H. E. WALLIS.

FURNACE.

APPLICATION FILED JAN. 8, 1907.

985,480.

Patented Feb. 28, 1911.

5 SHEETS—SHEET 1.

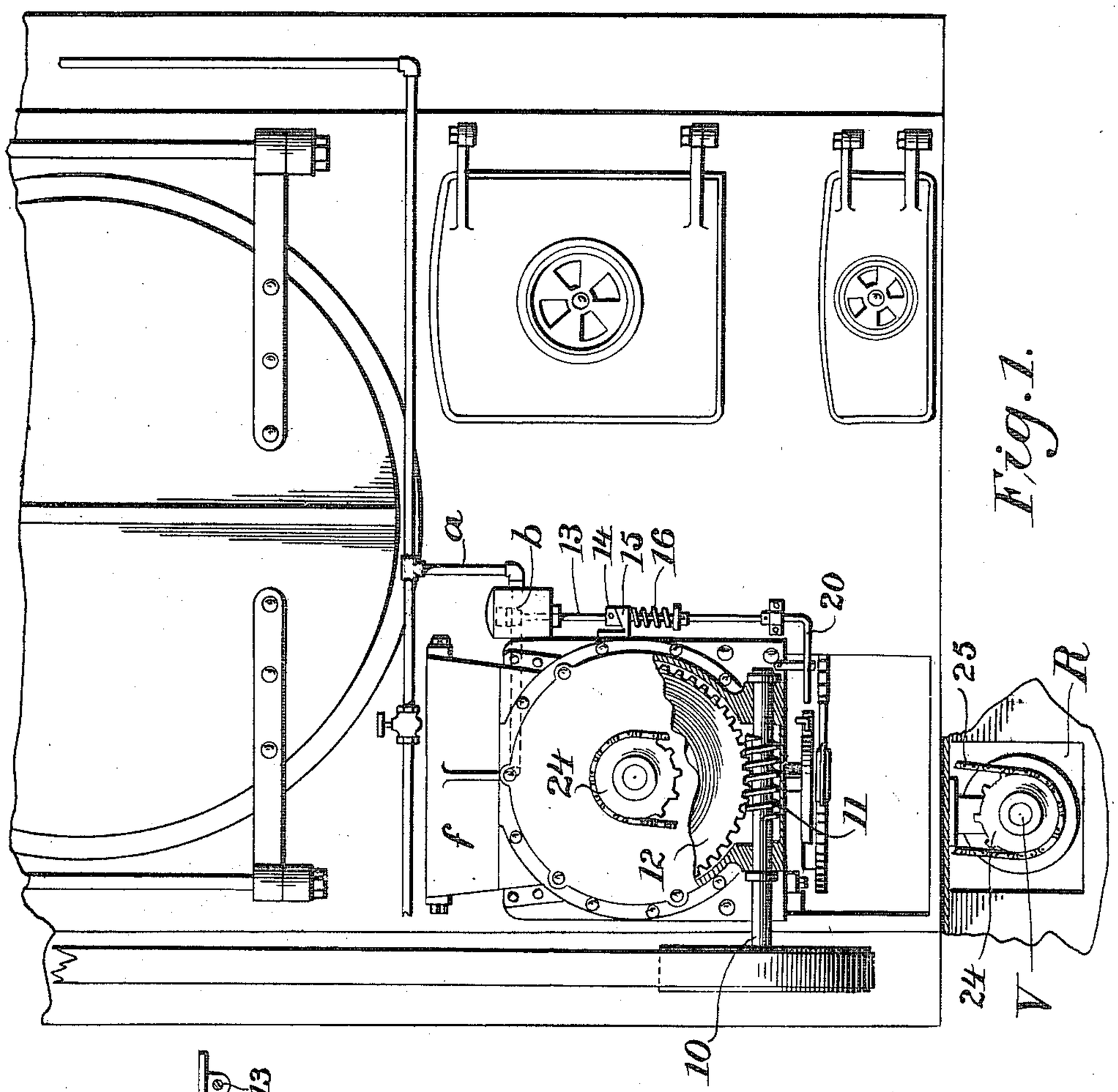

Fig. 1.

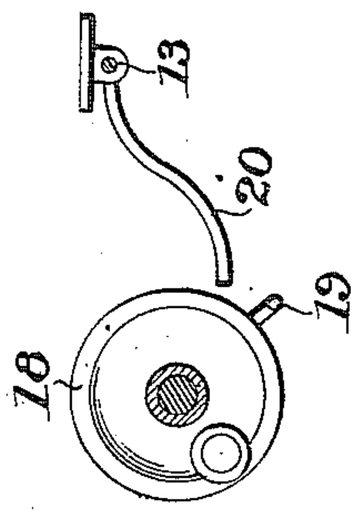

Fig. 2.

