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FURNACE CONSTRUCTION.
APPLICATION FILED NOV. 29, 1919.

2 SHEETS—SHEET 1.

WITNESSES

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Francis J. Tomason

INVENTOR

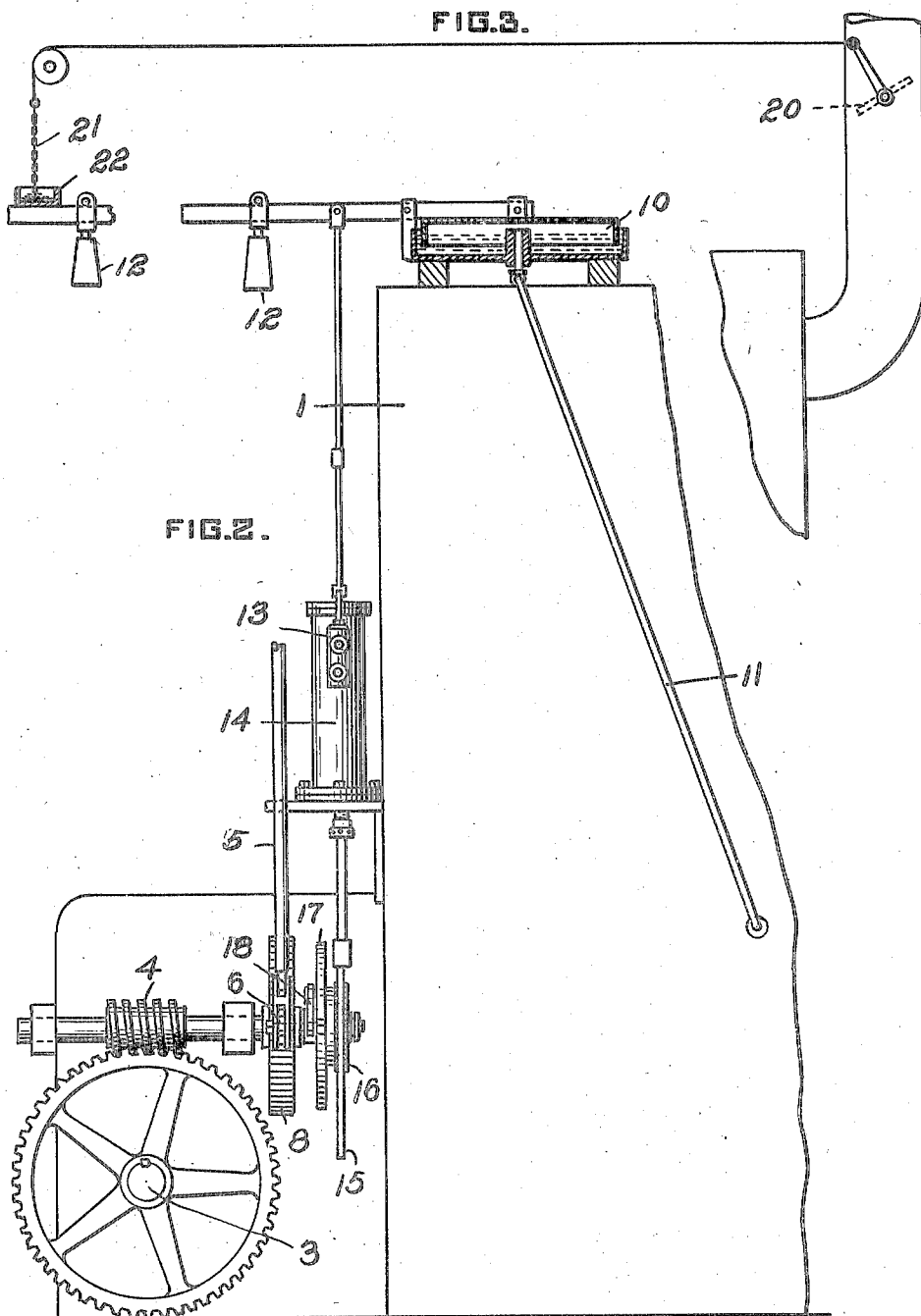
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Patented July 6, 1920.

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UNITED STATES PATENT OFFICE.

JOSEPH F. TUTTEIN, OF CRAFTON, PENNSYLVANIA.

FURNACE CONSTRUCTION.

1,345,652.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, JOSEPH F. TUTTEIN, residing at Crafton, in the county of Allegheny and State of Pennsylvania, citizen of the United States, have invented or discovered certain new and useful Improvements in Furnace Construction, of which improvements the following is a specification.

