July 3, 1934. M. ALPERN 1,965,444

AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

Original Filed March 19, 1928 11 Sheets-Sheet 1

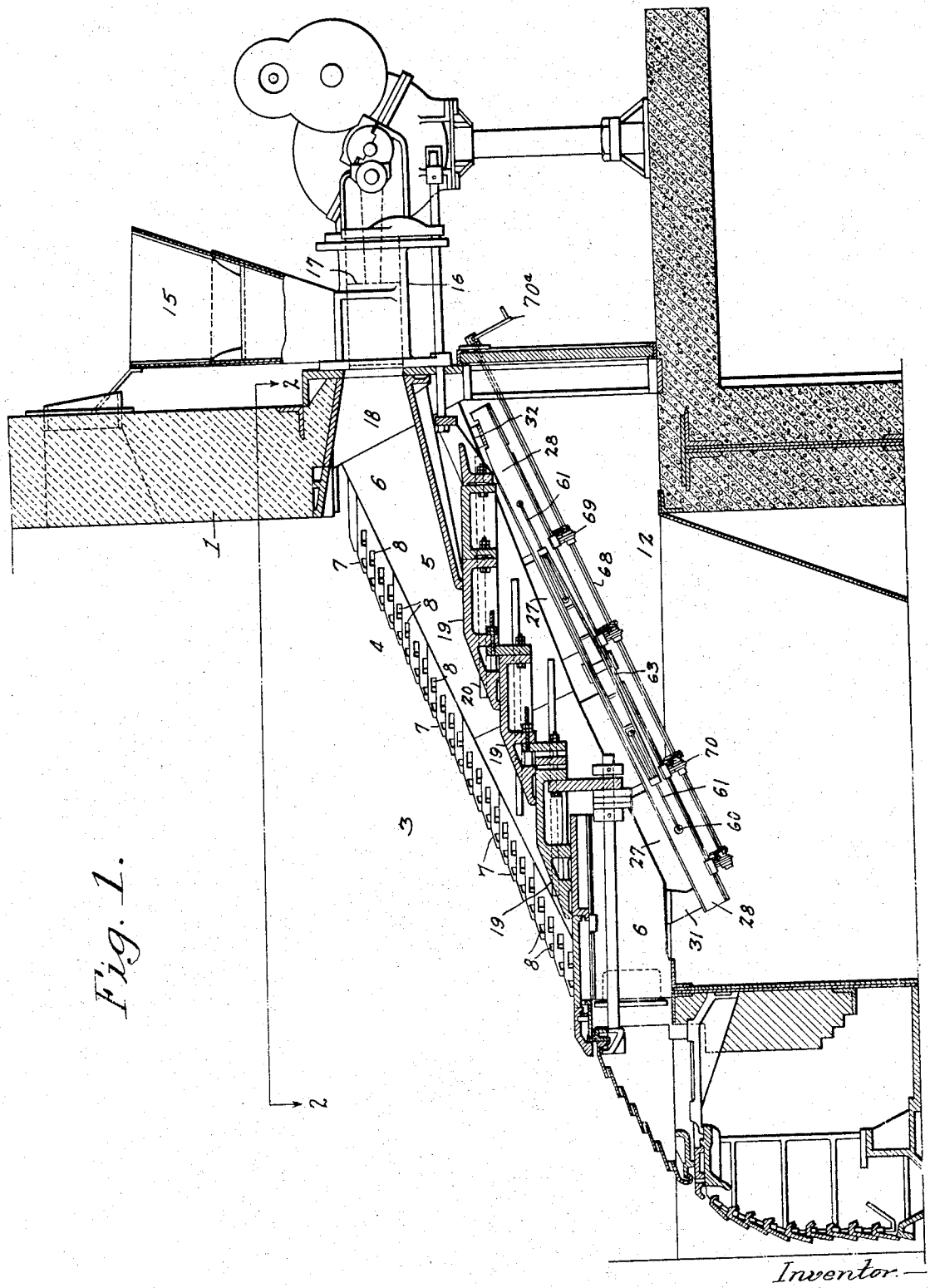


Fig. 1.

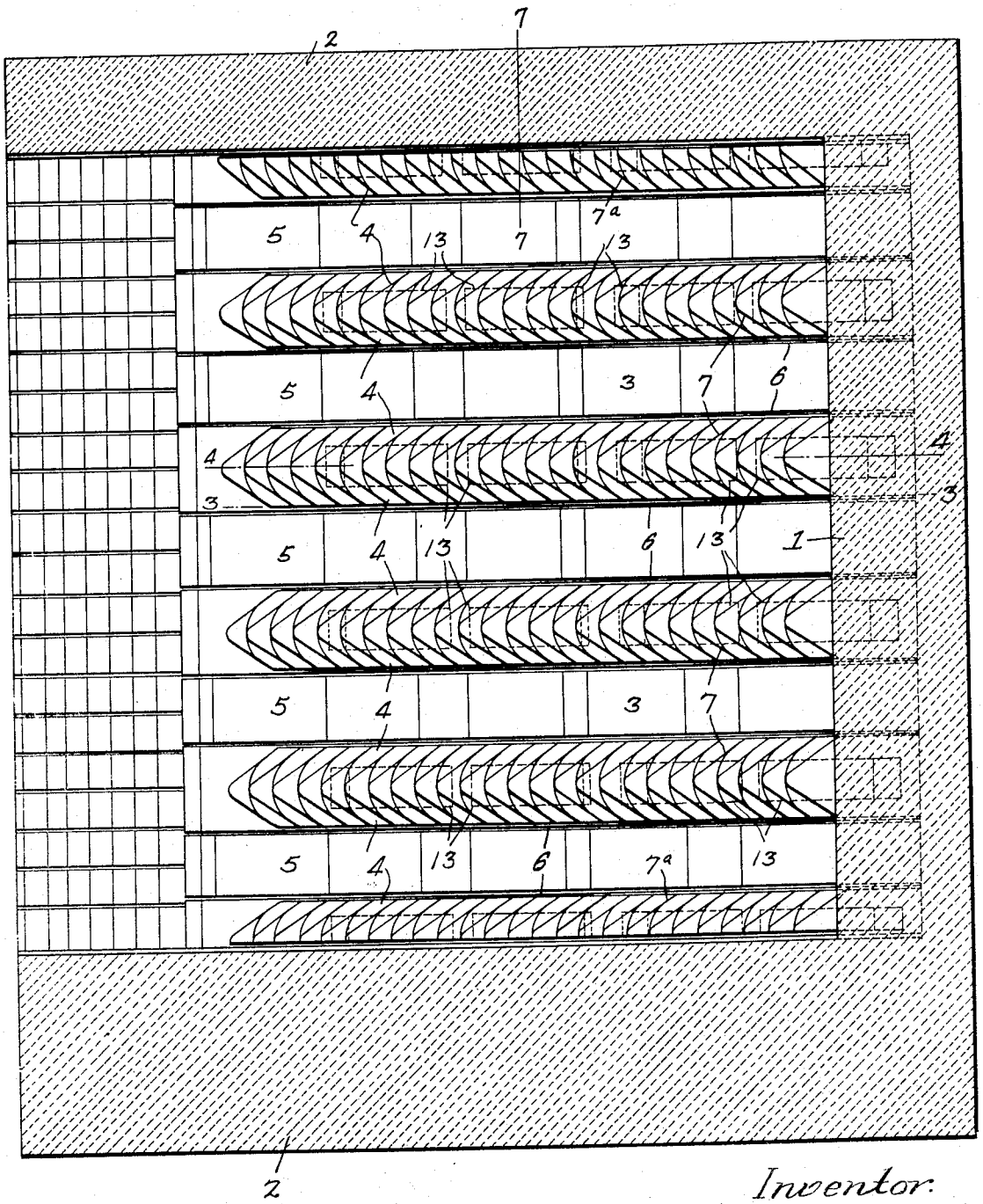
Inventor.
Maxwell Alpern.
By his Attorneys,
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AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

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Fig. 2.



