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APPARATUS FOR Firing FURNACES WITH POWDERED FUEL.
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5 SHEETS-SHEET 2.

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Att'y.
To all whom it may concern:

Be it known that I, JAMES JOHN CANTLEY BRAND, of Sydney, New South Wales, Australia, have invented certain new and useful Improvements in Apparatus for Firing Furnaces with Powdered Fuel, of which the following is a specification.

This invention consists in apparatus for feeding boiler furnaces with powdered coal or coke. The fuel, which is ground to a very fine gauge (in practice 85% passes through a 200 mesh screen and 95% through a 100 mesh screen), is maintained in a mobile condition by aerification and is circulated through a continuous conduit to which it is supplied from a feed hopper, the required feed for each furnace being taken out of the flow circuit through separate gates and control devices in the conduit and thence forced into the furnaces by a preheated air blast which with the circulation air provides the required volume of oxygen to effect combustion in the furnaces. The particular apparatus used for operating this system is hereinafter described with reference to the accompanying drawings, in which:

Figure 1 is a transverse sectional view through a vessel showing the firing apparatus as applied to use on a Scotch type boiler.
Figure 2 is an enlarged fragmentary vertical sectional view through the boiler and a part of the fuel delivering apparatus.
Figure 3 is a fragmentary horizontal sectional view of the hot box and blast nozzle.
Figure 4 is a vertical sectional view through the fuel delivery pipe to the furnace, showing a fragment of the latter.
Figure 5 is a fragmentary sectional view through the fuel conduit and conveying mechanism.
Figure 6 is a top plan view, partly in section, of the fuel feed circulating conduit, the air blast main and its connections.
Figure 7 is an enlarged front elevation partly in section, of the apparatus, shown in Figure 6, and illustrating the apparatus applied to a slightly different type of furnace from that disclosed in Figure 1.

Fig. 8 is a front elevation partly in section of a modification of the apparatus.
Fig. 9 is a fragmentary front elevation, partly in section of a further modification of the invention.

Throughout the drawings the same figures of reference indicate identical or corresponding parts.

Referring to Fig. 1, 20 is the hull of a steamer, 21 and 22 wing bunkers therein, 23 and 24 boilers, and 25 the smoke stack. Each of the boilers contains three furnaces, but obviously the invention is applicable irrespective of the number of furnaces or of the number or type of boilers in an installation. 26 is an air preheater located in the base of the smoke stack. It is a heater of the tubular type through which air is forced by means of a fan or impeller 27, the heated current of air being driven thereby through the preheater 26 into the air blast trunk 28, whence supplies of air are taken off to the separate furnace services. 29 is a closed hopper, and 30 a waste air shaft from the same leading up through the deck of the ship and in which a filter screen of the bag or other type may be arranged. 31 is an air separator of the "cyclone" type, having at the top of it a filter 32; the lower end of this separator discharges into the hopper 29. Powdered fuel entrained in an air draft, and therefore in a perfectly mobile condition, is drawn from the storage bunkers 21 and 22 by the centrifugal pump 33 through the pipe lines 34 and 35, and delivered through the pipe line 210 into the air separator 31. The pipes 34 and 35 are brought into communication with tubular conveyors 36 located in the bottoms of the storage bunkers 21 and 22. Each conveyor 36 consists of a pipe of considerable diameter set in the bottom of the bunker 22, having inlets at intervals into the bunker, which inlets are controlled by valves or shutters such as 37 which are manually operable from the stoke hold by a mechanical connection not shown. A downtake pipe 38 is led into the pipe 36 to supply air thereto. This air may be atmospheric air drawn through the
valved hood 59, or it may be cooled furnace gases drawn from the smoke stack 25 through a cowl 40 and passed through a series of pipes 41 adapted to be cooled by liquid contained in a suitable receptacle, (not shown). It is desirable to introduce cooled furnace gas rather than atmospheric air into the bunkers as it is less liable to involve risk of igniting the fuel by oxidation. 58 are mechanical agitators each consisting of a shaft with fingers or vanes or paddles thereon located in the store bunkers 21 and 22 and operating to maintain a free condition in the coal at the bottom of the bunker to facilitate its flow into the conveyors 42 through the valved apertures therein.

