W. D. WOOD & H. G. BARNHURST.

FEEDING AND BURNING FINE FUEL.

APPLICATION FILED JUNE 22, 1916.

1,228,632.

Patented June 5, 1917.

2 SHEETS—SHEET 1.

Fig. 1.

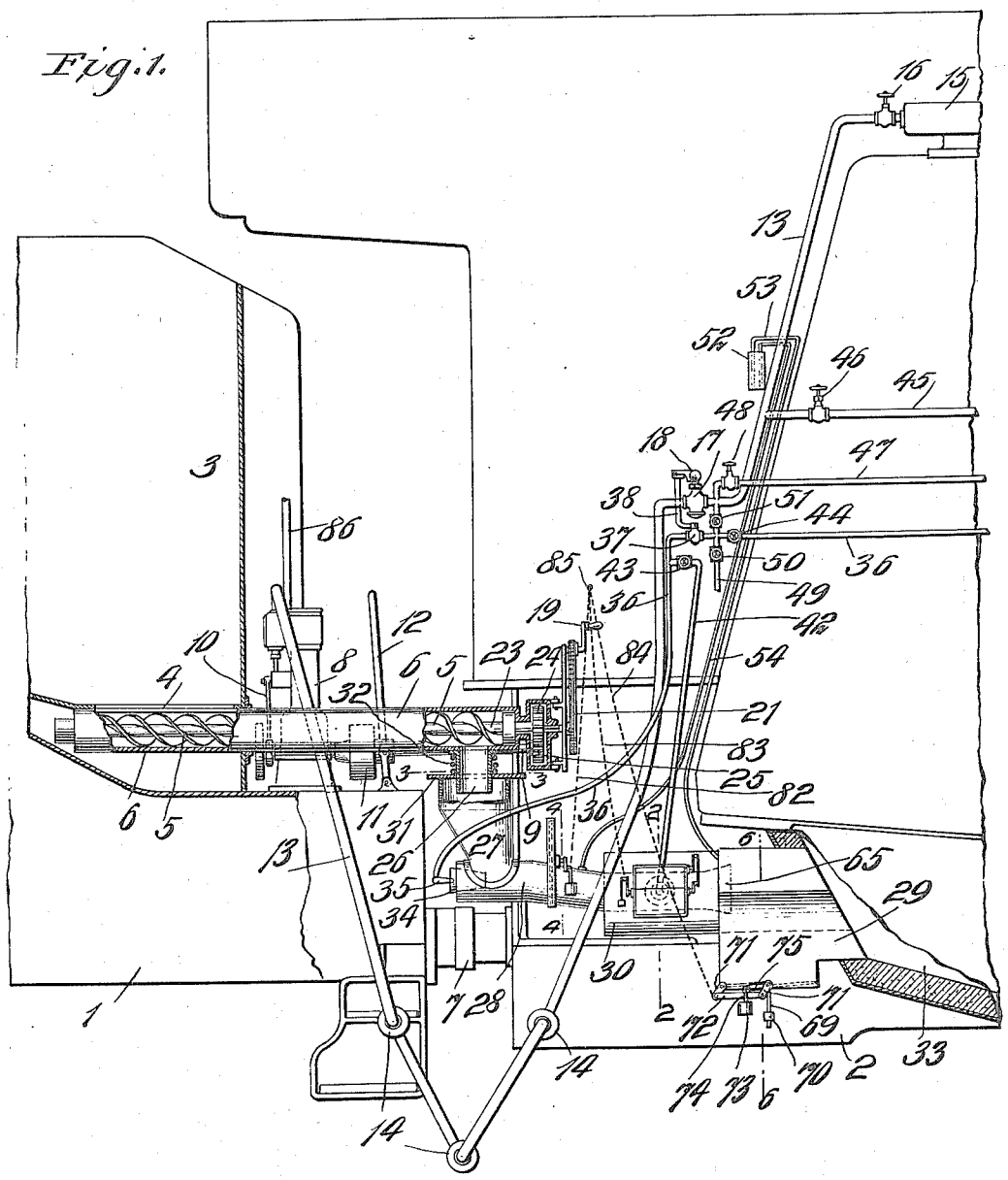
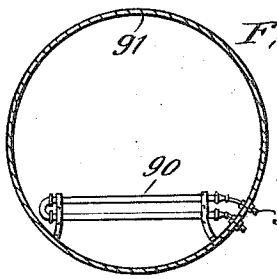


Fig. 9.



