No. 842,878. PATENTED FEB. 5, 1907.

J. S. S. FULTON.

AUTOMATIC STOKER.

APPLICATION FILED DEC. 7, 1904.

3 SHEETS—SHEET 1.

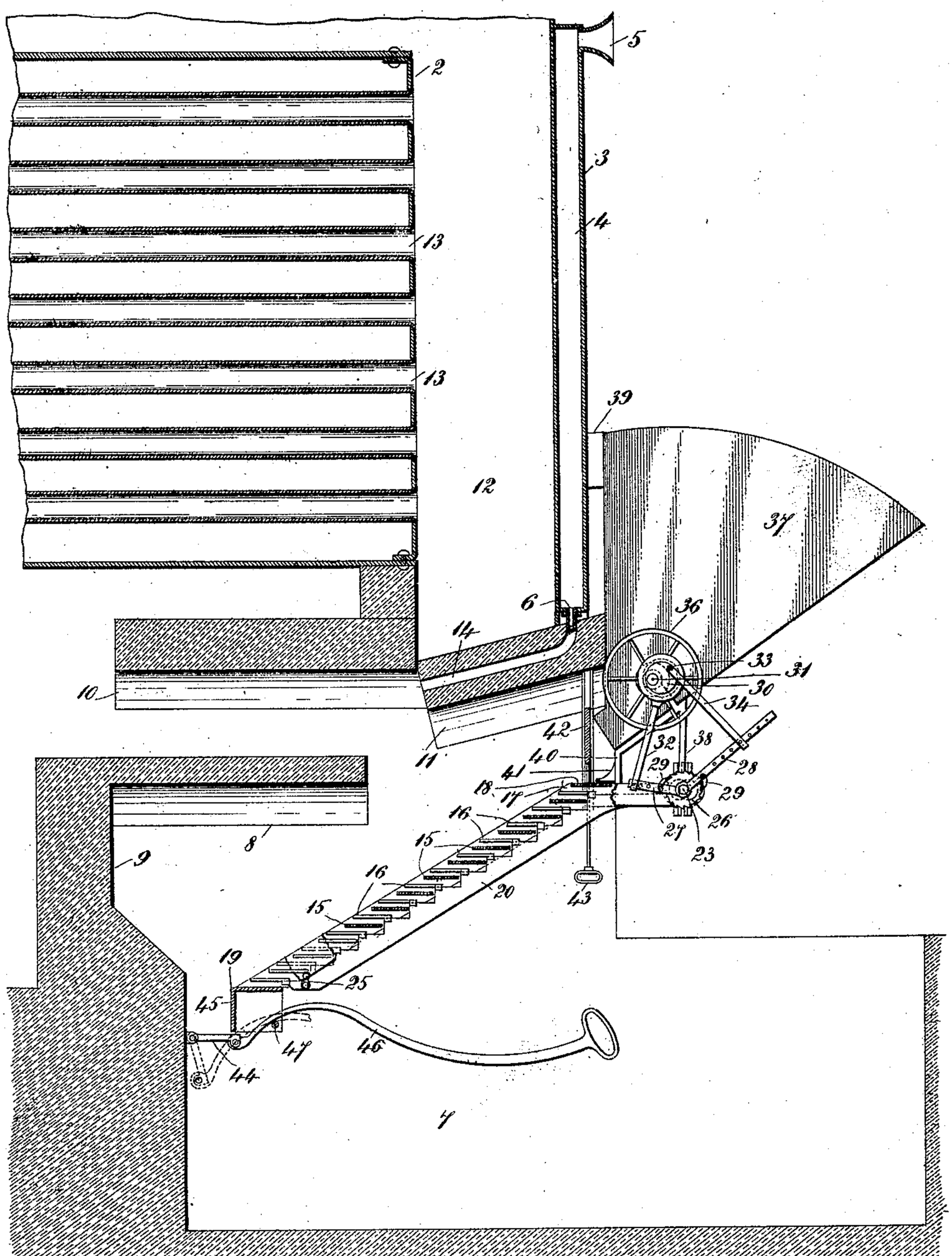

Fig. 1.

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Margaret A. Danihee.