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AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

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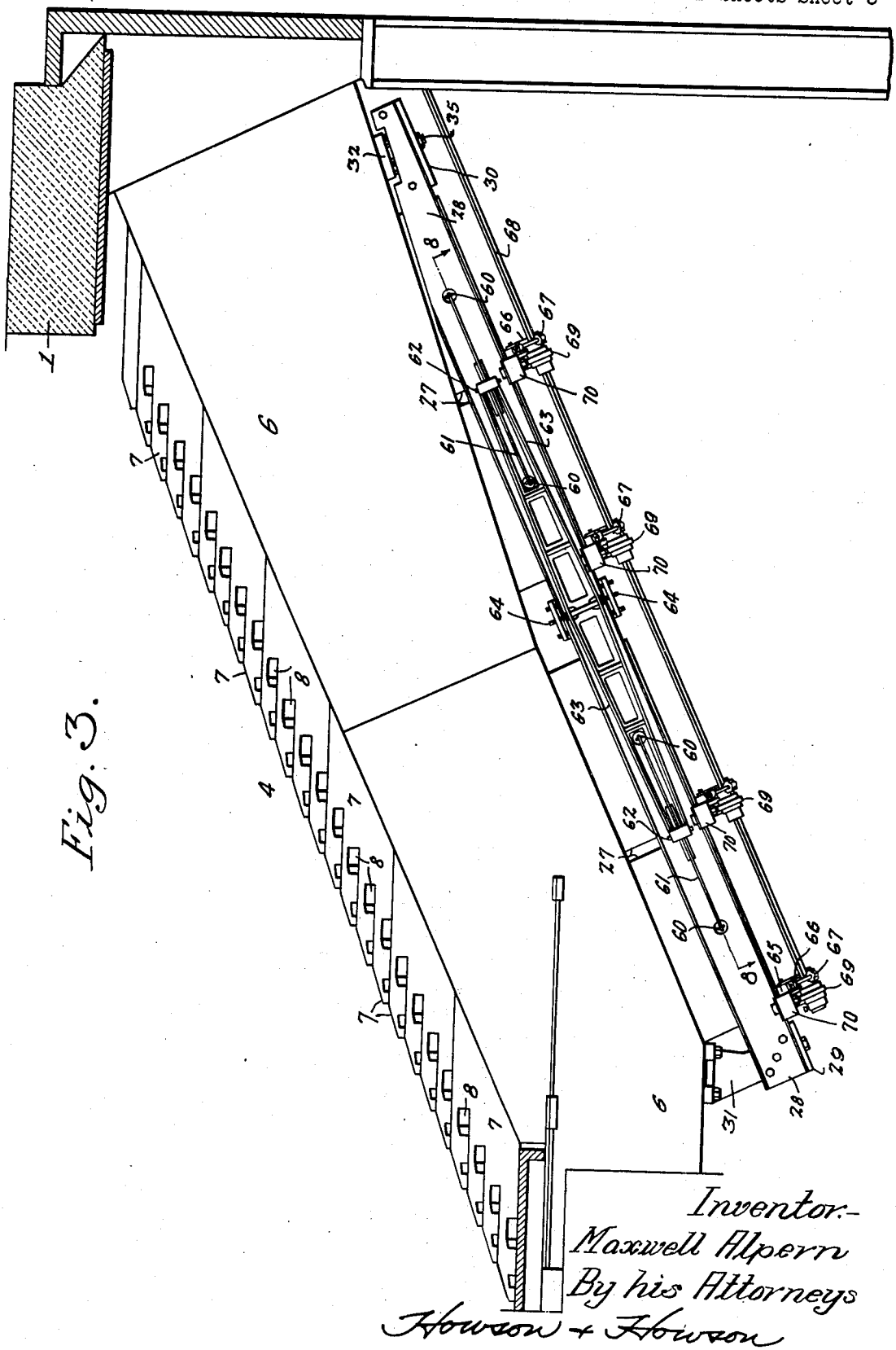


Fig. 3.

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AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

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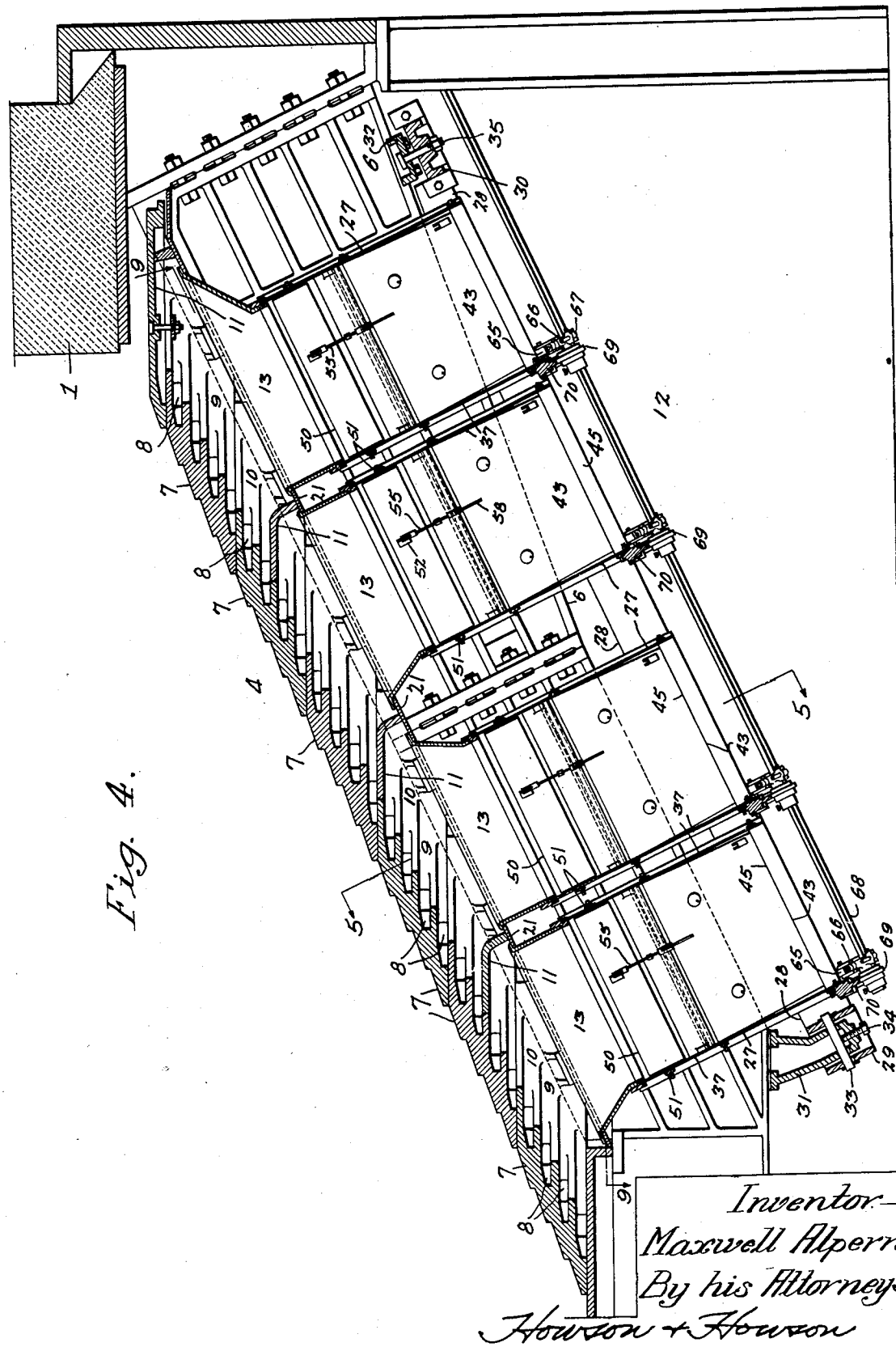


Fig. 4.

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AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

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Fig. 5.

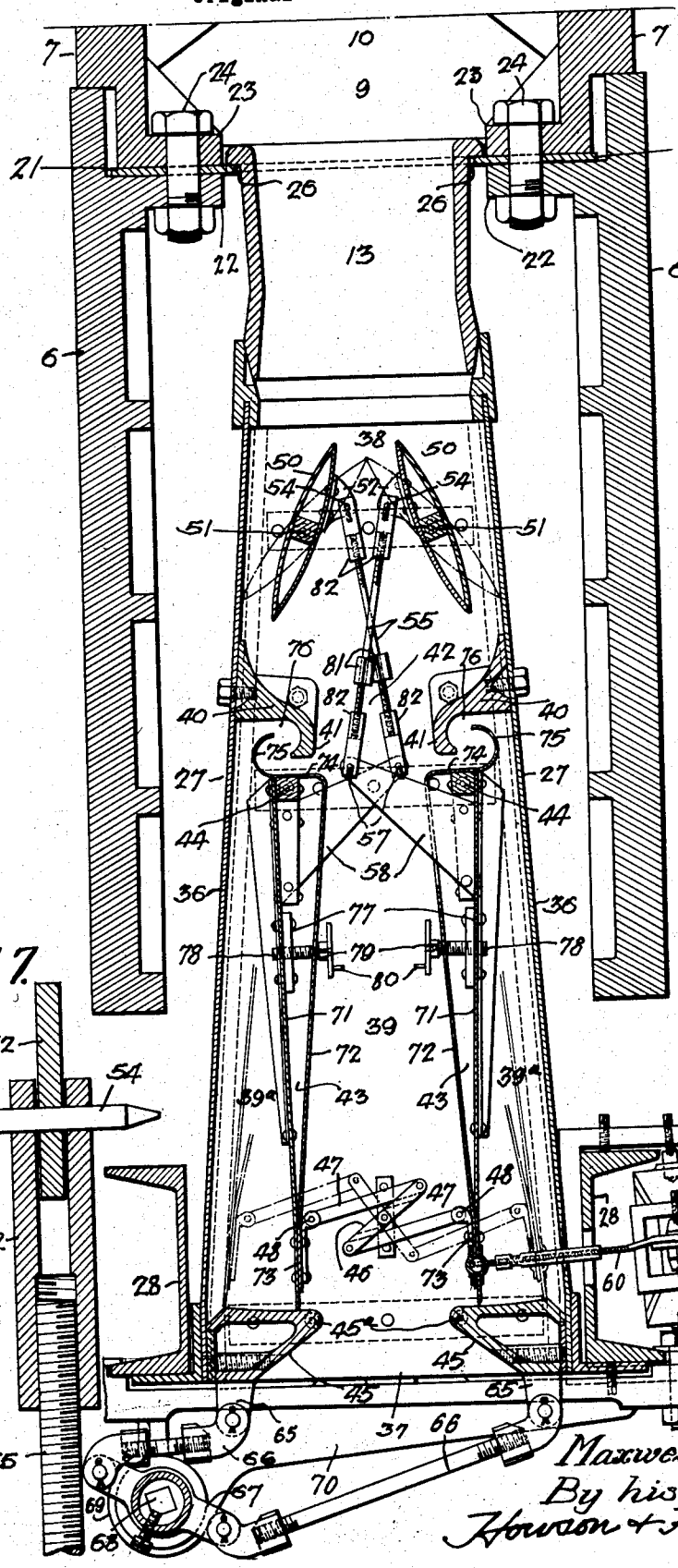


Fig. 17.

