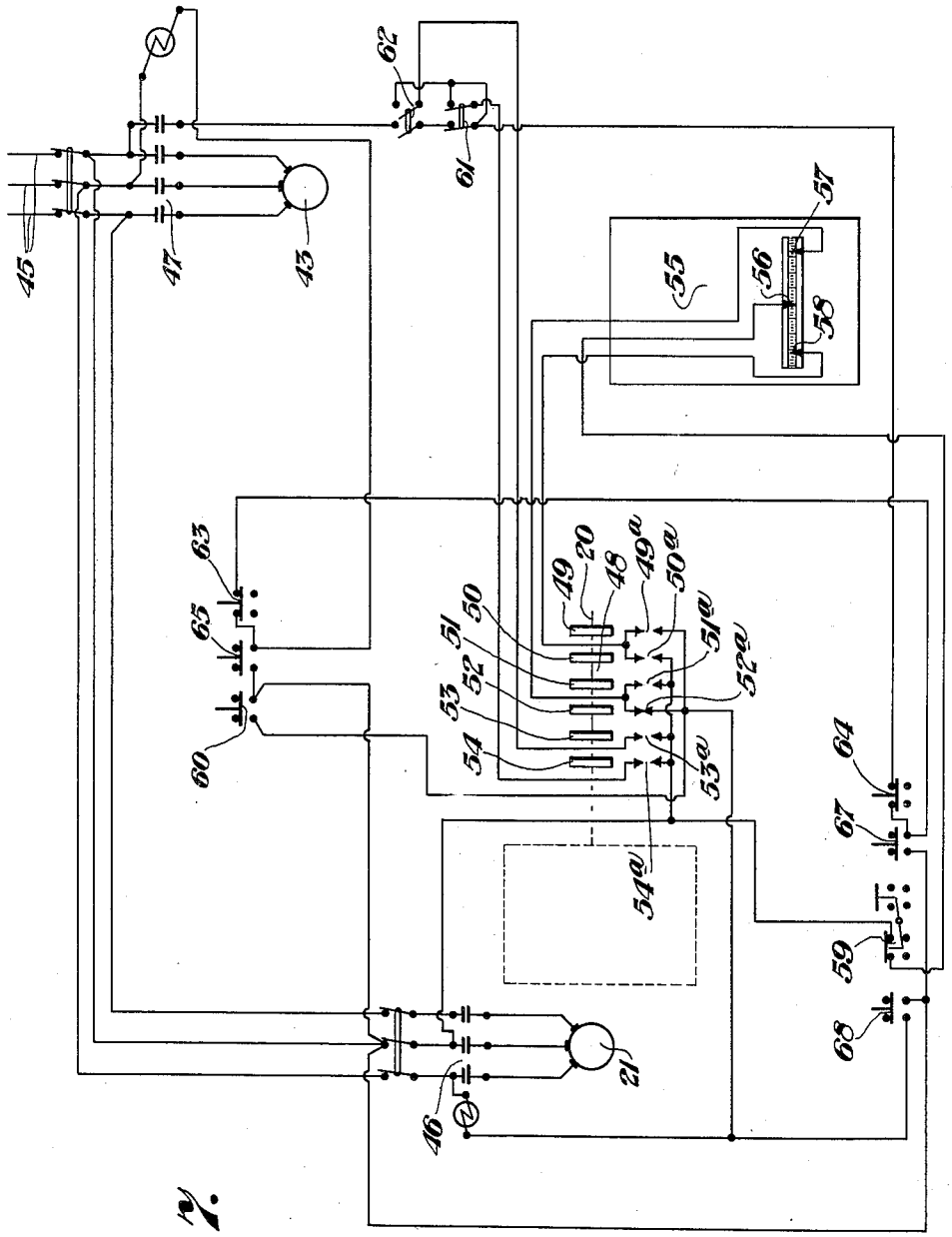


Fig. 2.

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Patented May 30, 1933

1,911,902

UNITED STATES PATENT OFFICE

THOMAS C. KING, OF MUNHALL, AND FREDERICK C. TRAUTMAN, OF HOMESTEAD, PENNSYLVANIA

FURNACE VALVE REVERSING SYSTEM

Application filed May 20, 1932. Serial No. 612,560.