In Figs. 6 and 7 detail of the installation is shown. The foot of the hopper 29 terminates in a sump 46 which is laterally offset from the continuous pipe conduit 47 carrying a mechanical conveyor of any well known type. As shown in Fig. 6, this conveyor consists of a continuous length of flexible steel wire rope 48 having attached to it at uniform intervals push plates or discs 49 of substantially smaller diameter than the conduit. These plates or discs should have considerable freedom so as to minimize risk of choking if any packing of fuel should occur in any part of the circulating system. The drive is applied by a jaw sprocket wheel 50 completely enclosed in one return end of the conduit, and driven through worm wheel 51 by a worm 52 geared to the shaft 52. This shaft serves also to drive the screw feeders which take fuel from the current circulating in the conduit 47 and deliver it to the several furnaces in the system. The detail of these feeders is shown in Figs. 2 and 6. 53 are the furnace feed pipes, 54 pockets which take fuel by gravity from the conduit 47 into the screw feeders which move it at a uniform rate into the pipes 53. The furnace doors 57 are constructed and hung so that they may be opened when required to permit access to the furnaces without disturbing the furnace feed pipes 53. The capacity of the conduit conveyor is such that it will always deliver fuel at a rate in excess of the maximum demand of the several furnace feeders served by it, so that some surplus is always carried round the circuit. At appropriate intervals in the conduit pipe 47 a system of grated ports or vents 60 in the bottom thereof open into the pockets 54 (Fig. 5) which form receivers for the furnace feeders working in the barrel 63. These ports are opened more or less as required by slide valves 61 which are controlled by hand grips 62 extended through the sides of the pockets 54. In these barrels, screw feeders 64 operate to move the fuel received through the pockets 54 into the furnace pipes 53. Above the junction of each barrel 63 and the pipe 53 a straight extension air pipe 65 is connected into the air trunk 28, a valve 66 of butterfly or gate type being fitted to control or to cut off the air supply from the trunk 28 through the air pipe 65 into the furnace pipe 70. A valved pipe 55 from the air trunk 28 is connected into the inlet end of each feeder barrel 63 to deliver air thereinto and maintain a mobile condition of the fuel in which the feed screw is working; this air passes also up into the conduit 47 through the ports or vents 60 therein, and thus assists to maintain a mobile condition of the fuel in circuit in the conduit. As the fuel is maintained in semi-suspension in the air passing through the various pipes and other parts of the apparatus it does not tend to deposit or pack in any part of the system to an extent which would cause operating difficulties. The spindle of the feed screw 85 is extended through the back end of the tube 63 and carries a friction disc 67 on a feathered sleeve 68. A helical spring 69 in compression operates normally to push the friction disc 67 against the edge of the drive in the shaft 52. A control handle 71 flocked to a grooved sleeve on the rear side of the disc 67 provides a means whereby the disc 67 may be reticled from contact with the driving disc 70 when it is required to put any particular furnace feeder out of operation. The rotational rate of the screw 64 is determined by the set of the drive disc 70 on the spindle 52, a faster rate being obtained by moving that disc nearer the centre of disc 67, and vice versa. 72 is a butterfly or gate valve in the pipe 55 for controlling the air supply from the air trunk 28 therethrough into the inlet end of the 105 feeder barrel 63. It is desirable to extend the fire door end of the furnace flue forward a greater or less distance for the purpose of shielding the flue plates of the boiler from injuriously excessive temperature. The fire doors 57 are mounted in the extension end plate 76, and behind said plate an air chamber 77 is contained forward of the fire brick diaphragm 78. The burner nozzle 79 is out wardly splayed and fitted internally with a mouth cone 80 which operates to spread the blast as a conical annulus. It is water jacketed as shown at 81 and fitted with a tubular collar 82 having vents 83 cut around it placing the annular air collar 55 in communication with the chamber 77. The chamber 77 is ported as indicated at 84, is connected through a pipe 95, (Fig. 1), with the air blast pipe 28. The collar vents 85 125 are formed tangentially, as best seen in Fig. 3, for the purpose of applying a whirling motion to air passing from the chamber 77 through them into the collar space 85 which surrounds the annular mouth 86 of 130
the nozzle. The nozzle is withdrawable without disturbing its relation to the conical collar 82 when the fire doors 57 are opened. To facilitate its withdrawal it is mounted on the end of the furnace feed pipe 53 by a slip joint 87. In the end of the furnace feed pipe a helical vane 88 is fitted to deflect the blast passing into the burner nozzle thereby to whirl the blast of fuel as it enters the furnace. The direction of rotation of the fuel blast and of the collar air blast correspond. Within the furnace flue 90 directly in front of the nozzle, a checker work fire brick hot box 91 is constructed. Initial combustion takes place in this box, which becomes incandescent, and the flaming gases therefrom pass through the checker vents into the flue 80 and thence through the tube system of the boiler, finally passing out as usual up through the smoke box 92 to the uptake 25. 93 and 94 are the inlet and outlet water connections to the water jacket 81. They are connected by flexible pipes to cooling water service and eduction pipes. In Fig. 1, portions of the air pressure connections into the chamber 77 are marked 95 and they arevalved so that the blast through the collar nozzle 85 is immediately controllable.

