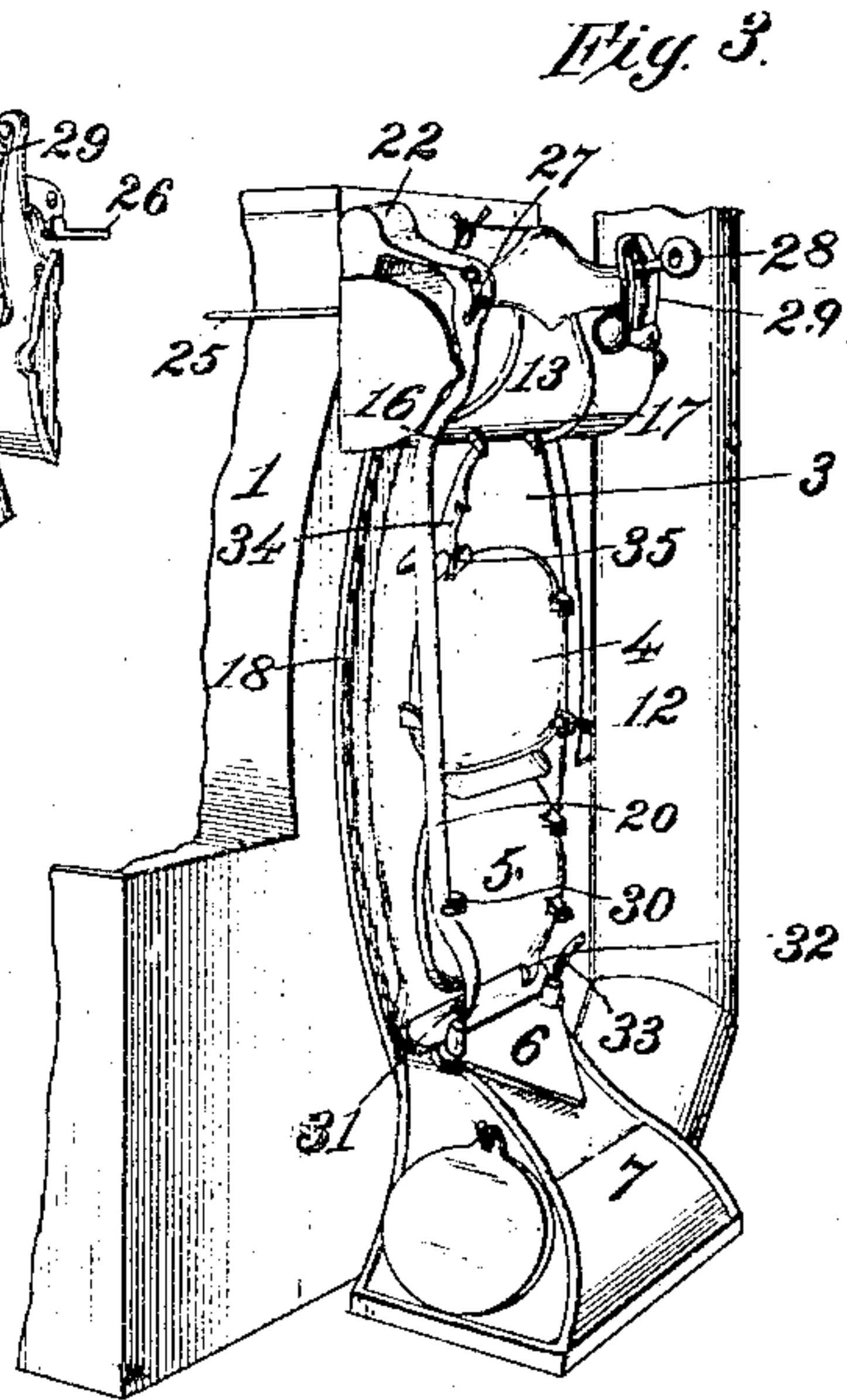
