

Sept. 6, 1932.

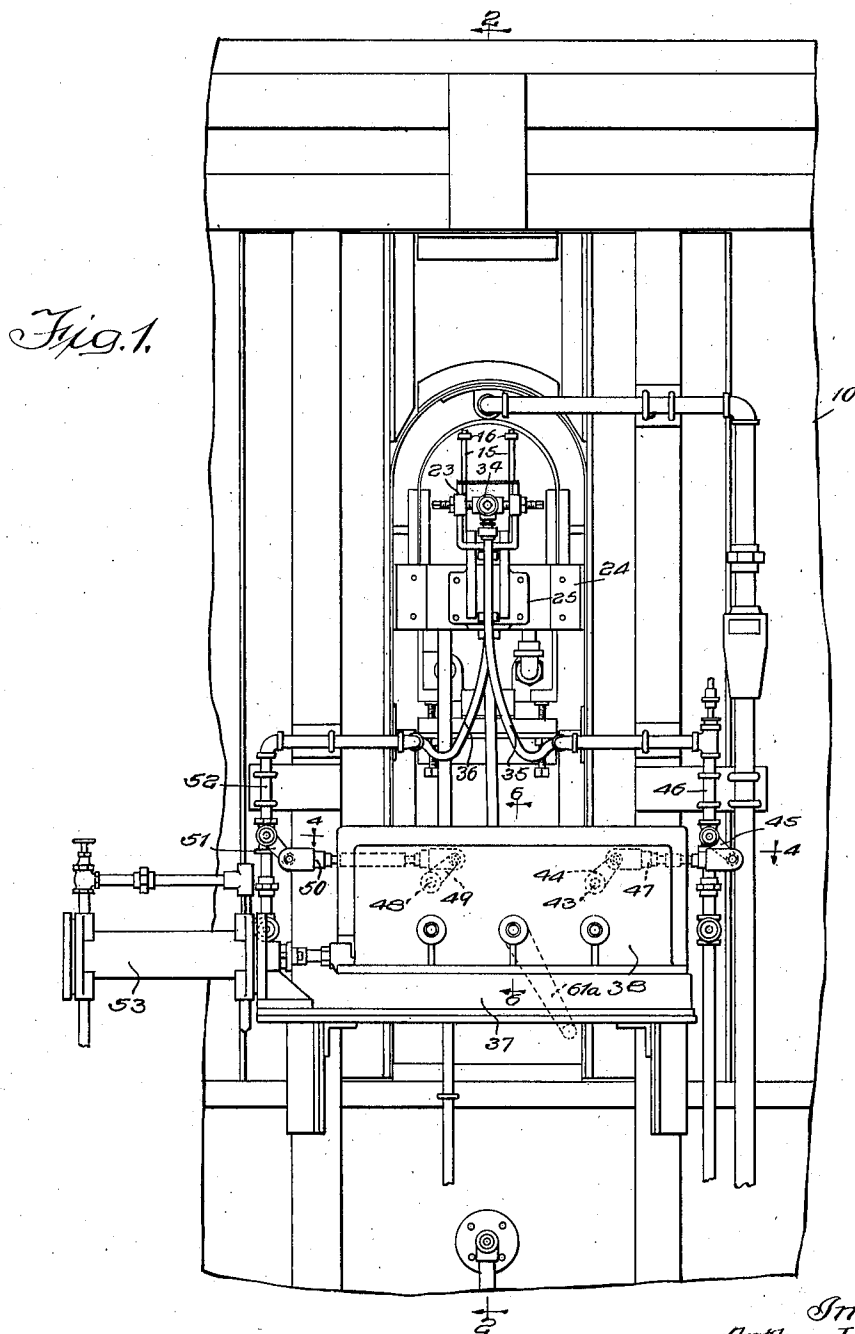
A. L. STEVENS

1,876,509

CONTROL FOR METALLURGICAL FURNACES

Filed March 18, 1929

5 Sheets-Sheet 1



Witness:

William V. Kilroy

Inventor
Arthur L. Stevens

Charles S. Gibson

जात्या

Sept. 6, 1932.