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2 SHEETS—SHEET 2.

Fig. 2.

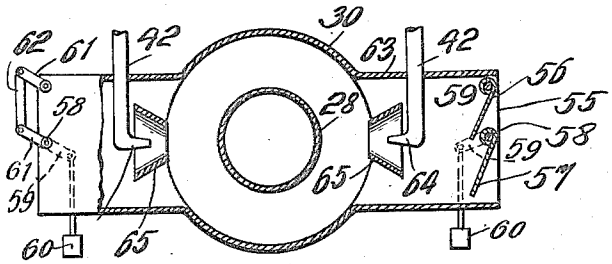


Fig. 4.

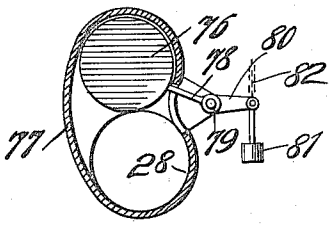


Fig. 3.

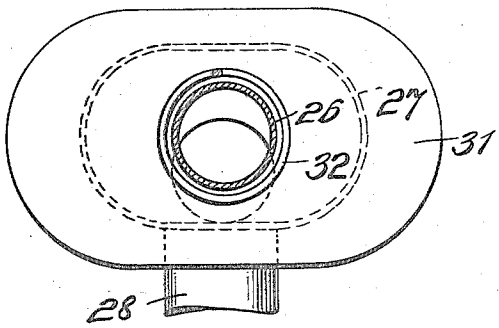


Fig. 5.

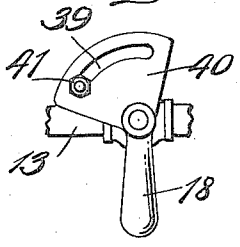


Fig. 6.

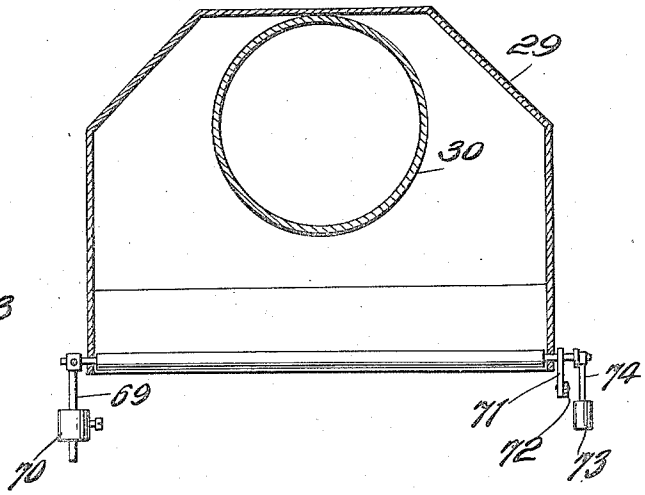
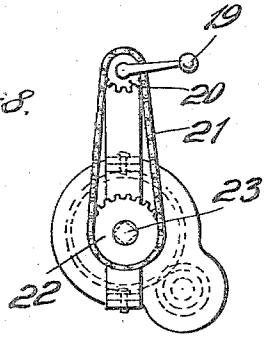


Fig. 8.



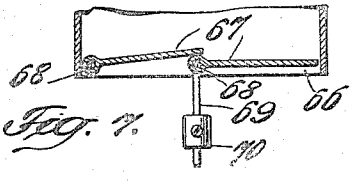


Fig. 7.

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WALTER D. WOOD AND HENRY G. BARNHURST, OF ALLENTOWN, PENNSYLVANIA, ASSIGNORS TO FUEL SAVING COMPANY, OF ALLENTOWN, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

FEEDING AND BURNING FINE FUEL.