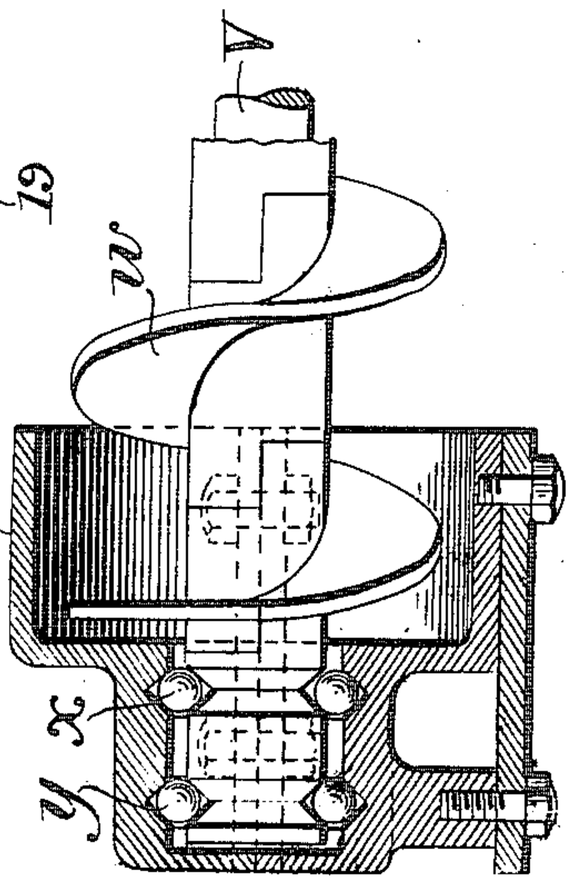

Fig. 3.

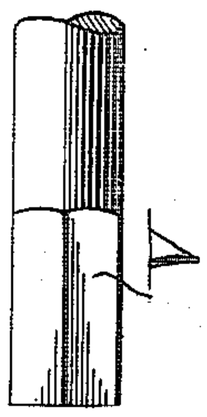

Fig. 4.

Witnesses.

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5 SHEETS—SHEET 2.

Fig. 5.