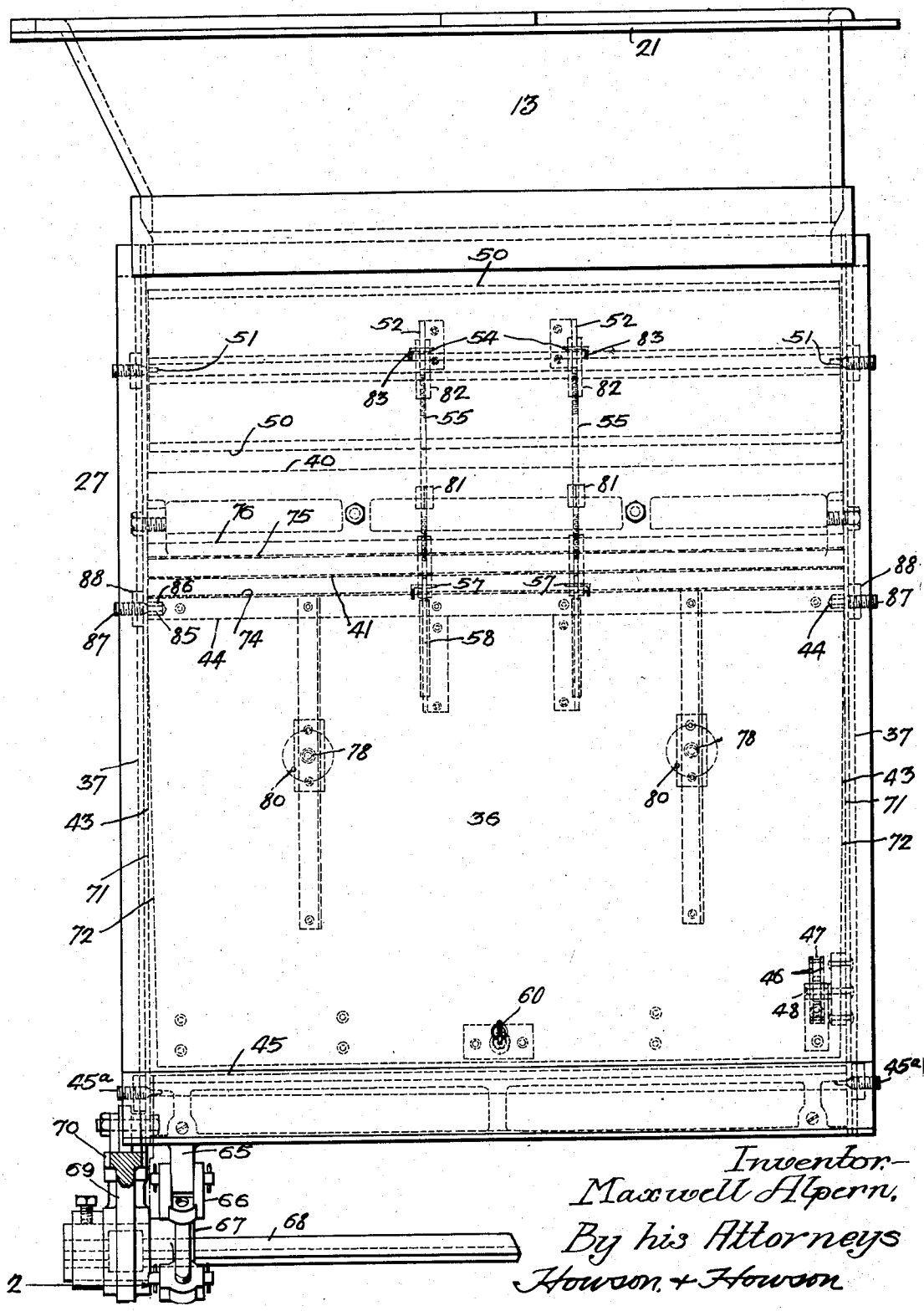
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AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

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Fig. 6.



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AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

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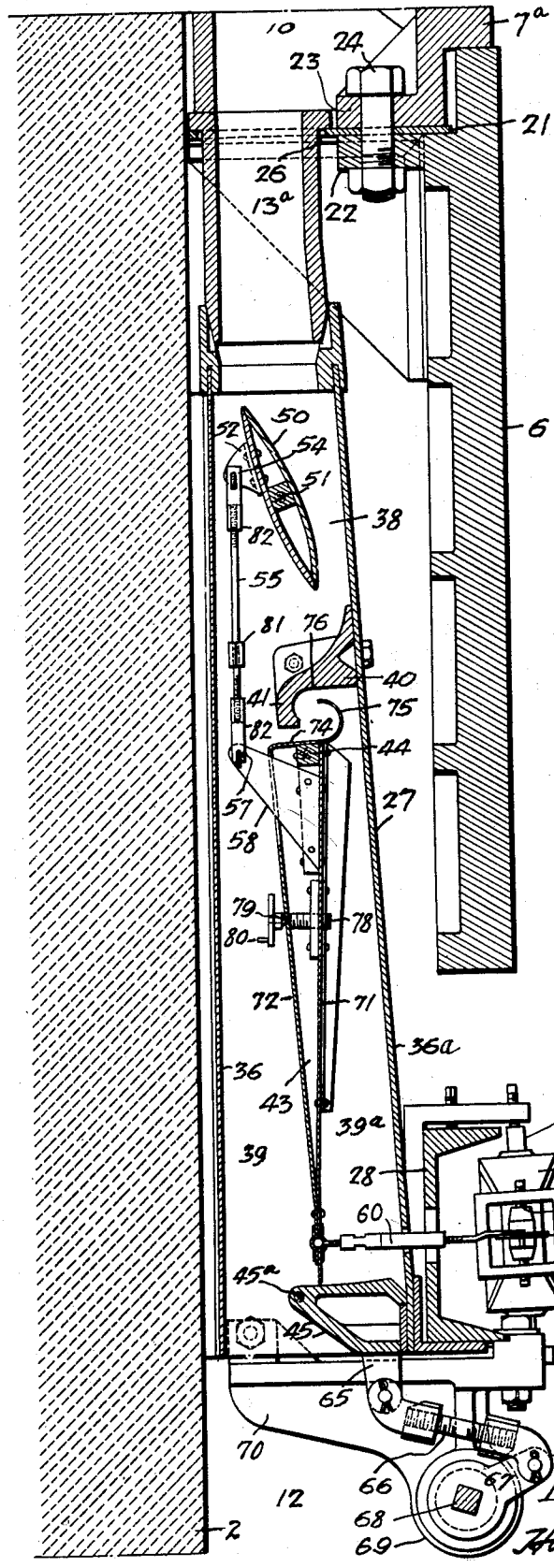


Fig. 7.

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AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

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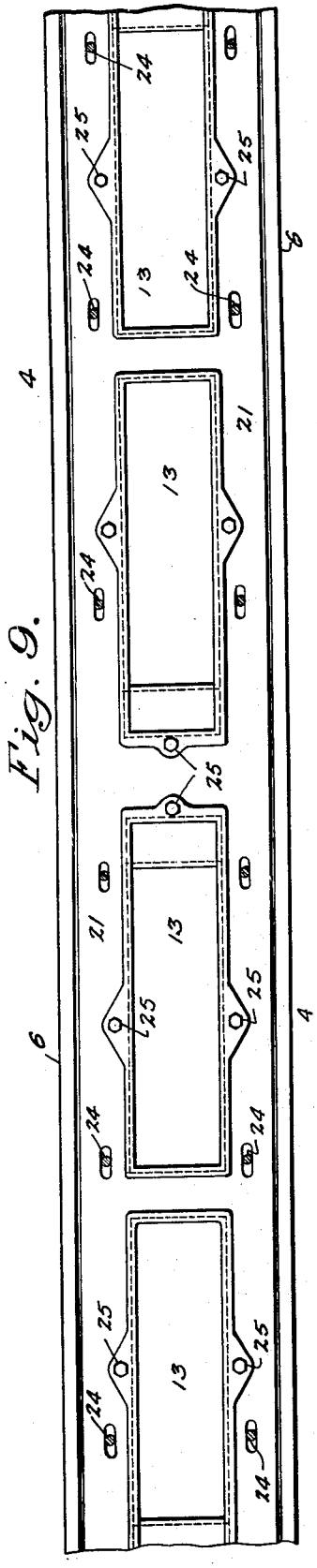


Fig. 9.