1,228,632. Specification of Letters Patent. Patented June 5, 1917.

Application filed June 22, 1916. Serial No. 105,120.

To all whom it may concern:

Be it known that we, WALTER D. WOOD and HENRY G. BARNHURST, citizens of the United States, and residents of Allentown, in the county of Lehigh and State of Pennsylvania, have invented certain new and useful Improvements in Feeding and Burning Fine Fuel, of which the following is a specification, reference being had therein to the accompanying drawing.

Our present invention refers to certain new and useful improvements in mechanism for feeding and burning fine or pulverized fuel such as coal dust, culm, or the fine screenings from coal mining operations; the invention being intended for use more particularly with the furnaces of locomotives, although it may be applied for operation in conjunction with any kind of a steam boiler or other device. One object among others which we have in view is to simplify and improve the construction and arrangement of the various parts so as to attain the best results with a given quantity of fuel, and enable the machine to be operated economically at all times. The invention, therefore, consists essentially in the construction, arrangement, and combination of the various parts and in various details and peculiarities thereof, substantially as will be hereinafter more fully described and then pointed out in the ensuing claims.

In the accompanying drawing illustrating our invention:

Figure 1 is a side elevation of our improved mechanism for feeding and burning fine fuel shown as applied to a tender and a locomotive, the latter being represented in outline only, and certain parts of our improved devices being shown in section.

Fig. 2 is an enlarged detail cross-section on the line 2, 2 of Fig. 1.

Fig. 3 is a horizontal sectional plan on the line 3, 3 of Fig. 1.

Fig. 4 is a detail cross-sectional view on the line 4, 4 of Fig. 1.

Fig. 5 is an enlarged plan view of the lever for operating the master control and other valves.

Fig. 6 is an enlarged cross-sectional detail view on the line 6, 6 of Fig. 1.

Fig. 7 is a detail cross-section of the valves at the bottom of the device shown in Fig. 6.

Fig. 8 is an end elevation of the mechanism for manually operating the feed screw.

Fig. 9 is a detail sectional front view of a superheater unit at the front end of the locomotive.

Similar characters of reference designate corresponding parts throughout the different figures of the drawing.

1 designates the tender, and 2 the locomotive, the same being coupled together in any ordinary way. These parts are shown only in outline, and in a very general manner, without any attempt at bringing out the details, as these are unimportant as affecting the principles of our present invention, and we reserve the liberty of varying the form of the same and of applying the invention to any kind of a tender, any form of locomotive, and in fact, any kind of a device where it is found to be useful and practicable. It must be borne in mind that the portion of the invention supported by the tender is distinct from that carried by the locomotive, or at least sufficiently so to enable the train and its parts to operate on the track in the usual way without any injurious effect upon the mechanism of the fuel feeder and burner.

On the tender 1 is a tank or fuel container 3 having any preferred dimensions and form of construction and built after any pattern and design. In the bottom of this fuel container 3 is an opening 4 below which is a horizontal feed screw 5 which takes the fuel as it drops through the opening 4 and carries it forward to a point where it is delivered into the means for carrying it to the fire box. This feed screw 5 is housed within a suitable boxing 6 which protects it, besides coöperating with it to form a channel or conduit through which the pulverized fuel is propelled.

Ordinarily the feed screw 5 will be rotated by means of an engine mounted on the tender 1, an example of said engine being indicated at 8 and consisting of a steam engine which is geared to drive the feed screw in any suitable manner, as for example, by the gear 24 on screw shaft 23 which engages a pinion 25 on the engine shaft 9, driven by suitable connections, 10 being the valve rod, and 11 a controlling clutch on shaft 9 operated by a lever 12. Steam is supplied to the engine 8 through the pipe 13 having suitable

