

M. J. & H. B. FARQUHAR.

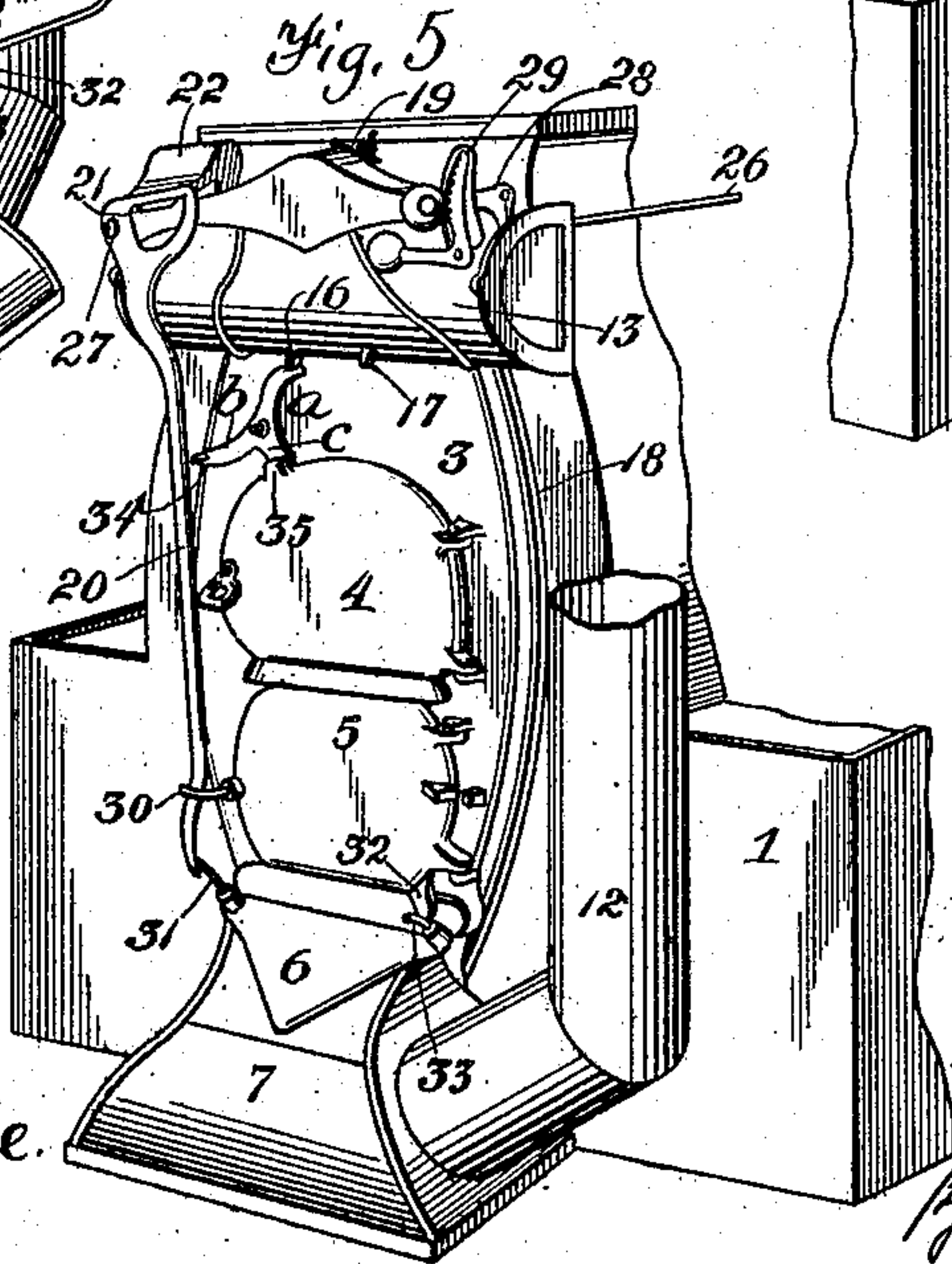