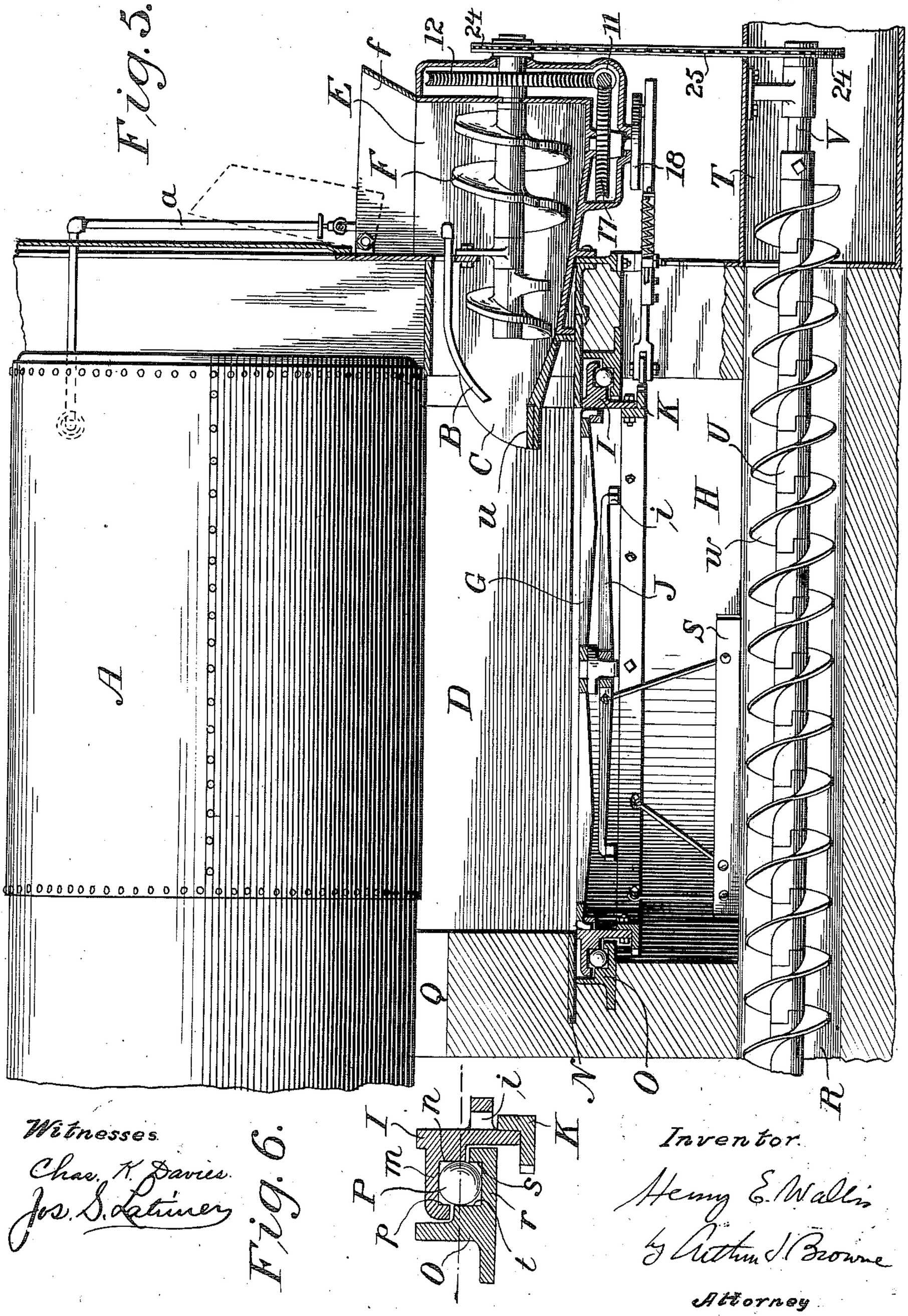

Fig. 6.

Witnesses.

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5 SHEETS—SHEET 3.

Fig. 8.

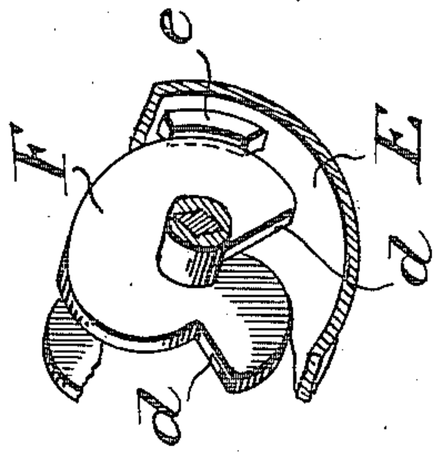
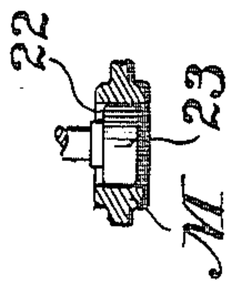


Fig. 7.

Fig. 9.



Witnesses.

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5 SHEETS—SHEET 4.

Fig. 10.