This invention relates to automatic reversing valve systems for regenerative furnaces, one of the objects being the provision of an automatic system functioning in absolute synchronism with a furnace's operating requirements yet not necessarily using reversing motors or relay switches as neither have proven very dependable when subjected to the dirt and heat incidental to commercial furnace practice.

Another object is to construct the above system so simply that it may be properly maintained by furnace men who are more used to handling furnaces than laboratory designed apparatus.

The further recital of other objects will only lengthen the specification and are therefore omitted, especially as they may be inferred from the invention itself.

The accompanying drawings illustrate a specific form of the invention applied to an open hearth furnace burning both tar and gas, this being a good example because the operating conditions around an open hearth are particularly severe and the loss of a heat is the probable penalty when its reversing valves are not thrown at the right time. The various individual figures of these drawings are described below:

Figure 1 is a side elevation.

Figure 2 is a top plan of the valve operating mechanism in detail.

Figure 3 is a side elevation of Figure 2.

Figures 4 and 5 are detail views of a valve operating unit, the former being a cross-section from the line IV—IV of the latter, which is a side elevation.

Figure 6 is a development of the cam shown in Figure 5.

Figure 7 is a wiring diagram of the control circuit.

Referring to the details shown in the above figures, a gas supply line 1 is connected to valves 2 and 3 which respectively communicate with the open hearth's left and right-hand gas burners. These valves are the type manually operated by chains 4 which pass over wheels 5, the latter being counterweighted to urge them towards closing positions.

A tar supply line 6 is connected to a valve 7 operated by a lever 8. This is an ordinary four-way valve having its straight-through passage permanently closed, and communicates with the furnace's left-hand tar burner when its operating lever is turned clockwise and with its right-hand one when turned the other way. When the lever 8 is vertical the valve is closed. The standard commercial three-way valve has been found to give unequal fuel distribution and is consequently not desirable.

A steam supply line 9 is connected to a valve 10 operated by a lever 11 and practically duplicating the valve 7 in construction, operation and burner communication. The steam it supplies to the tar burners is necessary for the proper ejection and burning of that fuel.

All the above valves are interconnected by rods 12 for simultaneous operation, slip joints 13 being arranged at the gas valves so that one may be pulled open while the other remains closed, or both may be closed at once. These valves, thus interconnected, enable complete stoppage of the furnace's fuel supply or its selective reversal from one end of the furnace to the other.

The tar lines and burners are purged immediately upon being shut off by steam from the supply line 9, a valve 14 sending the steam through each line as needed. This valve purges the right-hand line when its operating lever 15 is turned clockwise and the other line when it is oppositely turned. Check valves 16 shut off the tar supply during this purging operation while the valve 7 is open, the steam being under considerably greater pressure than the tar and its action on these valves 16 therefore over-balancing that of the latter. The purging valve is best left slightly open after functioning so that the purged line will be kept warm by a slight steam flow.

A valve operating machine is mounted on a horizontal section of the gas line 1 at a convenient point for connection to the various valves. It comprises a casing 17 in which cams 18 and 19 are fixedly mounted on a rotatable shaft 20 driven by a motor 21 through

a speed reducing gear train. These cams are drums having surface grooves which rollers 22 and 23 on levers 24 and 25 engage to swing shafts 26 and 27.

The shaft 26 is connected to the valve 14 by a lever 28 that is freely mounted and held in position by being bolted through a slotted segment 29 which turns with the shaft. A second lever 30 connects the shaft 27 to the fuel and steam reversing valves, this lever being likewise free on its shaft and held by a bolt through a slotted segment 31 which turns with the shaft.

The groove in the cam 18 has two longitudinally and circumferentially spaced portions 32 and 33 which are interconnected by oppositely inclined portions 34 and 35. The groove in the cam 19 also includes two longitudinally and circumferentially spaced portions 36 and 37. These two straight portions are interconnected by inclined portions 38 and 39 which are interrupted at their middle by short straight portions 40 and 41. The cams are respectively arranged so that the ends of the inclined portions of the cam 19 are alined approximately with the beginning of the inclined portions of the cam 18.