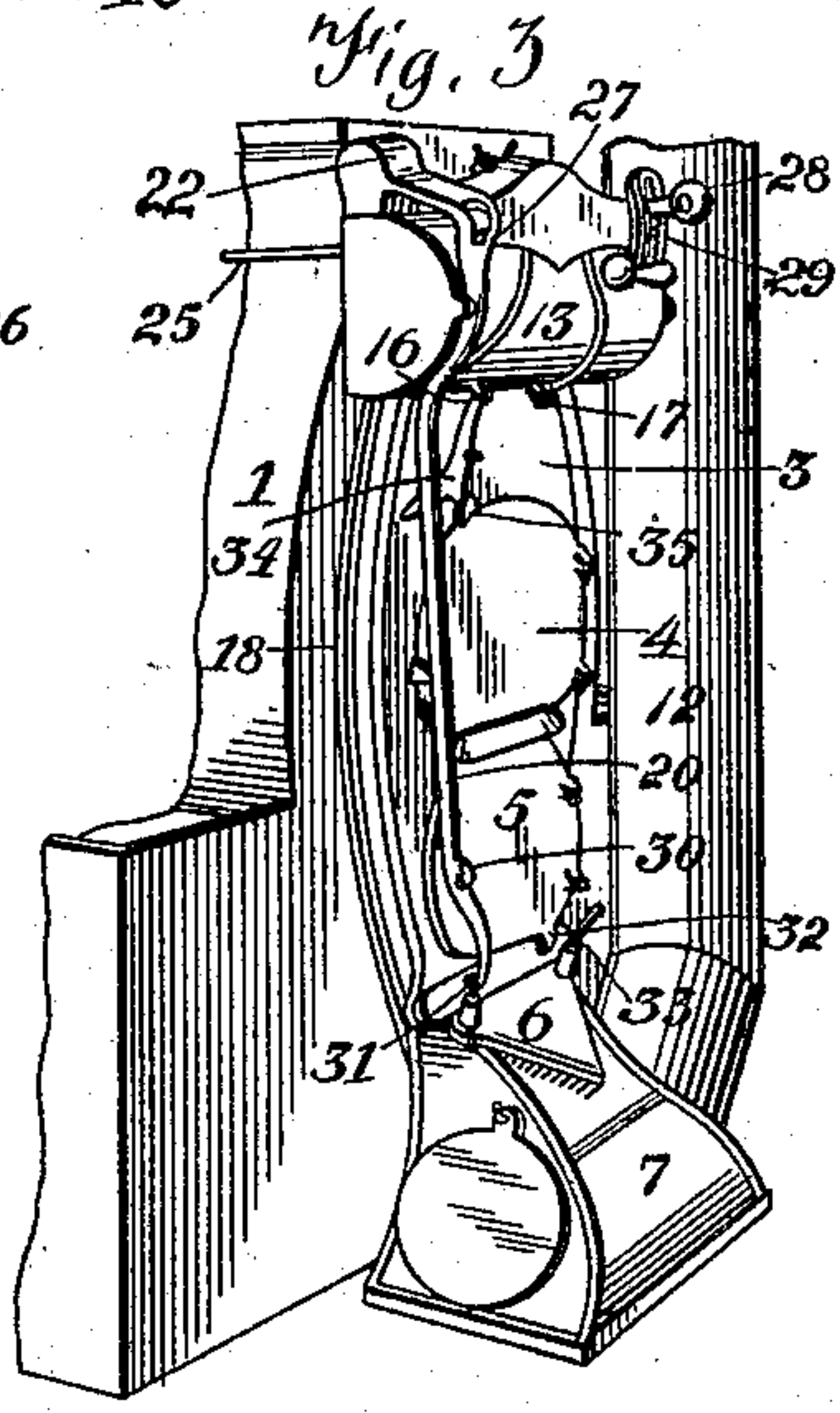
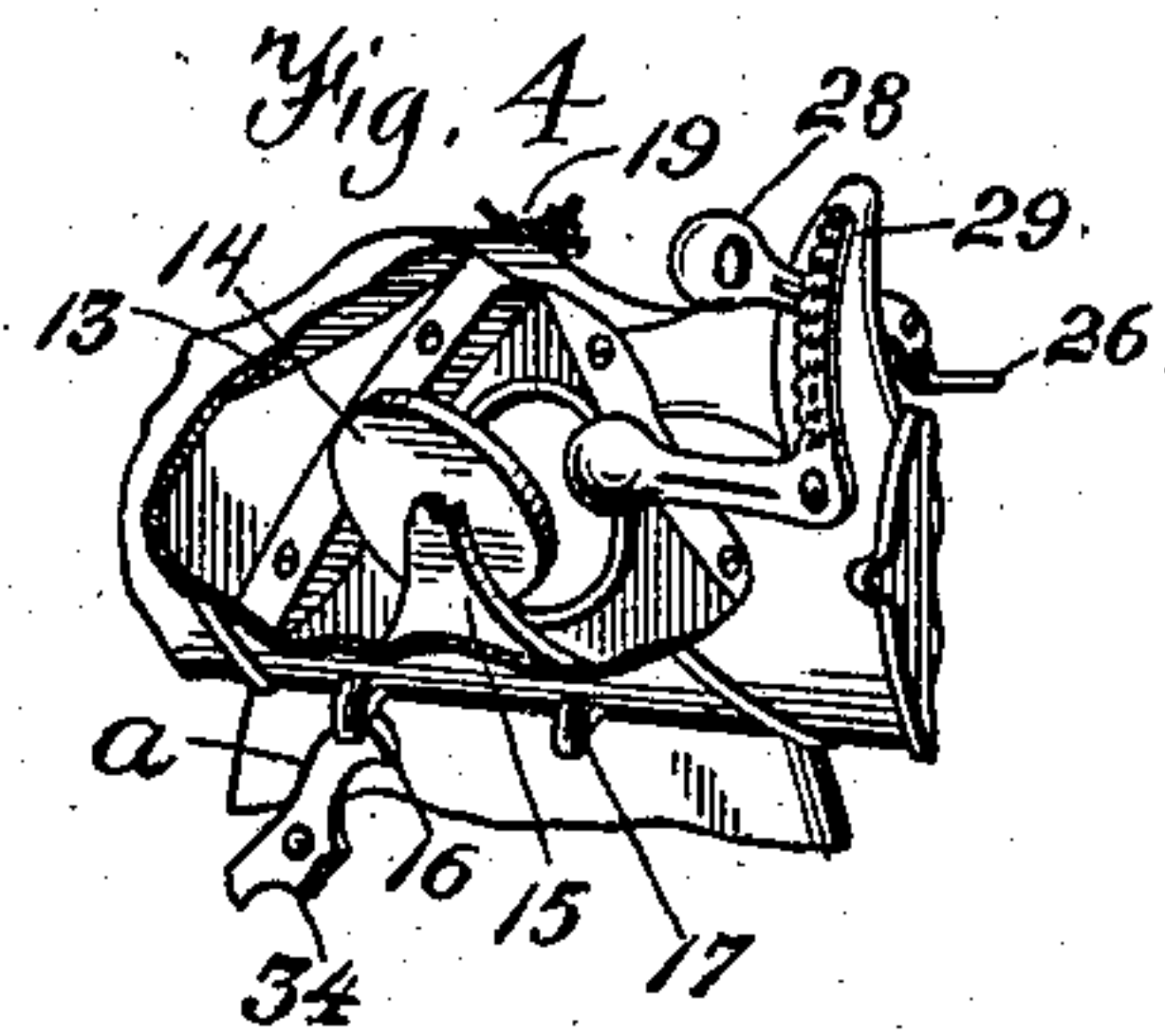
