

A. KIRCHHOFFER.
 PULVERIZED COAL BURNING MEANS FOR LOCOMOTIVES.
 APPLICATION FILED AUG. 28, 1915. RENEWED FEB. 8, 1917.

1,239,918.

Patented Sept. 11, 1917.

2 SHEETS—SHEET 1.

Fig. 1.

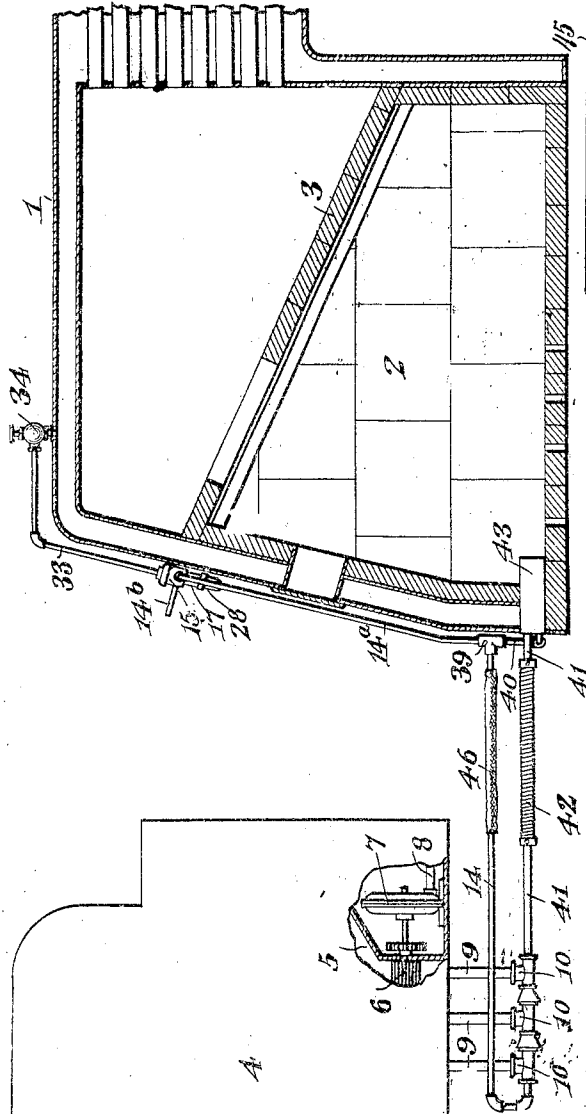


Fig. 6.

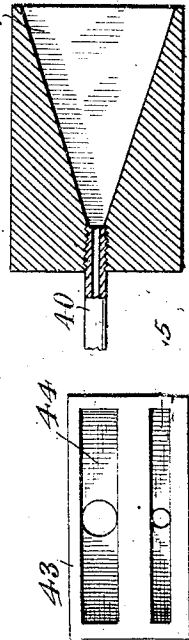
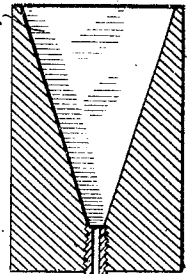


Fig. 7.



WITNESSES:

John K. McLaughlin
F. T. Chapman

August Kirchhofer,
 INVENTOR

BY

E. G. Sigges

Attorney

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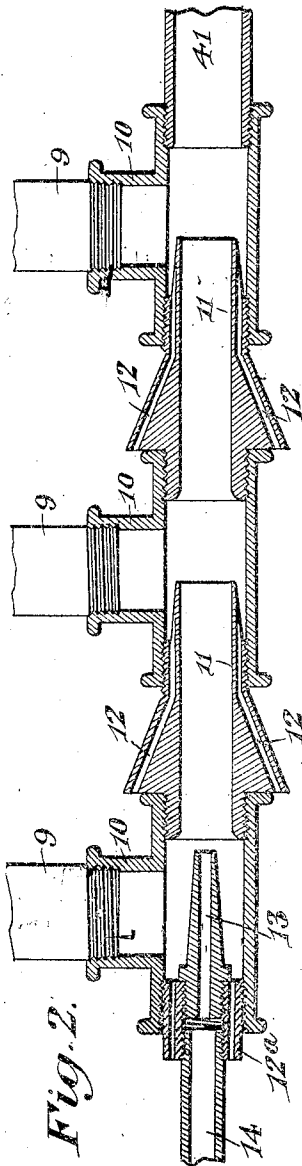


Fig. 2.

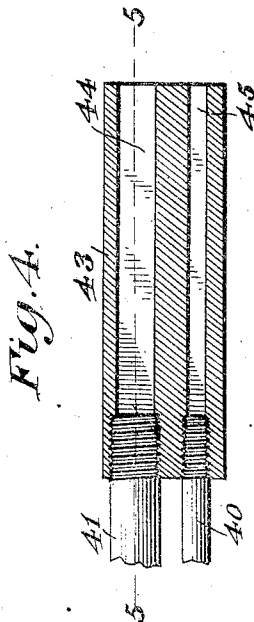


Fig. 4.

Fig. 5.