ball or other joints 14 at different points and leading over to the locomotive which supplies it with steam at the dome 15, said steam supply pipe 13 having a valve 16 near the boiler, and having also a master control valve 17 provided with a handle 18, this handle 18 being so located that it can be conveniently manipulated by the engineer or fireman when in his customary position within the cab of the locomotive. It will be understood, however, that other driving means located on the tender may be substituted for the steam engine 8. It is essential, however, that such engine or motor be located on the tender. The feed screw and its operating mechanism make a unitary arrangement with the tender, and the whole is self-contained and free to be moved about accordingly in one direction or the other entirely independently of the movement of the locomotive relatively to the tender. There are emergency times when it will be desired to operate the feed screw temporarily by hand, when for the time being there may be no supply of steam, air, or other agency for driving it, and accordingly I provide at the end of the housing 6 a crank handle 19 (see Fig. 8) which operates a sprocket wheel 20, around which passes a chain 21, said chain running around another sprocket wheel 22 on a square shaft that enters a square hole in end of the shaft 23 of the screw 5. Therefore, by rotating the crank 19 it will be obvious that the feed screw shaft 23 and consequently the screw 5 will be revolved and caused to perform its function in feeding fuel forward from the tank to the delivery point. This manual device is detachable, and when in use is held by pins or screws or other suitable devices.

The feed screw housing 6 is provided near its outermost end on the underside with a downwardly projecting spout 26 which projects into the upper open end of a hopper 27. This hopper is carried by a fuel pipe 28 of suitable shape and size supported on the locomotive 2 and leading toward the firing chamber 33 or an extension 29 of said chamber, said fuel pipe 28 having a flaring mouth and forming with a cylinder 30 which surrounds a portion thereof, as also with the extension 29, a duplex nozzle which delivers commingled fuel and air under pressure to the firing chamber in a manner we shall presently more fully describe. Returning again to the hopper 27 which receives the upper end of the fuel delivery spout 26, it will be observed that the top of said spout 27 is provided with a horizontal cover 31 which rests thereon, but is adapted to slide or oscillate more or less upon the top periphery of the hopper 27. This sliding cover 31 receives the spout 26 through a circular opening in said cover, and a spring 32 (see Fig. 1) is coiled around the spout 26 and tensioned between the underside of the housing 6 (or what is equivalent, the collar on the end of the spout 26), and also the cover 31 so that said spring is always acting to hold the cover 31 tightly upon the upper end of the hopper 27, while said sliding cover through which the spout 26 projects affords a certain latitude of movement for the spout relatively to the hopper and allows for the change in position of these parts which takes place when the engine and tender are vibrating in the consequence of the rapid running of the train. Such a loose connection, therefore, provides both for lateral and vertical movement of the related parts.

The locomotive fire box or chamber 33 is supplied with a fuel vehicle under strong air or steam pressure, which vehicle consists of the comminuted coal or other substance mingled thoroughly with air in a stream which is propelled steadily and rapidly forward through the tube 28 until it enters the furnace and bursts into flame upon meeting the material which is undergoing combustion in the furnace. The end of the pipe 28 beyond the point where the hopper 27 is superposed on said pipe, as shown in Fig. 1, is provided with an injector or some other suitable device consisting of a conical nozzle 34, and inside of it another nozzle or delivery end 35 which discharges into the nozzle 34, and through it into the pipe 28, either air or steam or other fluid or liquid under pressure. In the present example of our invention the nozzle 35 is carried by a pipe 36 which receives superheated steam from the boiler, or air from an air supply, said pipe having at a point below the control valve 17 another valve 37 which has an arm 38 thereon that engages a slot 39 in a sector 40 which is attached to and operated by the handle 18 already referred to, said arm 38 having on the upper end thereof a nut 41 by means of which it can be securely clamped at any point in the length of the slot 39. Thus it will be seen that by the operation of the handle 18 we not only control the passage of steam through the main supply pipe 13, but we also control the passage of the superheated steam (or air) through the pipe 36 to the nozzle 35 belonging to the injector at the left hand end of the fuel delivery conduit 28; and furthermore it will be observed that a pipe or pipes 42 lead off from the pipe 36 at a point below the valve 37 so that superheated steam at the time it is being conveyed to the left hand end of the fuel pipe 28 may also be carried to the sides of the box 30 surrounding the outlet end of the fuel pipe 28. Pipes 42 are provided with hand valves 43 which can be used to cut off the supply of pressure through said pipe; and also pipe 36 is provided with a hand valve 44 which will cut off the supply of superheated steam entirely. Air pressure

can be supplied when desired through pipes 42, by closing off the steam pipes and using the connection through pipe 49 to furnish a supply of air, in this case valve 51 being closed as well as valve 44 and valve 50 being opened.