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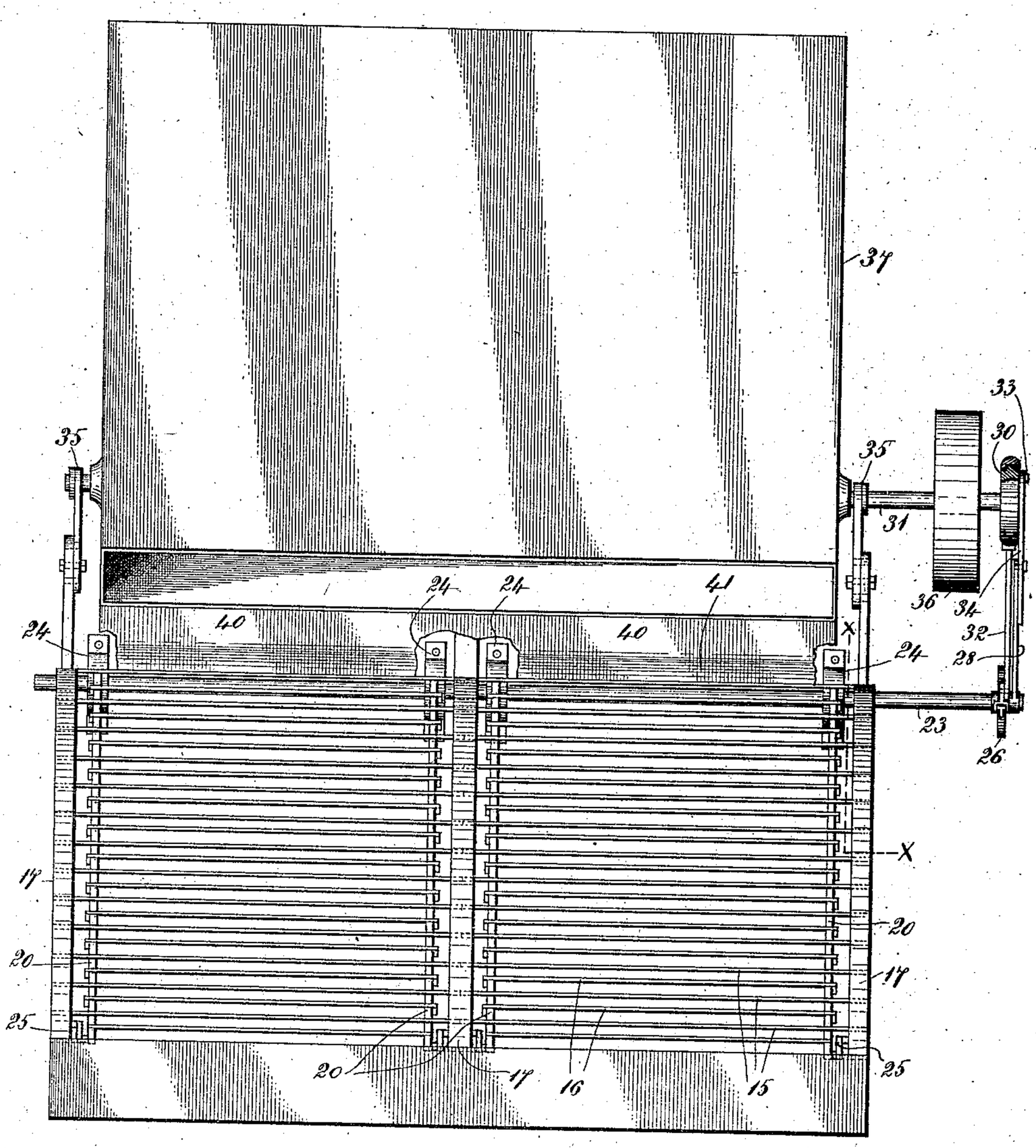

Fig. 2.

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3 SHEETS—SHEET 3.