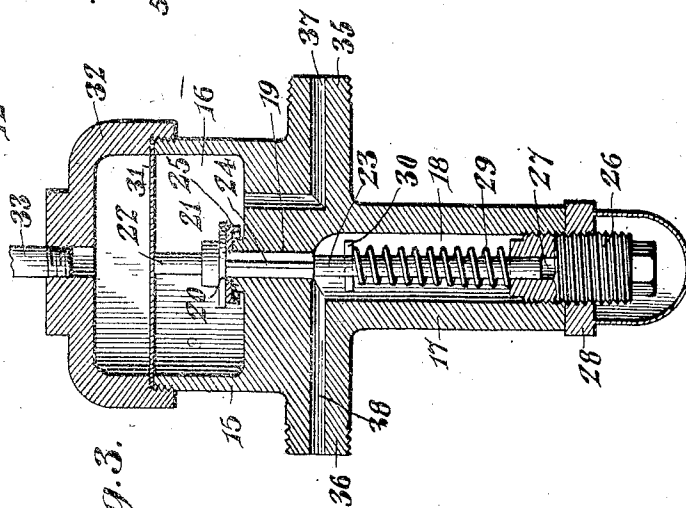
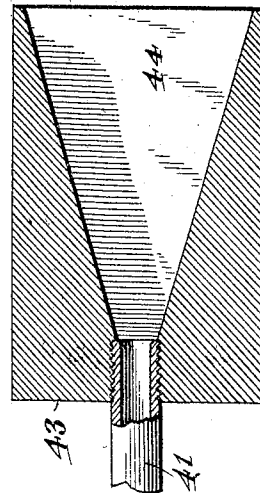


Fig. 3.

WITNESSES:

James McLaughlin
H. J. Chapman

August Kirchhofer, INVENTOR

BY

E. G. Siggers

Attorney

UNITED STATES PATENT OFFICE.

AUGUST KIRCHHOFER, OF NASHVILLE, TENNESSEE, ASSIGNOR OF ONE-HALF TO
THOMAS A. CLARKSON, OF NASHVILLE, TENNESSEE.

PULVERIZED-COAL-BURNING MEANS FOR LOCOMOTIVES.

1,239,918.

Specification of Letters Patent.

Patented Sept. 11, 1917.

Application filed August 28, 1915, Serial No. 47,789. Renewed February 8, 1917. Serial No. 147,496.

To all whom it may concern:

Be it known that I, AUGUST KIRCHHOFER, a citizen of the United States, residing at Nashville, in the county of Davidson and State of Tennessee, have invented a new and useful Pulverized-Coal-Burning Means for Locomotives, of which the following is a specification.

This invention has reference to pulverized-coal burning means for locomotives, and its object is to insure the total consumption of pulverized fuel and the consequent elimination of smoke.

By the present invention coal in forms which have heretofore been considered as waste may be employed in firing locomotive boilers, and in accordance with the present invention this is accomplished by using coal already in a finely pulverized state, or passing the coal already on the tender of the locomotive through pulverizing mechanism which may be driven by steam applied by the locomotive boiler. The pulverized coal with blasts of air is driven into the fire chamber of the boiler, the fire chamber being suitably modified with respect to the ordinary fire chambers of locomotives to accommodate the fuel employed. The injection of the pulverized fuel is brought about by air streams with the air under pressure, which air may be conveniently obtained from the main air reservoir of the brake system of the locomotive or from any other suitable source of air pressure. The injecting air streams are reinforced for burning purposes by air drawn by the injecting nozzles from the atmosphere.

In order to insure the proper consumption of the fuel and to eliminate waste due to imperfect combustion there is produced in the fire chamber of the boiler an expanded air stream in underlying relation to the injected stream of pulverized coal, thus supporting the pulverized material and supplying an ample amount of air to effect the complete combustion of the pulverized material. This eliminates smoke and prevents all the objectionable features of burning coal which has been but imperfectly consumed.

The air supply to the injecting devices is controlled by steam pressure which also controls the supporting and underriding stream of air passing into the fire chamber beneath the fuel.

The invention will be best understood from a consideration of the following detailed description, taken in connection with the accompanying drawings forming part of this specification, with the further understanding that while the drawings show a practical form of the invention, the latter is not confined to any strict conformity with the showing of the drawings, but may be changed and modified, so long as such changes and modifications come within the scope of the appended claims.

In the drawings:—

Figure 1 is a longitudinal section of a locomotive furnace equipped with the present invention and showing a portion of the engine tender.

Fig. 2 is a longitudinal section through the injecting devices for directing the pulverized coal to the furnace.

Fig. 3 is a longitudinal section of the steam-actuated air-controlling device.

Fig. 4 is a longitudinal section of the burner.

Fig. 5 is a section of the burner on the line 5—5 of Fig. 4.

Fig. 6 is an elevation of the burner as seen from the exit end.

Fig. 7 is a longitudinal section of the burner similar to that of Fig. 5, but taken through the lower or sustaining-air passage thereof.