My invention relates to the construction and operation of furnaces: such furnaces, for example, as are used to heat water and generate steam in boilers; and consists in an automatic control of fuel supply. Though not in its broader aspects so limited, my invention finds application in a natural-draft furnace, and in the accompanying drawings it is illustrated in such application.

Figures I and II are views in side elevation, and at right angles, one to the other, of a furnace structure having the automatic fuel control of my invention applied to it; Fig. III is a view showing diagrammatically an additional detail, which may or may not be employed.

In furnace operation, maximum efficiency is attained when combustion is free and when the burning gases in necessary volume pass over the heat-conducting surfaces (boiler tubes or other surfaces) at a minimum rate of flow. But there are variable circumstances that have to be dealt with: quality of fuel for example, and condition of fuel, and atmospheric conditions.

In a general way, such variations in circumstances may be reckoned with in advance. It is common practice to provide mechanical fuel-feed devices, and to place dampers either in the air-supply flues or in the chimney passages or in both, and, while keeping the rate of fuel feed constant, to vary the damper setting: as conditions grow less favorable to combustion, draft is increased; as they grow more favorable, it is decreased. The end in view is, of course, a maximum degree of efficiency. The highest possible efficiency cannot, however, be attained under varying conditions of burning, unless the rate of fuel feed be correspondingly varied.

It is common, also, in operating steam boilers, to provide automatic means for controlling the position of the dampers as steam pressure varies, to the end that, the rate of fuel feed being constant, draft conditions

shall always be such as to afford maximum heating effect. Such an arrangement, good and effective so far as it goes, possesses still this disadvantage: the rate of fuel feed may not be—indeed, under varying conditions, cannot always be—such as to attain maximum heating effects.

This disadvantage is recognized, and in recognition of it the expedient is resorted to, of superadding to the mechanical fuel-feed apparatus a speed-changing device. This speed-changing device is under the manual control of the operator; he, observing conditions of combustion, may vary the rate of fuel feed, to attain always (within the limits of his wisdom) best conditions of combustion.

My invention is predicated on perception of these facts: that pressure in the furnace chamber is the dominant factor in the problem; that, flues and chimney passage continuing unchanged in size, maximum efficiency is realized when pressure in furnace chamber is of a certain value; and that, under varying conditions of chimney passage, the furnace pressure affording maximum efficiency varies accordingly—for each damper setting there is a corresponding furnace chamber pressure, affording maximum efficiency. From these facts I proceed to my invention, which consists, first, in subjecting the speed of fuel feed to the automatic control of furnace pressure, to the end that, as furnace pressure tends to vary, the speed of fuel feed will vary to afford correction; and, second, in bringing damper setting into the equation just stated, to the end that while as before fuel speed is automatically dominated by furnace pressure (maintaining always the desired pressure of maximum efficiency), at the same time, that furnace pressure of maximum efficiency shall automatically, under varying damper settings, assume a correspondingly varying actual value. In other words: chimney size remaining constant, depth of fuel will remain constant, but speed of fuel feed will vary, under changing conditions of combustion, to afford always that pressure in the furnace chamber which affords maximum efficiency; and, again, damper setting varying, the same automatic means will operate to maintain always that furnace-chamber pressure which under the existing damper setting is most efficacious.

When here and elsewhere, in specification

or claims, I speak of the maintenance of constant pressure in furnace chamber, it will be understood that I recognize, and do not exclude from my meaning, those minor and transient variations which are incident to—
 5 essential indeed, to effect—the operation of my automatic feed control; again, when I say the thickness of fuel is constant, I mean still to include such minor irregularities as
 10 are incident to practical conditions, as well as those incidentally encountered, as the automatic machinery makes its adjustments; and so throughout.

My invention may be applied either to a furnace of forced draft or to one of natural draft; it is to the latter that I have actually applied it, and I shall describe it in such application. Its application to a forced-draft furnace will, from what I am about to say, be
 20 sufficiently plain to engineers. I shall first describe the invention in so far as it applies to a furnace of fixed chimney size, and in the sequel describe the further features of invention which concern furnaces having chimneys
 25 of variable effective openings—that is to say, damper-controlled chimneys.

Referring to Figs. I and II of the drawings, 1 is the wall of the furnace. The feed of fuel in this case is effected by chain grate
 30 2, and it is the driving of this chain grate 2 in well known manner which constitutes the mechanical fuel feed of this furnace. The driving shaft 3 of the chain grate 2 is turned by the worm drive 4, and this worm drive
 35 is in turn driven from a power shaft (not shown). This unseen power shaft, by means of an eccentric, imparts oscillation to a rod 5. The rod 5, connected to a pivoted arm 6, turns the worm drive 4, by means of the
 40 pawl-and-ratchet connection 7 and 8. All of this is familiar construction, and needs no further minute description. Examination of the drawings, in the light of what has just been said, will make the whole perfectly
 45 evident to anyone familiar with the subject. The connection between the rod 5 and the arm 6 is an adjustable one, movable in a slideway 9 nearer to and farther from the center of turning of the arm 6. In this way
 50 the throw of the pawl and ratchet may be increased and decreased, and so the speed of turning of the grate may be made to vary. As has above been indicated, this connection between rod 5 and arm 6 has heretofore been
 55 manually adjustable, to the end that the operator, observing furnace conditions, may vary the speed of the grate.