According to the option of the designer the type of conveyor used in the continuous conduit 47 may be varied. Thus, for instance, a chain conveyor with offset claws on its links carrying scrapers may be used. The invention is not concerned with the particular structure of the conveyor used so long as it functions to maintain movement of air borne fuel through the circuit without causing packing of the fuel and consequent choking. A modified type of conveyor is shown in the arrangement in Fig. 8. In this case the fuel is drawn from the bottom of the hopper 29 by a long screw conveyor which moves the fuel through the straight line conduit 98, said conduit being fitted with pockets and valves similar to those shown in Fig. 5, one for each furnace feeder as shown at 54. The surplus overcarried fuel passes into the end sump pipe 100 whence it is educted pneumatically and returned through the pipe 101 and the "cyclone" air separator 31 to the top of the hopper 29. Pneumatic conveyor action is effected by means of a centrifugal pump 102 which maintains circulation through the pipe 101 from the sump 100 to the air separator 32. To aid the pump 102, an air pressure injector is fitted in a junction 103 at the lower part of the pipe 101, and a blast air service thereto is provided through a pipe 212. Mobility of the fuel in the screw conduit 98 is ensured by carrying pressure air pipes 104 into said conduit above each of the fuel controlling valves 61. These pipes 104 take the place of the pipes 55, and the gate discharges directly into the furnace pipe 53, the feed screw 64 used in the other type of furnace feeder being omitted. The quantity of the feed served to each furnace is determined by adjustment of the shutter 70 valves identical to the one indicated at 61 in Fig. 5. Where one feed service is connected to a pair of furnaces as shown in the two lower furnaces in Fig. 8 a turnover valve 106 is fitted. The casing of this valve 75 is ported to deliver feed to either or to both furnaces. The air blast pipes 104 are connected through appropriate valves to the air main 107; this air main corresponds with the air main 28 shown in Fig. 1. 108 is an air main connected by branch pipes 109 to the air boxes 77 (see Fig. 8) which enclose the blast nozzles. The separate air main 107 may be omitted if the pipe connections 104 are led directly from the main 108. 85. This is in effect what is shown in Fig. 9. In a further modification Fig. 9 the fuel withdrawing arrangement from the bunker 21 consists of a conveyor 42 fitted with a continuously rotating shaft armed with screw vanes 43 which move the coal towards the sump 45. Powdered coal is in this case, together with the air, in which it is suspended, delivered into the air separator 31 from which it falls by gravity into either of two flasks 202—203, according to the set of the gate 204 in the breeches pipe 105. The lower ends of the breeches pipe are fitted with valves 206—207 which are movable by means of a screw spindle 208 which is readily turned by means of a hand chain 209 or otherwise. Foot valves in the chambers 202—203 are cross connected by a link 110 which may be interlocked by any convenient mechanism with the valve 204, 105 so that one of the chambers 202—203 is discharging while the other is filling. An air pipe 111 supplies air through a valve branch connection 112 to the top ends of the chambers 202—203, with the object of providing top pressure on the fuel in said chambers to force it by direct pressure behind it through the service conduit 113, whence it is drawn off direct through valves 114 into the furnace feed pipes 53, the upper ends of which are valved and connected into the air blast main 28.

The blast nozzle shown in Figs. 2 and 3 has been proved to be an effective instrument for introducing the aerified dust fuel 120 into the furnace in a way which ensures adequate control of air supply and effective combustion, but it is obvious that the fuel supply through the system to the furnace feed pipes 53 may be introduced into the 125 furnace by means of nozzles of known construction not corresponding structurally with the nozzle shown in Figs. 2 and 3, and that the baffle checker work within the fore end of the furnace flue may be structurally 130
varied to intercept the blast and localize the combustion and establish a zone of intense heat which will ensure the ignition of the fuel close to the point of its introduction into the furnace.

What I claim as my invention and desire to secure by Letters Patent is:

1. Apparatus for feeding powdered fuel to a plurality of furnaces comprising powdered fuel bunkers, a valve pipe in each bunker, means for supplying air to said pipe, a delivery pipe leading from each bunker, means for withdrawing aerified fuel through said delivery pipes, a feed hopper supplied by said withdrawing means, an endless fuel and air conduit communicating with said feed hopper and provided with valve controlled openings, a barrel fed from each valve opening, a furnace feed pipe supplied by each barrel, a powdered fuel burner on each furnace feed pipe adapted to be located in each furnace, an air preheater, an air pump, a hot air main communicating with said furnace feed pipe, and a valve pipe leading from said main to each barrel.