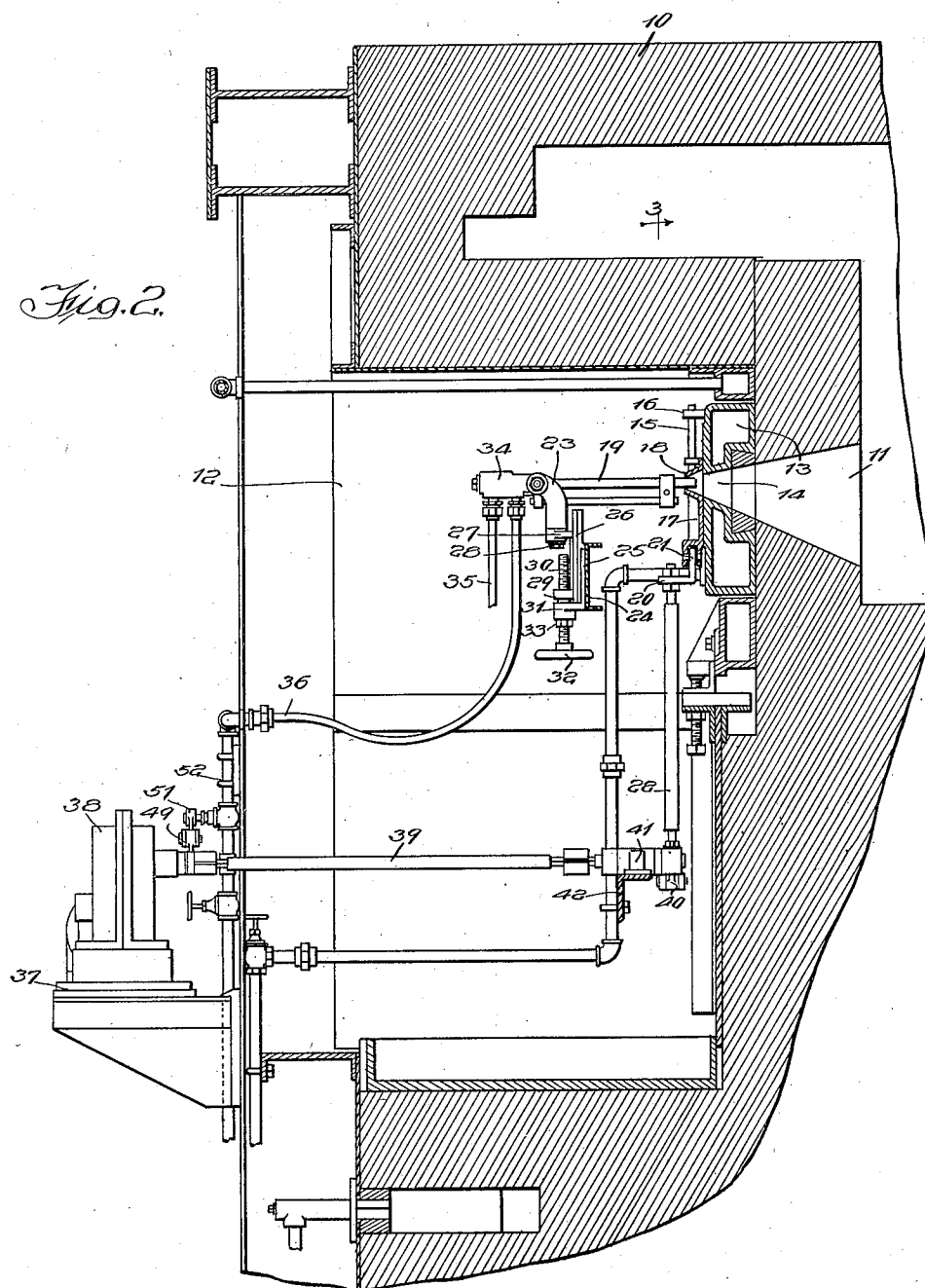
A. L. STEVENS

1,876,509

CONTROL FOR METALLURGICAL FURNACES

Filed March 18, 1929

5 Sheets-Sheet 2



Witness:

William G. Kiproy

3-3

Inventor:
Arthur L. Stevens

Charles S. Nielson

By

att'y

Sept. 6, 1932.

A. L. STEVENS

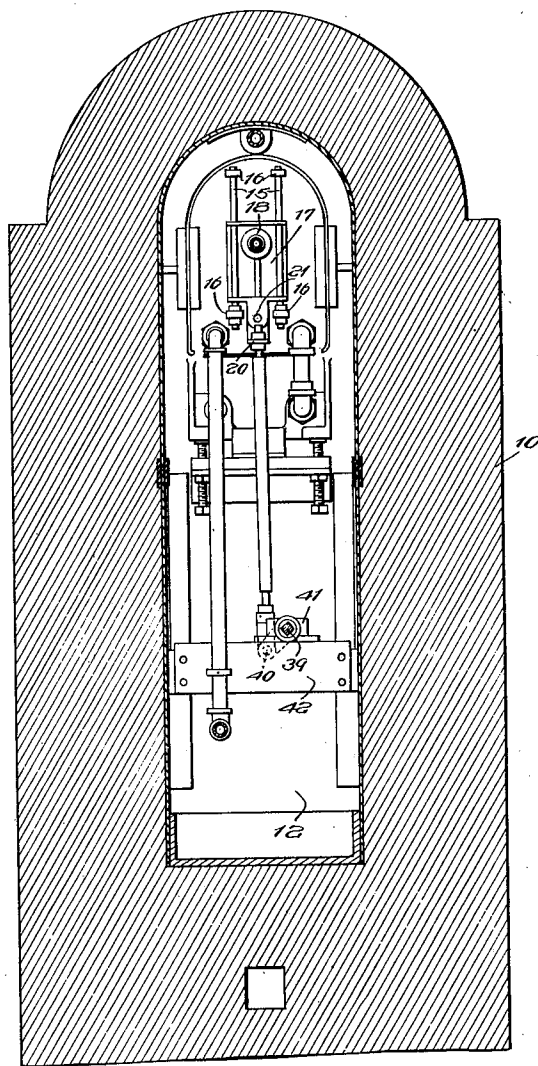
1,876,509

CONTROL FOR METALLURGICAL FURNACES

Filed March 18, 1929

5 Sheets-Sheet 3

Fig. 3.



Witness:

William V. Hilroy

Inventor:

Arthur L. Stevens

Charles S. Hilson

134

att'y

Sept. 6, 1932.

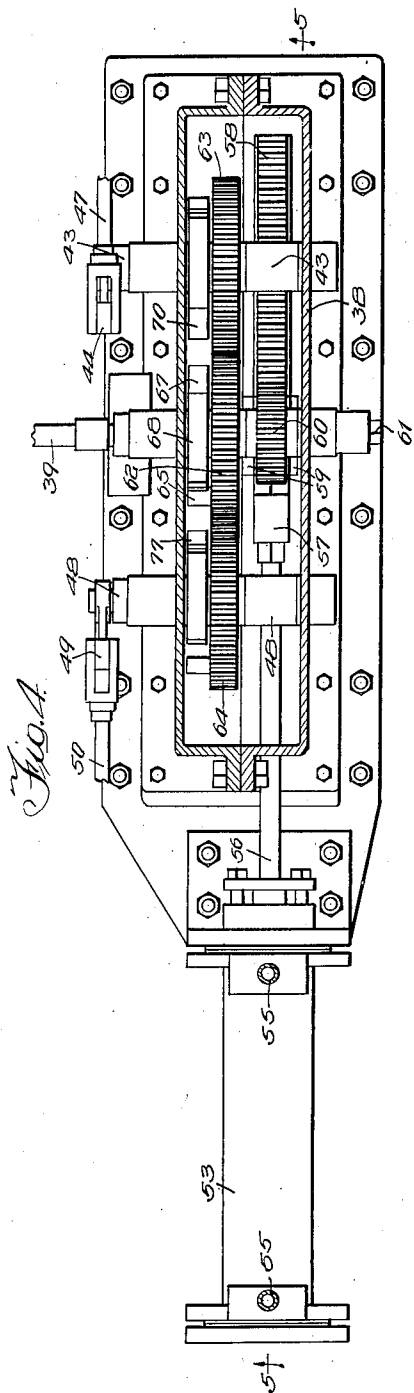
A. L. STEVENS

1,876,509

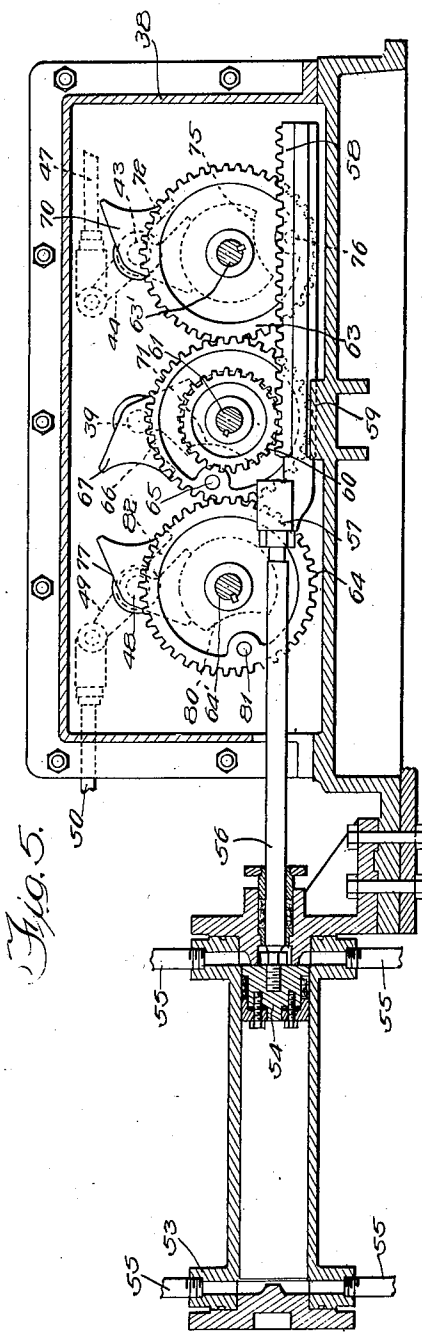
CONTROL FOR METALLURGICAL FURNACES

Filed March 18, 1929

5 Sheets-Sheet 4



Witness
William F. Kilroy



Inventor:
Arthur L. Stevens

Charles S. Wilson

134

JH191

Sept. 6, 1932.