It will be noted that from the pipe 13 near the upper portion thereof, there leads off a pipe 45 having a valve 46, said pipe 45 running outwardly alongside of the locomotive and being used for making a connection with the round house blower line; also a pipe 47 having a hand valve 48 leads off from the pipe 13 near the valve 17 and is used for carrying steam to the smoke box superheater. A branch pipe 49 runs to an air reservoir and is provided above and below steam pipe 36 which it crosses with hand valves 50 and 51 which can be used for the purpose of cutting off or opening the passage way within said pipe to accomplish the results in view, as above stated in furnishing a supply of air to the burner. Also, we find it convenient to arrange in the cab where it can be easily seen, a manometer 52 having a pipe 53 which connects with the firing chamber or with the extension 29 at the inlet to said chamber so that the draft vacuum in the firing chamber may be thereby indicated; and also said manometer is provided with another pipe 54 which connects with the air blast within the fuel pipe 28 so that the manometer may by reason of the pressure in said pipe indicate the pressure of said blast and thereby the rate of combustion of the fuel being fed, but we lay no claim in the present application to this manometer which we term a compensated draft manometer inasmuch as the same is covered by Letters Patent of Walter D. Wood, No. 1,197,881, dated September 12, 1916.

The fuel passage 28, as we have indicated, leads into or through a surrounding cylindrical box 30, and said box 30 passes through a larger box 29 which forms an extension of the firing chamber 33. There is a space between the cylinder 30 and box 29 which affords room to admit outside air to the fire box. The box 30 is provided at opposite sides with atmospheric air inlet openings 55 controlled by upper and lower valves 56, 57, which have each a pivot at its upper end so that they can swing freely. The pivot 58 of each lower valve 57 has thereon a crank arm 59 provided with a weight 60, and the two valves 56 and 57 at one side of each side of cylinder 30, also have their pivots provided with short arms 61 connected by a link 62 so that they may move in unison (see Fig. 2). The suction of the air from the stack vacuum through the locomotive will automatically open these valve leaves 56 and 57 drawing them inwardly and lifting them against the counterbalancing effect of the weight 60, and, obviously, as soon as the draft relaxes, the weight will automatically close these valves.

Further describing the cylinder 30 which surrounds the flaring end of the pipe 28, or at least that portion of the cylinder 30 which lies outside of the fire box extension 29, it will be noted that said cylinder 30 is provided with laterally projecting extensions, tubular, square, or other shaped, 63, in the ends of which are the openings 55, in connection with which the valve plates are arranged as we have already explained. The extensions 63 are entered by the steam pipes 42 which terminate in the tapering nozzles 64 that discharge into the conical pipes 65 forming with the nozzle 64 suitable injectors by which the steam or air is delivered into the interior of the cylinder 30 and allowed to commingle with the fuel vehicle as it emerges from the flaring mouth 65 of the pipe 28.

At the bottom of the box or extension 29 is an opening having therein a couple of valves 67 pivoted by means of pivots 68, one of said pivots having an arm 69 provided with an adjustable weight 70, the adjustment permitting a change in the power required to open the valves. On these pivots 68 are also short arms 71 connected by a link 72 at one side of box 29. Also there is a weight 73 on a rod 74 attached to an arm 75 which is fastened to one of the pivots, the function of this weight being to counterbalance the weight of the valves. These weights have the function of closing the valves 67 automatically whenever the suction which opens them diminishes in power. In the fuel pipe 28 there is a cut-off valve 76 (see Fig. 4) having a casing 77. Said valve is attached to an arm 78 pivoted at 79 and having a crank arm 80 to which is attached a weight 81, the purpose of which is to automatically open the valve 76 after the agency which closes it ceases to act. This valve 76 is controlled by a chain 82 attached to the arm 80 and operated by hand. There is also a chain 83 or pair of them, one for each side, which operates the valves 56 and 57 arranged in connection with the cylinder 30, as we have already explained, and there is also a chain 84 which is connected to the levers belonging to the air valves 67, so that the latter can be closed by hand if desired. All these chains 82, 83 and 84 are preferably attached at one end at a point 85 in the engineer's cab, or at some other convenient place where they can be readily laid hold of to be individually or jointly operated. Of course, in lieu of the chains other flexible or suitable connections can be arranged for doing the same work. Also by the manipulation of the single lever 18 the supply of air or steam or other fluid to operate the engine or motor 8 and also to propel the fuel current at the initial end and

