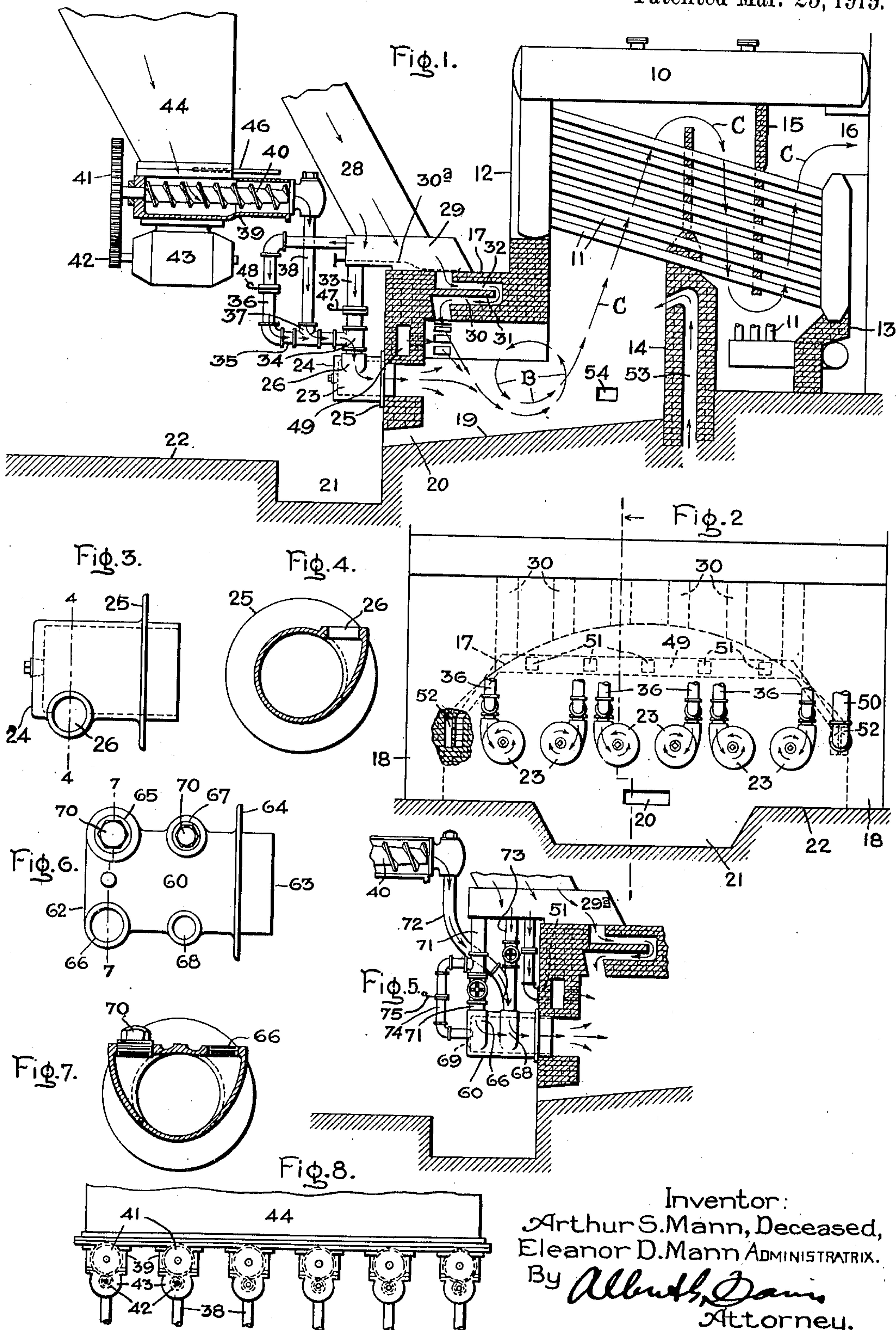


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APPARATUS FOR BURNING POWDERED FUEL.
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1,298,530.

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UNITED STATES PATENT OFFICE.

ARTHUR S. MANN, DECEASED, LATE OF SCHENECTADY, NEW YORK, BY ELEANOR D. MANN, ADMINISTRATRIX, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

APPARATUS FOR BURNING POWDERED FUEL.

1,298,530.

Specification of Letters Patent.