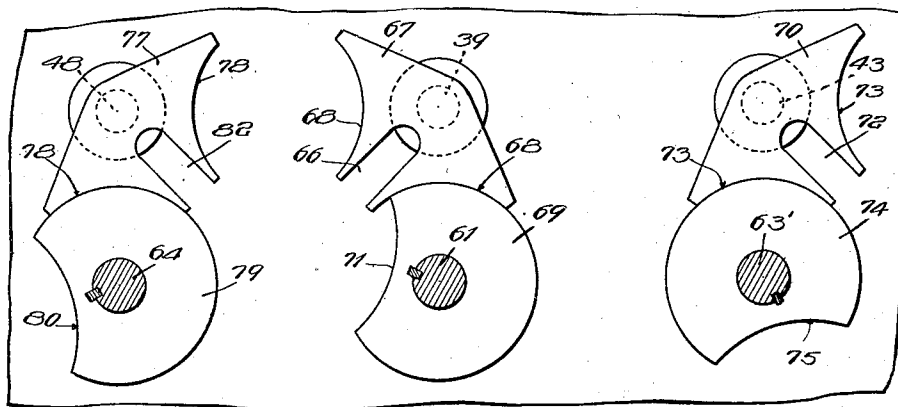
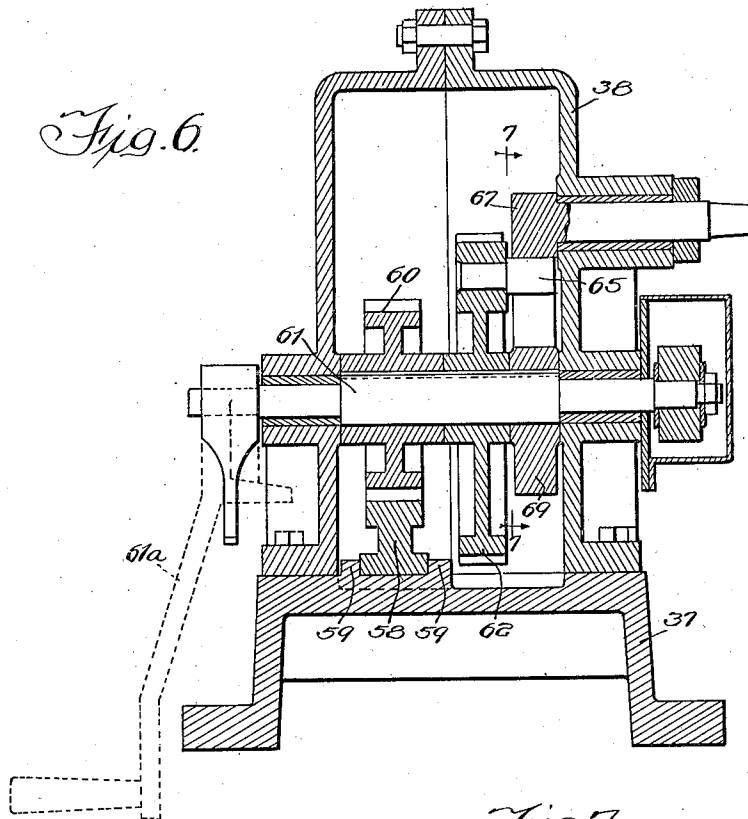
A. L. STEVENS

1,876,509

CONTROL FOR METALLURGICAL FURNACES

Filed March 18, 1929

5 Sheets-Sheet 5



Witness:

William P. Kilroy

Inventor:
Arthur L. Stevens

Charles S. Wilson
124 *Att'y*

UNITED STATES PATENT OFFICE

ARTHUR L. STEVENS, OF EVANSTON, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO
ARTHUR L. STEVENS CORPORATION, OF CHICAGO, ILLINOIS, A CORPORATION OF
DELAWARE

CONTROL FOR METALLURGICAL FURNACES

Application filed March 18, 1929. Serial No. 347,863.

This invention relates to controls for metallurgical furnaces and, while it is of general application and use, it is especially designed for use in conjunction with regenerative furnaces, having for its object the unitary control of the burners and burner openings, particularly, the timing and sequences of the operations thereof.

Among its other objects the present invention contemplates the automatic control of the timing and of the sequence of operation of the burner elements and sources of fuel, air and steam supply, from a remote point of control such, for instance, as the reversing or control table or platform.

With the above and other objects in view, as will be apparent, this invention consists of construction, combination and arrangement of parts, all as hereinafter more fully described, claimed and illustrated in the accompanying drawings, wherein:

Fig. 1 is a fragmentary elevation of a furnace adjoining a burner opening, illustrating the present invention in conjunction therewith;

Fig. 2 is a vertical section taken along line 2—2 of Fig. 1 illustrating the position of the timer mechanism, the burner and cooperating elements in side elevation, and the closure for the burner opening in section;

Fig. 3 is a vertical section taken along line 3—3 of Fig. 2 illustrating, in part, the movable mounting for the burner;

Fig. 4 is a horizontal longitudinal section taken along line 4—4 of Fig. 1 through the timing mechanism;

Fig. 5 is a vertical section through the timer taken along line 5—5 of Fig. 4, and

Fig. 6 is a transverse vertical section through the timer taken along line 6—6 of Fig. 1; and

Fig. 7 is a fragmentary vertical longitudinal section taken along line 7—7 of Fig. 6 to illustrate the timing escapement mechanism.

In the operation of regenerative, open hearth furnaces, the burners are generally located at the ends of the furnace to direct flames thereof longitudinally therethrough. One burner is operated at a time, the hot gases and products of combustion escaping

at the end of the furnace opposite to the operating burner, to pass through the checkers at that end for heat recovery.

After a period of such operation, the operating burner ceases to function, the reversing valves are manipulated to reverse the draught and the opposed burner commences operation with hot gases and products of combustion passing through checkers at the end of the furnace opposed to the operating burner.

The present invention is designed to automatically control these burners and the supply of fuel and steam thereto from the reversing table or platform in such manner that the necessary operations will take place in their proper sequence and in proper relation to the operation of the reversing valves. That is to say, with reference to the functioning burner, the fuel supply to the burner is initially cut off, then the steam supply, and finally the burner is moved from its opening in the furnace end wall and the opening is closed. After these operations have taken place in the sequence indicated at one end of the furnace, the reversing valves are changed and the burner opening at the opposite end of the furnace is opened, the burner positioned therein, steam supplied to the burner and finally the fuel is allowed to enter and pass through the burner.