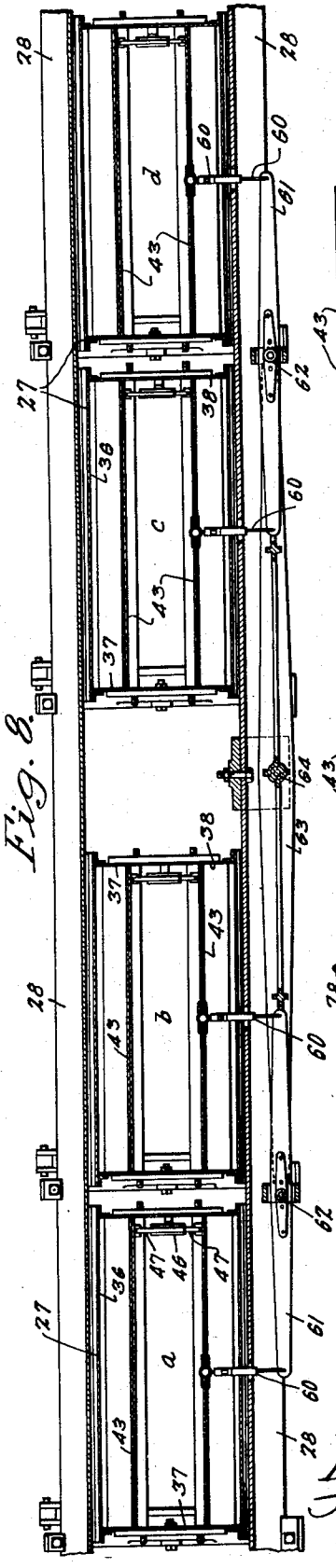


Fig. 8.

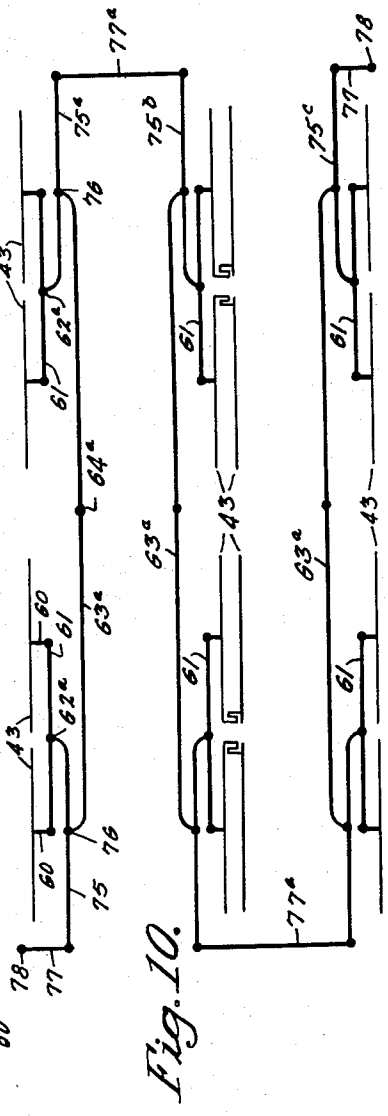


Fig. 10.

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AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

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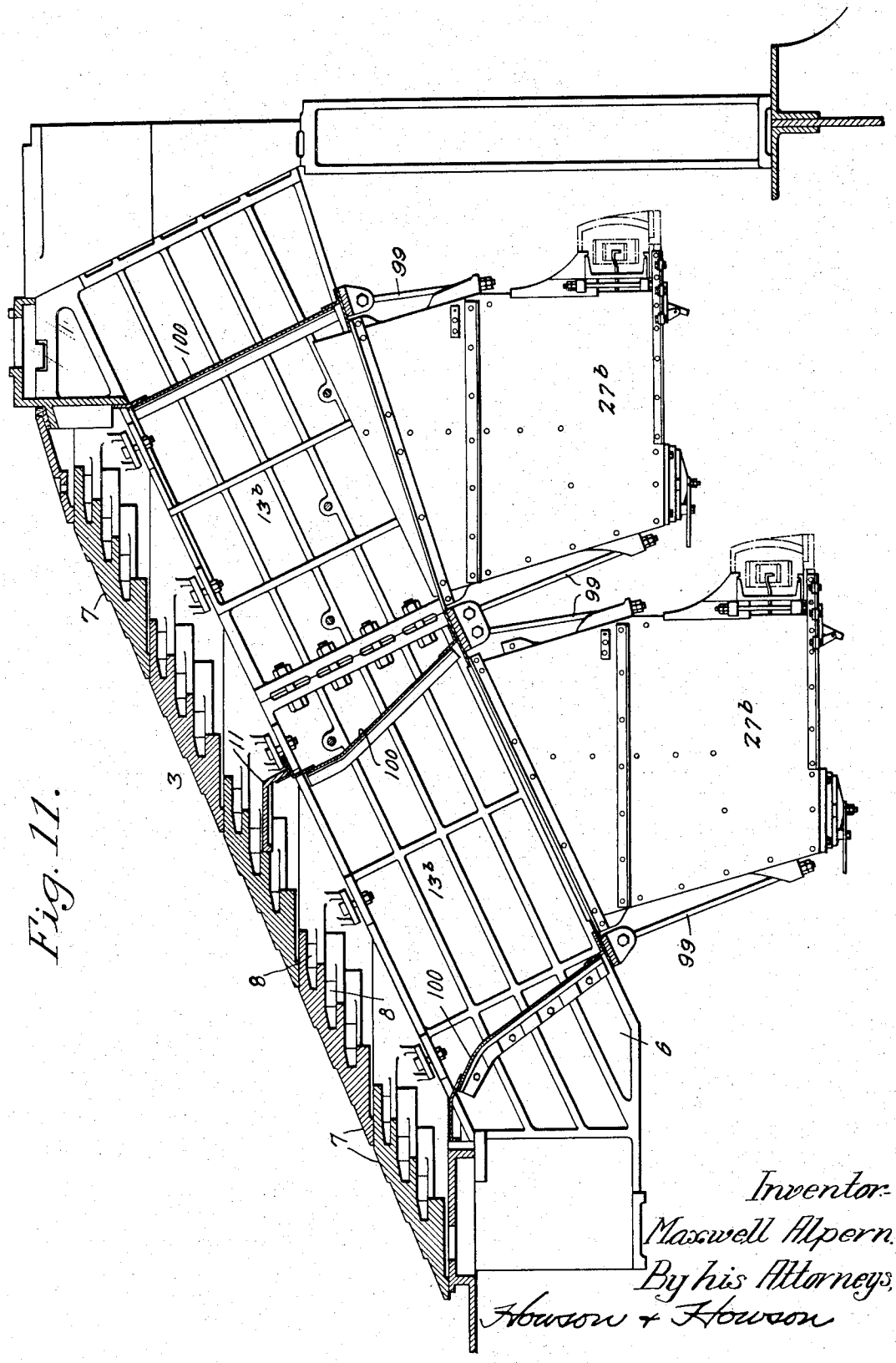


Fig. 11.

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AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

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Fig. 12.