When the furnace's left-hand burners are going the rollers 22 and 23 are at the points indicated in the development of the cams. To shift the furnace valves the motor 21 is energized so that it drives the cams through 180 degree turns. This forces the roller 22 towards the straight portion 32 of the groove in the cam 18 so that the purging valve is first completely closed and then thrown into wide open communication with the burners on heat. As the steam flows through the line it causes the check valves 16 to close the tar supply, and blows the line clean. The roller 23 holds the valve 10 and the valve 2 open during a portion of this time so that the purged tar may be completely burned. The roller 23 is then moved into the straight portion 40 so that all the burner valves are closed. This straight portion 40 is sufficiently long so that these valves are kept closed long enough to allow time for reversal of the furnace's checkerwork dampers. The roller 23 then moves into the beginning of the straight portion 37 of the cam 19, and the roller 22 moves almost to the middle of the inclined portion 35 of the groove in the cam 18. The burner valves are now all reversed and the purging valve is feeding a slight flow of warming steam to the other tar line.

The checkerwork dampers are reversed by the usual cable system 42. This system is operated by a motor 43 which drives a rotating arm 44 connected thereto. This arm rotates in only one direction and accomplishes a complete reversal of the checkerwork dampers for each 180 degrees turn, which is done while the burner valves are kept closed by their operating mechanism above described.

The control of the two motors 21 and 43 is effected automatically, both being supplied with current by an AC line 45. An electromagnetic switch 46 controls the current to the motor 21 and an electromagnetic switch 47 to the motor 43.

The shaft 20 of the valve-driving mechanism is directly connected to a timer, generally indicated by the number 48. The shaft of this timer carries six cams, 49 to 54 inclusive, which are arranged to have associated contacts which, in the drawings, have the same numbers as their operating cams with the addition of the letter *a*. The cams 49 and 52 are constructed so that either one or the other of their associated contacts is maintained closed at all times. The cams 50 and 51 are constructed to close one or the other of their associated contacts shortly after they begin to rotate. In each instance the cams 49 and 50 and 51 and 52 are constructed and respectively arranged so that after they have rotated through 180 degrees either the contact 50^a or 51^a is broken, it being understood that these two cams are arranged to function alternately. The cams 53 and 54 have very short cam surfaces which are respectively oppositely arranged and are designed to close their associated contacts only momentarily, occurring when the timer's shaft has been turned by the shaft 20 to a point where the latter is at its fuel valve closing position.

It is assumed that the furnace under consideration is equipped with a galvanometer 55 of the conventional type which indicates when the furnace's burning cycle must be reversed. This is altered by a central swinging contact 56 on its hand and a pair of end contacts 57 and 58 at each end of its dial. This swinging contact will touch one or the other of the fixed contacts 57 and 58, depending upon the condition of the furnace's checkerwork passages.

The swinging contact 56 is connected through a hand switch 59 to the right-hand wire of the AC line 45. This same wire is also connected to the contacts 50^a, 51^a, 53^a and 54^a of the timer. The operating coil of the electromagnetic switch 46 is arranged in series with the middle wire of the line 45 and the contacts 49^a and 52^a of the cam switch. This coil may be shunted around these contacts by a hand-operated switch 60. The left-hand fixed contact 58 of the galvanometer 55 is connected to the opposite sides of the contacts 49^a and 50^a, and the right-hand contact 57 is connected to the opposite sides of the contacts 51^a and 52^a.

When the contact 56 momentarily touches one or the other of its associated contacts the motor 21 is energized and begins to operate the various valves and to rotate the various cams mentioned. This circuit is established

because either the contacts 49ª or 52ª are always closed, the current going through the operating coil of the electromagnetic switch 46, the closed one of the contacts 49ª or 52ª, the closed contacts of the galvanometer, and from the swinging contact 56 of this galvanometer through the hand switch 59 to the right-hand wire of the line 45.

Now it will be observed that there is an association between the contacts 49ª and 52ª and the galvanometer contacts and that the contact 49ª must be closed when the movable contact 56 of this galvanometer touches the fixed contact 58, or no circuit will be established because of this association. This is likewise true in regard to the contact 52ª and the opposite contact of the galvanometer. This association maintains absolute synchronism between the valve operating mechanism and the galvanometer and insures that when the galvanometer indicates the right-hand burners should be burning they will in fact be burning.