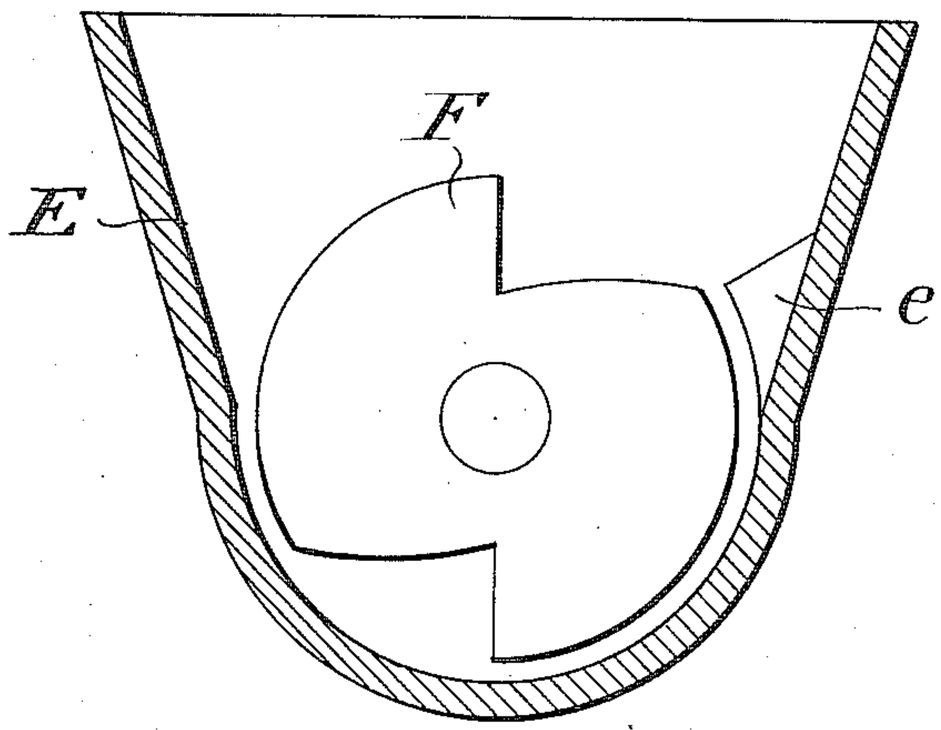
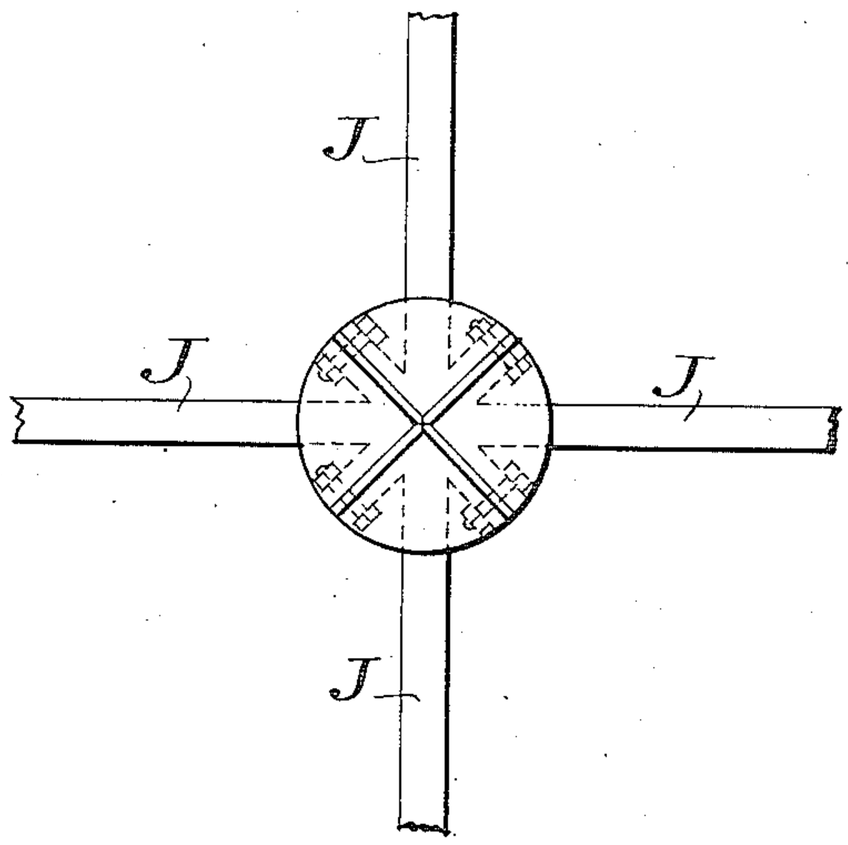


Fig. 11.



Witnesses
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985,480.

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FURNACE.

APPLICATION FILED JAN. 8, 1907.

Patented Feb. 28, 1911.