also to add a mixing agent thereto at the delivery end, is suitably controlled and properly measured. The feed screw and the supply of steam can be calibrated into proper proportions at any time and the proper changes or adjustments can be made at the valve during operation and when the locomotive is running in case a different operation is necessary so that one lever governs the whole operation from start to finish. It will be observed also that the air valves in connection with the extension 29, which we have seen are counterbalanced similarly to the lateral valves on the side of the nozzle cylinder 30, can be arranged so that they can be regulated to open any desired amount by the action of the draft from the stack and also that this arrangement can be changed to suit conditions.

The operation of the various parts will, therefore, be clearly perceived from the description of the construction and arrangement of the same, and various beneficial advantages gained will be easily noted. The exhaust from the engine which operates the feeding screw can either be led directly to the atmosphere through pipe 86 or can be directed to the stack through a flexible pipe for the purpose of augmenting draft if desired. With a combination and arrangement of parts similar to what we have outlined, no rubber or flexible pipes are required. As the connections between the locomotive and the tank are made by means of a pipe or pipes having ball joints, this eliminates to a great extent many features of other equipments which are now in operation, which are very expensive.

It will be noticed, therefore, that certain of our valve devices keep cold air from entering the fire box when the engine is coasting or running light, although enough draft is created to open to valves, but as no coal is being fed there is no object in allowing these to remain open, and, therefore, chains are required for closing them. With reference to the device for manually operating the screw conveyer at certain times it will be understood that the sprocket wheels 20 and 22 (the latter has a short shaft with a square end for insertion into the square opening in the shaft 23), the chain 21 and the crank device 19 with their separate framework provide a complete removable unit which has many advantages. It will be understood that although in many cases we have provided atmospheric valves arranged in pairs, that it is not essential to use pairs of valves, since in each one of the three cases mentioned, one large valve can do the work as well as the two connected valves, and in many places we prefer single large valves. With reference to the superheated steam it may be said that superheated steam will be regularly employed in the operation of the injectors 35 and 64 (that is, of course, after the locomotive fire box has been superheated to a high enough temperature) so that the gases of combustion will be hot enough to superheat the steam in the superheater unit. In this case valve 51 is closed and valves 48 and 44 are open. When starting up, or in case the superheater should spring a leak, then valves 48 and 44 are closed, and live steam not superheated is passed directly from the boiler by opening valve 51. Valve 50 of course is always closed except when air is being used.

A superheater unit for superheating the steam is located in the front end of the locomotive as indicated in the detail view in Fig. 9 where 91 represents such front end of the locomotive and 90 a form of superheater unit from which passes the pipe 36 that leads to the fuel feeder and blast pipe, as already explained.

Many changes in the precise construction, arrangement and combination of the various parts may be made without exceeding the scope of our invention, and we reserve the liberty of changing and rearranging the parts as may be found to be desirable in practice.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent, is:

1. In an apparatus for feeding and burning fine fuel, the combination of a fuel receptacle, a feed screw, means for actuating said screw, said actuating means, screw and receptacle being supported in the same unitary combination, a furnace, a pipe for transporting a stream of fuel to said furnace, and a nozzle at the end of said pipe, said nozzle being provided with counterbalanced automatically operated air valves, and means for carrying air or steam to said nozzle.