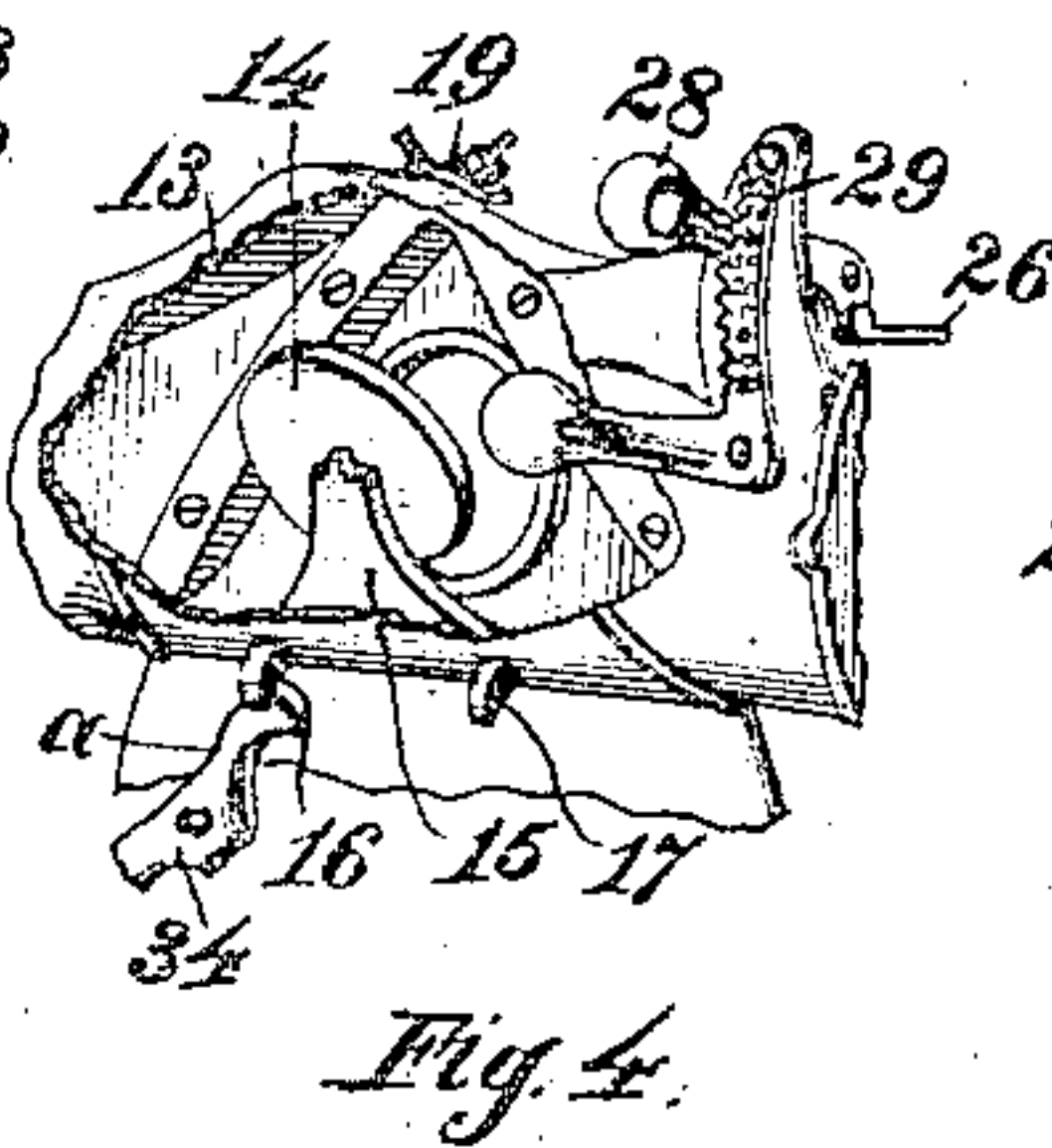
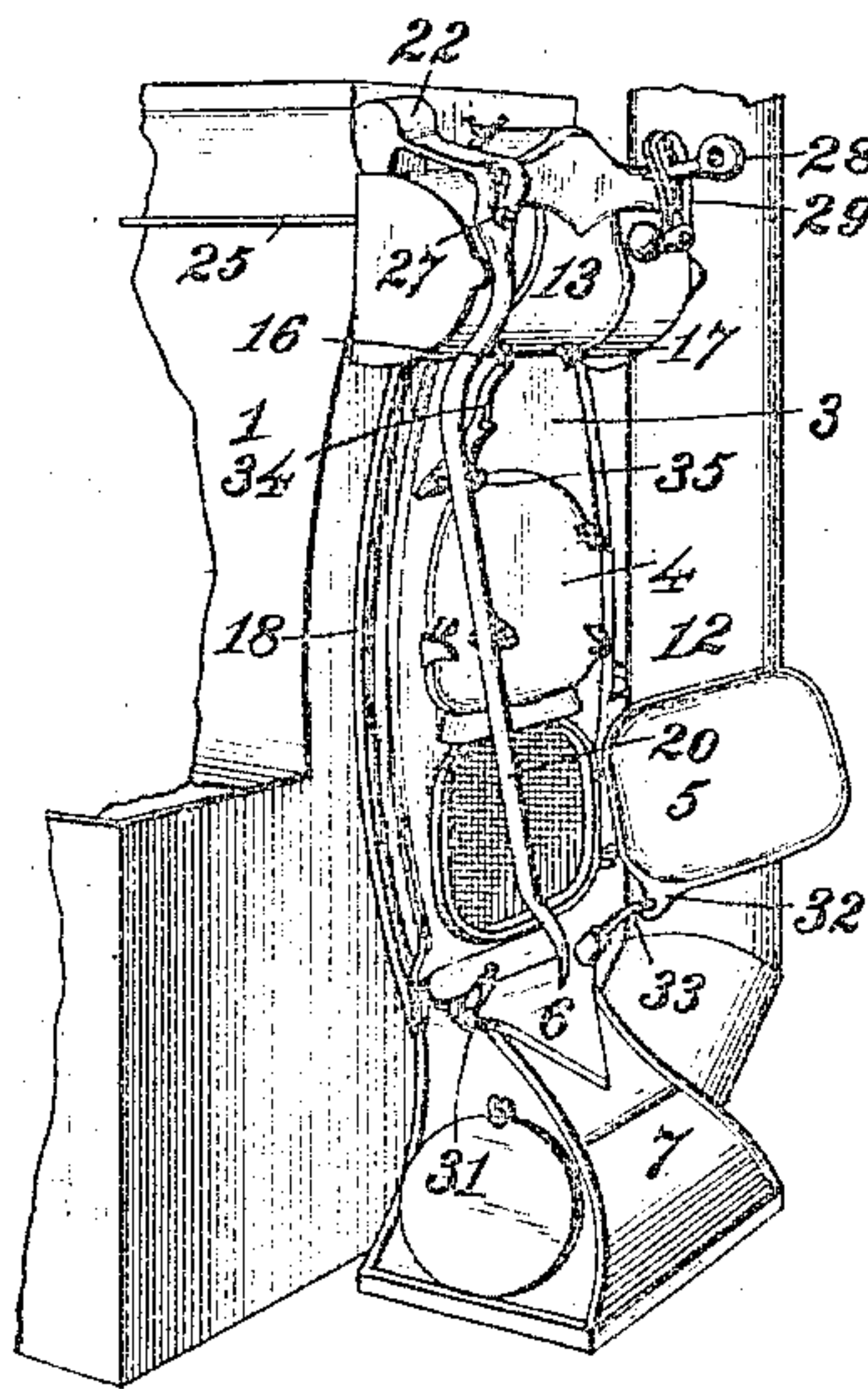