These operations are all controlled automatically from the reversing table or platform so that once the train of operations has been initiated, the various individual operations follow in their proper sequence until the reversing operation is completed and the operation of the burner at the opposite end of the furnace is completely established.

The present invention will be described in connection with oil as the fuel used in conjunction with steam, the latter of which is for atomizing purposes. It is to be understood that other fuels and means of atomization may be employed in connection with the present mechanism with equal efficiency and without departing from the spirit and scope hereof.

Reference being had more particularly to the drawings, 10 designates the end wall of an open hearth furnace having the burner

opening 11 extending therethrough. The exterior of the wall surrounding the burner opening is provided with a recess 12 in which may be housed the mechanism forming the subject matter of the present invention, it being understood, however, that the provision of such recess is unnecessary to the proper mounting and operation of the present structure.

Surrounding the burner opening 11 is a water cooled frame 13, which is fixed in place and through which the burner operates to direct a flame into the interior of the furnace. Upon each side of the burner opening 14, in the frame 13 and of the frame 13, and on the exterior of the frame is mounted a vertical guide 15 which is fixed in the brackets 16, secured to the outer wall of the frame 13. A plate 17 is mounted for movement on the guides 15 and has a central boss 18 at its upper end into which the burner 19 extends and through which the burner 19 communicates with the burner openings 11 and 14 of the wall 10 and the frame 13 respectively. When the boss 18 is in registration or alignment with the burner opening 14 of the frame 13, the boss 18 being positioned at the upper terminal of plate 17, the body of the plate 17 is located below the horizontal planes of the openings 11-14.

A burner 19 is mounted in front of plate 17 in general alignment with the boss 18 thereof and the discharge end of the burner 19 is received in and projects through or into the boss 18. Thus, when the boss 18 is in registration with the openings 11 and 14, the burner 19 will direct a flame through said openings into the furnace. In order to provide for the adjustment of the plate 17 to bring the boss 18 thereof into and out of registration with the openings 11 and 14, the lower end of the plate is provided with a lateral arm 20 pivotally connected, as at 21, to the plate 17, said arm at its outer end being attached to the upper end of an operating rod 22. As will be hereinafter more fully described, the lower end of the operating rod 22 is connected to a driving or controlling mechanism, which, at intervals, moves the rod upwardly or downwardly. When the rod 22 moves upwardly, the plate 17 under the impetus thereof likewise moves upwardly, positioning the boss 18 above the burner openings 11-14, thereby bringing the solid lower body portion of the plate 17 over the opening 14. Thus the opening 14 is closed. The abutting faces of the plate 17 and the frame 13 may be closely fitted, whereby a relatively air-tight joint is created between the plate 17 and the frame 13 to substantially seal the burner openings 14 and 11 when the plate 17 is elevated, thus preventing, or reducing to a minimum, the infiltration of air through said openings. The downward movement of the rod 22 moves the body portion of plate 17

away from the burner opening 14 and brings the boss 18 into alignment therewith, thereby positioning the burner 19 for operation.

The outer end of the burner is pivotally mounted on an adjustable yoke 23, so that the movement of the plate 17 causes the burner 19 to swing about the yoke 23 as a pivot, while the forward or discharge end of the burner has a sliding engagement with the boss 18 of the plate 17, said sliding engagement being insufficient to dis-engage the burner 19 from the boss 18 during the normal operation of the mechanism hereinbefore described.

In order to provide for adjustment of the yoke and the cooperative mechanism, as well as the mounting thereof, a bar or plate 24 is mounted transversely of the recess 12 in front of the frame 13, and on its forward face is provided with the guides 25. A supporting frame 26 is mounted slideably in the guides 25 and has an outstanding connection 27 at its upper end to which the yoke 23 is attached. By means of a locknut 28 the lateral position of the yoke with reference to the connection 27 may be adjusted, i. e. the yoke may be adjusted about a vertical pivot and by the locknut 28 fixed in such adjusted position. The lower end of the frame 26 is provided with an apertured lug 29, the aperture of which is interiorly threaded for engagement with the threads of the threaded shaft 30. This shaft 30 is mounted in the threaded bearing 31 positioned at the lower edge of the plate or bar 24 in registration with the lug 29. The lower end of the shaft 30 is provided with a manipulating wheel or handle 32, and a locknut 33 is mounted on the shaft below the bearing 31 to fix said shaft in its adjusted positions. By the rotation of the shaft 30 through the medium of the handle 32, the frame 26 and yoke 23, carried thereby, may be raised and lowered, thereby adjusting the position of the outer end of the burner 19.

From the foregoing, it is manifest that the yoke 23 carrying the burner 19 is capable of two adjustments by which the burner may be adjusted relatively to the plate 17 and the frame 13 and also be locked in such adjusted positions. That is to say, the yoke 23, carrying the burner 19, may be adjusted about a vertical pivot on the connection 27 and locked in any one of its adjusting positions by nut 28 or it may be adjusted vertically about a horizontal pivot by rotating the shaft 30, which has a threaded connection with the lug 29 carried by the frame 26, and be locked in such adjusted vertical position by the nut 33. These adjustments insure the proper positioning of the burner 19 in the boss 18 and with respect to the burner openings 11 and 14.

As has been before noted, the present apparatus is described as being used in connection with oil as a fuel and steam as an atomizing agent. Flexible connections deliver these fluids to the burner mixing head 34, the flex-

ible hose or pipe 35 delivering steam to the mixing head 34 and the flexible hose or pipe 36 delivering the fuel oil. It is to be understood that insofar as the present invention is concerned, the hose or pipe 35 could deliver any other suitable atomizing agent to mixing head 34, while the hose or pipe 36 could equally as well deliver any other suitable fuel, such as gas, to the mixing head 34.

In the operation of the present invention with respect to burner mechanisms described up to this point, a certain sequence of operation is maintained, and it is among the objects of the present invention to control and automatically regulate such sequence of operation.