2. In an apparatus for feeding and burning fine fuel, the combination of a feed screw, a motor for driving it, means for supplying steam from the locomotive to actuate said motor, a furnace, a delivery conduit for receiving the fuel from the screw and carrying it to the furnace, counterbalanced automatically operated air valves arranged in connection with said conduit, and means for supplying auxiliary air or steam jets to said conduit for forcing an induced stream of air thereinto, and at the same time acting upon the aforesaid air valves.

3. In an apparatus for feeding and burning fine fuel, the combination of a feed screw, a motor for driving it, a delivery conduit for receiving the fuel from the screw and carrying it to the furnace, counterbalanced automatically operated air valves arranged in connection with said conduit,

together with means for delivering air or steam to said conduit for forcing an induced stream of air therein for the purpose of effecting an opening of the air valves.

4. In an apparatus for feeding and burning fine fuel, the combination of a feed screw, a motor for driving it, means for manually operating the feed screw when the motor is idle, a delivery conduit for carrying the fuel from the screw to the firing chamber, counterbalanced automatically operated air valves arranged in connection with said conduit, and means for delivering auxiliary steam or air jets at opposite sides of the conduit for forcing an induced stream or streams of air into the openings containing these air valves so as to simultaneously open the said air valves.

5. In an apparatus for feeding and burning fine fuel, the combination of a feed screw having a discharge spout, a hopper, a sliding cover thereon, resilient means tensioned between the feed screw and the cover, a delivery conduit for receiving the fuel and carrying it to the furnace, a nozzle for said delivery conduit, counterbalanced automatically operated air valves arranged in connection with said nozzle, and means for delivering air or steam to said conduit to force an induced stream of air so as to open said air valves.

6. In an apparatus for feeding and burning fine fuel, the combination with a feed screw and its motor, said screw having a discharge spout, of a hopper entered by said spout, a sliding cover on said hopper, yielding means for holding the cover tightly, a delivery conduit for receiving the fuel from the hopper and carrying it to the furnace, a nozzle for said conduit, automatic valves for admitting air to said nozzle, and means for delivering auxiliary steam or air likewise to said nozzle, together with a valve controlling jointly the air or steam for the conduit and the steam for the screw actuating motor.

7. In an apparatus for feeding and burning fine fuel, the combination of a feed screw and its housing having a discharge spout, a hopper having an upper open end receiving said discharge spout, yielding means arranged on the top of said hopper and having an opening through which said discharge spout projects, a furnace, a pipe for carrying a stream of fuel from the hopper into the furnace, a cylinder surrounding said pipe and provided with lateral automatic valves, and means for carrying air or steam to the end of said pipe and also to the sides of the cylinder.

8. In an apparatus for feeding and burning fine fuel, the combination of a tender, a feed screw thereon having a discharge spout, a locomotive, a hopper carried thereby, means on the hopper through which the discharge spout projects, said means being provided with yielding mechanism bearing on the cover to allow the discharge spout and hopper to oscillate relatively, a conduit for carrying the fine fuel stream to the furnace, an injector for steam or air at one end of said conduit, a cylinder surrounding the other end of said conduit and having air inlets at opposite sides, automatic valves controlling said air inlets, and air or steam injectors at opposite sides of said cylinder.

9. In an apparatus for feeding and burning fine fuel, the combination with a furnace, of a pipe for carrying a stream of fuel into the furnace, a cylinder surrounding said pipe, and provided with lateral automatic valves, means for carrying air or steam to the end of the said pipe and also to the sides of the cylinder.

10. In an apparatus for feeding and burning fine fuel, the combination of a conduit for carrying the fuel stream to the furnace, an injector for steam or air at one end of said conduit, a cylinder surrounding the other end of the conduit and having air inlets at opposite sides, automatic valves controlling said air inlets, air or steam injectors at opposite sides of said cylinder, and valve controlled pipes carrying air or steam to all of said injectors.

11. In an apparatus for feeding and burning fine fuel, the combination of a conduit for carrying the fuel stream to the furnace, a cylinder surrounding the other end of the conduit and having air inlets at opposite sides, automatic valves controlling said air inlets, air or steam injectors at opposite sides of said cylinder, valve controlled pipes carrying air or steam to all of said injectors, and a fire box extension having an opening therein to the atmosphere, and automatic valves controlling said opening whereby combustion air is admitted directly to the furnace.