Patented Mar. 25, 1919.

Application filed July 20, 1916. Serial No. 110,397.

To all whom it may concern:

Be it known that ARTHUR S. MANN, deceased, late a citizen of the United States, and a resident of Schenectady, in the county of Schenectady, State of New York, during his lifetime invented certain new and useful Improvements in Apparatus for Burning Powdered Fuel, and that I, ELEANOR D. MANN, administratrix under the last will and testament of the said ARTHUR S. MANN, do hereby declare, to the best of my knowledge and belief, that the following specification, taken in connection with the accompanying drawings, is a clear, true, and complete description of said improvements.

The present invention relates to apparatus for burning powdered fuel and has for its object to provide an improved structure for this purpose.

For a consideration of what is believed to be novel and the invention, attention is directed to the accompanying specification and the claims appended thereto.

In the accompanying drawing, Figure 1 is a longitudinal sectional view, partly diagrammatic, of a powdered fuel burning apparatus embodying my invention, the section being taken on line 1—1, Fig. 2; Fig. 2 is a front elevation; Fig. 3 is a top plan view of a burner in which the air and fuel are mixed; Fig. 4 is a section on line 4—4, Fig. 3; Fig. 5 illustrates a modified form of burner connected to a furnace; Fig. 6 is a plan view thereof; Fig. 7 is a section taken on line 7—7, Fig. 6, and Fig. 8 is a front view of the hopper showing the arrangement of the feeder boxes across it.

Referring to Figs. 1 to 4, 10 indicates the steam drum of a boiler furnace and 11 the water tubes. These may be of any desired structure. 12 indicates the front wall of the boiler, 13 the back wall, and 14 and 15 intermediate walls which are arranged to cause the products of combustion to take a circuitous path over the water tubes 11. 16 indicates the flue leading to the chimney. The front wall of the boiler comprises a brick arch 17 supported by side walls 18. The hearth 19 slopes toward the front of the boiler which is provided with a slag hole 20 beneath which is a slag pit 21 built in the floor 22. Across the front of the furnace is a series of spaced burners 23, six being shown in the present instance. Each burner

comprises a casing which is preferably cylindrical, and is closed at one end as indicated at 24, and is open at the other end, the open end being inserted in an opening in the front boiler wall. Adjacent the open end is a flange or collar 25 which fits against the furnace wall to position the burner. In the top of the casing and located on one side of the longitudinal center line is a tangential opening 26 through which air and powdered fuel are introduced into the burner. With this arrangement a whirling action of the air and fuel in the burner is produced, the currents of air being forced to take irregular spiral forms. The burners are so arranged that the air currents issuing from them revolve in counter-directions with respect to each pair, as illustrated by the arrows in Fig. 2, this being accomplished by placing the tangential openings 26 of adjacent burners on opposite sides thereof. 28 indicates a conduit for supplying air to a manifold 29. It may be connected to any suitable type of blower. Built in the arch 17 are a series of flues 30 which connect with the manifold 29 and through which air is admitted in a vertically downward direction in front of the burners, there being one flue for each burner. 30^a is a damper for controlling the flow of air from the manifold 29 to the flue 30. The flues 30 are built so that the air takes a circuitous path in passing through them, as indicated by the arrows in Fig. 1, the arrangement thus acting as a preheater for the air. To this end a tongue and groove arrangement may be used, as shown at 31, 32. Leading from the manifold 29 to the opening 26 in each burner is a pipe 33 through which air is fed to it. In the conduit 33 is a T-coupling 34 into which is connected a pipe having a horizontal section 35 connected to the manifold 29 by a pipe section 36. In the horizontal section is a T-coupling 37 to which is connected a vertically extending pipe 38 through which powdered fuel is fed, the upper end of the pipe being connected to a suitable fuel feeding device. In the present instance the fuel feeding device is shown as comprising a feeder box 39 in which is located a feeding screw 40 or conveyer driven through a gear wheel 41 and pinion 42 by a suitable motor 43. The bottom of the thread of the screw 40 tapers from about the center to the dis-