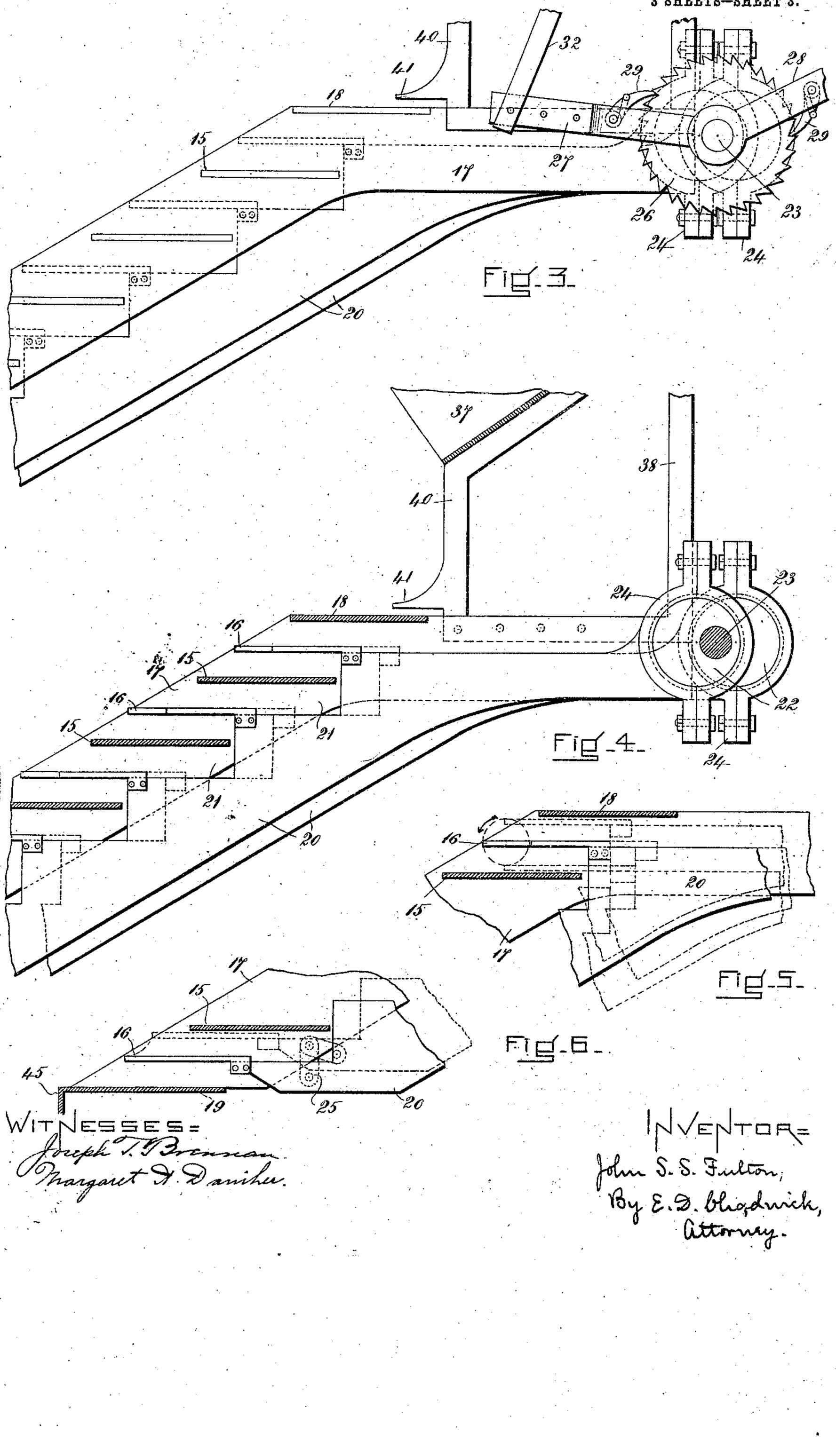

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

WITNESSES=

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UNITED STATES PATENT OFFICE.

JOHN S. S. FULTON, OF NEW YORK, N. Y., ASSIGNOR TO FULTON FURNACE COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

AUTOMATIC STOKER.

No. 842,878. Specification of Letters Patent. Patented Feb. 5, 1907.

Application filed December 7, 1904. Serial No. 235,820.

To all whom it may concern:

Be it known that I, JOHN S. S. FULTON, a citizen of the United States, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Automatic Stokers, of which the following is a specification.

The principal object of my invention is to produce a stoking apparatus for steam-boilers and the like which will make possible the successful and economical employment of peat as a fuel.