5 SHEETS—SHEET 5.

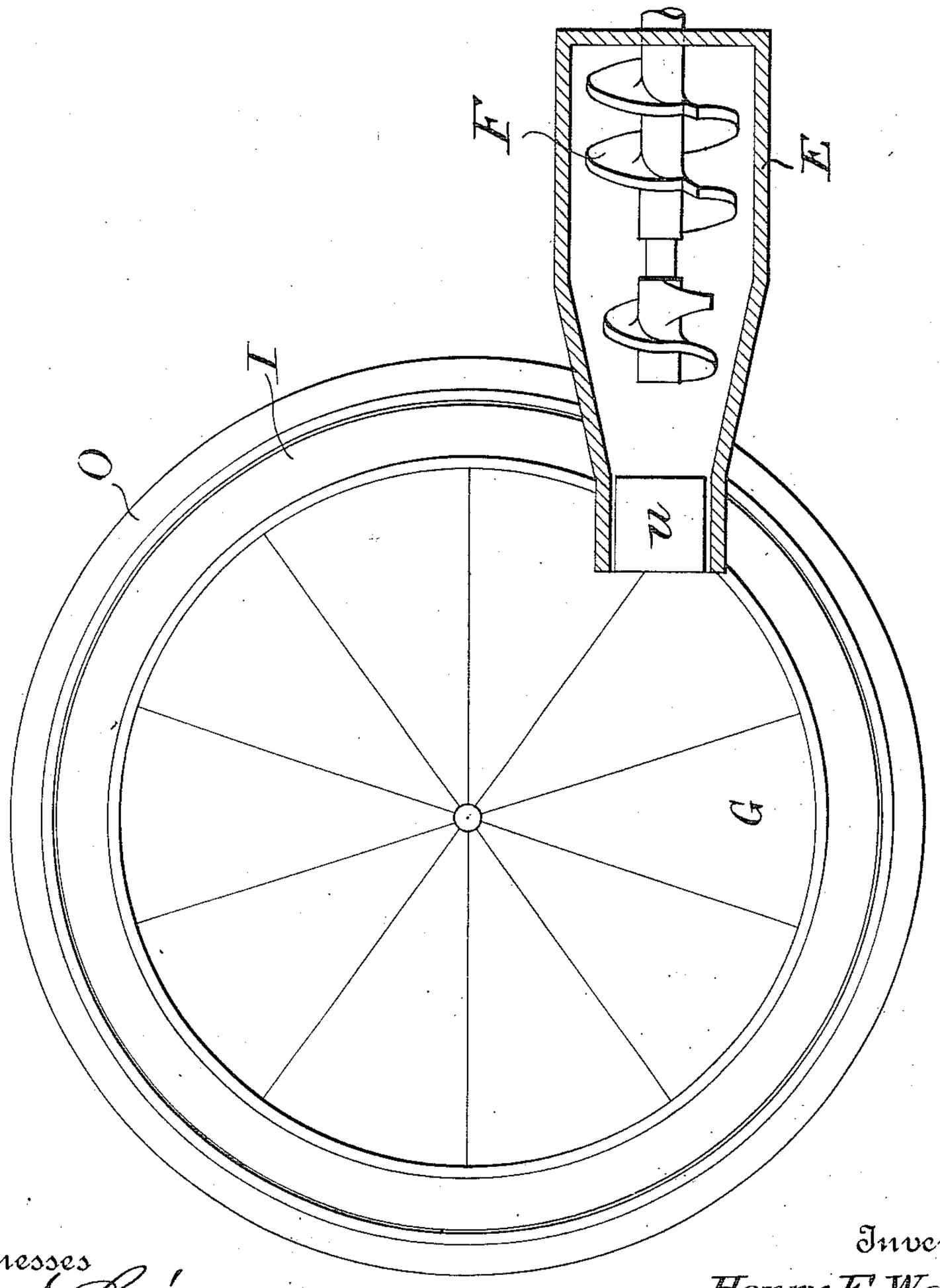

Fig. 12.

Witnesses
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UNITED STATES PATENT OFFICE.

HENRY E. WALLIS, OF TERRE HAUTE, INDIANA.

FURNACE.

985,480. Specification of Letters Patent. Patented Feb. 28, 1911.

Application filed January 8, 1907. Serial No. 351,349.

To all whom it may concern:

Be it known that I, HENRY E. WALLIS, of Terre Haute, in the county of Vigo and State of Indiana, have invented certain new and useful Improvements in Furnaces, of which the following is a specification.

This invention relates to furnaces and the fuel-feeding means thereof and has for its important objects to provide improved and efficient means for supplying solid fuel to furnaces in an automatic manner by the aid of a blast of steam or other suitable fluid fuel element under pressure which scatters fuel properly over a rotating grate; and adapting the device for use in connection with furnaces of ordinary construction without material change. Owing to the blast fuel feed, the rotation of the grate, and their relative location, the fuel is automatically deposited at different points on the grate surface, whereby over-stoking at any one point is avoided and the fuel throughout the entire grate surface is maintained in an incandescent state.

A furnace embodying the present improvements is illustrated in the accompanying drawings, in which:—

Figure 1, is a front elevation of the furnace, partly in section to illustrate some of the features. Fig. 2, is a detail of devices for controlling the blast. Fig. 3, is a detail sectional view showing one bearing for the ash-conveyer. Fig. 4, is a detail of the corresponding end of the screw conveyer-shaft. Fig. 5, is a longitudinal vertical section of the furnace. Fig. 6, is a detail of the bull-ring and ash-ring. Fig. 7, is a horizontal section of the furnace. Fig. 8, is a detail view of the solid fuel feeder. Fig. 9, is a detail view of a portion of the driving mechanism for the rotating grate. Fig. 10, is a vertical section through the feed hopper. Fig. 11, is a detail view of the connection between the grate-supporting truss-bars. Fig. 12 is a diagram illustrating, in plan, the relation between the grate and the feeder.