My invention, as I have indicated, consists in automatically controlling that adjustment, according to pressure conditions
 60 within the furnace chamber. An oil-sealed bell 10 is provided, of familiar form, the construction of which will be sufficiently understood by examining Fig. 2 of the drawings. The bell chamber is brought into

pneumatic communication with the furnace chamber through a pipe 11. Bell 10 is supported against pressure tending to depress it, by any suitable means, conveniently by the counterweight 12, which may advantage-
 70 ously be adjustable on the beam which carries it. The pressure within the bell, being that of the furnace chamber will (if it be a natural-draft furnace) be less than atmospheric. The counterweight 12 tends to raise
 75 the bell, the excess of air pressure above, over the furnace-chamber pressure beneath, tends to depress it; consequently the bell stands in equilibrium, and responds in movement to every change in pressure in the furnace chamber. Such movement of the bell
 80 is imparted conveniently through the instrumentalities shown to a valve 13, which controls the admission of fluid pressure into a fluid pressure cylinder 14. To the stem
 85 of a piston within this fluid pressure cylinder is connected a rack 15, and this rack engages a pinion 16 conveniently mounted idly upon the same shaft which carries the worm of the worm gear 4. Integral with
 90 this pinion 16 is a disk 17. (The disk shape is unimportant; it serves merely as a connecting lever.) To the disk is pivoted a rod 18, which rod 18 connects the disk 17 to the end of the rod 5. According as this
 95 disk 17 turns, the point of connection between rod 5 and arm 6 will vary, and it will be apparent that, according as pressure in the furnace chamber varies, so the position of the connection between rod 5 and arm 6
 100 will vary, the effective length of arm 6 will vary, and so the speed of turning of the chain grate will vary.

Such being the structure, it will be at once apparent that variations in furnace-chamber pressure express themselves in changes
 105 in rate of fuel feed, and these changes of fuel feed correct the pressure variations, bringing it back to normal.

I come now to the next feature of my invention; that, namely, which adapts the subject-matter already explained to a furnace which has a damper-controlled chimney—or damper-controlled air supply. I
 110 show and shall describe a damper-controlled chimney; the wider application indicated will readily be understood.

Referring to Fig. III of the drawings, a damper 20 is diagrammatically shown in a chimney flue, which it will be understood is
 120 a flue leading from the furnace. Conveniently located with respect to such flue, and also with respect to the furnace chamber; for the ends already described, is a bell, such as that shown at 10 in Figs. I and II.
 125 Fig. III is so located with respect to Fig. II that the collocation will be understood without more words. In addition to the counterweight 12, a chain weight 21 is provided, and this, rising and descending as damper
 130

20 turns, rests to a greater or less extent within a cup 22 borne on the beam of the counterweighted bell 10, and adds a greater or less portion of its weight, to augment the effect of weight 12 upon bell 10. The chain 21 will be selected, to the end that its weight per linear unit may suit conditions. This showing is diagrammatic merely, to indicate one particular means, whereby the force exerted upon bell 10 in opposition to furnace-chamber pressure to hold the bell in equilibrium, may vary as damper position varies. For every damper position there is an ideal furnace-chamber pressure, automatically brought about by the actual weight of so much of chain 21 as rests in cup 22 and the proportioning of the parts; and, that ideal pressure being so brought about, speed of fuel feed automatically accommodates itself, to maintain that pressure. The position of the damper may be manually determined, or it may, by known instrumentalities, be caused to vary automatically to meet related conditions: for example, it may be controlled by pressure in a steam boiler heated by the furnace. But, however controlled, the damper will be effective in its movement to accomplish the operation of the parts described. According as the demand upon the furnace is great or small—that is to say, for great quantities of heat or less—the damper opening will be increased or diminished. (This may be manual or automatic.) But, by the operation of my automatic apparatus now described, the rate of fuel feed will be automatically increased or diminished. Always the most efficient depth of fuel will be maintained, and that depth, whatever the condition is, for the given furnace, substantially constant.

It will be seen that, whether the furnace be one of fixed or of variable chimney opening, whether the damper of the variable chimney opening be manually or automatically controlled, my invention still is applicable, and consists in the automatic control of the rate of fuel supply, to suit the ideal pressure (whatever its actual value may be) maintained in the furnace chamber.