Much trouble has been experienced heretofore in using peat as a fuel, the difficulties encountered being due chiefly to the physical characteristics of the peat and particularly to its soft and crumbly nature, which causes it to disintegrate readily into a fine powder, especially when exposed to heat. This powder, both before ignition and during combustion, flows very freely, so that it will readily sift through the vertical openings in a grate of the ordinary type, and the particles of peat while burning also settle or pack closely together to such an extent as to prevent air from passing in between and among them in sufficient quantities to produce combustion. In these respects peat is the exact opposite of fuels like bituminous coal, the particles of which amalgamate while burning and do not flow freely or pack together in such a way as to prevent the flow of air between them. Furthermore, peat-ashes tend to pack solidly into the air-spaces and other openings of an ordinary grate, and thus to obstruct the flow of air through the grate and arrest combustion, and in this respect also peat is the opposite of coal, the ashes of which remain porous or do not pack sufficiently to exclude air. Other characteristics of peat are that it ignites slowly, relatively speaking, and normally contains a high percentage of moisture and also a large proportion of hydrocarbon gases or gas-producing compounds, which gases are driven out of the peat upon ignition of the latter and burn as a flame, requiring not only a large amount of oxygen, but also on account of the large percentage of moisture in the peat the maintenance of a high temperature in order to support it and effect complete combustion. On the other hand, the solid part or fixed carbon of the peat merely glows during combustion, burning practically without flame, and requires that practically the entire surface of each particle be freely exposed to the action of the oxygen in the air. Furthermore, peat being a very light and feathery fuel and the suction or partial vacuum above the grate developed by the draft being equally effective over the entire top surface of the grate it is a requisite that the peat be fed with great precision and supplied in equal quantities and to an equal depth over all portions of the grate, since otherwise the draft through the grate will concentrate itself at the point of least resistance or where the peat has the least depth, with the result that considerable portions of the peat will be blown off the grate and wasted.

According to my invention I overcome the difficulties above referred to by so handling the peat that at all times during combustion it is divided into small separate portions, which are kept constantly agitated in such manner as to provide for the ready access of air in sufficient quantities to support combustion, the peat being also gradually fed from one end of the grate to the other and provision being made for air-spaces through the grate, which are always kept open and prevented from clogging without permitting the burning peat to sift through them. To this end I provide a step-grate comprising a number of horizontal plates or bars forming an inclined series, a portion of the bars being movable with respect to the remaining bars and being operated to effect the positive feeding of the peat from the upper to the lower end of the grate, as hereinafter described. In connection with this grate when used for burning peat I employ a combustion-chamber, which provides for the admission above the grate of sufficient air to insure the complete combustion of the inflammable gases driven off from the peat, which combustion-chamber is preferably constructed and arranged in a manner similar to that shown and described in my prior United States Patent, No. 711,044, dated October 14, 1902, although in combination with my grate this chamber operates to secure new and useful results in effecting the proper combustion of peat fuel, and particularly in securing its immediate ignition when fed in at the upper end of the grate.

My invention also includes certain special

mechanisms and details, the nature of which will appear from the ensuing description.

An apparatus embodying the various features of my invention in their preferred form is illustrated in the accompanying drawings, in which—

Figure 1 shows the complete apparatus and also a portion of a return tubular boiler arranged in the usual manner to be heated thereby, certain parts of the apparatus being represented in side elevation and the remainder in vertical longitudinal section. Fig. 2 shows the automatic feeding-grate, feed-hopper, and operating parts in front elevation—*i. e.*, looking from the left in Fig. 1. Fig. 3 is a detail view showing in side elevation the upper end of the grate proper and some of the adjacent parts. Fig. 4 is a sectional view showing the same parts, the plane of section being indicated by the line *x x* in Fig. 2. Figs. 5 and 6 are detail sectional views illustrating the relative movements of the grate-bars.

Referring to Fig. 1 of the drawings, 2 indicates one end of a tubular boiler, which may be of any usual construction and forms no part of my present invention, being shown merely to illustrate the relative arrangement of my improvements when used in connection therewith. The end 3 of the boiler-casing is made double, thus providing an air-space 4, which has an open inlet 5 at its upper end and is provided with outlets 6 at its lower end. 7 represents the ash-pit, the front end of which is covered from side to side by a transverse arch 8 or other suitable division-wall extending rearwardly from a vertical wall 9, and above this arch is another transverse arch or wall 10. A third arch or wall 11 extends from the rear end of the arch 10 to and beneath the adjacent end 3 of the boiler-casing and closes the bottom of the space 12, which separates the latter from the tubes, the upper end of which space 12 leads into the smoke-stack in the usual manner. These arches spring from and are supported by side walls (not shown) of any suitable or ordinary construction, and the arch 11 is preferably inclined somewhat, as shown, for reasons which will hereinafter appear. A passage for the burning and burnt gases is thus provided between the arches 8 and 10, and it will be understood that these gases pass beneath the boiler to its farther end and thence back through the tubes 13 into the space 12 in the usual manner. The arch 11 is provided with a number of air tubes or passages 14, extending longitudinally through it and affording communication between the outlets 6 and the space above the arch 8, the construction and arrangement of these arches and tubes being similar to that shown and described in my prior patent above referred to.