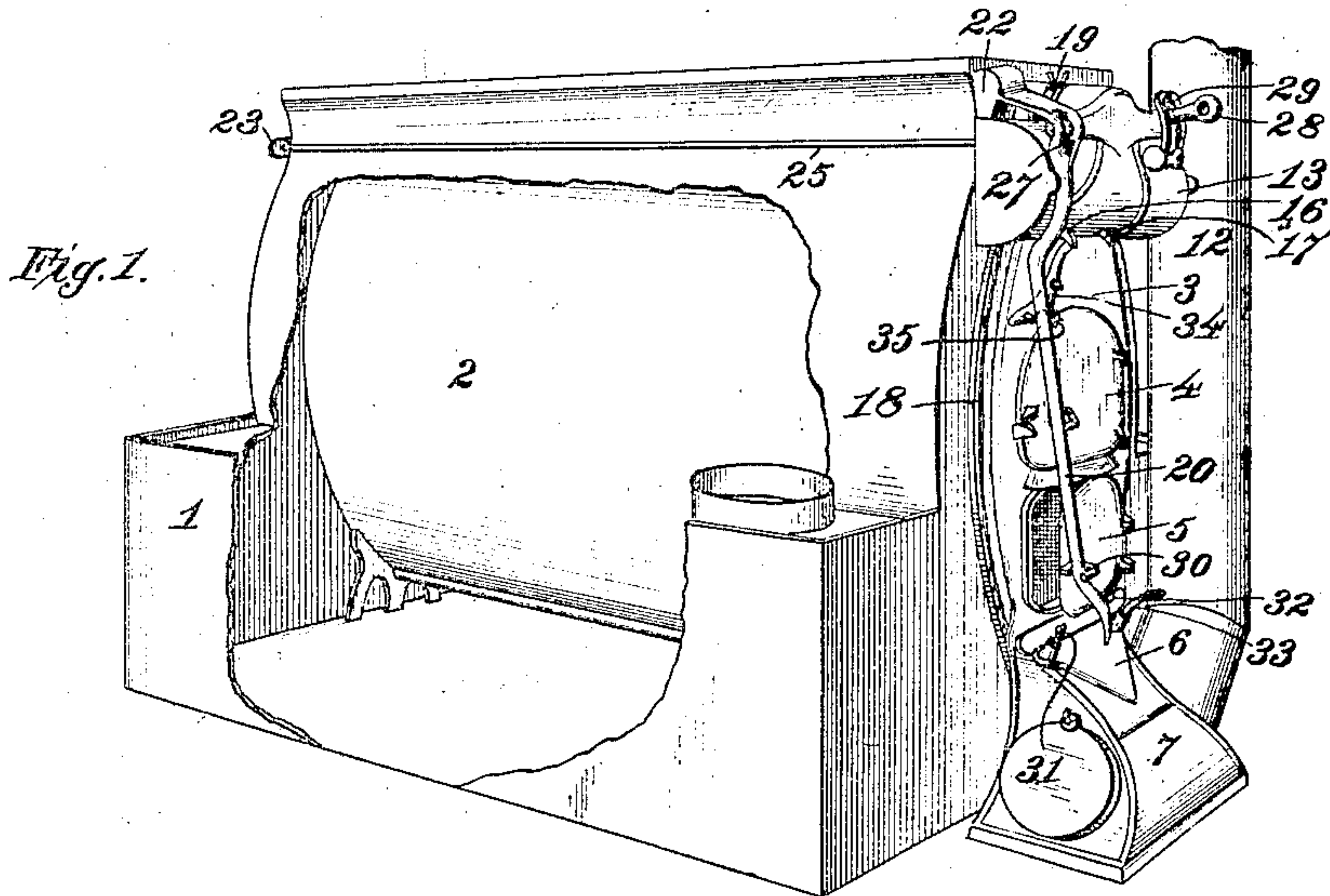