In setting the burner in operation, the initial step of the sequence of operation is to lower the plate 17 to bring the boss 18 and burner 19 into registration with the burner openings 11 and 14 in the furnace wall 10. The valve controlling the flow through the hose or pipe 35 is then opened, admitting steam into the mixing head 34 and burner 19, and finally, the valve controlling the fuel hose or pipe 36 is opened to permit the fuel to enter the mixing head 34 and the burner 19. The reverse of this action, that is, when it is desired to take the burner out of service, is to initially close the valve controlling the fuel hose or pipe 36, then the valve controlling the steam hose or pipe 35, and finally to elevate the plate 17, removing the burner 19 and boss 18 from alignment with the burner apertures 11 and 14 and sealing or closing such openings. As there are two burners, one at each end of the furnace, and one of which is out of service while the other is operating, it is also necessary to maintain a relative sequence of operation between these two burners. In other words; one burner is taken out of service, as above described, and when it is completely out of service, the burner at the opposite end of the furnace is put into service or operation, as above described, and vice versa. The foregoing operation and sequences of operation with respect to each individual burner and the relative sequences of operation between the burners of a single furnace are maintained and controlled automatically by the mechanism to be described:

Mounted on a platform 37, adjoining the recess 12 at the end wall of the furnace, is a casing 38 in which is mounted and housed the mechanism that acts as a control for the various elements at that end of the furnace. A shaft 39 projects from the center of the casing 38 and extends to a point adjoining the lower end of the rod 22, to which it is connected by a crank 40, the inner end of this shaft 39 being mounted in a bearing 41 supported by a transverse plate 42 located in the recess 12. As the shaft 39 is oscillated, the crank 40 operates through an arc which causes the rod 22 to move upwardly

and downwardly and impart a reciprocatory movement to plate 17, as hereinbefore described. At one end of the casing 38 and to one side of the shaft 39 is a control shaft 43, which at its outer projecting end has a crank 44 that connects with the handle 45 of a valve in the pipe 46, which delivers steam to the flexible hose or pipe 35. This connection between the crank 44 and handle 45 is a pitman 47. As the shaft 43 is oscillated, crank 44 operates through an arc to reciprocate the pitman and open and close the valve under the control of the handle 45 to control the supply of steam to the hose or pipe 35. Upon the opposite side of the shaft 39 to the shaft 43 is a second control shaft 48, which is provided at its outer end with crank 49 connected by pitman 50 to the handle 51 of a valve controlling the supply pipe 52 which delivers fuel to the hose or pipe 36. As the shaft 48 is oscillated, the crank 49 on the exterior of the casing 38 will swing through an arc to reciprocate the pitman 50 and the valve handle 51 will control the flow of fuel through the pipes 52 to the hose or pipe 36.

The mechanism housed in the casing 38 is designed to automatically regulate the oscillation of the shafts 39, 43 and 48 to accomplish the sequence of operation hereinbefore described. That is to say, assuming that the elements are as illustrated in Fig. 2, and it is desired to discontinue the operation of the burner, the shaft 48 must first oscillate to close the valve controlled by the handle 51 to stop the delivery of fuel through the hose or pipe 36 to the mixing head 34; after which the shaft 43 must oscillate to close the valve under the control of the handle 45 to eliminate the delivery of steam through the hose or pipe 35 to the mixing head 34; and finally the shaft 39 must oscillate to elevate the crank 40 and rod 22 and by them to elevate the plate 17 whereby the boss 18 is moved out of alignment with the burner openings 11 and 14 and the body of the plate is brought across the opening 14 to close and seal the same. In its reverse operation, the shaft 39 must first oscillate in the reverse direction to lower the crank 40 and rod 22, thereby lowering the plate 17 to bring the boss 18 in alignment with the opening 14 and thus position the burner to direct a flame through the openings 11 and 14; then the shaft 43 must oscillate in the reverse direction to open the valve under the control of the handle 45 to permit steam to pass into and through the hose or pipe 35; and, finally, the shaft 48 must oscillate in a reverse direction to open the valve under the control of the handle 51 to permit the delivery of fuel from the pipe 52 into the hose or pipe 36.

This relative oscillation of the shafts 39, 43 and 48 is controlled from a motor 53. This motor 53 may be of any suitable type, but in

Fig. 5, is illustrated as being a hydraulic or fluid operated motor which consists of a cylinder in which a piston 54 is designed to operate. At each end of the cylinder of motor 53 are the standard supply and exhaust pipes 55, by means of which the operating fluid is admitted to and escapes from the cylinder. The piston 54 of the motor is connected to a horizontally reciprocable shaft 56, which is reciprocated with the piston 54. Thus, if the piston 54 moves toward one end of the cylinder of the motor the shaft 56 will move in a similar direction, and if the piston 54 moves in the opposite direction, the shaft 56 will move also in that direction. The admission of fluid to the cylinder of the motor 53 is automatically controlled from the reversing platform or table, and the oscillation of the shafts 39, 43 and 48 is accomplished, in the proper sequence, by and from the movement of the shaft 56 under the control of the piston 54.

The shaft 56 extends into the casing 38 through one end wall thereof, and its inner end is connected as at 57 to a rack 58, which operates between the guides 59 in the bottom of the casing 38. As the shaft 56 reciprocates, it is obvious that the rack 58 will be similarly reciprocated, and in so doing, rotates a gear 60 in either direction dependent upon the direction of reciprocation of the rack 58. This gear is keyed to shaft 61 which projects laterally through the casing 38, and at one end this shaft may be provided with a crank 61a for the manual operation thereof, if this is desired. Thus, through the medium of the gear 60, the reciprocation of rack 58 causes the shaft 61 to oscillate in a direction dependent upon the direction of reciprocation of said rack.

Keyed to the shaft 61 and adjoining the rear side of the casing 38 is a gear 62 which is the driving gear for the timer mechanism. Upon one side of the gear 62 is a shaft 63', parallel to the shaft 61, and upon which is mounted a gear 63 for the control of the shaft 43; while on the opposite side of gear 62 is a shaft 64' parallel to the shaft 61, and upon which is mounted a gear 64 for the control of the shaft 48. Therefore, as the gear 62 is oscillated, the gears 63 and 64 in mesh therewith will be also oscillated. The center gear 62 carries an outstanding pin 65, which is designed to engage with the slot 66 in the driven element 67 of a Geneva escapement. This driven element 67 is keyed to the shaft 39, and upon each side of the slot 66 is provided with an arcuate locking surface 68. Below the shaft 39 and for cooperation with the driven element 67 is a disc 69 keyed to the shaft 61, upon which the gear 62 is mounted and keyed. As the gear 62 is oscillated, the disc 69 is simultaneously and similarly oscillated. At one point in its periphery, the disc 69 is cut away as at 71 for the accommo-

dation of the projection carrying the slot 66 of the driven element 67 thereby permitting the latter to swing when the slot 66 engages the pin 65 of the gear 62. When the elements are in the positions shown in Fig. 7, the arcuate locking portion 68 of the driven element 67 contacts with the periphery of the disc 69, locking the driven element 67, to which it is fixed, and shaft 39, from movement. As the disc 69 rotates with the gear 62, the periphery of the disc gradually leaves the arcuate locking disc 68, with which it contacts, until the driven element 67 is free for movement, at which time the outstanding pin 65 on the gear 62 enters the slot 66 of the driven element 67 and oscillates such driven element in the direction of rotation of the gear 62, thereby bringing the opposite arcuate locking surface 68 into contact with the periphery of the disc 69 on the opposite side of the cutaway portion 71 thereof, to that originally contacting with the driven element 67; in this manner, the shaft 39 by the rotation of gear 62 is oscillated from one position to another, as the reverse movement of the rack 58 causes a reverse oscillation of said shaft and the elements coacting therewith. When the arcuate surfaces 68 of the driven member contact with the periphery of the disc 69, it is obvious that the shaft 39 and the driven element 67 are locked from movement and it is only when the cutaway portion 71 of the disc 69 is positioned below the slot 66 of the driven element 67, that the driven element is free for oscillation under the control of the pin 65 of the gear 62.