The grate proper is located beneath the arches 8 and 11, at a suitable distance therefrom, and inclines downwardly from its rear or outer end to its front or inner end. This grate comprises a number of flat horizontal plates or bars 15 and 16, of which the bars 15 are rigidly secured to a stationary supporting-framework and arranged like a flight of steps, while the bars 16 are secured to a movable framework and are also arranged like a flight of steps, being interleaved between the stationary bars 15 and alternating therewith in the direction of the incline. The grate is preferably composed of two similar portions, arranged side by side, as shown in Fig. 2, for a reason which will hereinafter appear; but as the construction of these two portions is the same it will be necessary to describe the details of but one of them. These details are illustrated in Figs. 2, 3, and 4, in which the numerals 17 represent three stationary side bars connected by transversely-extending top and bottom plates 18 and 19, thus forming a rigid framework which is supported in any suitable manner at the sides of the ash-pit. These side bars 17 are provided with alined slots, in which the ends of the horizontal grate-bars 15 are located and held immovable.

Two movable side bars 20 are located between each pair of stationary side bars 17 and carry the grate-bars 16, which are rigidly secured thereto at their rear edges, said side bars 20 being cut away, as at 21, Fig. 4, to provide spaces for the reception of the stationary grate-bars when the parts are in the position illustrated in said figure.

Means are provided for imparting to each of the two sets of grate-bars 16 a series of movements such that, starting from the position shown in Fig. 4, each bar 16 moves successively upward and rearward with respect to the fixed bar 15 next above it and then downward and forward over the bar 15 next below it, and so on continuously. In the specific construction illustrated the means just referred to consist of eccentrics 22, one pair for each set of movable bars, which eccentrics are carried by a shaft 23, journaled in rearwardly-extending portions of the side bars 17 and the straps 24 of which are rigidly secured to or formed integral with the similarly-extended upper ends of the side bars 20, the lower ends of said side bars being respectively suspended on links 25, pivoted to the adjacent bars 17. The shaft 23 is rotated by suitable means, such as a ratchet-wheel 26, secured thereto and operated by a pair of arms 27 and 28, independently journaled on one end of the shaft 23 and each provided with a spring-pawl 29, adapted to engage the ratchet-wheel when the arm which carries it is oscillated. The oscillating means for said arms are represented as an eccentric 30, secured to a driving-shaft 31 and having its connecting-rod 32 adjustably piv-

oted to the arm 27, said eccentric 30 being also provided with a crank-pin 33 and a connecting-rod 34, adjustably pivoted to the arm 28. The shaft 31 is journaled in fixed uprights 35 and carries a driving-pulley 36, and the arrangement of the parts just described is preferably such that when the arm 27 is operating the ratchet-wheel 36 the arm 28 is performing its backward or inoperative movement, and vice versa, the shaft 23 being thus given a practically continuous rotation in the same direction, yet being susceptible to a wide variation in speed without changing the speed of the driving-pulley. The two pairs of eccentrics which carry the two sets of movable grate-bars are preferably secured to the shaft 23 in such relation that the throw of each pair is diametrically opposite to that of the other pair, so that when either set of grate-bars 16 and its load is moving upward the other set is moving downward, the weights necessary to be lifted being thus balanced and the power required for operating the grate being diminished.

Above the rear or upper end of the grate is located a hopper 37, the discharge-opening of which is located over the top plate 18. This hopper is shown as supported by brackets 38, rising from the side bars 17, and by plates 39, Fig. 1, connecting the ends of the hopper and the sides of the boiler, and between the lower edge of the mouth of the hopper and the grate is located a vertical plate 40, extending transversely across the grate and having a rib 41 projecting over the plate 18, the object being to prevent fuel from falling over the rear edge of said plate 18. The delivery of fuel from the hopper may be regulated by means of a vertically-adjustable plate 42, adapted to slide in front of the mouth of the hopper and operated by a handle 43.

At the lower end of the grate is provided an arrangement for dumping ashes, preferably consisting of a plate 44, extending the entire width of the grate and normally closing the bottom of a space provided between the adjacent front wall of the ash-pit and a vertical plate 45, carried by the side bars 17, said plate 44 being pivoted at its front edge to said wall and provided with an operating-handle 46, pivotally attached to its rear edge, which handle passes over and rests upon a pin 47, fixed to the stationary framework of the grate near the pivoted end of the handle. When said handle is lifted and slid forward over the pin 47 into the position shown in dotted lines in Fig. 1, the ashes received on the plate 44 are dumped into the ash-pit, and when said plate is drawn back into its normal position it is held there by the weight of the handle 46 acting through the leverage due to the position of said pin 47.