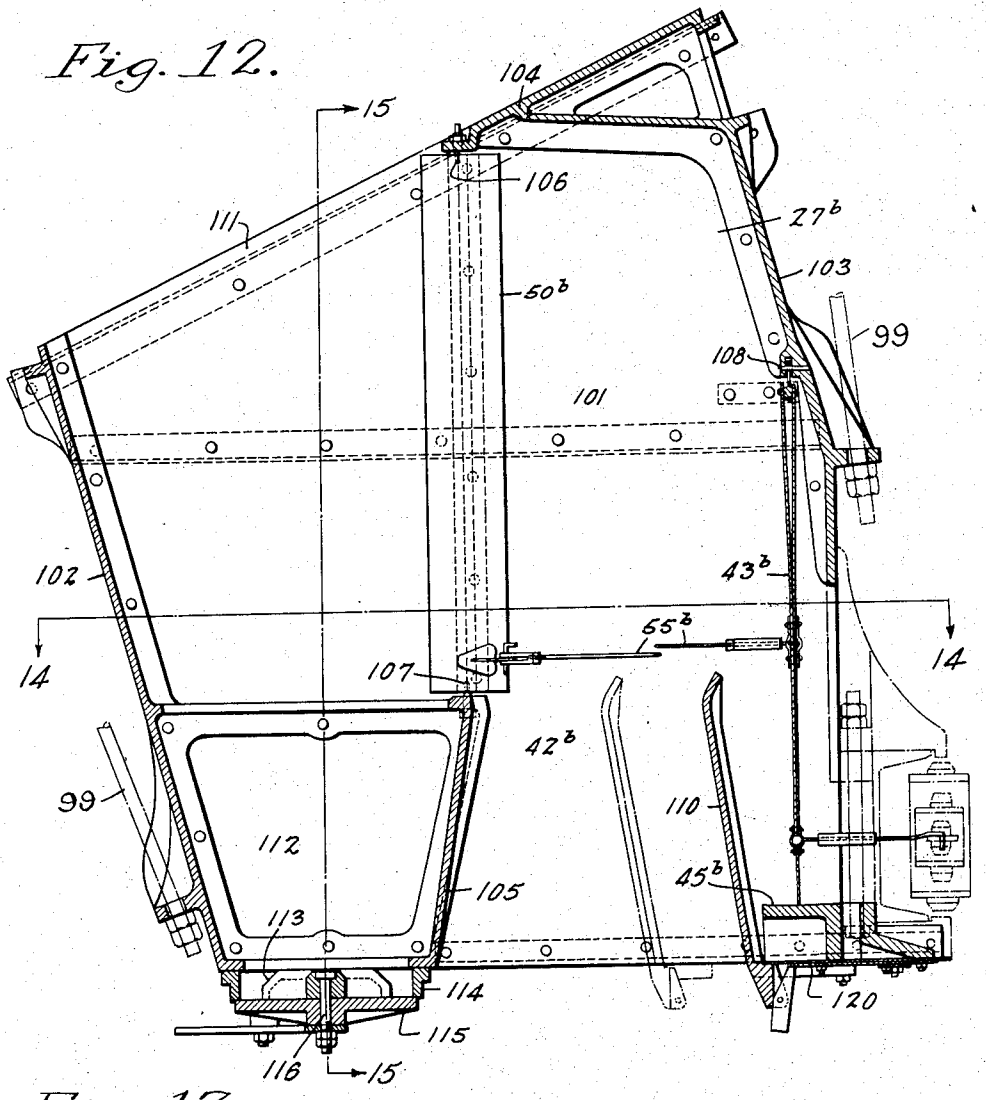
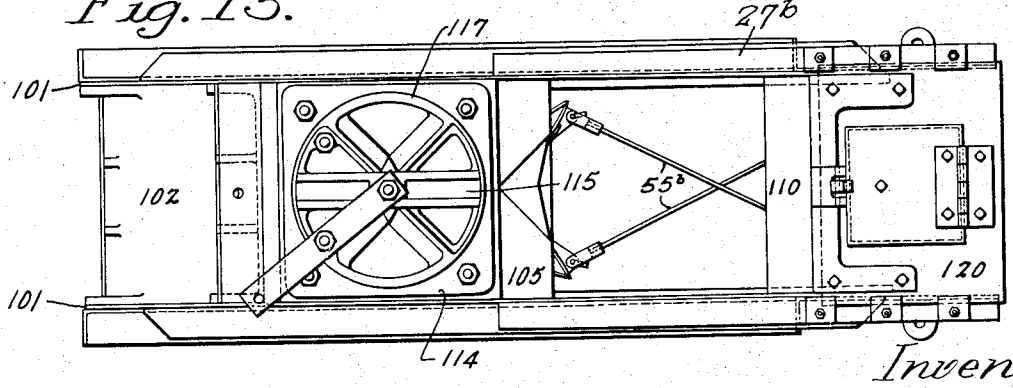


Fig. 13.



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AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

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Fig. 14.

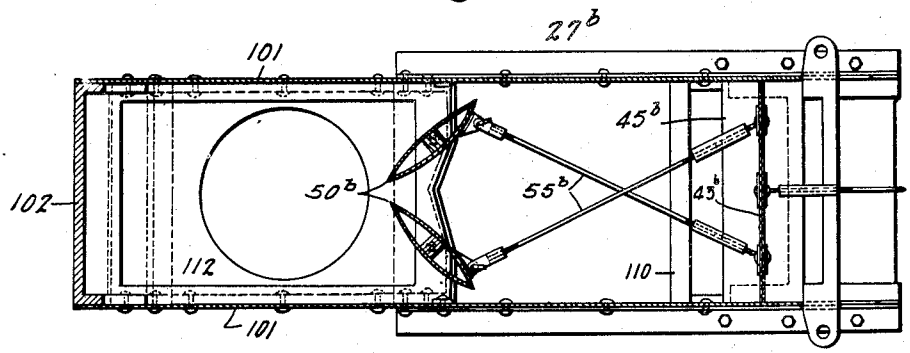


Fig. 15.

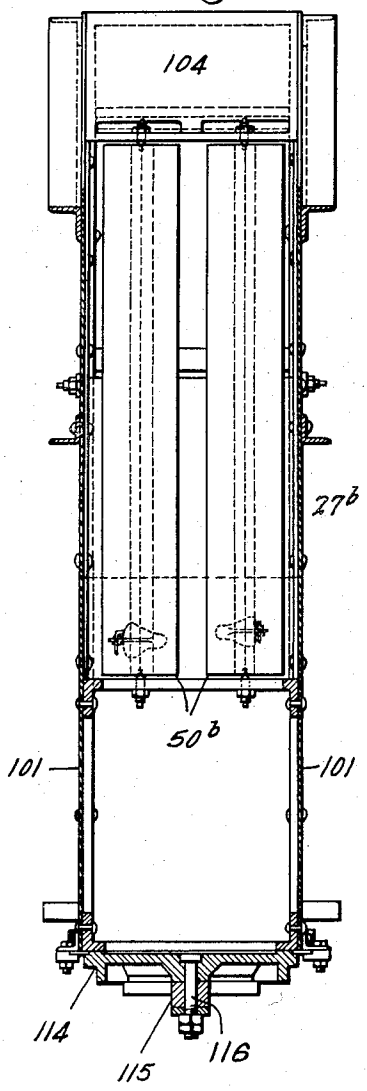
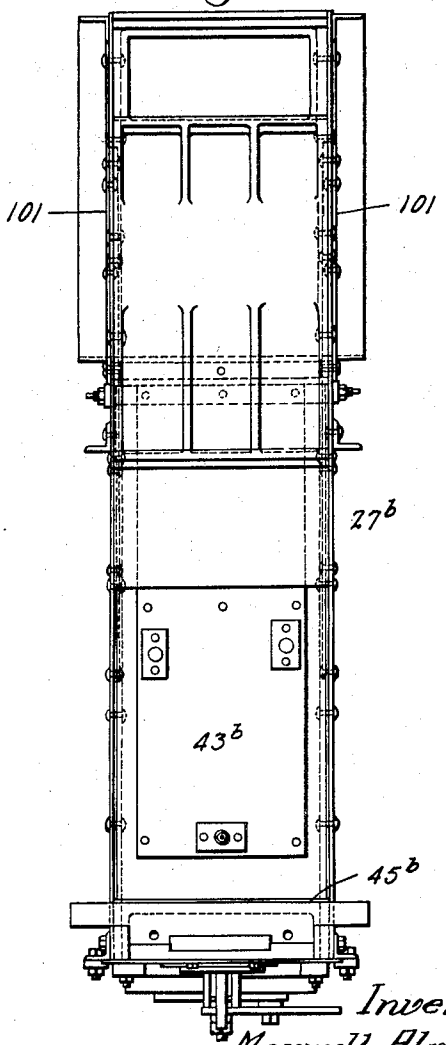


Fig. 16.



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Patented July 3, 1934 1,965,444

UNITED STATES PATENT OFFICE

1,965,444

AUTOMATIC CONTROL SYSTEM FOR FURNACE COMBUSTION AIR

Maxwell Alpern, Philadelphia, Pa., assignor to American Engineering Company, Philadelphia, Pa., a corporation of Pennsylvania

Original application March 19, 1928, Serial No. 262,935. Divided and this application October 12, 1929, Serial No. 399,315

8 Claims. (Cl. 110—44)

This invention relates to systems employed in the handling of fluids, in either a gaseous or liquid state, and comprises means for controlling the flow of such fluids in passing through the said systems.

This application is a division of my application, Serial Number 262,935, filed March 19, 1928, which application on January 28, 1930, matured into Patent No. 1,745,238.

The invention involves a fundamental principle of fluid control as adapted to the regulation of either a natural or a forced draft in furnaces, boilers, etc.

The principle involved, which forms the subject of my invention, is applicable to and is equally efficient in fluid systems operating under either pressure or vacuum, and comprises the utilization of the resistance, or the lack of resistance as the case may be, which is presented to the flow of fluid at a given point in the system as a means for actuating a mechanical controlling device by which the said flow is regulated at that particular point in the system and, if desired, at other points throughout the system.

According to the principle on which my invention is based, the reduction of the amount of resistance at the one point in the system will function in a manner to operate the mechanical means which controls the flow of air to that particular point in the system, consequently the flow of air to that particular point will be reduced in accordance with the reduction of the amount of resistance offered. By this means the other points will continue to receive their proportionate volumes of air. If desired, the mechanical controlling means, for the air passing to the different points through branch ducts, may be balanced or interconnected so that a reduction of the flow at one point in the system will automatically react to increase the flow to the other points proportionately.