M. J. & H. B. FARQUHAR.
 SELF REGULATING FURNACE.
 APPLICATION FILED MAY 16, 1904.

923,346.

Patented June 1, 1909.

2 SHEETS—SHEET 1.



WITNESSES:

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Fig. 5.

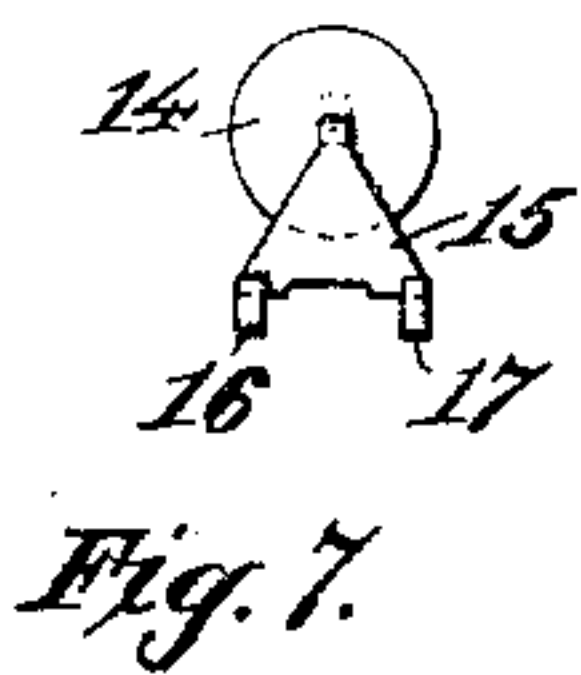
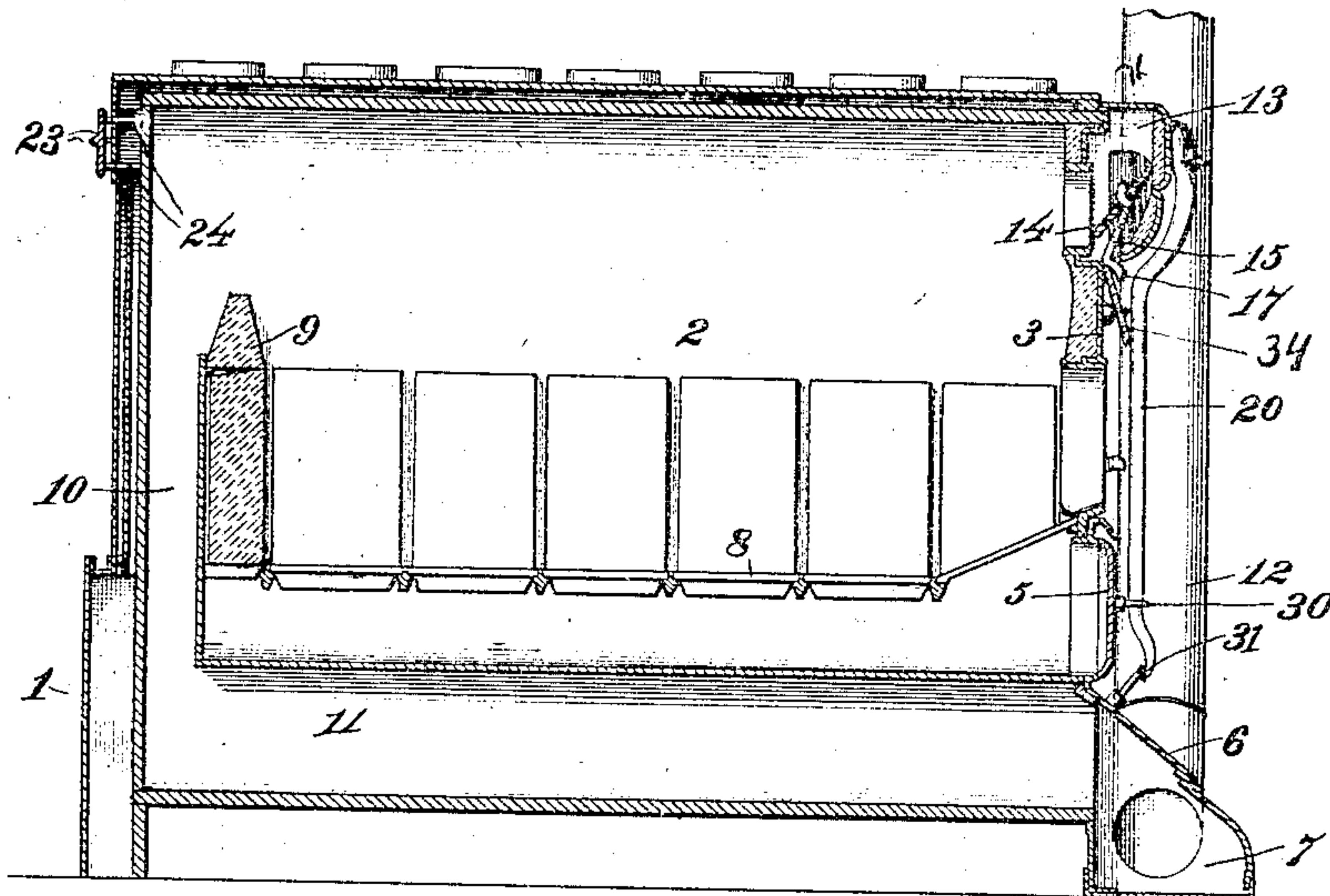


Fig. 7.