As thus constructed the operation is as follows: A quantity of peat having been placed in the hopper 37, it flows through the open lower end of the latter in a stream the thickness of which is determined by the position of the regulator 42. After as much peat has accumulated on the top of the fixed plate 18 as will remain on the same it begins to flow over the front edge of said plate onto the front portion of the movable grate-bar 16 next below and thence down the upper portion of the grate until its flow is stopped by the clogging of the mouth of the hopper due to the accumulation of peat beneath it. No further flow of peat will take place so long as the movable parts of the grate remain stationary; but as soon as the bars 16 are operated in the manner hereinbefore referred to the peat is thereafter fed positively down the grate, and at the same time a fresh supply of peat is continuously delivered upon the upper end of the grate, so that ultimately each grate-bar of one series or the other will be carrying at any given instant a small pile of peat extending along its exposed front edge. The positive feeding of the peat down the incline results from the succession of the upward, rearward, downward, and forward movements of the grate-bars 16, whereby the peat resting on any one of said movable bars 16 is first carried up in front of the edge of the stationary bar next above it, so that upon the rearward movement of the movable bar the peat is engaged by the front edge of said stationary bar and pushed over the edge of said movable bar, falling upon the stationary bar next below. Thereupon said movable bar moves downward until it is located just above the last-mentioned stationary bar and also moves forward over said bar, whereupon the front edge of the movable bar engages the pile of peat just delivered to the stationary bar and pushes it over the front edge of the latter onto the movable bar next below, whereupon the cycle of movements is repeated. These movements are caused to take place at such a speed that the peat is cascaded in a practically continuous thin stream from one grate-bar to another and is thus continually agitated, so that the entire surfaces of all the particles are exposed to the air flowing through the grate. The peat is ignited at the upper portion of the grate, as hereinafter described, and is gradually consumed during its travel down the same. The greater part of the combustion occurs while the peat is falling from one grate-bar to another, and the rate of feed is so determined that the combustion is completed by the time the peat reaches the lower end of the grate, so that nothing but the ashes will fall over upon the plate 44. The feeding of the peat is readily governed by suitably adjusting the connections between the arms 27 and 28 and the connecting-rods 32 and 34, respectively, by which adjustment the speed of rotation of

the shaft 23 is varied in an obvious manner, and if a very slow feed is desired one of said arms may be disconnected from its operating means or omitted entirely.

It will be evident that inasmuch as the combustion of the peat progresses continuously during its travel down the grate the quantities of fuel carried by the respective grate-bars will tend to diminish as the lower end of the grate is approached, and for this reason I prefer to cause the feeding action of the grate-bars to diminish progressively from the upper to the lower end of the grate. Such a diminishing feed is secured by the construction illustrated, since the circular movement of the movable bars at the upper end of the grate (illustrated by the dotted circle in Fig. 5) is gradually transformed into a movement in the arc of a circle resulting from the link suspension of the movable bars at the lower end of the grate, and it will be obvious that the feeding action due to the movement last mentioned will be less pronounced than at the upper end of the grate.

By the construction and mode of operation above described provision is made for keeping the peat constantly in motion while burning, thus shifting the position of the ignited particles and exposing them to contact with the air necessary for their combustion, and it will also be noted that inasmuch as the peat always falls from one horizontal grate-bar upon another there will be no tendency for it to sift through the open spaces between the bars. My arrangement also provides air-spaces between the grate-bars, which are constantly kept open by the relative movements described, so that an ample supply of air is provided for and the ashes are kept from accumulating by being carried along as fast as formed and deposited in the space above the plate 44 at the lower end of the grate.