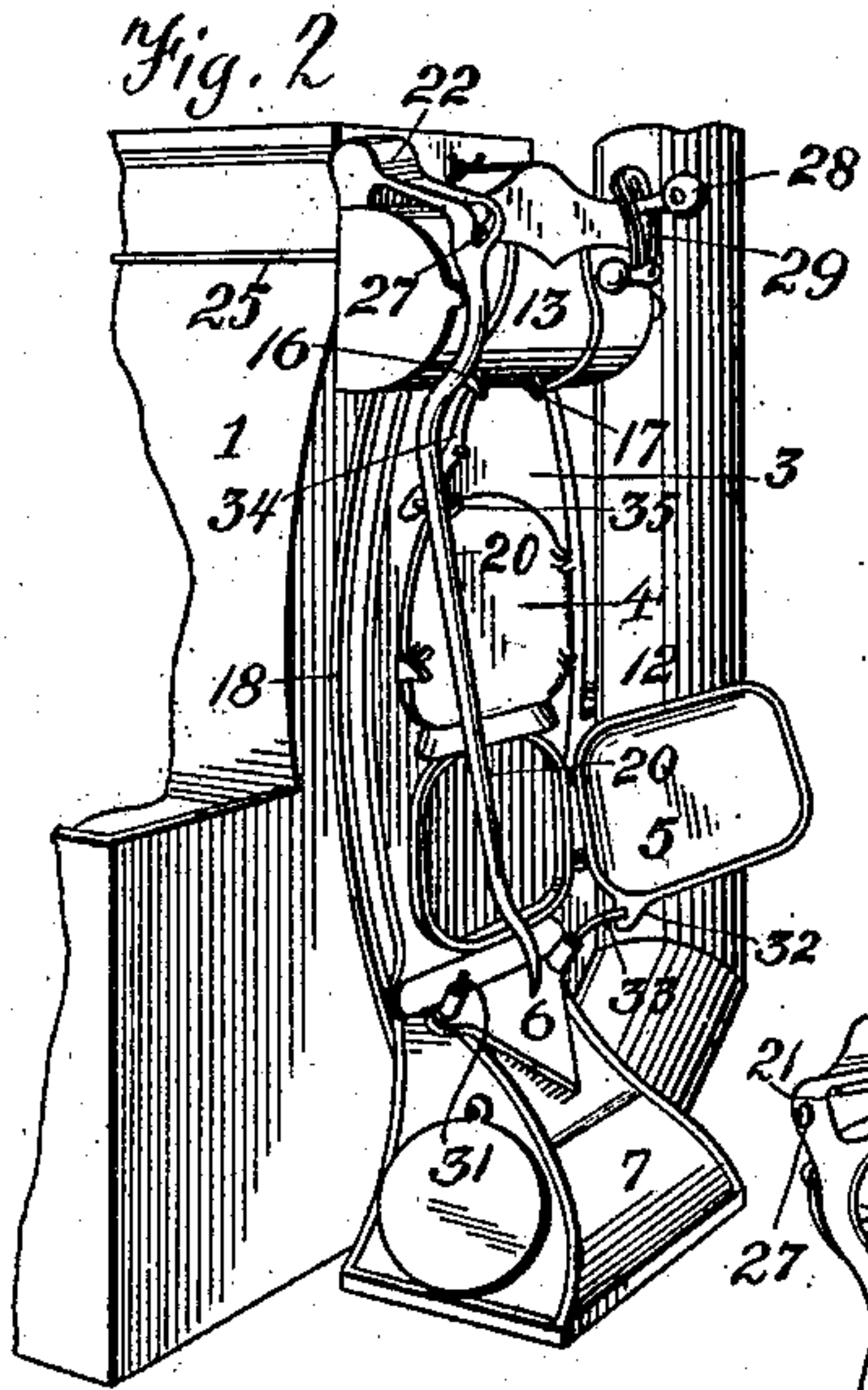
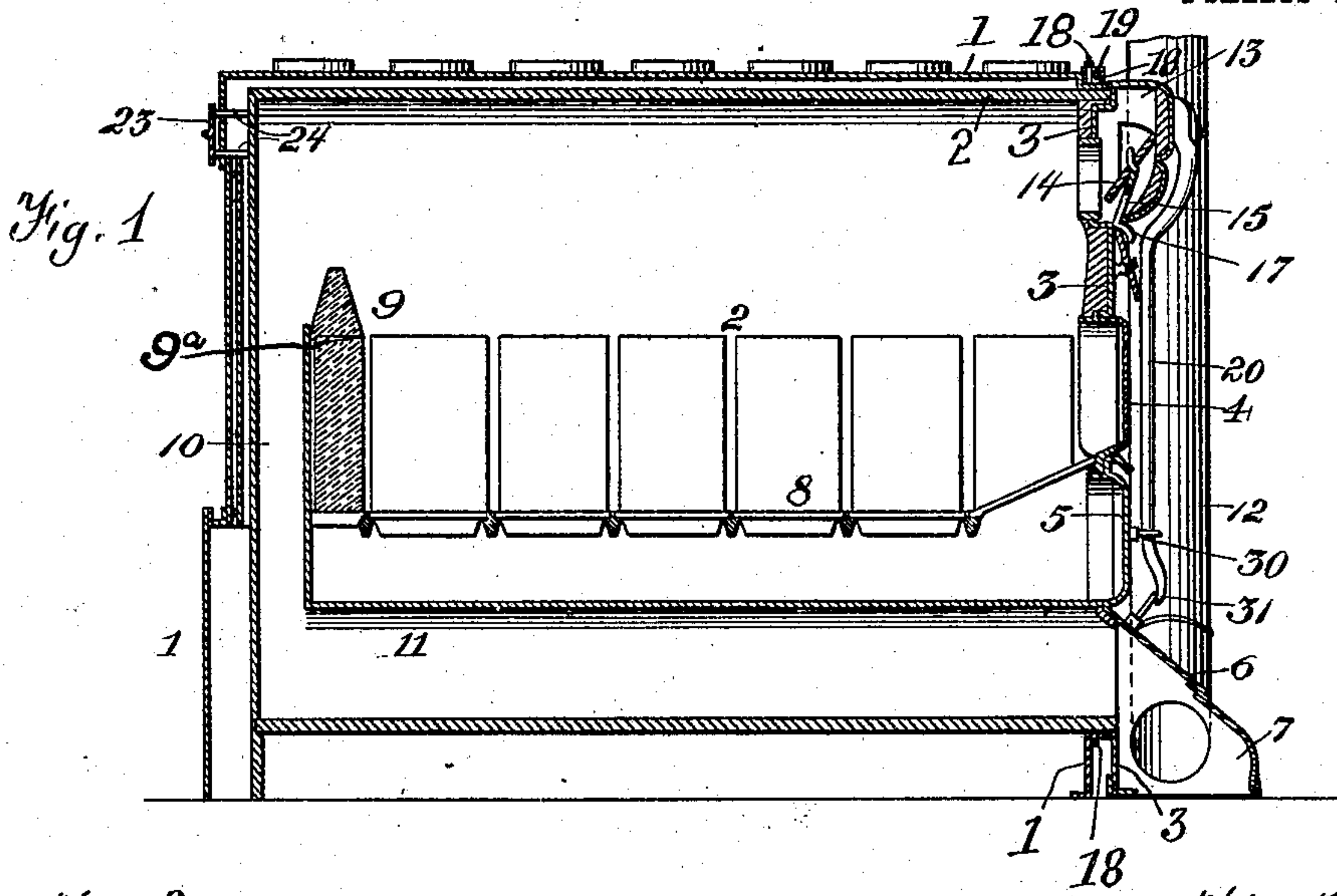
FURNACE.