The improvements are shown in connection with a steam boiler furnace, for which they have special and characteristic advantages, but they are applicable to furnaces for other purposes; it being, however, necessary for the purposes of the invention to have at hand some suitable source of fluid under pressure such as steam, air or gas for producing the blast which injects the fuel into the furnace. In the example shown in the drawings this blast is produced by steam drawn from the boiler A, through pipe *a*, which, as shown, may be provided with a valve *b*, which is automatically actuated to periodically or intermittently permit the steam from pipe *a*, to enter a perforated blast pipe B. This blast pipe B, is arranged, as shown in Fig. 5, directly above a throat C, fitting in one of the usual stoking apertures at one side of the furnace (Fig. 1) and communicating at its inner end with the fire-box or combustion chamber D, of the furnace and at its outer end having communication with the side outlet of a feed hopper E, in the rounded bottom of which is fitted a screw conveyer or feeder F, which, when rotated, causes the solid fuel in the hopper to move inwardly and over the throat C, beneath and in front of the blast pipe B, which when supplied with a blast of steam by the valve *b*, will inject the solid fuel in front of it into the furnace and scatter the same upon the grate G. The fuel is supported in front of the blast pipe B, or in other words, between the blast pipe and the fire preparatory to its injection, by the bottom of the throat C. The solid fuel rests momentarily in front of the blast-pipe within the fire-box before being scattered upon the grate, and hence is subjected to a sufficient degree of heat to evaporate any moisture remaining therein and to partially evolve the gases of the fuel, a result greatly beneficial to combustion.

It is desirable that the solid fuel used be more or less comminuted in order not only that it may be more easily acted upon by the steam blast, but that its combustion in this state will more readily take place and it may be more evenly distributed over the surface of the grate. The fuel deposited for use in the hopper E, may be reduced to the desired degree of fineness in any suitable way, but in order that large lumps may be automatically broken up after introduction into the hopper and reduced to a sufficient degree of fineness to be blown into the fire by the blast, special means, hereafter specified, are employed.

As the fuel is injected into the furnace the grate G, is gradually rotated to present fresh surfaces of its incandescent fuel bed for receiving the successively deposited solid fuel and thus by simultaneously rotating the grate and injecting the fuel, the fresh fuel is injected onto live coals and the fuel

throughout the entire grate surface is thus maintained in an incandescent condition and state of perfect combustion. Special means for rotating the grate are hereinafter described.

Owing to the characteristics of the grate-rotating means, the portion of the grate which is on the same side of the longitudinal vertical plane of the furnace passing through the center of the grate as the fuel feeder, moves toward or approaches the throat of the solid fuel feeder and the fluid fuel blast pipe. The mechanical feeder for the solid fuel and the fluid fuel blast pipe, which together constitute a blast fuel feed, being at one side of the center of the grate and in front thereof, project the fuel tangentially with respect to the grate and not radially toward the center thereof. As the result of this arrangement the solid fuel is projected by the fluid fuel blast upon the traveling and advancing live fuel bed upon the grate. The solid fuel is thus deposited in a fine stream upon successively fresh portions of the live fuel bed which are in a highly heated incandescent state, and as fast as the fresh solid fuel falls upon the live fuel bed the rotation of the grate carries the fresh fuel beyond range of the incoming stream of solid fuel. The combustion of the solid fuel in the side of the fire-box remote from the blast fuel feed causes the presentation of an incandescent or live fuel bed to receive the deposit of the stream of fresh fuel. There is therefore present the most effective conditions for the complete combustion of the solid fuel.

Owing to the fact that the solid fuel is deposited upon a grate, which has passages between the grate bars for the downward passage of ashes and the upward passage of air, provision is thereby made for the discharge of the ashes and the admission of air to support combustion. The air in passing through the grate and the live fuel bed is thereby preheated to proper temperature to promote complete combustion. The fluid fuel (preferably steam, particularly with steam-boiler furnaces) not only projects the stream of solid fuel upon the grate but also is a fuel element and it is ejected into the fire chamber above the live fuel bed where it is heated to the required temperature and mixes with gases rising from the freshly delivered solid fuel and facilitates combustion.

The result of this combination of a blast fuel feed and a rotary grate is high efficiency and the substantial elimination of smoke.

The mechanically operated feeder for the solid fuel and the rotating grate are actuated by connected mechanisms, thus securing a proper relation between the feed of the fuel and the travel of the fuel bed on the grate so that the fresh fuel is fed in proper quantity with respect to the condition of the live fuel on the grate.

As an example of proper practice, the grate should be about five feet in diameter for a furnace for a one-hundred horse power steam boiler. Such a grate should be rotated once in about six or seven minutes; and should be supplied with fuel at the rate of five or six charges a minute, in case the intermittent blast is used. In case low grade bituminous slack coal is used, each charge should be about one and a half pounds in weight. It will be found efficient to use steam at a pressure of from fifteen to twenty pounds per square inch at the blast pipe B.