The principle also operates in a reverse order i. e. if the amount of resistance to the flow increases at any given point in the system, such a condition will cause the mechanical controlling means to operate in a manner to permit an increased flow at the particular point in the system which has been subjected to the increased resistance.

Each of the mechanical controlling devices is provided with an operating motor which is actuated by differential pressures created in the said device by the resistance offered to the flow passing through the device, said motor being connected to dampers, valves or some other form of flow controlling device for effecting a regulation of the flow through the portion of the system to which said mechanical controlling device is connected. As above noted, the operating motors, the dampers or the valves throughout the system may be interconnected in such a manner that the operation of one of said devices will effect operation of the other devices in a ratio proportionate to their number.

For the purpose of illustrating the invention, I have chosen the furnace showing a system for supplying a forced draft, in the present instance, to a stocker of the under-feed type, generally known as the Taylor stoker. In this type of boiler the coal is fed to the bed of the fire by suitable rams and pushers, and air under pressure is supplied, for the purpose of aiding combustion, through a series of tuyères arranged in banks, alternating with the said rams and pushers. The air is supplied by a suitable blower to a chamber underlying the pushers and the tuyères, which is commonly designated as the wind-box, the air passing from the wind-box through suitable apertures in the tuyères, and combining with the gases emanating from the heated coal for the purpose of properly effecting combustion.

In the operation of this type of stoker, there are times when the coal-feeding apparatus fails to uniformly distribute the coal over the adjacent tuyères, some portions of the fuel bed are consequently thin or lacking in density and other portions comparatively thick or dense. Obviously, these different portions of the fuel bed will present a resistance to the draft which will vary in accordance with the density of the fuel bed in these different areas. The thin areas offering the least resistance to the draft have a tendency to burn through more quickly than the dense areas, permitting an excessive rush of air through these thin portions of the fuel bed and thereby causing a reduction in the amount of air accessible at the dense areas. The excessive rush of air at the thin areas causes a quick burning of the fuel and an abnormal and extremely high temperature to develop at these places, which consequently causes the tuyères to burn out, requiring the boiler to be placed out of operation while the burned out tuyères are being replaced. In the dense area of the fuel bed, not receiving a sufficient amount of air, the fuel is not properly consumed, resulting in an unevenly burning fire, which is quite unsatisfactory.

In applying my invention to a boiler of the above mentioned type, the fire bed is theoretically divided into a plurality of areas and a draft-

controlling device is provided for each of these areas, between the fuel bed and the wind-box of the furnace.

Assuming that the air pressure in the wind-box is substantially uniform throughout, under the uneven condition of the fuel bed above noted, there would exist the tendency for the air to rush through the portions of the fuel bed presenting the least resistance to the draft, with a consequent reduction of the flow of air through the more densely packed areas of the fuel bed which present the greater resistance to the draft and which should receive the greater amount of air

With my invention, the mechanical control devices of the different areas will be actuated, by the flow of air to the respective areas, in such a manner, governed by the amount of resistance presented in the respective areas, as to cause the flow of air to the thinly covered or less dense areas of the fuel bed to be reduced and the flow to the more thickly covered or dense areas to be increased, resulting in an evenly burning fire, and eliminating the possibilities of burning out the tuyères.

In the illustrated adaptation of the principles of my invention, the mechanical controlling devices are inter-connected in such a manner that operation of one of said devices will cause a reverse actuation of others of the series of controlling devices, thus, when some of the devices actuate to cause a reduction of the air flow to their respective areas of the fuel bed, they will assist in the actuation of the other devices to increase the flow of air to their respective areas of the fuel bed.

This interconnecting of the control devices is not absolutely essential as each device is capable of operating independently, to control the amount of air passing to the area of the fuel bed which it is adapted to control.

The details of the construction of the particular adaptation of the principles of my invention will be more fully disclosed hereinafter, reference inating distortion of these elements, and by which:

Fig. 1 is a longitudinal sectional elevation through the coal-feeding apparatus of a furnace embodying the features of my invention;

Fig. 2 is a sectional plan view taken along the line 2—2 of Fig. 1, and illustrating the arrangement of tuyères and coal pushers;

Fig. 3 is a longitudinal sectional elevation taken along the line 3—3 of Fig. 2, illustrating a tuyère bank in side elevation, and my improved controlling apparatus applied thereto;

Fig. 4 is a longitudinal section elevation through the tuyère bank taken along the line 4—4 of Fig. 2;

Fig. 5 is a transverse sectional elevation taken along the line 5—5 of Fig. 4, and illustrating the air control mechanism for one particular section of the fire bed;

Fig. 6 is a side elevation of the control unit shown in Fig. 5;

Fig. 7 is a transverse sectional elevation taken along the line 7—7 of Fig. 2, and illustrating a control unit for another particular section of the fire bed;

Fig. 8 is a sectional plan view taken along the line 8—8 of Fig. 3, illustrating the mechanism by which a series of the air control units are operatively connected, one with the other;

Fig. 9 is a sectional plan view taken along the line 9—9 of Fig. 4;

Fig. 10 is a diagrammatic view illustrating an arrangement of levers whereby the entire fire bed may be affected by the operation of my one single control unit;

Fig. 11 is a view similar to Fig. 4, but illustrating a modified form of the invention;

Fig. 12 is a longitudinal sectional elevation of one of the control boxes shown in Fig. 11;

Fig. 13 is an inverted plan view of the structure shown in Fig. 12;

Fig. 14 is a sectional plan view taken on the line 14—14, Fig. 12;

Fig. 15 is a transverse sectional elevation taken on the line 15—15, Fig. 12;

Fig. 16 is an end elevation of the structure shown in Fig. 12, and

Fig. 17 is a detail of the invention.

As illustrated in Figs. 1 and 2, the furnace selected for the purpose of illustrating my invention comprises a front wall 1, and side walls 2, 2, defining the fire bed space generally indicated at 3, within which is suitably mounted a series of tuyère banks 4, the individual banks alternating with retorts 5. Each of the tuyère banks comprises a pair of side walls or beams 6, 6 suitably mounted in the furnace, each bank comprising a series of tuyère units 7, 7 of the usual construction and comprising air outlets 8, which communicate with air passages 9 formed within the tuyère units.

As illustrated in Fig. 4, the air passage 9 is divided into sub-chambers 10 by means of partitions 11 suitably formed in or attached to the tuyère units 7 at the desired points. Each of the air chambers 10 communicates with the wind-box 12 of the furnace through and by means of an air nozzle 13, each of which is suitably connected to a controlling mechanism for the air passing therethrough, which will be more fully described hereinafter.

Each of the coal feeding units 5 comprises the usual fuel hopper 15 which communicates with a cylinder 16 provided with a ram 17, which is adapted to be reciprocated by any suitable means to force the coal, which passes from the hopper 15 into the cylinder 16, by gravity, out of the cylinder 16 into the coal passage 18 formed between the side plates 6, 6 of each pair of tuyère banks 4.

Suitably mounted between the said side plates 6 is a series of coal pushers 19, 19 adapted to be reciprocated upon rails 20 formed on the said side plates in the usual manner. The pushers 19, 19 are suitably connected with a mechanism which reciprocates the ram 17 and co-operates therewith to move the coal outward through the passage 18 and up and over the tuyère bank at each side thereof.

Each tuyère bank 4 includes a plate 21 which is secured at each of its sides to a flange 22, formed integral with the side plates 6, 6. Each tuyère unit 7 is provided at each side with a foot 23. Bolts 24, 24 pass through the plate 21, flanges 22 and feet 23, by means of which these three elements are secured together.

Each of the air nozzles 13 is secured to the plate 21 by bolts 25, and passes downward through an aperture 26 formed in the plate 21. A control box 27 is provided between each of the air nozzles 13 and the wind-box 12 of the furnace, by means of which the amount of air passing from the wind-box to the air nozzle may be accurately and automatically controlled.

The series of control boxes for each tuyère bank 4 is suitably mounted upon a pair of longitudinally extending supporting beams 28, 28 which

are connected at their opposite ends by transversely extending members 29 and 30. Extending between and suitably secured to the side plates 6, 6 of each tuyère bank is a pair of transverse supporting members 31 and 32. The transverse member 29 is horizontally pivoted to the transverse member 31 by a short shaft 33 secured within the member 31 by a set screw 34, in the present instance. The transverse member 30 is vertically pivoted to the transverse member 32 by a pivot bolt 35, as illustrated in Fig. 4.

The upper end of each of the control boxes 27 engages the lower end of the respective air nozzle 13, but is not rigidly secured thereto, permitting relative movement between these two elements. On furnaces employing the above described construction, warping or misalignment of the side plates 6 will not affect the alignment or operation of the movable elements contained in the control boxes 27, due to the fact that the frame on which the control boxes are mounted, which comprises the side beams 28, 28 and the transverse connecting members 29 and 30, is supported at but two points on the side plates. Distortion of the side plates and tuyères 7 is more or less common in this type of furnace, due to the heat of the fire bed. The control boxes being in direct communication with the wind-box of the furnace remain comparatively cool thereby eliminating distortion of these elements, and by mounting the control boxes in a manner as above described, relative movement between the control boxes and nozzles is permitted without affecting the operation of the mechanism of the control boxes.