For the operation of the shaft 43, the latter has a driven element 70 of a Geneva escapement fixed thereto, which is provided with a slot 72 flanked by the arcuate surfaces 73. Keyed to the shaft 63' is a locking disc 74, having a cut-away portion 75. The gear 63 carries an outstanding pin 76, which is positioned above the cut-away portions 75 of the locking disc 74. The rack 58 in imparting an oscillatory movement to the gears 60 and 62, imparts a similar movement to the gear 63 by virtue of the latter meshing with the gear 62. This oscillatory movement of the gear 63 causes the disc 74 to position the cut-away portion 75 thereof below the slot 72 in the driven member 70 of the Geneva escapement, which releases the arcuate surfaces 73 thereof from contact thereof with the disc 74 and permits the pin 76 of the gear 63 to engage the slot 72 and move the driven member 70. This movement of the driven member 70 causes the shaft 43 to oscillate, and by its movement, through the crank 44 and pitman 47, control the steam valve operated by the handle 45 as hereinbefore described. The operation of the gear 63, disc 74 and driven member 70, is similar in all respects to the operation of the gear 62, the disc 69 and driven member 67, except that its timing

in the sequence of operations is such that the operation thereof will take place either prior or subsequently to the operation of the shaft 39.

At the opposite end of the casing 38 to the shaft 63' is located the shaft 64', upon which is mounted the gear 64 meshing with the gear 62. Above the shaft 63' is located the shaft 48 for the control of the oil supply valve operated by the handle 51. This shaft 48 is provided with a driven member of a Geneva escapement 77, which has the arcuate surfaces 78 to coact with the surface or periphery of the disc 79 keyed to the shaft 64'. This disc 79 is cut away as at 80 in a manner similar to the discs 69 and 74 and the gear 64 is provided with an outstanding pin 81 for engagement with a slot 82 in the driven member 77 of the Geneva escapement. As the gear 62 oscillates, in the manner heretofore described, the gear 64 will also be oscillated, moving the disc 79 to release one or the other of the arcuate surfaces 78 of the driven member 77 of the Geneva escapement in contact therewith, to permit the outstanding pin 81 of the gear to engage the slot 82 and shift said driven member in a manner similar to the shifting of the driven members 67 and 70. This shifting of the driven member 77 causes the shaft 78 to oscillate to control the pitman 50 whereby the valve under the control of the handle 51 is closed and opened.

From the foregoing it is apparent that each of the valves under control of the handles 46 and 51 is provided with a mechanism driven from the gear 62, which closes and opens the valves by virtue of the oscillation of the driven members 70 and 77 respectively. Also that the shaft 39, which controls the position of the plate 17, as heretofore described, is oscillated to control the position of the plate 17 by means of the oscillation imparted to the driven member 67 fixed to said shaft.

Assuming that the parts are positioned as illustrated in Figs. 5 and 7, the movement of the rack 58 toward the left in Fig. 7 will cause the gear 62 to operate in a clockwise direction, while the gears 63 and 64 meshing therewith will move in a counter-clockwise direction. Reversely, should the rack 58 be in the position at the left end of its path of movement, i. e. at the left of Fig. 5, and would then be moved toward the right in Fig. 5, the gear 62 would then move in a counter-clockwise direction, while the gears 63 and 64 would move in a clockwise direction. When the gear 62 moves in a clockwise direction, it will be for the purpose of placing a burner 19 in operation, which has been previously inactive. Therefore, it will first be necessary, as heretofore described, to move the plate 17 downwardly to uncover the burner openings 11 and 14 and position the burner 19 in alignment with said openings, then open the valve under control of the handle 45

to admit steam to the mixing head 34 of the burner 19; and finally open the valve under the control of the handle 51 to admit oil to the mixing head of the burner. Thus the movement of the gear 62 in a clock-wise direction accomplishes first: the oscillation of the shaft 39 to properly position the plate 17; second: the oscillation of the shaft 48 to open the valve under control of the handle 45; and third: the oscillation of the shaft 48 to open the valve under the control of the handle 51. Reversely, if the gear 62 moves in a counter-clockwise direction, it is for the purpose of removing the burner 19 from action which has been previously in operation. Hence, this counter-clockwise movement accomplishes, first: the oscillation of the shaft 48 to close the valve under control of the handle 51; second: the oscillation of the shaft 43 to close the valve under control of the handle 45; and third: the oscillation of the shaft 39 to lift the plate 17 and remove the burner 19 from alignment with the burner openings 11 and 14 and close and seal said openings.

With the elements in the positions shown in Fig. 5, the movement of the rack 58 toward the left in that view, first causes the pin 65 of the gear 62 to contact with the slot 66 of the driven member 67, which oscillates the shaft 39 to bring the plate 17 to the position illustrated in Fig. 2. This initial movement of the rack 58 brings the pins 76 and 81 and the shafts 63' and 64' respectively, each one step nearer the slots 72 and 82 in their respective driven members 70 and 77. The continued movement of the rack 58 toward the left then causes the pin 76 of the gear 63 to engage the slot 72 of the driven member 70, oscillating the shaft 43, to open the valve under control of the handle 45. After this has taken place, the pin 65 of the gear 62 is two operative steps away from the driven member 67, while the pin 81 of the gear 64 is in position to next engage its driven member 77. Therefore, as the rack 58 completes its movement to the left, the pin 81 of the gear 64 engages the slot 82 of the driven member 77 and oscillates the shaft 48 to open the valve under control of the handle 51. Thus, when the rack 58 reaches the limit of its movement toward the left in Fig. 5, the pin of the gear 62 is three operative steps from engagement with the slot 66 of its driven member 67, the pin 76 of the gear 63 is two operative steps from engagement with the slot 72 of its driven member 70, and the pin 81 of the gear 64 is one operative step from engagement with the slot 82 of its driven member 77. When the elements described are in these positions, the burner is operating.

When, under the influence of the motor 53, the rack 58 starts from its position on the extreme left of its path of movement to return to its position illustrated in Fig. 5, the pin 81 of the gear 64 first engages the slot 82 of

its driven member 77 to operate the valve under control of the handle 51 to close the same; then the pin 76 of the gear 63 engages the slot 72 of its driven member 70 to operate the valve under control of the handle 45 to close the same; and finally the pin 65 of the gear 62 engages the slot 66 of its driven member to oscillate the shaft 39, moving the plate 17 to take the burner out of alignment with the burner openings 11 and 14 and to seal the latter. This movement to the right (Fig. 5) returns the elements to the positions shown in Fig. 5 and takes the burner 19, under control of the mechanism, out of service.