APPLICATION FILED JAN. 30, 1905.

Patented June 1, 1909.

2 SHEETS—SHEET 1.

923,784.



Witnesses

W. B. Brundage.
Frank J. Kent.

Inventors
Milton J. Farquhar
and Henry B. Farquhar
By Julian C. Woodson
Their Attorneys

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Fig. 6

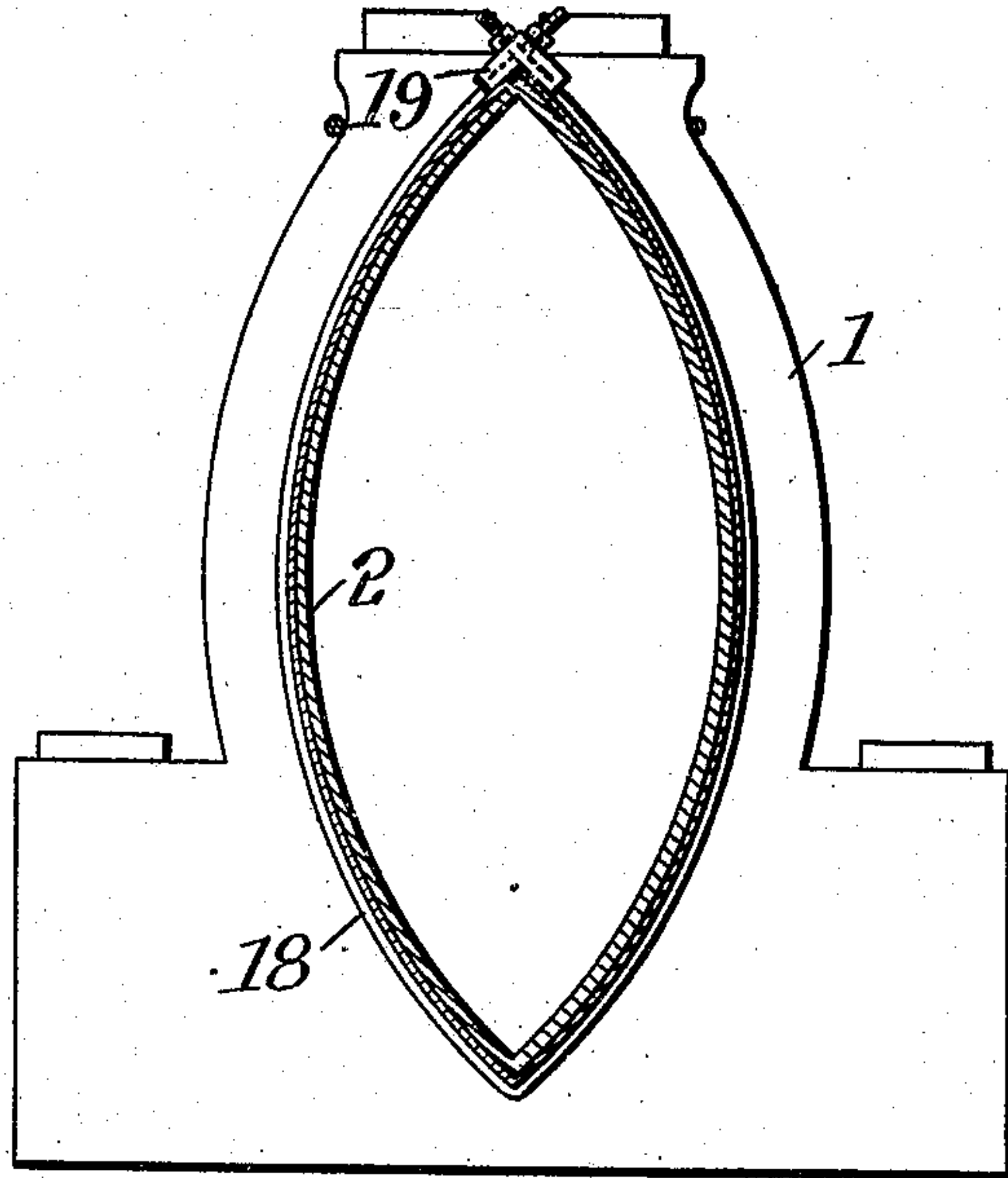