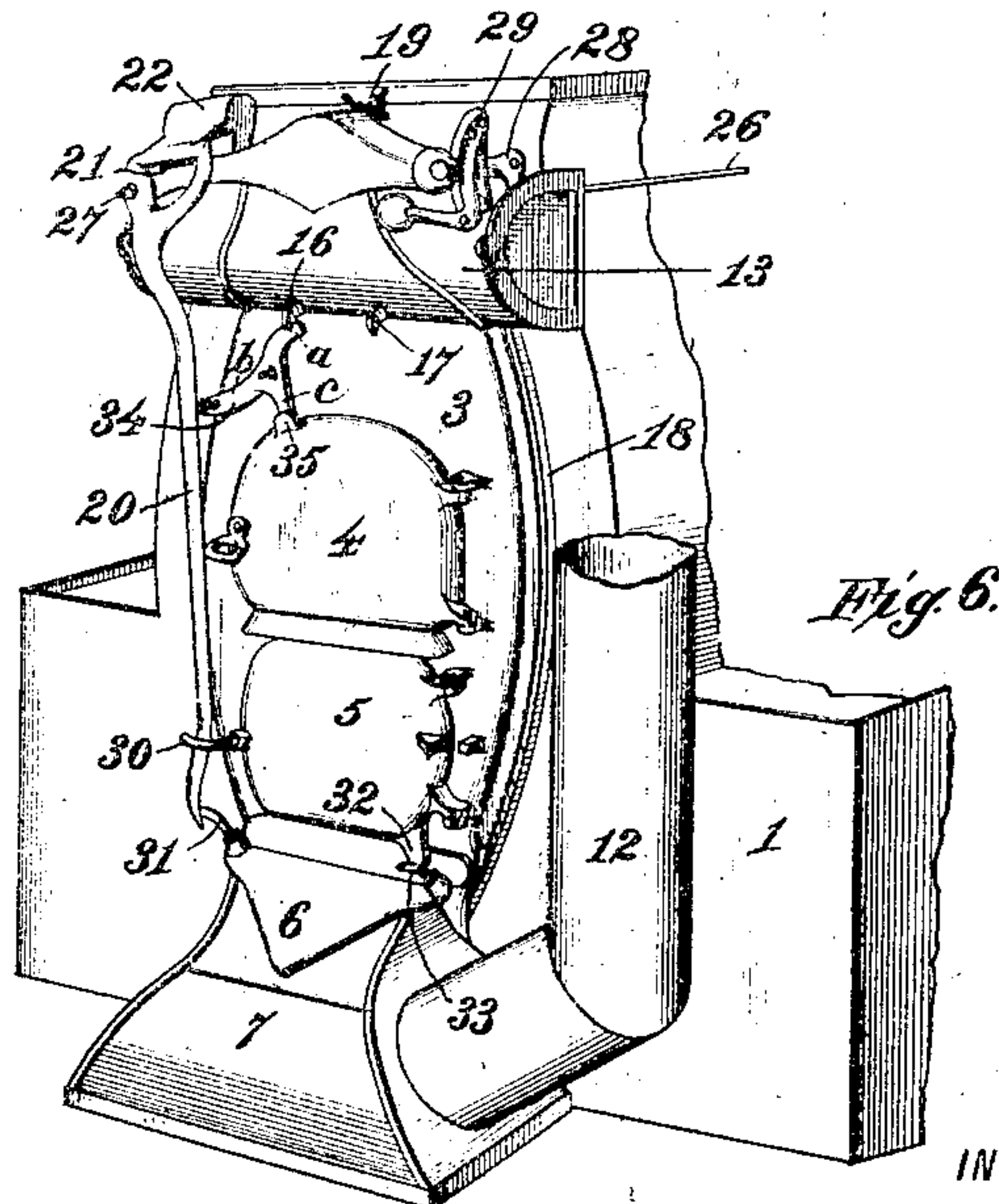


Fig. 6.

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UNITED STATES PATENT OFFICE.

MILTON J. FARQUHAR AND HENRY B. FARQUHAR, OF WILMINGTON, OHIO, ASSIGNORS, BY
DIRECT AND MESNE ASSIGNMENTS, TO THE FARQUHAR FURNACE COMPANY, OF WIL-
MINGTON, OHIO, A CORPORATION OF OHIO.

SELF-REGULATING FURNACE.

No. 923,346.

Specification of Letters Patent.

Patented June 1, 1909.

Application filed May 16, 1904. Serial No. 208,218.

To all whom it may concern:

Be it known that we, MILTON J. FARQUHAR and HENRY B. FARQUHAR, citizens of the United States, residing at Wilmington, in the
5 county of Clinton and State of Ohio, have invented certain new and useful Improvements in Self-Regulating Furnaces; and we do hereby declare the following to be a full, clear, and exact description of the invention,
10 such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to stoves and furnaces, and particularly to devices for controlling the temperature of the fire-box and regulating the combustion of the fuel.

In the accompanying drawings, which are to be taken as a part of this specification, we have represented our invention embodied in
20 a hot-air furnace of horizontal type, of similar construction and design to the furnace shown and described in our copending application for patent, filed March 15, 1902, Serial No. 98445; but it will be understood
25 that the invention is not limited to this or any specific embodiment and is capable of incorporation in various styles of stoves and furnaces as well as susceptible to modifications in details of construction and arrange-
30 ment. The following description will therefore be given with reference more particularly to the illustrated furnace, embodying our invention, which will thereafter be defined in the claims.

35 The principal objects of the invention are: to obtain better control of the combustion, by means of the draft, both in starting the fire and when the furnace is in operation, with a view to promoting combustion, gener-
40 ating a maximum amount of heat from the fuel, and utilizing practically all the heat without waste; to automatically regulate the draft-openings, so as to maintain a constant temperature, prevent waste and damage
45 through carelessness or accident in attending to the furnace, render the furnace self-regulating, and especially prevent accidental overheating; and to arrange the various doors, openings and regulating devices where
50 most effective and convenient to the one managing the furnace.

Figure 1 of the drawings is a perspective view of the aforementioned furnace, embody-

ing our invention, with part of the outside casing or air-box broken away. In this
55 view, the ash-door and automatic controlling mechanism at the front are represented in the position assumed when the furnace is at a low temperature. Fig. 2 is a fragmentary
60 perspective view of the furnace-front, showing the ash-door open wide, as when starting the furnace, and held so by engagement of a lug on the ash-door with a finger or lug on the check-valve of the lower smoke-box at the front of the furnace. Fig. 3 is a view
65 similar to Fig. 2, showing the automatic governing mechanism, when it has been moved, owing to an increase in temperature of the fire-box, and has released or closed the
70 ash-door, while it has raised the said check-valve or lid of the lower smoke-box. Fig. 4 is a perspective view of a fragment of the upper furnace front, showing the front of the upper smoke-box broken away and its damper open. Fig. 5 is a central longitudinal
75 vertical section of said furnace. Fig. 6 is a perspective view of the furnace front, looking at the opposite side to that shown in Figs. 1, 2 and 3. In this view the doors and governing devices are in the positions assumed when
80 the furnace is running and at an ordinary temperature. Fig. 7 is a detail view of the damper in the upper smoke-box.