12. In an apparatus for feeding and burning fine fuel, the combination of a fuel pipe, an injector in one end of said pipe for admitting air or steam, an outer cylinder surrounding said nozzle and having combustion air inlets, valves controlling said inlets, injectors within the inlets for supplying air or steam, means for admitting combustion air directly from the atmosphere to the furnace, means for supplying air or steam to said injectors, valve mechanism for controlling said latter means, and suitable connections for mechanically operating the various air valves.

13. In an apparatus for feeding and burning fine fuel, the combination with a locomotive, of a fuel pipe leading to the fire box, a hopper on said pipe receiving fuel fed thereto, means for delivering air or steam into the end of said pipe contiguous to the hopper, a cut-off valve in the length

of said pipe for closing said pipe to the atmosphere, a cylinder surrounding the end of said pipe and provided with automatic valves for admitting atmospheric air and also with means for admitting additional air or steam under pressure, and means for mechanically operating the cut-off valve and also the automatic valves, together with means for jointly controlling the supply of air or steam for the end of the fuel pipe and also for the lateral supply.

14. In an apparatus for feeding and burning fine fuel, the combination with a locomotive having a fire box and a fuel pipe having a cylinder surrounding the end of said pipe and provided with lateral branches, the ends of which are provided with automatic valves operating in unison by suction and having counterweights for returning them to position, means for delivering air or steam under pressure at the end of the fuel pipe and also at the sides contiguous to the automatic valves, and an extension box on the firing chamber having an opening to the atmosphere provided with one or more automatic valves operating likewise by suction and provided with counterbalanced weights for returning them to position.

15. In an apparatus for feeding and burning fine fuel, the combination of a feed screw carrying fuel from one point to another, a motor for driving it, means for manually operating the feed screw when the motor is idle, a pipe for carrying a stream of fuel which it receives from the feed screw onward into the furnace, a cylinder surrounding said pipe to form a nozzle, counterbalanced automatically operating air valves arranged in connection with said nozzle, and means for introducing auxiliary steam jets at opposite sides of the nozzle so as to force an induced stream of air into the nozzle to open the air valves.

16. In an apparatus for feeding and burning fine fuel, the combination with a screw conveyer, having a shaft, of a manually operated device for said screw shaft, a pipe for receiving a stream of fuel from the screw and conveying it into the furnace, a nozzle for said pipe, lateral automatic valves on said nozzle, and means for carrying air or steam to said nozzle and also to the opposite end of said pipe.

17. In an apparatus for feeding and burning fine fuel, the combination of a feed screw, means for driving it, a delivery conduit for receiving the fuel from the screw and carrying it to the furnace, a nozzle for said conduit, pivoted air valves for said nozzle, means for counterbalancing said valves consisting of weights of proper size and distance from their pivotal points to determine the amount that the valves will be drawn open by the draft of the fire box and burner.

18. In an apparatus for feeding and burning fine fuel, the combination with a furnace, of a pipe for carrying a stream of fuel thereto, a cylinder surrounding said pipe, and counterbalanced automatically operated air valves used in connection with said cylinder.

19. In an apparatus for feeding and burning fine fuel, the combination of a conduit for carrying a fuel stream to the furnace, a cylinder surrounding one end of the same and having air inlets at opposite sides, counterbalanced automatically operated air valves for said inlets, and means for introducing auxiliary steam jets at opposite sides for forcing an induced stream of air into the nozzle so as to effect an opening of the air valves.

20. In an apparatus for feeding and burning fine fuel, the combination with a locomotive, of a fuel conduit leading to the fire box, a nozzle on the end of the same, automatic air valves arranged in connection with said nozzle, means for supplying steam or air to said nozzle so as to force an induced blast of air to act automatically upon the air valves, and a superheater unit on the locomotive for supplying superheated steam to the fuel.

In testimony whereof we hereunto affix our signatures.

WALTER D. WOOD.
HENRY G. BARNHURST.