Fig. 7

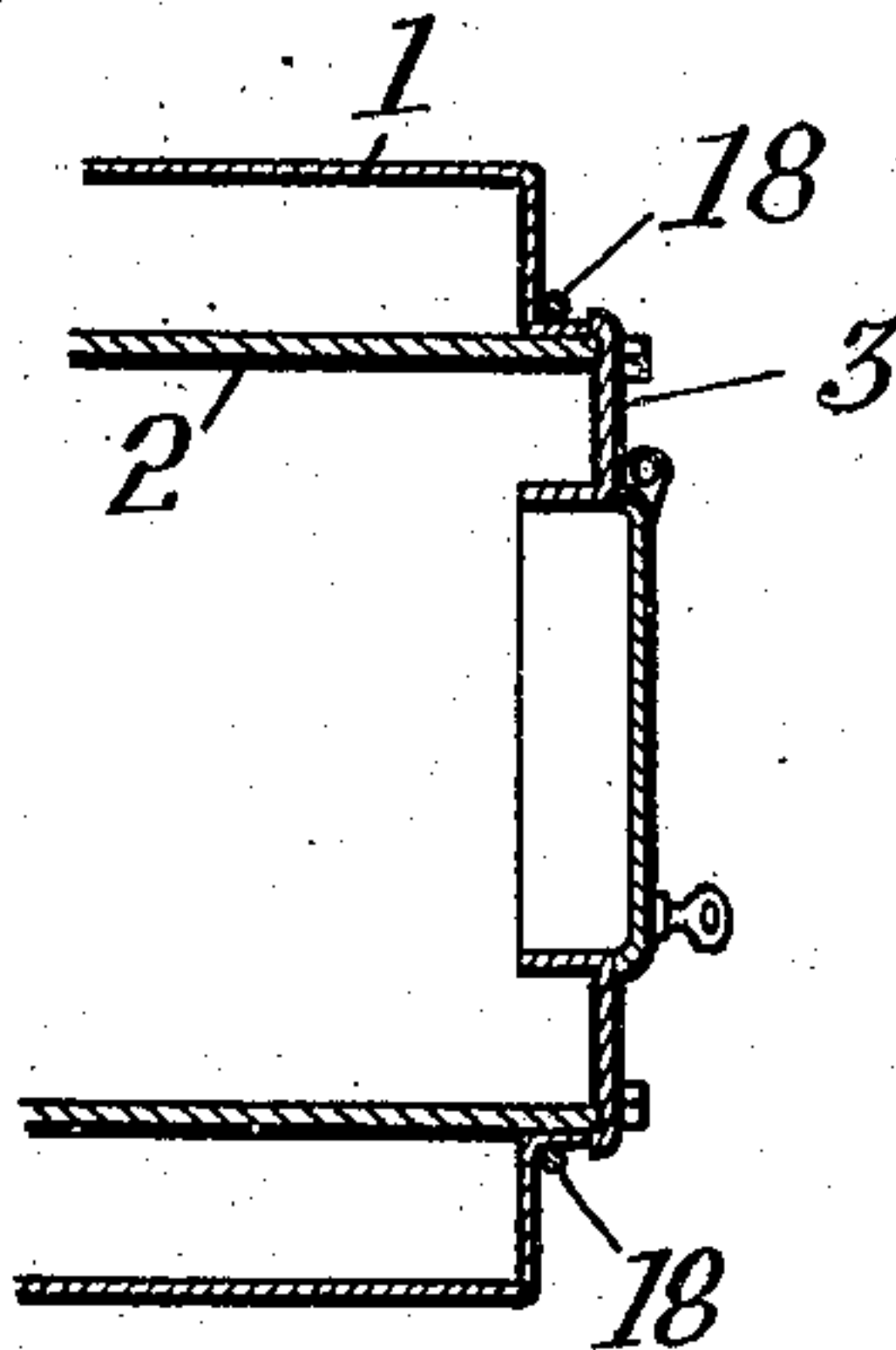
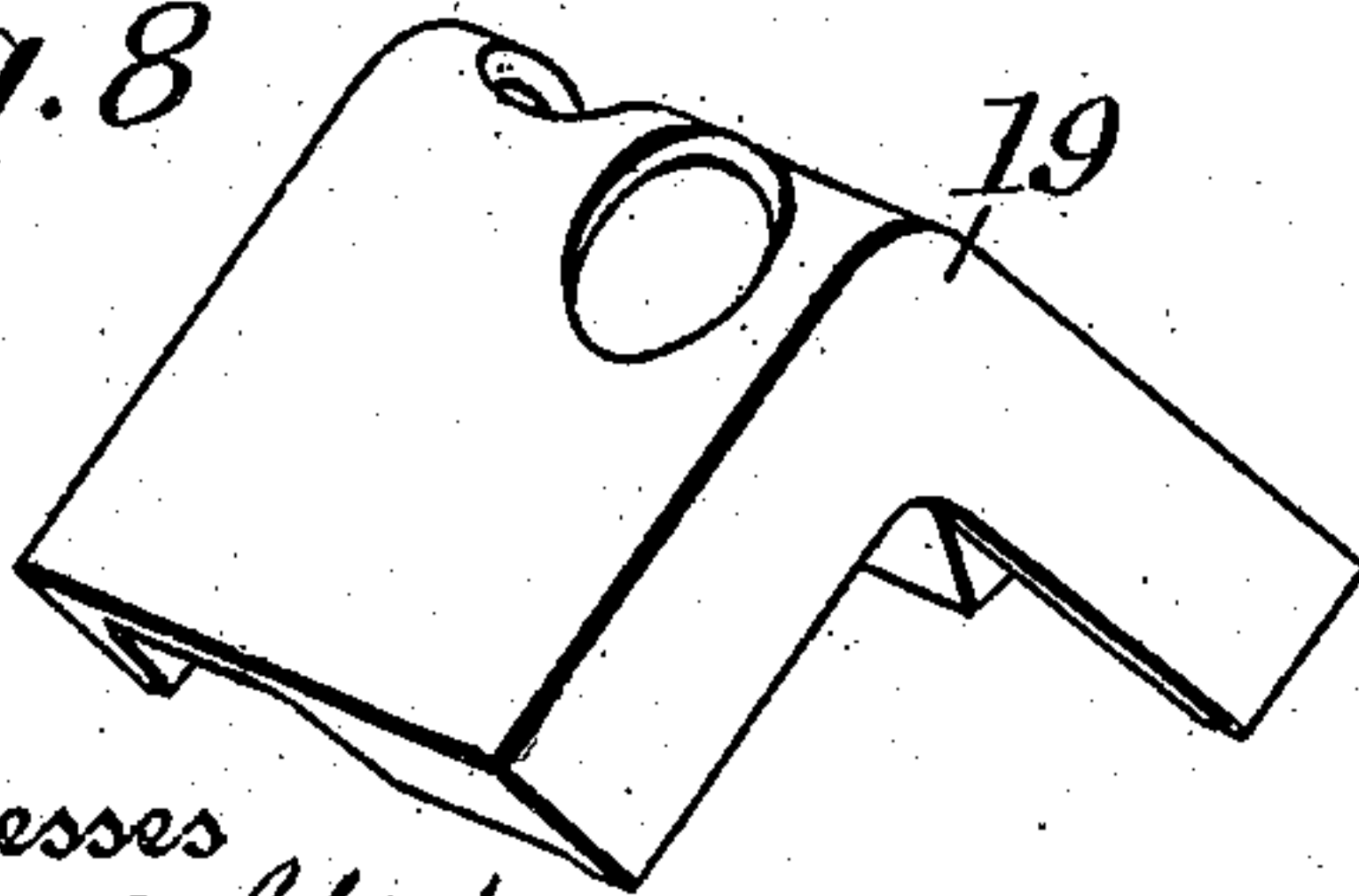
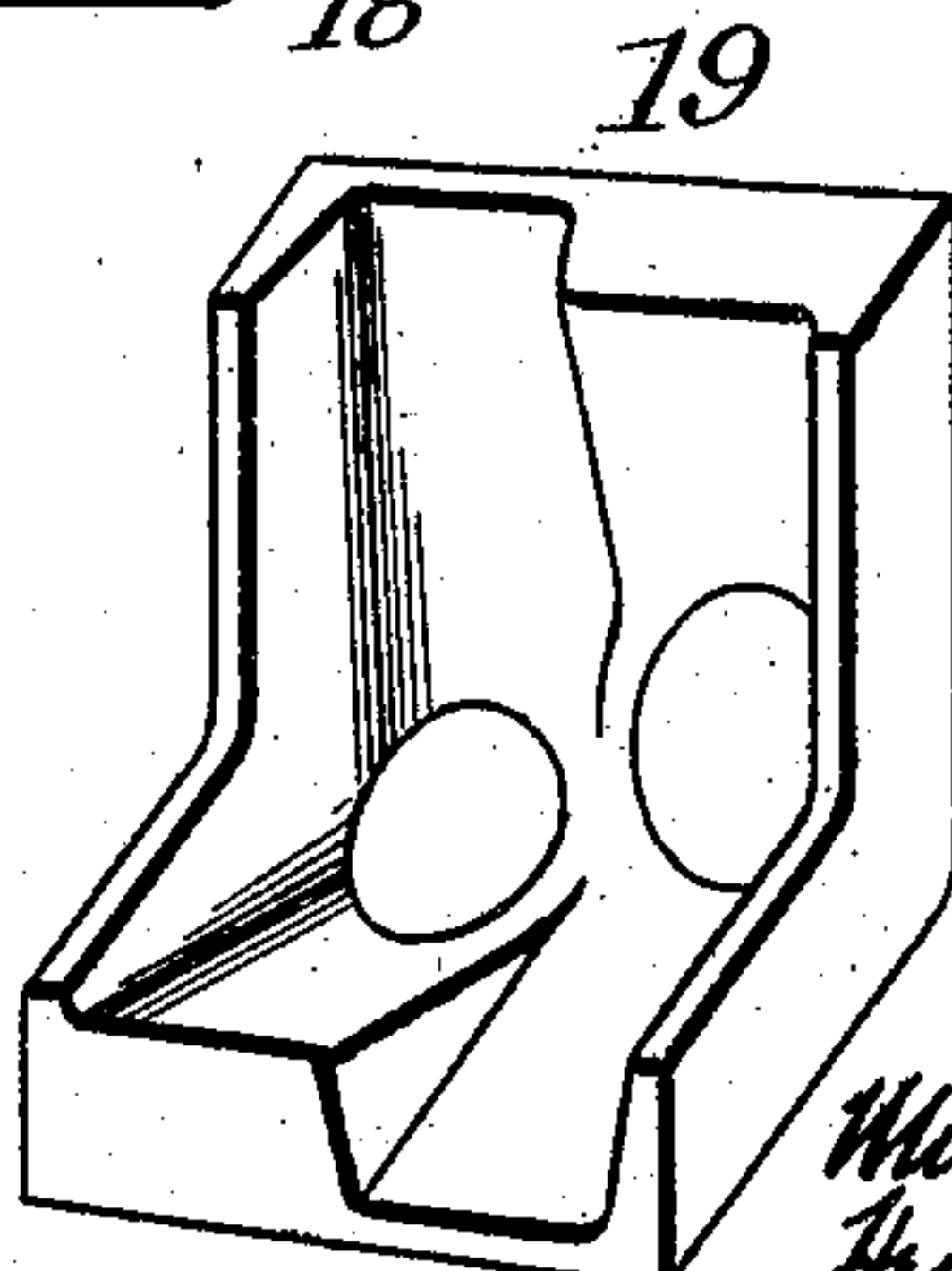