Each control box 27 comprises side walls 36, 36 and end walls 37, 37, and is divided into a damper or delivery chamber 38 and a motor or receiving chamber 39, by a rail 40 secured to each of the side walls 36, 36. Each rail 40 is provided with a downwardly extending flange 41, whereby a throat 42 is formed between the upper and lower chambers.

Within the lower chamber 39 of the control box 27 is a pair of motor elements 43, 43 which are pivoted at 44, 44 in each of the end walls 37, 37. A lower rail 45 is suitably mounted in the lower portion of the chamber 39 and at each side thereof, immediately below each of the motor elements 43. A lever 46 is pivoted intermediate its ends, to one of the end walls 37, and a pair of links 47, 47 is provided, each link having one of its ends pivoted to one end of the lever 46 and its opposite end pivoted to one of the motor elements 43, at a point 48.

In the upper or damper chamber is provided a pair of balanced dampers 50, 50 pivoted at 51, 51 in each of the end walls 37, 37. Each damper is provided with a lug 52 to which is pivotally connected, at 54, one end of a connecting rod 55, the opposite end of which is pivotally connected at 57 to a bracket 58 secured to the motor element 43 underlying the particular damper with which it co-operates.

Under normal operating conditions and with the proper amount of fuel overlying the tuyère units 7, uniformly throughout the bed of the fire, the elements of each of the control boxes 27 occupy positions substantially as shown in Fig. 5, and a uniform amount of air passes from the wind-box 12 through the chamber 39 between the motor elements 43, 43, the throat 42, the chamber 38, between the dampers 50, 50, through the nozzle 13 into the chamber 10, thence through the openings in the tuyère 7 and through the body of fuel overlying the tuyères, whereby proper combustion is obtained over the entire fire bed, the body of fuel offering a certain amount of resistance to the air passing therethrough.

Between the side walls 36, 36 and each motor element 43 a supplemental chamber 39*a* is formed. Under the said normal operating conditions, the air pressure in the chambers 38, 39 and the two supplemental chambers 39*a*, 39*a* is substantially uniform, therefore, the motor elements 43, 43 assume a neutral position, substantially as illustrated in Fig. 5. The dampers 50, 50, being directly connected to the motor elements 43, 43, likewise assume a neutral position substantially as shown. When a spot in the fire bed burns through and the normal resistance to the normal air flow thereby reduced, the pressure in the chamber 38 is caused to drop below normal whereby the above mentioned increased flow of air between the wind-box and the tuyère chamber 10 begins. The increased flow of air in passing through the throat 42 in the control box 27 causes the air to be drawn from each of the supplemental chambers 39*a* over the top of the motor element 43, and under the bottom of the flange 41 of the rail 40. The drawing of the air from the supplemental chamber 39*a* reduces the air pressure therein to such an extent that the normal air pressure at the opposite side of each of the elements 43, 43 causes the said elements to turn on their pivots 44, thereby causing the dampers 50, 50 to turn on their pivots 51, 51, from the position shown in full lines to that shown in broken lines, whereby the passage of air from the chamber 38 to the air nozzle 13 is effectively reduced.

By reducing the flow of air to the nozzle 13, the flow of air through the tuyère openings is also reduced, and the excessive temperature otherwise obtained is effectively prevented.

The elements of the control box 27 also operate in a reverse order as follows: If the resistance of the fuel bed is increased over the nozzle 13, by the addition of new fuel, etc., the pressure at the throat 42 increases and this increase in pressure is transmitted to the chambers 39*a* and the difference in pressure on either side of the elements 43 is reduced, thus preventing further movement of the blades 43 away from each other. If the fuel bed resistance is less in any other portion of the furnace, the motor blades in that portion will tend to move away from each other and this movement is transmitted through the linkages 46 to the motor blades of the section of greater bed resistance, thus tending to move the blades of that section toward each other and open the dampers 50, permitting a greater flow of air through the nozzle 13, to the fuel bed thereover, and maintaining unchanged the total volume of air passing to the fuel bed.

Each motor element 43 comprises a blade 71 to which the pivot bar 44 is secured. A flexible blade 72 is secured at 73 to the blade 71 and has a flange 74 overlying the pivot bar 44, said flange being curved upward at 75, said curved flange extending into a cavity 76 formed in the rail 40 for the purpose of preventing siftings from the fuel bed passing into the chambers 39*a* and settling on the concave surfaces supporting the blades 71.

A nut 77 is secured to the blade 71 and is adapted to receive the threaded end of an adjusting screw 78 which is provided with a groove 79 adapted to receive the movable blade 72, a crank 80 being provided by means of which the screw 78 may be turned and the upper edge of the blade

72 moved relative to the blade 71, for the purpose of determining the proper throat opening between the motor elements and consequently between the chambers 38 and 39.

The blades 72 may be adjusted relative to the blades 71 from the wind-box 12 of the furnace by inserting a rod upward therefrom into the chamber 39, the rod being provided with a suitable eye for engagement with the crank 80.

Adjustment of the rods 55, 55 and subsequently the relation between the motor elements 43, 43 and the dampers 50, 50 may also be effected from the wind-box 12, in a manner as above described, the rod employed being provided with a suitable aperture to engage the hexagonal portions 81 of the rods 55. The rods 55 are each provided at their opposite ends with forked heads 82 provided with threaded openings having right and left hand threads respectively, the rods 55 being provided with similarly formed threads, whereby the turning of the rods 55 effects a change in the relation between each motor element 43 and its respective damper 50.

The pivots 54, 54 and 57, 57 by means of which the rods 55, 55 are respectively connected to the damper lugs 52, 52 and the motor arms 58, 58, may be constructed in a manner illustrated in Fig. 17, wherein the pivot rod 54 is shown as having a depending arm 83 threaded as at 84, for engagement with a suitably threaded socket rod (not shown) which may be employed to remove or replace any of the pivot rods 54, 54 or 57, 57, from the wind-box of the furnace.

The pivots 44, 44 of the motor elements 43, 43 and also the pivots 51, 51 of the dampers 50, 50 may be formed by drilling the opposite ends of the said pivot bars 44, 44 and 51, 51 as at 85 for the reception of plain circular ends 86 of pivot screws 87 threaded into supporting bar 88 secured to the end plates 37 of the control box 27.

When the flow of air to any of the nozzles 13 is altered, it may be desirable, though not essential, to alter, in reverse order, the flow of air to the remaining nozzles of the particular tuyère bank to which these nozzles belong, and for this purpose I have provided means whereby the checking of one or more nozzles of the series contained in the tuyère bank will automatically increase the flow of air to the remaining nozzles, or vice versa, by means of the following mechanism:

Upon reference to Fig. 8, it will be noted that one of the motor blades 43, of each pair, is operatively connected by means of a link 60 to one end of a lever 61. Each of the levers 61 is pivoted intermediate its ends, at a point 62, to one end of a main lever 63 which in turn is pivoted intermediate its ends, at a point 64, to one of the supporting beams 28.

For the purpose of illustration, I have designated the nozzle units in Fig. 8 as *a*, *b*, *c* and *d*. Should the fuel bed be thin or tend to burn out in the spot overlying the unit *b*, for example, with a consequent operation of the motor blades 43 thereof, as described above, the outward movement of the motor blades 43 would have a tendency to rock the lever 61, and thereby cause the motor blades of the nozzle unit *a* to move toward each other. It will be understood that the flow of air through the units *a*, *c*, and *d* is primarily controlled by the density of the fuel bed thereover, and the pressure upon the blades 43 thereof would vary accordingly. Therefore, the outward movement of the blades of the unit *b* would cause the blades of the units *a*, *c* and *d* to move toward each other a distance varying in accordance with the variation of pressure on these blades, by means of the lever 61 being turned on its pivot 62, the blades 43 of the unit *a* establishing a resistance to the inward movement of the end of the lever 61 connected thereto and this established resistance would cause the lever 63 to turn on its pivot 64 thereby causing the pivot 62 of the lever 61, lying intermediate the units *c* and *d*, to move inward and by means of the lever 61 and links 60, 60 the pair of blades 43 in each of the units *c* and *d* would move toward each other, a distance substantially equal to the movement of the blades of the unit *a*, whereby the dampers 50, 50 of each of the units *a*, *c* and *d* would be caused to turn on their pivots, and thereby increase the distance intermediate their upper edges, permitting an increased flow of air from the respective chambers 38 to the nozzle 13 communicating therewith.

If the fuel-bed over the unit *b* becomes dense or is increased in thickness, the flow of air through this unit is decreased, with a consequent corresponding diversion of air to the other units. The increased flow through the latter units tends to effect a re-adjustment of the motor vanes as described above, this re-adjustment tending in turn to effect an opening up of the dampers in the section *b*, through the balance lever connection, to admit more air to that portion of the fuel-bed. Retardation of flow in the unit has caused the pressure in the chambers 39*a* to build up and to approach the volume of pressure in the chamber 39, which makes actuation of the motor vanes through the balance lever mechanism relatively easy.