The numeral 1 denotes the outer casing of the air-box; 2 the fire-box, which is of hori-
85 zontal tubular form and closed at the rear; 3 the front plate of the fire-box, outside the front wall of the air-box; 4 the fire-door; 5 the ash-door; 6 the check-door or valve of the smoke-box 7, which latter is located at
90 the lower front of the furnace; 8 the grate; 9 the rear bridge-wall; 10 a passage or flue from the fuel-space down behind the bridge-wall, or between it and the back-plate of the fire-box; 11 a smoke-passage or flue extending
95 from said passage 10 forward along or under the ash-pan to the smoke-box 7, which latter has an outlet to the smoke-pipe or chimney 12 located preferably below or at the base of the front end of said passage 11, so as to draw
100 off only the coolest lower strata of the products of combustion. It will be observed that the furnace represented is of the indirect draft type; for the smoke and products of combustion pass from the fire over the rear
105 bridge-wall, down the back flue or passage

10, and forward through the passage 11 to the smoke-box 7. Air is of course supplied to the fuel from the ash-door 5, passing up through the grate; and in this type of furnace preferably an air-blast is also admitted from the rear of the ash-pan up through a passage in the bridge-wall to the fire-space above the fuel, where it meets the gases at a heat sufficient to ignite the mixture. The construction thus far described is substantially similar to that shown and described in our aforesaid copending application Serial No. 98445; this particular furnace, to which our invention is especially adapted, being illustrated for the purpose of setting forth the invention most clearly and satisfactorily.

At the upper part of the fire-box is an upper smoke-box 13, communicating with the smoke-pipe 12. This upper smoke-box is shown as a casing extending across the upper part of the front-plate 3, from which it projects, and is joined at one end to the smoke-pipe, the opposite end being closed. However, the smoke-pipe may be located at either side of the front-plate, and joined to either end of the upper smoke-box and also to either end of the lower smoke-box, each smoke-box being constructed to permit this change in location of the smoke-pipe. The opening from the fire-box into the upper smoke-box is controlled by a damper or valve 14, consisting of a plate carried by an upright tilting lever 15, to which said plate is loosely attached as by means of a bent pin. Said lever 15 is fulcrumed at the bottom of said smoke-box and has short trip-lugs or tail-pieces 16 and 17, projecting outward through slots or openings in the lower wall of said smoke-box. The weight of the damper or plate 14, when in front of the fulcrums of the lever, will hold it open as in Figs. 4 and 5; and, when tilted over to the opposite side of or behind said fulcrums, will carry it against the draft-opening and hold it there. The damper may be operated by the trip-lugs or fingers 16, 17, such operation being both manual when desired and also automatic, by means of the heat-governing mechanism hereinafter described. This upper smoke-box, with the valve-controlled draft-opening, provides a direct draft to the smoke-pipe at the upper front or part of the fire-box, which may be availed of when necessary or desired. The damper is opened when the fire is started, or when the fire is burning low and it is necessary for the furnace to draw hard in order to increase the rate of combustion quickly; and it is closed when the furnace is at high heat or running at its regular temperature, so that only the indirect draft is used, which is far more economical. The direct damper draft is also opened when the operator opens the fire-door, so as to prevent smoke from flying out through the fire-door.

Coming now to the automatic governing-

mechanism, 20 denotes a lever depending from its fulcrum 21 at one side of the front-plate and held outward or with its lower end away from the furnace-front by means of a weight 22. This lever, which controls the various dampers or doors automatically, is actuated to swing inward by the rising temperature of the furnace; for which purpose we preferably utilize, as in the furnace of our other application Serial No. 98445, the force of expansion of the fire-box when heated against an inclosing frame not affected by the heat. Said frame as shown consists of a rear cross-piece 23, having pins or projections 24 that bear against the back of the fire-box to receive its thrust when expanded by the heat; and longitudinal connecting rods 25 and 26 connected to opposite ends of said cross-piece; one of which rods 25 is connected to the lever 20 a little below its fulcrum, as at 27; while the other rod 26 is connected to an adjusting lever 28 having a tooth engaging a graduated locking rack 29, by means of which the lever 28 can be adjusted to extend or shorten the frame so as to cause the expansion of the fire-box to act on the frame at different temperatures. The adjusting lever may be operated by suitable connections from an upper room in the building if desired. The frame-work is set outside the air-box, so as to be practically unaffected by the temperature of the furnace. It may surround the air-box as described, or may occupy one side only, the adjusting device being suitably located to correspond. It is understood that when the heat of the fire-box causes it to expand against the rear cross-piece 23, the rod 25 draws the lever 20 inward with sufficient force to overcome the weight.

The lever 20, in its inward and outward movements, controls the ash-door 5, the check-door or valve 6 in the lower smoke-box, and the damper or valve 14 in the upper smoke-box; for which purpose means substantially as follows or other suitable devices are provided.

The ash-door 5 is in this instance self-closing, by arranging its hinges eccentrically or with its upper hinge behind its lower one. A finger 30 projecting from the door engages the lever 20, holding the door partly open while the lever remains outward; but as the lever is drawn inward the door follows it and is allowed to gradually move inward or close. Other equivalent arrangements may of course be adopted, such as hinging the door at the top instead of at the side as shown; or the door may be so connected with the lever as to be positively moved thereby both in opening and closing. Thus, as the temperature of the furnace is raised by the combustion of the fuel, the door is gradually moved inward to a position needed to maintain the desired temperature, according to the adjust-

ment of the governing mechanism. Any fluctuation from this temperature will be avoided; since a greater heat would cause restriction of the ash-door opening, while any reduction in temperature would cause the lever to move outward and open the door to a greater extent. A constant temperature, during the ordinary run of the furnace, is thus automatically maintained; by the drawing back or the relaxing of the rod 25 which is connected to the lever 20.

The check-door 6 of the lower smoke-box, which in this instance is hinged at its upper end, though not essentially so, has a finger or projection 31, standing behind the lower part of the lever 20 and adapted to be engaged thereby when the lever is drawn still farther inward, or after said lever has allowed the ash-door to close. The effect of such engagement is to raise or open slightly the check-door or valve 6, thereby admitting a draft directly to the smoke-pipe or chimney, to relieve or check the draft thereto from the fire-box and consequently lower combustion. Thus should the temperature of the fire-box rise higher than desired, notwithstanding the closing of the ash-door, as in moderate weather or when the fire is allowed to burn high by thoughtlessness in leaving open the ash-door, the check-door will be opened and cause a reduction of temperature.