charge end as shown, so that after the screw has taken its bite the volume increases as the threadful advances and the flow to the pipe 38 is free and easy in consequence. 44 indicates a fuel hopper connected to the feeder boxes. There is a separate fuel feeder box for each burner, but the fuel hopper is preferably common to all of them. 46 indicates a slide which acts as a valve for regulating the flow of fuel from the hopper to the feeder boxes. With this arrangement the powdered fuel will not pack in the hopper because the series of descending columns work upon each other. The air pipes 33 and 36 are provided with suitable dampers 47 and 48 for regulating the flow of air through them. Built in the front furnace wall beneath the arch and extending entirely across it is a flue 49 connected at its two ends to the manifold 29 by pipes 50. The right-hand pipe 50 shows in Fig. 2, but the left-hand one has been removed and the wall broken away in order to better illustrate the structure. Leading out from the flue 49 are a series of openings 51, one located between each two burners, such openings being staggered relative to the flues 30. These openings are below the arch and discharge a stream of air just over the flame issuing from the burners, thus protecting the arch from the flame. There is also a flue 52 on each side of the furnace which is connected with the corresponding pipe 50 and discharges a sheet of air along the two side walls of the boiler to protect them from the flames of the two adjacent burners. Built in the intermediate wall 14 is a flue 53 through which air may be admitted if found desirable, as will be referred to hereinafter. Air may also be admitted through the air port 54 in case of very heavy loads.

In operation a fire may be started by means of kindling placed at the mouth of one of the burners and fired, air being then admitted by pipes 33 and 36. The motor 43 is then started slowly to feed fuel which will immediately catch fire from the kindling. The other burners will then catch from the first one. The motor is preferably of a type to provide a wide range of speed so that the fuel may be fed according to the load. At each burner the powdered fuel falls through the pipe 38 into the pipe section 35 and is caught by the air flowing through it and carried into the T-coupling 34. Here it encounters the air flowing down through pipe 33 and is carried by it into the burner 23. It will be noted that in each instance the fuel enters the air pipe at right angles to the direction of the flow through it. This gives a thorough mixing of the air and fuel. The mixture of air and fuel enters the burner at a high velocity, and since the opening 26 is placed at a tangent to the wall of the burner, a whirling motion is imparted to

it and the mixture is moved toward the open end of the burner with a spiral motion. In the burning of powdered fuel a high velocity of the air is necessary in order to keep the particles in suspension until completely burned, and to bring sufficient air into contact with each particle to insure its complete combustion in a very short space of time since it must be burned if at all very quickly. On the other hand, a high velocity of flow through the furnace is not desirable since it of necessity means a very long flame. By the arrangement just described wherein the mixture of fuel and air is fed from the burner with a spiral motion, the benefit of a high velocity is obtained with a relatively slow movement through the furnace. The air and fuel shortly after it emerges from the burner is met by the down draft streams of heated air coming from the flues 30. This drives the whole mass downward and sets up a whirling spiral, as indicated by the arrows B. At the same time air from the openings 51 strikes into the whirl of air across the top thereof. The slag is deposited on the hearth, and the products of combustion pass over the water tubes to the chimney by the circuitous path indicated by the arrows C. By this arrangement a complete combustion is obtained with a comparatively short flame. A powdered fuel particle in order to be completely burned has to mix or be brought into contact with a very large number of air volume units. It has been found that this can best be effected by means of a series of successive mixings; i. e., by supplying the air at numerous points as described, rather than by supplying the total amount of air required at one time. In actual practice it is preferable to supply a good quantity of air through the flues 30 as this air is preheated and hence the more readily burns the fuel. At times of heavy load when a considerable amount of fuel is being supplied it may all not be completely burned adjacent the burners. At such time additional air in such quantities as may be found desirable can be admitted through flues 53 and 54.

In Figs. 5, 6, and 7 a modified type of burner is shown in connection with a boiler of the same structure as that shown in Figs. 1 and 2, although it may be used in connection with other types if found desirable. It comprises a cylindrical casing 60 closed at the one end 62 and open at the other end 63, and provided with a collar 64 the same as the burner in Figs. 1 to 4. In its top it is provided with four tangential openings 65, 66, 67 and 68 and in the end 62 it has an opening 69. Only one of each pair of openings 65, 66, and 67, 68 is used at the same time, the openings 65 and 66 being for primary combustion air and the openings 67 and 68 for secondary combustion air.