2. Apparatus for feeding powdered fuel to a plurality of furnaces simultaneously or in order as required comprising powdered fuel bunkers, a valve pipe in each bunker, a delivery pipe leading from each valve opening, a furnace feed pipe for each furnace feed pipe adapted to be located in each furnace, means for admitting the coal in the vicinity of each valve opening, a delivery pipe leading from each valve pipe, an air separator, a small capacity hopper communicating with the delivery pipe through the air separator, an endless fuel circulation conduit communicating with the hopper, means comprising a pump for drawing aerified powdered fuel from the lower part of the bunkers, through said delivery pipe and furnace feed pipe and said small capacity hopper and thence into the endless conduit, and means for feeding the fuel from said conduit to individual furnaces.

3. Apparatus for feeding a plurality of furnaces, a powdered fuel bunker, means for withdrawing fuel from said bunker, an endless fuel conduit fed by said fuel withdrawing means, the bottom of said conduit carrying a valve control opening therein for each furnace to be fired, a mechanical feeder associated with each valve opening, a furnace feed pipe leading from the outlet end of each mechanical feeder, a powdered fuel burner communicating with each feed pipe, means for driving each mechanical feeder independently, a hot air pressure main to supply air to each mechanical feeder, and valve pipe connections establishing communication between said hot air main and the inlet and the outlet ends of each mechanical feeder.

4. Apparatus for feeding powdered fuel to a plurality of furnaces simultaneously or in order as required, comprising fuel bunkers, a valve pipe in each bunker, downtake pipes to supply air to said valve pipes, means for agitating the fuel in the bottom of each bunker, a high level hopper, pneumatic means for delivering fuel from each bunker to said hopper, an endless fuel conduit fed by said hopper, a conveyor in said conduit, said conduit having valve control openings therein, mechanical feeders associated with said valve openings, a hot air main, pipes establishing communication between said mechanical feeders and said hot air main, a furnace feed pipe leading from each mechanical feeder, and a burner nozzle on each furnace feed pipe adapted to be located in the inlet end of each boiler furnace.

5. Apparatus for feeding powdered fuel to a plurality of furnaces simultaneously or in order as required, comprising powdered fuel bunkers and means for withdrawing powdered fuel from said bunkers comprising a valve pipe laid horizontally in the bottom of each bunker, an agitator operating in each bunker contiguous to said pipe, means for introducing air into said pipe, a pipe line leading from each valve pipe, suction means operating to maintain a condition of partial vacuum in said valve pipe and pipe line and to discharge aerified fuel ejected thereby an air separator communicating with the discharge end of said suction means, a high level hopper communicating with said air separator, and fuel delivering means associated with said hopper.

6. Apparatus for feeding powdered fuel to a plurality of furnaces simultaneously or in order as required including powdered fuel bunkers, a valve pipe in each bunker, means for aerating fuel in each valve pipe fuel conducting means connected with the valve pipes, an endless conduit fed by said connecting means through which aerified fuel is maintained in circulation, controllable valve openings in said conduit, mechanical feeders each supplied by one of said valve openings, a hot-air blast main, a valve pipe from the hot air blast main into the inlet of each mechanical feeder, a valve for aerating fuel pipe from said hot air main connected with the delivery end of each mechanical feeder, and a water jacketed burner nozzle on the delivery end of each furnace feed pipe.

7. Apparatus for feeding a plurality of furnaces, powdered fuel bunkers, a valve pipe in each bunker, pipe lines and pneumatic means for withdrawing fuel throughout from said bunkers, a high level hopper fed by said pneumatic means, an endless conduit communicating with said hopper, a valve controlled opening in the bottom of the conduit for each furnace to be
fed, a mechanical feeder associated with each valved opening, a furnace feed pipe leading from the outlet end of each mechanical feeder, a powdered fuel burner in connection with each feed pipe, means for driving each mechanical feeder independently, a hot air pressure main to supply air to each mechanical feeder, and valved pipe connections from said hot air main into the inlet and the outlet ends of each mechanical feeder.

In testimony whereof I have affixed my signature hereto.

JAMES JOHN CANTLEY BRAND.

Witnesses:

W. G. HUPHREYS,

H. C. CAMPBELL.