As the cams turn, one or the other of the contacts 53ª or 54ª are closed momentarily. As stated, this is timed to occur when the roller 23 reaches the middle straight portion 40 of the groove in the cam 19, at which time the fuel valves will all be closed. These cams are also arranged in association to a pair of switches 61 and 62 which are respectively opened and closed so that they must be closed synchronously with these cams' contacts before they will energize the operating coil of the electromagnetic switch 47 which starts the motor 43 reversing the furnace's dampers.

The switches 61 and 62 mentioned are limit switches fixed to the cable which reverses the furnace's damper valves and are arranged so that one or the other is open when these dampers are in wide open and completely closed positions respectively. As shown in the wiring diagram, the limit switch 61 is closed so that a circuit may be established from the middle wire of the line 45 through the coil of the electromagnetic switch 47 and hand-operated switches 63 and 64, the limit switch 61 and the right-hand wire of the line 45 when the contacts 54ª are closed. Also, in this instance, absolute synchronism is maintained between the damper operating motor and the required conditions as indicated by the galvanometer. This is because the cams 53 and 54 are associated with the other cams and with the limit switches 61 and 62.

The cams 50 and 51 function to close their associated contacts as soon as they begin rotating so as to establish a circuit around the galvanometer contacts and relieve them from carrying anything other than the required starting current. For instance, assuming the contact 49ª is the closed one, it will be seen that when the contact 50ª closes, a circuit will be established through the operating coil of the switch 46 through the contacts 49ª and 50ª and to the right-hand wire of the line 45.

This is likewise true for the damper motor, the open limit switch closing the moment the motor 43 starts so that a circuit is established between the two to maintain the operating coil of the electromagnetic switch 47 energized. This is the reason that it is only necessary to momentarily close the contacts 53ª and 54ª. Of course, when the dampers are completely reversed the opposite one of the limit switches will be opened so that the coil of the switch 47 is deenergized and the motor 43 stopped.

Several hand switches have already been mentioned. In addition to these the hand switch 65 is shunted around the limit switches 61 and 62 so that the motor 43 may be operated independently of the latter. A second hand switch 67 likewise accomplishes this. A hand switch 68 is arranged to shunt the current by the cam operated switches directly to the operating coil of the switch 46 so that the motor 21 may be operated independently, the switch 60 likewise accomplishing this function. Now it will be noticed that these hand switches are supplied in pairs for each of their functions. This is so that one set may be arranged above the floor level and the other down in the cellar close to the damper valve operating mechanism. This is necessary so that workmen may manually operate the various valves when repairs are necessary. After the hand operation the entire system will automatically resynchronize itself with the conditions indicated by the galvanometer 55.

Although a specific form of this invention has been shown and described in accordance with the patent statutes, it is not intended to limit the scope of the invention exactly thereto, except as defined by the following claims.

We claim:

1. A regenerative furnace valve control system including means for reversing said furnace's fuel valves with an intermediate off period and means for automatically reversing said furnace's checkerwork dampers during said off period.

2. A regenerative furnace valve control system including means for indicating when said furnace's heating cycle should be reversed to maintain its checkerwork at their proper relative temperatures, means controlled by said first named means for reversing said furnace's valves and means for maintaining synchronism between said first and second named means.

3. A regenerative furnace valve control system including valve operating means, a rotative cam constructed and arranged to reciprocate said means when given a unidirec-

tional rotation and means for rotating said cam.

4. A regenerative furnace valve control system including valve operating means, a rotative cam constructed and arranged to drive said means with an interrupted reciprocatory motion when unidirectionally rotated and means for rotating said cam.

5. A regenerative furnace valve control system including a plurality of valve operating means, a plurality of cams respectively operatively associated with said means, said cams being constructed to drive one of said means with a reciprocatory motion that pauses at each extreme and another of said means with a reciprocatory motion that pauses at each extreme and at the middle, and means for rotating said cams.

6. A regenerative furnace valve control system including a plurality of valve operating means, a plurality of cams respectively operatively associated with said means, said cams being constructed so that when unidirectionally rotated one drives one of said means with a reciprocatory motion that pauses at each extreme and another drives another of said means with a reciprocatory motion that pauses at each extreme and at the middle, and means for rotating said cams.

In testimony whereof, we have hereunto set our hands.

THOMAS C. KING.
FREDERICK C. TRAUTMAN.