Fig. 8



Witnesses
Joseph C. Stack.
M. A. Jones.

Fig. 9



Inventors
Wilton J. Farquhar
Harry B. Farquhar
By Julian C. Dourl, Jr.
their Attorneys.

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 WILMINGTON, OHIO, A CORPORATION OF OHIO.

FURNACE.

No. 923,784.

Specification of Letters Patent.

Patented June 1, 1909.

Original application filed May 16, 1904, Serial No. 208,218. Divided and this application filed January 30, 1905. Serial No. 243,400.

To all whom it may concern:

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

This invention (for which the present application is filed as a division of our pending application Serial No. 208,218, filed May 16, 1904, for a self-regulating furnace) relates to hot-air or other heating furnaces having a fire-box within an air-box or casing for the heating medium.

One object of the invention is to improve the construction and operation of furnaces of the character set forth in our pending application Serial No. 98,445, filed March 15, 1902 (from which we have also made a divisional application Serial No. 243,399, filed January 30, 1905); and particularly to provide, in connection with the indirect draft in the rear and bottom of the fire-box, a damper-controlled direct draft through the upper front of the fire-box, while avoiding pipe-joints within the air-casing and preserving the structural characteristic of a fire-shell having all doors, dampers or valves, pipe-connections etc. placed on its exposed front plate outside the air-casing.

Another object is to form a practical airtight joint between the air-box or casing and the fire-box at the front of the furnace where the fire-box or shell extends through the front wall of the air-casing.

In the accompanying drawings, which are to be taken as a part of this specification: Figure 1 is a central longitudinal vertical section of a hot-air furnace of the type disclosed in said application Serial No. 98,445 and embodying this invention. Fig. 2 is a perspective view of the furnace-front, showing the ash-door wide open, 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-door of the lower smoke-box at the base of the furnace-front. Fig. 3 is a view similar to Fig. 2, showing the automatic

governing mechanism when it has moved, owing to an increase in temperature of the fire-box, and has released or closed the ash-door, while it has raised the 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 perspective view of the furnace-front, looking at the opposite side to that shown in Figs. 2 and 3, and showing the doors and governing devices in the positions assumed when the furnace is running at ordinary temperature. Fig. 6 is a vertical cross-section, taken just behind the upper and lower smoke-boxes, through the fire-box where it extends through the front-wall of the air-box or casing, the latter appearing in front elevation. In this figure, the internal construction in the fire-box is omitted, only its cross-sectional outline appearing. Fig. 7 is a horizontal section through the front of the air-casing and fire-box. Fig. 8 is a detail view of the angle-piece or member through which are inserted the ends of the hoop which fastens the front flange of the air-casing upon or around the fire-box. Fig. 9 is another view of said angle-piece looking at its under side.