To summarize, in the operation of the furnace to which my invention is applied, thickness of fuel is maintained substantially constant, and of predetermined value, under varying conditions of burning—and that is as much as to say, under varying rates of combustion; the ideal pressure in the furnace chamber is maintained under varying conditions of burning, and this is true, even when that ideal pressure itself varies to meet changed circumstances elsewhere; furnace-chamber pressure varies where effective flue area varies, and varies proportionately, so that always it may stand at ideal maximum, and, at the same time (as has been said) variations in conditions of burn-

ing are elsewhere compensated for, and the ideal pressure is not widely nor permanently disturbed, but remains substantially and essentially "constant."

The particular forms of apparatus are not of the essence of my invention. For instance, it is unimportant that the grate used be a chain grate. The important thing is that the rate of fuel feed be controlled by the automatic control of the nature indicated. Again, it is unimportant what the particular form of the pressure operated motor may be, and so throughout.

I have, in some of the ensuing claims, in defining the forces to which the oil-sealed bell 10 is subject, characterized one of them as "an independently determined force," and by this phrase I mean to define a force whose value is not determined by fluctuation in gaseous pressure either in the furnace chamber or anywhere in the line of draft of the furnace. In the case shown this independently determined force is the effective value of the chain weight 21, and this value is determined by the position of damper 20. The determination then of the value of the force is quite independent of pressure in line of draft.

I claim as my invention:

1. In a furnace structure the combination, with a furnace chamber, a mechanical fuel feed, and a speed-changing device applied to said fuel feed, of an automatic control for said speed-changing device including a movable element subject in opposite directions to furnace-chamber pressure and to atmospheric pressure, substantially as described.

2. In a furnace structure the combination, with a furnace chamber, a mechanical fuel feed, and a speed-changing device applied to said fuel feed, of an automatic control for said speed-changing device including a movable element maintained in equilibrium between atmospheric pressure and the sum of two forces: one, furnace-chamber pressure, and the other, an independently determined force, substantially as described.

3. In a furnace structure the combination, with a furnace chamber having draft passageways, a mechanical fuel feed, and a speed-changing device applied to said fuel feed, of an automatic control for said speed-changing device including a movable element maintained in equilibrium between atmospheric pressure and the sum of two forces: one, furnace-chamber pressure, and the other, a force constant while said draft passageways remain constant, substantially as described.

4. In a furnace structure the combination, with a furnace chamber, a mechanical fuel feed, and a speed-changing device applied to said fuel feed, of an automatic control for said speed-changing device includ-

ing a movable element maintained in equilibrium between atmospheric pressure and the sum of two forces: one, furnace-chamber pressure, and the other, gravity, substantially as described.

5 5. In a furnace structure the combination, with a furnace chamber, a mechanical fuel feed, and a speed-changing device applied to said fuel feed, of an automatic control
10 for said speed-changing device including a movable element maintained in equilibrium between atmospheric pressure and the sum of two forces: one, furnace-chamber pressure, and the other, a force of a value under
15 the control of the operator, substantially as described.

6. In a furnace structure, the combination, with a furnace chamber having draft passageways and a damper, a mechanical
20 fuel feed, and a speed-changing device applied to said fuel feed, of an automatic control for said speed-changing device including a movable element maintained in equilibrium between atmospheric pressure and
25 the sum of two forces: one, furnace-chamber pressure, and the other, a variable force, together with automatic means for effecting variation of force in accordance with movement of said damper, substantially as described.
30

7. In a furnace structure the combination, with a furnace chamber and a mechanical fuel feed, of a counter-weighted oil-sealed bell communicating with said furnace cham-

ber, a speed-changing device applied to said fuel feed, and means operated by said bell for controlling said speed-changing device, substantially as described. 35

8. In a furnace structure the combination, with a furnace chamber and a mechanical fuel feed, of an oil-sealed bell, an adjustable counterweight for said bell, pneumatic connection from said furnace chamber to said bell, a speed-changing device applied to said fuel feed, and means operated by said bell for controlling said speed-changing device, substantially as described. 40 45

9. In a furnace structure the combination, with a furnace chamber, a mechanical fuel feed, and a damper controlling draft through said furnace chamber, of an oil-sealed bell, a counterweight for said bell, pneumatic connection from said furnace chamber to said bell, a speed-changing device applied to said fuel feed, means operated by said bell controlling said speed-changing device, and means for automatically effecting variation in the value of said counterweight, according to variation in the position of said damper, substantially as described. 50 55 60

In testimony whereof I have hereunto set my hand.

JOSEPH F. TUTEIN.

Witnesses:

ELMER E. BOYD,
H. H. SHAKELY.