The combustion-chamber described performs important functions in the burning of peat in my apparatus in that the arch 8 deflects the radiant heat and hot gases rising from the lower portions of the grate, where the burning peat contains practically nothing but carbon, and throws them back under the arch 11 and upon the bed of peat near the upper end of the grate, thus driving the moisture out of the peat practically as soon as it leaves the hopper and igniting it at a short distance therefrom. The arch 11 assists in this operation, as it reflects the heat downward upon the upper end of the grate, and I have found that peat containing as high a percentage of moisture as fifty per cent. will readily burn in my apparatus without being subjected to any preliminary drying operation. In fact, it is desirable that the peat should contain as much as forty per cent. of moisture, since otherwise it will be so light as to give more or less trouble during combustion for reasons previously stated. The combustion-chamber also provides an ample space for the complete burning of the inflammable gases driven off from the ignited peat, and air in sufficient quantities for supporting the combustion of these gases is drawn in through the tubes 14 by the draft induced by the fire, which air is first heated to some extent as it passes through the air-space 4 by the hot waste gases which come in contact with the inner wall of said air-space on their way up into the stack and is then heated to approximately the igniting temperature of the unconsumed peat-gases during its passage through the tubes 14, which are continuously exposed to the intense heat of the fire itself. Thus said gases are completely burned without danger of reducing their temperature below the point of ignition.

While I have described my improvements as particularly adapted and intended for the burning of peat, it is to be understood that they are not limited to such use, since they are also effective for the burning of other substances, especially sawdust, and also fuels—such as bituminous coal, for example—and it will be evident that the described details of construction of my apparatus may be widely varied without departing from my invention.

I claim as my invention—

1. In an automatic stoker, a step-grate comprising two inclined series of substantially horizontal grate-bars, the bars of one series being interleaved between those of the other series, and means for producing relative upward, backward, downward and forward movements between alternate bars and the bars next above and below them.

2. In an automatic stoker, a step-grate comprising two inclined series of substantially horizontal grate-bars, the bars of one series being interleaved between those of the other series, and means for producing relative upward, backward, downward and forward movements between alternate bars and the bars next above and below them, said movements diminishing in extent from the upper to the lower end of the grate.

3. In an automatic stoker, a step-grate comprising an inclined series of stationary grate-bars and an inclined series of movable grate-bars interleaved between the stationary bars, and means for imparting to the movable series of bars sequential upward, backward, downward and forward movements.

4. In an automatic stoker, a step-grate comprising an inclined series of stationary grate-bars and an inclined series of movable grate-bars interleaved between the stationary bars, and means for operating the movable series of bars in such manner that the upper end of the series moves in a circular

path while the lower end moves in an arc of a circle less than the circumference of the latter, substantially as set forth.

5. In an automatic stoker, a step-grate comprising an inclined series of stationary grate-bars, an inclined framework movably supported at its lower end and carrying a series of grate-bars interleaved between the stationary bars, and means for moving the upper end of said framework in a circular path.

6. In an automatic stoker, a step-grate composed of two similar portions located side by side and each comprising two inclined series of grate-bars, the bars of one series being interleaved between and movable with respect to those of the other series, and means for moving one series of movable bars upward and backward and for simultaneously moving the other series of movable bars downward and forward, and vice versa.

7. In an automatic stoker, a step-grate comprising an inclined series of stationary grate-bars, an inclined movable framework pivotally supported on links at its lower end and carried by eccentrics at its upper end, a shaft to which said eccentrics are secured, a series of grate-bars carried by said movable framework and interleaved between the stationary grate-bars, and means for rotating said shaft.

8. In an automatic stoker, a step-grate composed of two similar portions located side by side and each comprising an inclined series of stationary grate-bars, an inclined framework movably supported at its lower end and carried by eccentrics at its upper end, and a series of grate-bars carried by the movable framework and interleaved between the corresponding stationary grate-bars, a shaft to which said eccentrics are secured, the eccentrics for one movable framework being disposed on said shaft in diametrically opposite relation to the eccentrics which carry the other movable framework, and means for rotating said shaft.

9. In an automatic stoker, a step-grate comprising two inclined series of substantially horizontal grate-bars supported for relative movement at their lower ends, the bars of one series being interleaved between those of the other series, and means for producing relative upward, backward, downward and forward movements between the upper ends of said series of bars.

10. In an automatic stoker, a step-grate comprising two inclined series of substantially horizontal grate-bars supported for relative movement at their ends, the bars of one series being interleaved between those of the other series, and means for producing a relative circular movement between the upper ends of said series of bars.

11. In an automatic stoker, a step-grate composed of two similar portions located side by side and comprising respectively two inclined series of substantially horizontal grate-bars, the bars of one series being interleaved between those of the other series, and means common to the two portions of the grate for producing relative upward, backward, downward and forward movements between the interleaved bars, the relative movements of the bars in the two portions of the grate being opposite in phase.