The numeral 1 denotes the outer casing of the air-box; 2 the fire-box, which is of horizontal 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 in the smoke-box 7, which latter is shown located at 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 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 off only the coolest lower strata of the products of combustion. It will be observed that the furnace represented is of the direct draft type; for the smoke and products of combustion pass from the fire over the rear bridge-wall, down the back flue or passage 10, and forward through the pas-

sage 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 our improved type of furnace preferably an
 5 air-blast is also admitted from the rear of the ash-pan up through a passage 9^a 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
 10 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 pur-
 15 pose 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
 20 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
 25 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
 30 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
 35 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
 40 plate 14, when in front of the fulcrums of the lever, will hold it open as in Figs. 1 and 4; and, when tilted over to the opposite side of or behind said fulcrums, will carry it against the draft-opening and hold it there.
 45 The damper may be operated by the trip lugs or fingers 16, 17, its operation being both manual when desired and also automatic, by means of the heat-governing mechanism hereinafter described. This upper smoke-box,
 50 with the valve-controlled draft-opening, provides a direct draft to the smoke-pipe at the upper front of the fire-box, which may be availed of when necessary or desired. The damper is opened when the fire is started, or
 55 when the fire is burning low and it is necessary for the furnace to draw hard in order to raise it or increase the rate of combustion quickly; and it is closed when the furnace is at high heat or running at its regular tem-
 60 perature, so that only the indirect draft is used, which is far more economical. The direct draft damper is also opened when the operator opens the fire-door, so as to prevent smoke from flying out through the fire-door.
 65 Inasmuch as both the upper and lower

smoke-boxes are located at the front or on the front-plate 3, we avoid all pipe-joints in the fire-box, within the air-box; which joints would impair the efficiency of the fire-box, be subject to the action of flames and heat, and
 70 liable to rupture or gaping, with consequent leakage of air into the fire-box to interfere with its control and escape of gases into the air-box to poison the atmosphere of the building. Thus we are enabled to employ a tubular
 75 seamless or welded fire-box, without breaks or joints within the air-box; the manifold advantages of which are pointed out in our aforesaid application, Serial No. 98445.

As a further improvement in construction, in order to form an air-tight joint between the air-box and fire-box at the front, where the fire-box extends through the front wall of the air-box, said front wall is preferably
 80 flanged closely around the fire-box, and embracing this flange is a metal hoop 18, the upper ends of which are inserted through a member or angle-piece 19 at the top and drawn tight by nuts screwed onto the said
 85 ends of the hoop. See Figs. 6 to 9.

The illustrated furnace is adapted for regulation automatically by mechanism such as disclosed in our said application Serial No. 208,218, and which may be described as follows: 20 denotes a lever de-
 90 pending 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 auto-
 95 matically, is actuated to swing inward by the rising temperature of the furnace; for which purpose we preferably utilize, as in the furnace of our application Serial No. 98445, the force of expansion of the fire-box
 100 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
 105 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
 110 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
 115 fire-box to act on the frame at different temperatures. 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
 120 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
 125 130

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. 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 adjustment of the governing mechanism. Any fluctuation from this temperature will be avoided; since a greater heat would cause the door to move closer inward or close, 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 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 combus-

tion 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; the 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. 1; 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 fire-box 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 relieving or checking the draft from the fuel, while releasing the ash-door and allowing it to close. The furnace will then relax to its de-

sired 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.

In this application, we make no specific claim to the improved automatic governing mechanism, *per se*, since the same forms the principal subject-matter claimed in our aforesaid application, Serial No. 208218, of which the present case is a division.

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

1. In a furnace, the combination of an air-box or casing for the medium to be heated, a horizontally-disposed tubular fire-box inclosed therein and having its front projecting through the front-wall of said casing, said front of the fire-box constructed with upper and lower smoke-boxes and having a fire-door and ash door between them, both smoke-boxes having outlets respectively adapted for connection with a common smoke-pipe, the fire-box being interiorly provided with a grate, rear bridge-wall and raised ash-pan under the grate so arranged as to provide in the rear and bottom of the fire-box an indirect smoke and draft passage having its final outlet into the lower smoke-box, and the upper smoke-box having in its rear or inner side a valve-controlled opening for establishing direct draft thereinto.

2. In a furnace, the combination of an outer casing for air or medium to be heated, a fire-box enveloped thereby, said outer casing having a front opening, through which the front of the fire-box projects, and provided around said opening with a flange fitted around said fire-box, and a hoop embracing said flange and having its ends drawn together for tightening said hoop.

3. In a furnace, the combination of an outer casing for air or medium to be heated, a fire-box enveloped thereby, said outer casing having a front opening, through which the front of the fire-box projects, and provided around said opening with a flange fitted around said fire-box, a hoop embracing said flange, a member through which the ends of the hoop are inserted, and nuts for tightening said hoop screwed on the ends thereof against said member.

4. A furnace comprising a casing, and a horizontally-arranged fire-box enveloped thereby and having its front exposed through the front wall of said casing and provided with all doors and draft-openings or pipe-connections, including an upper

smoke-outlet and a lower smoke-outlet, the fire-box being internally constructed to provide an indirect draft-passage to said lower smoke-outlet and having a direct
5 draft through said upper smoke-outlet, and a damper for controlling the latter.

10 5. A furnace comprising a casing, and a fire-box therein having its front end extending through the front wall of said casing and provided with a fire-door and ash-door and constructed with smoke-boxes above and below said doors, the fire-box being wholly closed or without pipe-joints

inside the casing and containing a fire-pot with grate and ash-pan thereunder arranged 15 to provide a bottom indirect draft flue having its outlet into the lower smoke-box, there being also a damper-controlled outlet into the upper smoke-box.

In testimony whereof we affix our signatures, in presence of two witnesses. 20

MILTON J. FARQUHAR.

HENRY B. FARQUHAR.

Witnesses:

C. W. SWAIM,

E. R. K. HAYES.