The power for actuating the various parts of the mechanism may be received from any suitable source, and a main drive shaft is shown at 10. This main shaft has a worm 11 (shown in Figs. 1, and 5), which engages a worm-wheel 12, on the shaft of the solid fuel feeder F. This feeder F, extends horizontally through the hopper E, toward the throat C. It is in the form of a spiral conveyer. In order to reduce to proper degree of fineness any lumps of fuel which may be deposited into the hopper, the edges of the conveyer are provided with teeth *d*, which engage such lumps and force them against ribs *e*, arranged above the bottom of the hopper E. (see Fig. 8) and intermeshing with the flights of the conveyer, the purpose of the said ribs being to hold the lumps aloof from the bottom of the hopper while they are impinged at an intermediate point between the ribs by the teeth *d*, and thus broken into two or more pieces. A tooth *d*, is formed at each turn of the spiral rib of the feeder F, and each tooth has a substantially radial face which faces forward in the direction of rotation of the feeder. The bottom of the hopper constitutes a channel in which the rotary conveyer or feeder turns. The discharge throat C, extends from the inner end of the hopper beyond the conveyer or feeder F, so as to provide a support for a charge of fuel preparatory to its injection into the combustion chamber. To facilitate access to the spiral solid fuel feeder F, the mouth *f*, of the hopper is arranged to swing upwardly as indicated in dotted lines in Fig. 5.

The fluid fuel element (such as steam) may be a continuous blast; but, preferably, it is intermittent. To this end a suitable valve *b*, is employed between the feed pipe *a*, and the blast pipe B. Any suitable form of valve may be employed, and there is indicated in Fig. 1, an ordinary puppet valve. A vertical stem 13, of this valve (see Fig. 1) has a cam surface 14, coöperating with a fixed lifting cam 15. The valve is held normally closed by spring 16. The driving

worm 11, coöperates with a horizontally arranged work wheel 17, (see Fig. 5) on the shaft of which is a wheel 18. This wheel 18, as shown in Fig. 2, has a laterally extending bunter 19, which, at each revolution of the wheel 18, is adapted to strike a laterally projecting arm 20 on the stem 13, of the puppet valve *b*. This partly rotates the stem 13, and hence the valve is lifted through the co-action of the cams 14, and 15. As soon as the bunter 19, releases the arm 20, the spring 16, closes the valve. In this manner an intermittent blast of fluid fuel is furnished.

The rotary grate is composed of grate sections *g*, each of sector shape, and each having a plurality of separate grate bars furnishing air spaces for the upward passage of air from the ash-pit H, beneath through the fuel on the grate to the combustion chamber D, above, and also providing for the downward passage of the ashes. The outer margins of the grate sections are supported upon an annular bull-ring I. This bull-ring has integral loops *h*, with which lugs on the grate sections coöperate, as shown in Fig. 5. The inner ends of the grate sections are supported upon a truss-spider consisting of truss-bars J, which meet at the center and each of which has at its outer end a bent end to engage an integral loop I, on the bull-ring. This construction of rotating grate involves the minimum obstruction on the underside of the grate. The lower edge of the bull-ring is stiffened by a ratchet-ring K, bolted thereto having ratchet-teeth on its outer periphery. This ratchet-ring coöperates with a driving spring-controlled pawl L, which is pivotally mounted upon a swinging sway-bar M, pivoted at its middle at 21, as shown in Figs. 5, and 7. The outer end of the sway-bar has a longitudinal slot 22 (see Fig. 7), in which enters a bowl 23 (see Fig. 9), carried on the underside of the wheel 18, as shown in Fig. 2. Consequently, the rotary grate is advanced one step at each rotation of the wheel 18.

It is important that the grate should always rotate freely and easily and in such a way as not to be affected by accumulating ashes. To this end the construction illustrated is employed. The bull-ring I, is located wholly beneath a fixed dead-plate N, and the dead-plate is as close to the bull-ring as free rotation will permit. The bull-ring is rotatively located upon a fixed ash-ring O, and the construction of ash-ring and bull-ring is such as to provide a race-way for anti-friction balls P. As the result of this construction the bull-ring turns on ball bearings and hence is readily and easily rotated. The ball race is provided by the co-operative constructions of the bull-ring and ash-ring respectively, as best shown in Fig. 6. The bull-ring has a horizontal flange *m*, an inner vertical wall *n*, and outer vertical wall *p*. Similarly, the ash-ring O, has a bottom *r*, inner vertical wall *s*, and outer vertical wall *t*. The balls rest on the bottom *r*, of the ash-ring and the flange *m*, of the bull-ring rests on the balls. As shown in Fig. 6, the outer wall *t*, of the ash-ring extends above the center of the balls; while the inner wall of the bull-ring extends below the center of the balls. This is an important feature, taken in connection with the vertical character of these walls, since it prevents the climbing up of the balls, due to their outward thrust, which would cause the bull-ring to bind and hence fail to rotate. With the construction shown the grate always rotates freely and attention is reduced to the minimum.