The ash-door can be held wide open, when desired, by means of a lug 32 thereon adapted when the door is so opened to engage a finger 33 projecting from the check-door so as to permit the lug 32 to move outwardly past it but abut it when moved back. In starting the fire, it is desirable thus to open the ash-door all the way; but should the attendant through accident or forgetfulness go away without closing the ash-door, the automatic governing devices will take care of this; for as soon as the temperature of the furnace rises sufficiently to draw the lever 20 inward against the finger 31 on the check-door, said check-door will be raised, releasing the ash-door and allowing it to close; while at the same time the draft admitted to the lower smoke-box checks the combustion in the fire-box and lowers the temperature. After this action occurs, as the temperature subsides the lever 20 will gradually be relaxed to open the ash-door the slight amount required to preserve the desired constant temperature. The introduction of this feature makes it desirable to employ a self-closing ash-door, as shown, rather than one positively closed by the inward movement of lever 20.

The direct draft-valve 14 in the upper smoke-box is operated by lever 20 through the medium of a tri-armed centrally fulcrumed lever 34; one arm *a* of which projects under one of the trip-lugs or tail-pieces

16 of the valve-carrying lever 15, another arm *b* of which projects behind the lever 20, and the third arm *c* of which projects behind a lug 35 on the fire-door 4. In starting the fire, the draft-valve 14 is open. On closing the fire-door, unless it be closed gently, the action of lug 35 on the arm *c* of tri-arm lever 34 will cause the upper arm *a* thereof to engage the trip or tail-piece 16 and thus tilt the lever 15 to close the draft-valve; which however can again be opened by bearing down with the hand against one of the trips or tail-pieces 16 or 17. The direct draft-valve 14 thus being open, the combustion increases, gradually raising the temperature of the furnace, which causes the lever 20 to be drawn inward by expansion of the fire-box so as to abut the arm *b* of said tri-arm lever 34; thus rocking said lever and by engagement of the arm *a* against lug 16 closing the direct draft-opening; after which the combustion continues steadily under the indirect draft. This engagement of arm *b* by lever 20 transpires before the lever 20 has moved inward sufficiently to allow the ash-door 5 to close. The tri-arm lever 34 has preferably a central ball-seat fulcrum, as shown in Fig. 5; allowing a universal movement, so that movement of one arm will affect the two others, or if one arm be held stationary the device may be rocked on its seat with respect to the other two arms. Thus, when the fire-door is closed, the arm *c* being caught, the device is practically transformed to a two-armed lever *a b*, with the arm *b* in position for early engagement by lever 20, so that pressure against arm *b* will rock arm *a* against lug 16 and close the direct draft-valve. However, should a simple double-arm lever be employed, when the lever 20 so engaged arm *b* it would not be possible to open the direct draft valve, if this should be desired while the furnace is in full blast. But by means of the tri-arm device, if it be desired to open the direct draft-valve during such operation, it is simply necessary to open the fire-door 4, thus releasing arm *c*. The device may then be considered a two-arm lever *a c*, and the arm *c* being released will allow the attendant to bear against one or both of the trip-lugs 16, 17, and thus open the direct draft-valve. The valve operating mechanism here described is desirable for its efficiency and simplicity, but it will be understood that the direct-draft valve may be automatically operated from lever 20 through any suitable connections.

To summarize the operation of the automatic governing mechanism, let us assume that the furnace is set for freezing weather, or thirty degrees Fahrenheit; that is the adjusting lever 28 is set at that point, so that the frame 23—25—26 is set to permit a certain expansion of the furnace before it affects the lever 20. Should the adjusting lever be set

for a higher temperature, as at fifty degrees, the connections 26—23—25 would be shortened, causing the expansion of the firebox to act sooner. Should it be set at a lower temperature, as at zero; said connections 26—23—25 would be lengthened, causing the fire-box to expand still more against the back cross-piece 23 before drawing inward said lever 20.

Now, the furnace being set for the desired temperature, say thirty degrees, the fire is started with the direct draft-valve 14 and ash-door 5 open, and with the check-door 6 of the lower smoke-box closed. After starting the fire, and when ready to leave the furnace, the attendant should move inward the ash-door 5 till its finger or projection 30 engages the outwardly suspended lever 20, thus limiting the inward movement of the door and maintaining a proper opening for the draft. As the temperature of the fire-box rises, the force of its expansion against the rear cross-piece 23, by virtue of the connecting rods 25 and 26, gradually draws the lever 20 inward. First, said lever engages the arm *b* of the tri-arm lever 34, thus by virtue of the connections *a* and 16 tilting the lever 15 and closing the direct draft-valve 14, throwing the products of combustion entirely to the indirect draft-flue. The ash-door 5 follows the lever 20 inward, until only the necessary draft-opening is left to maintain the desired furnace temperature. Any rise above this temperature will be compensated for by the restriction of the ash-door opening, any decrease by enlargement thereof, due to action of lever 20; so that the desired temperature will be steadily maintained. Now should the operator have forgotten to move inward the ash-door, and gone away leaving it held open by the lug 32 engaging finger 33 on the check-door 6, the resultant strong draft will produce a higher rate of combustion, raising the temperature and expanding the fire-box sufficiently to draw in the lever against the lug 31 on the check-door, thus lifting the latter and checking draft from the fuel, while releasing the ash-door and allowing it to close. The furnace will then relax to its desired temperature, and allow the lever 20 to open the ash-door the slight amount necessary to maintain the same.