The operation described relative to the thinning or burning out of the fuel bed or to an increased thickness or density in that section of the fire bed controlled by the unit *b* would be effective in a similar manner upon the remaining units of the series regardless of which one of the units should become operable in event of the fuel bed thinning or burning through in the section of the fire bed controlled by that particular unit.

It will be understood that the flow of air through each and every one of the control units is primarily controlled by the resistance offered by the bed of fuel overlying the particular section of the fire bed which that particular unit communicates with, and should the fuel bed overlying each of the units vary with respect to the other units the amount of air passing in that particular section of the fire would vary in accordance therewith.

As illustrated in Figs. 2 and 7, the tuyère bank, immediately adjacent each side wall 2 of the furnace, is composed of half section units 7*a*, 7*a*. In accordance with the half section tuyère units, the control box 27*a*, therefore, likewise contains but a single motor blade 43 and a single damper 50 which co-operates with a side wall 36*a* to reduce the air flow through the control box 27*a*, otherwise the operation of the half section is substantially similar to the operation of the complete units.

In each control box 27, 27*a* the lower rail 45 thereof is pivoted at 45*a* in the end walls 38, 38 thereof, for the purpose of permitting the rail to be turned or dumped, to remove any ash or siftings from the upper side thereof, which may accumulate thereon. For the purpose of dumping the rails 45, each rail is provided with a lug 65 connected by means of a rod 66 with opposite ends of a lever 67 secured to a shaker rod 68,

pivotally mounted in suitable bearings 69 formed on brackets 70 secured to the supporting beams 28, 28. The shaker rod 69 extends beyond the front wall of the furnace and is provided with a crank 70*a*.

In Fig. 10, I have illustrated diagrammatically a method of connecting the motor blades 43 of all the control boxes 27 for the entire fire bed, in such a manner that a variation in the air flow through any of the control boxes thereof will automatically affect the flow in the remainder of the boxes in a reverse order. As illustrated in said figure, the motor blades 43 of each pair of adjacent control boxes are connected to the lever 61 in the same manner as illustrated in Fig. 8. One lever 61 of the side tuyère bank is pivoted to a lever 75 at 62*a*, the lever 75 being pivoted at 76 to one end of the main balance lever 63*a*, pivoted at 64*a* to the beam 28 in the manner above noted. The opposite end of the lever 75 is connected by a link 77 to a stationary pivot 78. The other lever 61 of the side tuyere bank is connected in the manner above noted with the following exception, the lever 75*a* is connected by a link 77*a* to the lever 75*b* of the control box of the first intermediate tuyère bank as illustrated, and so on throughout the entire fire box, the last lever 75*c* of the opposite side of the tuyère bank being anchored through a link 77*a* corresponding to the link 77 at the other side of the fire box. By interconnecting the control boxes of the several tuyère banks, any movement of one of the motor blades will affect the position of each of the other blades throughout the stoker and subsequently the damper which it controls with a consequent adjustment of the amount of air passing through that particular control box.

In the form of the invention shown in Figs. 11, 12, 13, 14, 15 and 16, the control boxes 27*b* are hung below the plates 6, 6 by means of bolts 99, and the nozzles 13*b* are formed by plates 100, 100 extending transversely between the said plates 6, 6.

In this form of the device, the dampers 50*b*, 50*b* are vertically arranged and are both connected by rods 55*b*, 55*b* to a single operating motor blade 43*b*.

The control box 27*b* comprises side walls 101, 101, end walls 102, 103, a top wall 104 and a transversely and vertically extending stationary partition 105.

The dampers are pivotally mounted in the top wall 104 and the partition 105 as indicated at 106 and 107 respectively. The motor blade 43*b* is pivotally hung at 108 in the end wall 103, its lower edge lying adjacent a curved bar 45*b* located in the lower portion of the box 27*b* intermediate the side walls 101, 101.

A throat 42*b* is formed between the stationary partition 105 and a movable partition 110. The partition 110 is adapted to be moved to any position including and intermediate the positions shown in full and broken lines respectively in Fig. 12, for the purpose of determining and regulating the normal flow of air passing into the control box. The partition also functions as a means for causing a differential pressure to be developed in the control box 27*b*, whereby the motor blade 43*b* is operated.

If the fuel bed becomes dense, the air pressure, due to the retardation of the flow, builds up between the partition 110 and the blade 43*b* whereby the dampers 50*b*, 50*b* may readily be opened wider to increase the flow of air through the control box 27*b* to the nozzle 13*b* by action of the motors of the other control units working through the balance lever mechanism. On the other hand, if the fuel bed becomes thin and the air flow increases, a partial vacuum is formed between the blade 43*b* and the partition 110 causing the blade to move in a direction to effect a closing of the dampers 50*b*, 50*b*, and consequently checking the flow of air to the nozzle 13*b*.

The top wall 104 of the control box 27*b* is open from the point wherein the dampers 50*b*, 50*b* are pivoted thereto to the end wall 102, thereby forming an opening 111 providing communication between the interior of the control box 27*b* and the nozzle 13*b*. Directly below this opening 111, an ash receiving chamber 112 is formed, between the end wall 102 and the fixed partition 105. The ashes accumulating in the chamber 112 may be removed through openings 113 formed in the bottom 114 of said chamber. These openings 113 are normally closed by a rotatable plate 115 pivotally mounted at 116 to the bottom 114. The plate 115 is provided with openings 117, which are adapted to be brought into registry with the openings 113 of the bottom 114.

The movable partition 110 is provided with a plate 120 rigidly connected therewith and slidably mounted in the side walls 101, 101 of the control box 27*b* for the purpose of closing the space between the bar 45*b* and the movable partition 110 when the same is moved from its full line position shown in Fig. 12.

I claim:

1. In a stoker furnace, a fuel-supporting structure comprising a plurality of beams defining the sides of alternately arranged tuyère and retort sections, means for supplying combustion air under pressure to said tuyère sections, said means comprising a plurality of nozzles connected with said beams, means operatively associated with said nozzles for regulating the flow of air therethrough, and means for supporting said regulating means on said beams and providing for relative movement between the regulating means and the said beams whereby said regulating mechanism is not affected by distortion of the beams.

2. In a stoker furnace, a plurality of beams defining the sides of alternately arranged tuyère and retort sections, and means for supplying combustion air under pressure to said tuyère sections, said means comprising a plurality of nozzles arranged to direct said air to different parts of each of said tuyère sections, throttling mechanism for each of said nozzles, and means for suspending said nozzles and their associated throttling mechanisms from said beams, said suspension means affording substantially free relative expansive adjustment between the beams and said throttling mechanisms.

3. In a furnace comprising a plurality of tuyère structures, a series of air chambers, formed under each of the tuyère structures, an air nozzle for each of said air chambers, a control device for the air passing through each nozzle including a damper, and a motor cooperatively connected to the damper, and means operable from exterior the furnace for removing accumulated ash and siftings from the interior of each control device to permit unobstructed operation of the motor elements.

4. In a furnace comprising a plurality of tuyère structures, a series of air chambers formed under each of the tuyère structures, an

air nozzle for each of said air chambers, said nozzles communicating respectively with different portions of the tuyère structure, and a control device for the air passing through each nozzle including a damper and a motor operatively connected to the damper, said motors being located in the respective chambers in positions transversely offset from said nozzles whereby said motors are maintained substantially free from siftings passing through said nozzles from the fuel-bed.

5. In a furnace, a tuyère structure, nozzles depending in said structure and connected with different portions of the latter respectively, and means for controlling passage of air through said nozzles comprising a damper for each nozzle and a motor cooperatively connected to the damper, said motor being located transversely of the lower end of said nozzle whereby the motor is maintained substantially free from siftings passing through said nozzle from the fuel-bed, a trap positioned below each of said nozzles, and means for clearing said traps of accumulated siftings.

6. In a furnace, a tuyere structure, a plurality of air chambers formed under said structure, and a nozzle extending from each of said chambers and respectively to different portions of said structure, a control device for the air passing through each nozzle including a damper and a motor cooperatively connected to the damper, said dampers and motors being positioned in the respective chambers in positions substantially transversely offset from the lower ends of said nozzles, a trap in the bottom of each of said chambers underlying the respective nozzles, and means for emptying said traps of accumulations of siftings passing from the fuel-bed through the nozzles.

7. In a furnace comprising a plurality of tuyère sections having nozzles attached to their under side in combination with a series of control devices for regulating the flow of air to each of said tuyère sections, a frame supporting each series of said control devices, and means for mounting said frame to permit relative expansive movement between the control devices of each series and the respective tuyère section.

8. A furnace structure comprising a plurality of tuyère sections having nozles attached to their under sides in combination with control devices for regulating the flow of air to each of the tuyère sections through the said nozzles, and means for supporting said control devices to permit relative expansive movement between the control devices and the said tuyère sections and nozzles, said means comprising a frame on which said control devices are rigidly secured, and horizontally and vertically disposed pivots on the furnace structure beneath said tuyère sections for supporting the opposite ends of the said frame.

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