The bridge wall Q, as shown in Fig. 5, extends above the throat C, and above the nozzle of the blast pipe and the axis of the mechanical feeder, thus minimizing the danger of any portion of the solid fuel being blown over the bridge wall. To aid in avoiding this blowing over of solid fuel, the blast is downward as well as inward. In order to prevent destruction of the throat by the force of the blast and the presence of the comminuted fuel, a hardened steel plate *u*, is placed in the throat as shown in Fig. 5. It is important that the ashes should be removed as fast as they accumulate in the ash-pit H, in order to maintain a uniform air supply beneath the grate. Accordingly a depressed channel R, is provided below the bottom of the ash-pit into which the ashes are swept by means of the ash sweep S, which is carried by the rotary grate and which travels just above the floor of the ash-pit. The ashes are continuously discharged from the depressed channel R, into a receiver T, at the front of the furnace (from which place they can be conveniently removed from time to time) by a screw ash-conveyer U. This ash-conveyer consists of spiral flights *w*, mounted upon a rotary shaft V. This shaft is rotated by sprocket wheels 24 and sprocket chain 25, connecting it with the worm wheel 12. To facilitate the turning of this ash-conveyer, its rear end is supported by ball bearings formed in a sectional casing W, at the rear (see Fig. 3), the sectional construction of which enables the balls *x*, to be located in the grooves *y*. The sectional casing partly incloses the spiral flights of the ash-conveyer so that the ash-conveyer continuously keeps ashes away from the ball bearing.

Fig. 10, illustrates a convenient and preferred construction and location of the ribs *e*, which coöperate with the spiral feeder F, to break lumps. Preferably, there are as many of these ribs as there are turns to the spiral feeder; and they are spaced apart to

correspond to the pitch of the flights of the conveyer. Preferably, also, the flight of the conveyer F, which is nearest the discharge mouth of the hopper, is of slightly greater pitch than the other flights so as to prevent choking.

Fig. 11, illustrates the preferred plan for connecting the truss-bars J, at the middle of the grate. As here shown, there are four radial truss-bars which meet at the middle of the grate, and are bolted together.

The grate mounting herein illustrated and described constitutes the subject matter of a divisional application filed September 26, 1907, Serial No. 394,696.

I claim—

1. A steam-boiler smoke-consuming furnace for burning solid fuel having, in combination, a horizontal rotating grate having spaces for the passage of ashes from above and of air from below, a feeder for solid fuel arranged at one side of the furnace and in front of the grate for feeding solid fuel to one side of the center of the grate and toward an approaching portion of the grate, and a steam blast-pipe which directs a blast of steam into contact with the solid fuel in the discharge throat of the feeder and thence across the approaching portion of the grate and at one side of the center thereof, said steam-blast projecting the solid fuel with it and upon the advancing live fuel-bed on the grate.

2. A steam-boiler furnace having, in combination, a horizontal rotating grate, a feeder for solid fuel feeding the solid fuel to one side of the center of the grate and toward an approaching portion of the grate, and a steam blast-pipe which directs a blast of steam into contact with the solid fuel in the discharge throat of the feeder and thence across the approaching portion of the grate and at one side of the center thereof, said blast projecting the solid fuel with it and upon the advancing live fuel-bed on the grate.

3. A steam-boiler furnace having, in combination, a horizontal rotating grate, and a steam-blast fuel-feed which delivers solid fuel to one side of the center of the grate and upon a live fuel-bed on the grate.

4. A steam-boiler furnace having, in combination, a horizontal rotating grate, and a steam-blast fuel-feed which delivers solid fuel upon a live fuel-bed on the grate.

5. A steam-boiler furnace having, in combination, a horizontal rotating grate, a mechanical feeder for solid fuel, connected mechanisms for rotating the grate and driving the feeder, and a steam blast-pipe which directs a blast of steam into contact with the solid fuel in the discharge throat of the feeder, thereby projecting the solid fuel onto the grate.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

HENRY E. WALLIS.

Witnesses:
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A. L. MILLER.