Should it be desired to maintain a low furnace temperature, as in mild weather, the frame or connections 23, 25, 26 being properly shortened, the expansion of the fire-box will act immediately, draw the lever inward to close the ash-door and maintain the check-door slightly raised.

We make no claim herein to improvements in the structure of the furnace *per se*, since the same forms the subject-matter of our divisional application filed January 30, 1905, Serial No. 243 400.

We claim as our invention and desire to secure by Letters Patent of the United States:

1. In a furnace or heater, the combination with a fire-box having an indirect draft-passage with its smoke-outlet at the base of the front of the heater and having also a direct smoke-outlet at the upper front part of the heater, and a damper therefor, said fire-box having a front ash-door for controlling the supply of air for combustion, a lever operating directly on said door for opening and closing it, mechanism controlled by the temperature of the fire-box for operating said lever, and means directly engaged by said lever for operating said damper to close the upper direct smoke-outlet after combustion has progressed, a common smoke-pipe in communication with both smoke-outlets, and a check-valve for controlling the inlet of air to said pipe at the base of the heater, and said lever operating directly upon and controlling said check-valve.

2. In combination with a fire-box having an indirect draft-passage to and from its lower front and a direct draft-passage through its upper front, and provided with a front ash-door, a check-valve controlling admission of air to said indirect draft-passage, and a damper controlling said direct draft-passage, of a pendent lever at the front of said fire-box, means on said fire-box actuated by expansion thereof to move said lever inward or toward the fire-box, means actuated by said lever for moving said damper to close said direct draft-passage when the lever first moves inward, connection between said lever and ash-door whereby the latter is controlled by said lever, and means actuated by said lever for opening said check-valve when the lever continues its inward movement after the closing of said ash-door.

3. In a furnace, the combination of the fire-box having at its front upper and lower smoke-boxes respectively adapted for connection with a smoke-pipe, there being an indirect draft-passage into the lower smoke-box and a direct draft-passage into the upper smoke-box, a damper for said latter passage, an upright tilting lever carrying said damper, said tilting lever having at its foot a tail-piece projecting out through said smoke-box, a heat-controlled lever mounted at the front of the fire-box and actuated by rise of heat to move inward or toward the fire-box, an intermediately-fulcrumed lever having one arm engaging said tail-piece of the damper-carrying lever and whose other arm is adapted to be engaged by said heat-controlled lever when the latter is first moved inward, whereby said damper is caused to close said direct draft-passage, an ash-door on the front of the fire-box having a finger engaging said heat-controlled lever, whereby said ash-door is controlled by the motion of said lever, and

a check-valve on the lower smoke-box having a projection adapted to be engaged by said heat-controlled lever on continued inward movement thereof, whereby the check-valve is opened.

4. In a furnace, the combination with the fire-box having a front fire-door and upper smoke-box, there being an opening into said smoke-box from the fire-box, of a damper for said opening, a rocking lever carrying said damper and provided with a tail-piece, a governing lever and heat-controlled means actuating the same, and a tri-armed centrally-fulcrumed lever having one arm adapted to be engaged by the fire-door when closed, and a second arm adapted to be engaged by said governing lever when moved by rise of temperature, and a third arm adapted when the second arm is so engaged to trip said tail-piece and thereby close said damper.

5. In a furnace, the combination of a fire-box having a self-closing ash-door mounted on lateral hinges so as to be swung from closed position to a position at one side of the door-way, a pendent lever at the opposite side of said door-way adapted to move inward and outward or to and from the heater, heat-controlled means operating on said lever, and a finger projecting from the ash-door at the side opposite its hinges and overlying said lever, whereby the ash-door follows the inward and outward movements of the lever.

6. In a furnace or heater, the combination of a fire-box having a front ash-door, a smoke-pipe communicating with the bottom of the fire-box below said ash-door, a check-valve located below said ash-door for controlling admission of air into said smoke-pipe, a pendent lever mounted on the front of the heater adapted to move inward and outward and connected with the ash-door for controlling the same, said lever having its foot engaging said check-valve for controlling the same, and means controlled by expansion and contraction of the fire-box for operating said lever.

7. In a furnace, the combination with the fire-box having a self-closing ash-door, of a

pendent lever, heat-controlled means actuating said lever to move inward and outward according to rising and lowering temperature, said ash-door having a finger overlying said lever, whereby the ash-door will move to and fro with the inward and outward motions of the lever, a check-valve adjacent to the ash-door, means whereby the ash-door can be held ajar by the check-valve when the latter is closed, and means whereby said lever on moving inward a certain distance will open the check-valve and thereby release the ash-door.

8. In a furnace, the combination with the fire-box having a self-closing ash-door, of a pendent lever adjacent to said ash-door, a weight acting on said lever to normally hold it outward from the fire-box, heat-controlled means for moving said lever inward, said ash-door having a finger or projection overlying said lever, whereby said ash-door will follow the inward motion of the lever, a smoke-pipe having direct and indirect communication with the fire-box respectively above and below said ash-door, a direct-draft controlling damper designed to be left open on starting combustion, and means whereby said lever closes said damper on inward movement of the lever after combustion has progressed.

9. In a furnace, the combination of a pendent lever, a weight acting upon the upper end of the same tending to hold the lower end outward, means actuated by heat for moving the lever inward, and a self-closing ash-door having a finger or projection overlying the lever and adapted to follow it inward, a smoke-flue, and a hinged check-door for admitting air to the flue below the ash-door having a lug or finger thereon adapted to be engaged by said lever when drawn inward.

In testimony whereof we affix our signatures, in presence of two witnesses.

MILTON J. FARQUHAR.
HENRY B. FARQUHAR.

Witnesses:

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