There is one casing 38 and contained mechanism at each end of the furnace, one of which is positioned to operate a burner 19 located at each end of the furnace. When one of the timing and controlling mechanisms, such as illustrated in Fig. 5, has operated to place a burner 19 in action, the other timing and controlling mechanism located at the opposite end of the furnace has previously operated to take the burner 19 at that end of the furnace out of action. That is to say, the burner 19 at one end of the furnace is first taken out of action by its controlling mechanism and subsequently the burner at the opposite end of the furnace is placed in service by the operation of its companion controlling mechanism such as heretofore described and vice versa.

A crank 61a engages a projecting end of the shaft 61, for an emergency operation of the mechanism in the casing 48, should the motor 53 be ineffective.

It is obvious, from the foregoing, that any type of motor may be used in conjunction with the mechanism described in lieu of a fluid operated motor 53 disclosed in the drawings. It is, furthermore, obvious that any suitable operative connection may be present on the reversing table or platform for automatically controlling the operation of the controlling and timing mechanisms, which form the subject matter of the present invention; or the respective controlling and timing mechanisms may be manually regulated from the reversing table or platform, without any automatic connection with the control of the reversing valves, if that is desired. That is to say, upon the operation of the mechanism for controlling the reversing valves, any suitable mechanism may be used for automatically, initially operating the motor 53 of the controlling mechanism at one end of the furnace to take a burner 19 out of service, then operate the reversing valves, and finally operate the motor 53 at the opposite end of the furnace to put the burner 19 at that end into operation. This may be done automatically, if desired, but the mechanism therefor is not a part of the present invention, and is, hence, not described herein.

The present invention has been described in conjunction with the apparatus at one end of the furnace only, and the duplicate mechanism at the opposite end of the furnace has been neither disclosed or described, nor has the mechanism nor controls for the motors 53 been disclosed or described, the present application being confined to the mechanism for controlling the operation of the burner and of the doors for the burner openings in the furnace.

What is claimed is:

1. The combination with a furnace, having a burner opening in the wall thereof, of a closure therefor, a burner, a plurality of valved supply pipes for said burner, and means for operating said closure and the valves of said supply pipes in a predetermined sequence.
2. The combination with a furnace, having a burner opening in the wall thereof, of a closure therefor, a burner, a plurality of valved supply pipes for said burner, means for operating said closure and the valves of said supply pipes in a predetermined sequence, and a single unitary control for said means.
3. The combination with a furnace, having a burner opening in the wall thereof, of a closure therefor, a burner, a plurality of valved supply pipes for said burner, means for operating said closure and the valves of said supply pipes in alternately predetermined sequences, and a unitary control for said means.
4. The combination with a furnace, having a burner opening in the wall thereof, of a burner mounted for cooperation with said opening, sources of fluid supply for said burner, means for controlling said sources of supply, a movable closure for said burner opening, and means for operating said closure and the means for controlling said sources of supply in a predetermined sequence.
5. The combination with a furnace, having a burner opening in the wall thereof, of a movable closure for said opening, and a burner cooperating with said closure to be moved into and out of co-acting position with respect to said opening by the movement of the closure aforesaid.
6. The combination with a furnace, having a burner opening in the wall thereof, of a closure for said burner opening, comprising a body having an aperture in one end, said closure being movable to bring the body over said burner opening or to align its aperture therewith, and a burner cooperating with the aperture of the closure aforesaid.
7. The combination with a furnace, having a burner opening in the wall thereof, of a closure for said burner opening, comprising a body having an aperture in one end, said closure being movable to bring the body over said burner opening or to align its aper-

ture therewith, and a burner so mounted that the discharge end thereof coacts at all times with the aperture of the closure aforesaid.

8. The combination with a furnace, having a burner opening in the wall thereof, of a closure for said opening comprising a plate having an imperforate body with an aperture therein, means for moving said closure relatively to the burner opening to position the imperforate body of the plate thereover or to align the aperture of the closure with the burner opening in the furnace, and a burner pivotally mounted at one end and having the opposite end sealed in the aperture of said closure for movement therewith.

9. The combination with a furnace, having a burner opening in the wall thereof, of a closure for said opening, comprising a plate having an imperforate body with an opening in one end thereof, a mounting for said closure to permit it to be moved to a position with the imperforate body closing said burner opening or to a position with the aperture thereof aligned with said burner opening, and a burner pivotally mounted at one end and having its opposite end coacting at all times with the aperture in said closure.

10. The combination with a furnace, having a burner opening in the wall thereof, of a closure for said opening, comprising a plate having an imperforate body with an opening in one end thereof, a mounting for said closure to permit it to be moved to a position with the imperforate body closing said burner opening or to a position with the aperture thereof aligned with said burner opening, means for moving said closure to either of its two positions, a burner pivotally mounted at one end and having its opposite end coacting at all times with the aperture in said closure, valved supply pipes for said burner, means for controlling the valves of said pipes, and having a unitary control for the valve operating means and the means for moving the closure.

11. The combination with a burner for a metallurgical furnace, of a movable closure cooperating therewith, valved supply pipes for said burner, and a unitary means for operating said closure and the valves of said pipes in a predetermined sequence.

12. The combination with a burner for a metallurgical furnace, of a movable closure cooperating therewith, valved supply pipes for said burner, and means for operating said valves and closure successively and alternately in one of two predetermined sequences.

13. The combination with a movable closure, of a burner cooperating therewith, a steam pipe to deliver steam to said burner, a fuel pipe to deliver fuel to said burner, a valve for each of said pipes to control the flow therethrough and a unitary control for said valves and closure to operate the same

alternately in one of two predetermined sequences.

14. The combination with a movable closure, of a burner cooperating therewith, a steam pipe to deliver steam to said burner, a fuel pipe to deliver fuel to said burner, a valve for each of said pipes to control the flow therethrough, a unitary control for said valves and closure whereby in one direction of operation of said control the closure is moved, the valve of the steam pipe opened and the valve of the fuel supply pipe is opened in the order given.

15. The combination with a movable closure, a series of valves, and controlling means for said closures and valves whereby they are operated in a predetermined sequence.

16. The combination with a closure, of a plurality of valves, and a control for said valves and closure where by one operation the closure is moved and subsequently the valves are operated in a predetermined sequence and on the next operation of the controlling means the valves are operated in a predetermined sequence and the closure is moved.

17. The combination with a closure, of a plurality of valves, individual means for operating each of said valves and said closure, a unitary control for said operating means comprising a series of gears and Geneva escapements coacting to operate said valves and closure in pre-determined sequences.

18. The combination with a furnace having a burner opening, of a movable closure for said opening, a burner coacting with said closure to be moved into and out of alinement with said opening by the action of the closure, supply pipes cooperating with said burner, valves for said pipes, and a unitary control to successively operate the closure and said valves.

19. The combination with a furnace having a burner opening, of a movable closure for said opening, a burner coacting with said closure to be moved into and out of alinement with said opening by the action of the closure, supply pipes cooperating with said burner, valves for said pipes, and a unitary control to successively operate the closure and said valves and to reverse said operation.