and 68 being for fuel and its carrying air. In the present instance the burner is shown as having the openings on one side plugged up and those on the other side connected to the air supply and fuel feeder means, the openings 65 and 67 being closed by plugs 70. Connected into opening 66 is an air pipe 71 leading from the manifold 29^a, and connected into opening 68 is the fuel pipe 72 which is joined to the pipe 73 for supplying fuel carrying air. Connected into the opening 69 is a pipe 74 provided with a damper 75, for supplying to the burner what may be termed auxiliary combustion air. With this arrangement of connections it will be seen that the fuel and its carrying air admitted through opening 68 swirl in the same direction in the burner as does the primary combustion air admitted through opening 66. This gives a very rapid whirling action and also creates a fairly high axial velocity so that a comparatively long flame will result. The length of the flame may be increased at will by admitting more or less auxiliary combustion air through opening 69. With a series of these burners, it will be understood that they will be connected up in the right and left-hand manner as shown in Fig. 2 so that adjacent ones swirl in the opposite direction. In certain instances, or for certain types of work, it may be desirable to have a very short flame, and to this end the primary air and the fuel and its carrying air may be connected on opposite sides of the burner so that they swirl in opposite directions. They thus counteract each other to a great extent and the axial movement can be made quite slow so that a comparatively short flame results. In either event the swirling action is obtained so that a good mixture results.

While the invention is disclosed in each instance in connection with a boiler furnace, it will be understood that it is not limited thereto for it may be embodied in connection with other types of furnaces, as for example, forges.

The burning of powdered fuel differs in one very essential respect from the burning of ordinary fuel, in that powdered fuel is burned in suspension, and one of the most essential requirements is to obtain a thorough mixing of the necessary amount of air with the fuel to obtain complete combustion in the very limited time which is available. By the improved arrangement herein described wherein the mixing is produced by adding the air in small quantities at successive intervals in the travel of the fuel, it has been found that very thorough mixing and complete combustion results in a comparatively short space so that a good efficiency is obtained.

In accordance with the provisions of the

patent statutes, the principle of operation of the invention has been described, together with the apparatus which is now considered to represent the best embodiment thereof; but it is to be understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What is claimed as new and desired to secure by Letters Patent of the United States, is:—

1. In an apparatus of the character described, the combination of a furnace and a series of burners arranged across the front of it for feeding powdered fuel thereto, said burners each comprising a casing having a closed outer end and an open inner end and being provided with a tangential opening through which fuel and air are fed to it whereby a whirl is set up in the casing, the tangential openings of adjacent burners being arranged on opposite sides so that the whirl in them is in opposite directions.

2. The combination with a furnace having an arch, of a plurality of burners arranged across its front below the arch, means forming circuitous flues in the arch one above and in front of each burner for supplying a down draft of heated combustion air, and flues staggered with relation to the first named flues for directing air along the arch above the flames issuing from the burners.

3. The combination with a furnace having an arch, of a plurality of burners arranged across the front of the furnace beneath the arch, said burners having tangential openings, conduits for feeding powdered fuel and air through said openings, means forming circuitous flues in the arch one above and in front of each burner for supplying a down draft of heated combustion air, and flues staggered with relation to the first named flues for directing air along the arch above the flames issuing from the burners.

4. In an apparatus of the character described, the combination of a furnace and a series of burners arranged across the front of it for feeding powdered fuel thereto, said burners each comprising a casing having a closed outer end and an open inner end, and being provided with a tangential opening through which fuel and air are fed to it, whereby a whirl is set up in the casing, the tangential openings of adjacent burners being arranged on opposite sides, so that the whirl in them is in opposite directions, means forming circuitous flues in the top wall of the furnace, one above and in front of each burner, for supplying a down draft of heated combustion air, and flues staggered with relation to the first-named flues for directing air into the furnace parallel with the fuel and air fed from the burners.

5. The combination with a furnace having an arch, of a plurality of burners arranged across its front below the arch, said burners

having tangential openings to which fuel and
air are fed, whereby a whirling motion is set
up, the whirling motion of adjacent burners
being in opposite directions, means forming
5 flues in the arch for supplying a down draft
of heated combustion air to the furnace, and
flues staggered in relation to the first-named

flues for directing air along the arch above
the flames issuing from the burners.

In witness whereof, I have hereunto set my 10
hand this 19th day of July, 1916.

ELEANOR D. MANN,
*Administratrix of the estate of Arthur S.
Mann, deceased.*