12. In an automatic stoker, the combination of a step-grate comprising an inclined series of stationary grate-bars, an inclined series of movable grate-bars interleaved between the stationary grate-bars, a shaft, and operating connections between the same and said movable series of grate-bars, and means for rotating said shaft comprising a ratchet-wheel secured thereto, two arms independently journaled concentrically with said shaft and provided respectively with pawls adapted to engage and rotate said ratchet-wheel, and means for oscillating said arms simultaneously in opposite directions.

13. In an automatic stoker, the combination of a step-grate comprising an inclined series of stationary grate-bars, an inclined series of movable grate-bars interleaved between the stationary grate-bars, a shaft, and operating connections between the same and said movable series of grate-bars, and means for rotating said shaft comprising a ratchet-wheel secured thereto, two arms independently journaled concentrically with said shaft and provided respectively with pawls adapted to engage and rotate said ratchet-wheel, and means for oscillating said arms simultaneously in opposite directions, said means comprising a driving-shaft and means for rotating the same, an eccentric carried thereby and having its connecting-rod adjustably secured to one of said arms, and a crank-pin carried by said eccentric and provided with a connecting-rod which is adjustably secured to the other of said arms.

14. In an automatic stoker, the combination of a step-grate comprising a stationary framework having a horizontal top plate and an inclined series of grate-bars extending downward therefrom, a movable framework carrying an inclined series of grate-bars which are interleaved between the stationary grate-bars, means for imparting to the movable series of bars sequential upward, backward, downward and forward movements, a hopper having its discharge-opening located above the top plate of the stationary framework in position to deliver fuel upon said top plate and upon the movable bar next below it, and means for regulating the delivery of fuel from said hopper.

15. In an automatic stoker, the combination of a step-grate comprising two inclined series of grate-bars, the bars of one series being interleaved between those of the other series, means for operating said bars in such

manner that each bar of one of the series moves successively upward, backward, downward and forward with respect to the bars above and below it, and transverse division-walls 8 and 11 located above said grate and providing a combustion-chamber, substantially as described.

16. In an automatic stoker, the combination of a step-grate comprising two inclined series of grate-bars, the bars of one series being interleaved between those of the other series, means for operating said bars in such manner that each bar of one of the series moves successively upward, backward, downward and forward with respect to the bars above and below it, and transverse division-walls 8 and 11 located above said grate and providing a combustion-chamber, the wall 11 being provided with air-passages opening into the space at the front end of said wall, substantially as described.

17. In an automatic stoker, the combination with a step-grate located between side walls and comprising two inclined series of substantially horizontal grate-bars, the bars of one series being interleaved between those of the other series, and means for producing relative upward, backward, downward and forward movements between alternate bars and the bars next above and below them, of transverse division-walls overhanging the upper and lower portions of said grate and providing a combustion-chamber above the grate and an outlet-passage between the ends thereof, substantially as described.

18. In an automatic stoker, the combination with a step-grate located between side walls and comprising two inclined series of substantially horizontal grate-bars, the bars of one series being interleaved between those of the other series, and means for producing relative upward, backward, downward and forward movements between alternate bars and the bars next above and below them, of transverse division-walls overhanging the upper and lower portions of said grate and providing a combustion-chamber above the grate and an outlet-passage between the ends thereof, the transverse wall over the lower portion of the grate being arranged to reflect heat back under the other transverse wall.

19. In an automatic stoker, the combination with a step-grate located between side walls and comprising two inclined series of substantially horizontal grate-bars, the bars of one series being interleaved between those of the other series, and means for producing relative upward, backward, downward and forward movements between alternate bars and the bars next above and below them, of transverse division-walls overhanging the upper and lower portions of said grate and providing a combustion-chamber above the grate and an outlet-passage between the ends thereof, and means for delivering heated air into said outlet-passage.

20. In an automatic stoker, the combination with a step-grate located between side walls and comprising two inclined series of substantially horizontal grate-bars, the bars of one series being interleaved between those of the other series, and means for producing relative upward, backward, downward and forward movements between alternate bars and the bars next above and below them, of transverse division-walls overhanging the upper and lower portions of said grate and providing a combustion-chamber above the grate and an outlet-passage between the ends thereof, the transverse wall over the upper portion of the grate being provided with air-passages opening into the space at its front end, and a hollow casing exposed to the heat of the waste products of combustion and forming an air-space communicating with said air-passages and with the external air.

In testimony whereof I have hereunto subscribed my name this 20th day of October, 1904.

JNO. S. S. FULTON.

Witnesses:
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E. D. CHADWICK.