20. The combination with a furnace having a burner opening, of a movable closure for said opening, a burner coacting with said closure to be moved into and out of alinement with said opening by the action of the closure, a fuel supply pipe and a steam supply pipe cooperating with said burner, a valve for each of said pipes, and a unitary control to successively operate the closure, the valve of the steam pipe and the valve of the fuel pipe.

21. The combination with a furnace having a burner opening, of a movable closure

for said opening, a burner coacting with said closure to be moved into and out of alinement with said opening by the action of the closure, a fuel supply pipe and a steam supply pipe cooperating with said burner, a valve for each of said pipes, and a unitary control to successively operate the closure, the valve of the steam pipe and the valve of the fuel pipe to put the burner in service and to reverse said successive operation to take said burner out of service.

22. The combination with a furnace wall having a burner opening therein, of a frame surrounding said opening having an opening in registration with the wall opening, guides on the exterior of the frame, a burner plate slidably mounted on said guides, having an opening therein to be moved into and out of registration with openings in the frame and wall, a burner having one end coacting with the opening in the burner plate, and adjustable means for mounting the opposite end of the burner.

23. The combination with a furnace wall having a burner opening therein, of a frame surrounding said opening having an opening in registration with the wall opening, guides on the exterior of the frame, a burner plate slidably mounted on said guides, having an opening therein to be moved into and out of registration with openings in the frame and wall, a burner having its discharge end coacting with the opening in the burner plate, and means for pivotally and adjustably supporting the opposite end of the burner.

24. The combination with a furnace wall having a burner opening therein, of a frame surrounding said opening having an opening in registration with the wall opening, guides on the exterior of the frame, a burner plate slidably mounted on said guides, having an opening therein to be moved into and out of registration with openings in the frame and wall, a burner having its discharge end coacting with the opening in the burner plate, a bar secured to the wall, guides on said bar, a supporting frame slidably mounted on said guides, means for adjusting the position of the frame on said guides, and means for pivotally mounting the burner on said frame.

25. The combination with a furnace wall having a burner opening therein, of a frame surrounding said opening having an opening in registration with the wall opening, guides on the exterior of the frame, a burner plate slidably mounted on said guides, having an opening therein to be moved into and out of registration with openings in the frame and wall, a burner having its discharge end coacting with the opening in the burner plate, a bar secured to the wall, guides on said bar, a supporting frame slidably mounted on said guides, a threaded bearing outstanding from the bar, a corresponding threaded lug on the frame, a threaded shaft co-operating with

said bearing and lug for the adjustment of the position of the frame, and means for pivotally mounting the burner, adjoining its intake end on said supporting frame.

26. The combination with a furnace wall having a burner opening therein, of a frame surrounding said opening having an opening in registration with the wall opening, guides on the exterior of the frame, a burner plate slidably mounted on said guides, having an opening therein to be moved into and out of registration with openings in the frame and wall, a burner having its discharge end coacting with the opening in the burner plate, a bar secured to the wall, guides on said bar, a supporting frame slidably mounted on said guides, a threaded bearing outstanding from the bar, a corresponding threaded lug on the frame, a threaded shaft co-operating with said bearing and lug for the adjustment of the position of the frame, an outstanding connection at the end of the supporting frame opposed to the lug, a yoke mounted on said connection, and means for pivoting the burner to the yoke.

27. The combination with a furnace wall having a burner opening therein, of a frame surrounding said opening having an opening in registration with the wall opening, guides on the exterior of the frame, a burner plate slidably mounted on said guides, having an opening therein to be moved into and out of registration with openings in the frame and wall, a burner having its discharge end coacting with the opening in the burner plate, a bar secured to the wall, guides on said bar, a supporting frame slidably mounted on said guides, a threaded bearing outstanding from the bar, a corresponding threaded lug on the frame, a threaded shaft cooperating with said bearing and lug for the adjustment of the position of the frame, a yoke mounted for adjustment on said connection, means for retaining the yoke in its adjusted position, and means for pivoting the burner, adjoining its intake end, between the arms of the yoke, whereby the discharge end of the burner may move with the burner plate.

28. The combination with a furnace wall having a burner opening therein, of a frame surrounding said opening having an opening in registration with the wall opening, guides on the exterior of the frame, a burner plate slidably mounted on said guides, having an opening therein to be moved into and out of registration with openings in the frame and wall, a lateral arm pivoted at the end of the burner plate, an operating rod connected to said arm, and means for reciprocating said rod.

29. The combination with a furnace wall having a burner opening therein, of a frame surrounding said opening having an opening in registration with the wall opening, guides on the exterior of the frame, a burner

plate slidably mounted on said guides, having an opening therein to be moved into and out of registration with openings in the frame and wall, a burner having its discharge end coacting with the opening in the burner plate, a bar secured to the wall, guides on said bar, a supporting frame slidably mounted on said guides, a threaded bearing outstanding from the bar, a corresponding threaded lug on the frame, a threaded shaft cooperating with said bearing and lug for the adjustment of the position of the frame, a yoke mounted for adjustment on said connection, means for retaining the yoke in its adjusted position, means for pivoting the burner between the arms of the yoke, whereby the discharge end of the burner may move with the burner plate, a lateral arm pivoted to the burner plate, an operating rod connected to the lateral arm, and means for reciprocating said rod.

30. The combination with a movable burner, of valved supply pipes leading thereto, and means for operating the valves and moving the burner in a predetermined sequence comprising an operating shaft for each valve and the burner, a driven member on each such shaft, a unitary oscillatory driving shaft, intermediate shafts for operation from the driving shaft, means whereby the intermediate shafts operate the driven members of the shafts operating the valves, and means whereby the driving shaft operates the shaft controlling the burner.

31. The combination with a movable burner, of valved supply pipes leading thereto, and means for operating the valves and moving the burner in a predetermined sequence comprising an operating shaft for each valve and the burner, a driven member on each such shaft, having a slotted engaging portion flanked by curved locking surfaces, a driving shaft for each driven member, a gear on each driving shaft, said gears meshing one with the other, a pin on each gear to at times engage the slot of the engaging portion of the coacting driven member, a disc fixed to each gear the periphery of which engages one or the other of the locking surfaces of the co-operating driven member to lock it from movement, and means whereby one of said driving shafts may be oscillated.

32. The combination with a movable burner of valved supply pipes leading thereto, and means for operating the valves and moving the burner in a predetermined sequence comprising an operating shaft for each valve and the burner, a driven member on each such shaft, having a slotted engaging portion flanked by curved locking surfaces, a driving shaft for each driven member, a gear on each driving shaft, said gears meshing one with the other, a pin on each gear to at times engage the slot of the engaging portion of the coacting driven member, a disc, fixed to each gear the periphery of which engages one or

the other of the locking surfaces of the co-operating driven member to lock it from movement, except when the pin of the co-acting gear engages the slotted engaging portion of the driven member, a reciprocatory rack, and means whereby the movement of the rack will oscillate one of said driving shafts.

ARTHUR L. STEVENS

75

80

85

90

95

100

105

110

115

120

130