Referring to the drawings there is shown in Fig. 1 a small portion of a locomotive boiler 1, this being the fire chamber end of the boiler, but no attempt is made to show the parts with any degree of accuracy, since the showing may be taken as typical of various types of locomotive boilers. There is also indicated a fire chamber 2 lined with fire-brick 3, but no attempt at accuracy is made with respect to the fire chamber. The structure so far as the fire chamber is concerned may be similar to the fire chambers employed in oil burning locomotive boilers, or may be otherwise changed as found necessary.

There is also indicated a portion of a tender 4 which may be assumed to contain a receptacle 5 for coal either in the already pulverized condition, or in the form of slack or the like requiring further pulverization. In the latter case a pulverizing device 6 may be employed driven by a small turbine en-

gine 7 which may be assumed as supplied with steam from the boiler 1 through a pipe 8 or otherwise.

The receptacle 5 discharges below the pulverizer by way of a number of down-pipes 9, each leading into a T coupling 10. It is customary to employ a series of pipes 9 with injector nozzles 11 between adjacent T couplings 10, these injector nozzles having air inlet channels 12 and the nozzles are arranged in alinement. At one end of the series there is an air inlet nozzle 13 connected to a pipe 14, which may be considered as coming from a source of air under pressure, such as the main air reservoir of the brake system on the locomotive, or from any other source of air under pressure, and this pipe 14 has interposed in it between the source of air under pressure and the nozzle 13 a controlling device shown separately in Fig. 3 and also appearing in Fig. 1. This controlling device consists of a head 15 inclosing a chamber 16 and from the head there extends an axially arranged neck 17 on the side of the head remote from the chamber 16. The neck has a bore 18 communicating with the chamber 16 through an axially arranged passage 19 opening into the chamber 16 through a valve seat 20. Adapted to the valve seat 20 is a valve 21 within the chamber having a stem 22 projecting on one side of the valve into the chamber and on the other side provided with a stem 23 with a portion 24 where extending through the passage 19 of winged construction. The valve 21 may be provided with a valve leather 25 adapted to the seat 20.

The end of the neck 17 remote from the head 15 is interiorly threaded, and is closed by a screw plug 26 counterbored as shown at 27 for a portion of its length to receive and guide the corresponding end of the valve stem 23. The plug 26 is locked in place and protected by a cap nut 28 threaded on to the plug 26. The stem 23 is surrounded by a spring 29 bearing at one end against the plug 26 and at the other end against a pin 30 traversing the stem 23. The tendency of the spring 29 is to lift the valve 21 away from the seat 20. The stem extension 22 of the valve is in engagement with a diaphragm 31 forming one wall of the chamber 16 and held in place by a chambered head 32 screwed or otherwise secured on the head 15 in clamping relation to the diaphragm. The chambered head 32 is entered by a pipe 33 which, as shown in Fig. 1, connects through a valve 34 to the steam space of the boiler 1 so that steam at boiler pressure may be directed into the chambered head 32 and acting on the diaphragm 31 control the degree of opening of the valve 21.

On opposite sides of the head 15, or in any other suitable arrangement with respect thereto, are nipples 35, 36, respectively.

The nipple 35 has a bore 37 leading into the chamber 16, and the nipple 36 has a bore 38 leading into the bore 18 of the neck 17.

The pipe 14 is connected to a T coupling 39 from which extends another pipe 14^a to the nipple 36 to which it is connected, while from the nipple 35 there is another pipe 14^b which may be considered as leading to the supply of air under pressure. Connected to the coupling 39 on the other side thereof from the pipe 14^a is another pipe 40 to which reference will presently be made.

The nozzles 11 and 13 are so arranged with relation to the down-pipes 9 and couplings 10 that an air stream emitted by the nozzle 13 tends to carry along with it the fine coal entering the couplings through the pipes 9 and also such amount of air as the main air stream may draw into the injector structure through the air passages 12 in the nozzles 11 and the air passages 12^a about the nozzle 13. The mixture of pulverized coal or coal dust and air is directed into a pipe 41 containing a flexible section 42 and leading into what may be termed a burner 43, which in the showing of the drawings is in the general shape of a rectangular block, but which, of course, may have any other suitable shape. The pipe 41 communicates with an expanding passage 44 through the burner 43, and below the passage 44 in the installed position of the burner is another similar passage 45 expanding toward the exit end of the burner and at the narrow end the passage 45 is entered by the air pipe 40 before referred to. The passage 45 is of sufficient size and expands sufficiently toward the exit end to direct a broad expanding stream of air and suspended coal dust into the fire chamber 2, and assuming that the fuel has been lighted there is produced an intensely hot flame in which the carbon of the coal dust is entirely consumed in the abundance of oxygen provided by the air streams.

Despite the force of the primary air stream causing the flow of the finely divided fuel or coal dust into the fire chamber, the action of gravity will cause particles of fine coal to drop toward the bottom of the fire chamber and so be either unconsumed or only partly consumed. This represents waste, and some of the unconsumed carbon may find its way through the boiler to the smoke stack and be emitted in the form of smoke. To avoid such waste there is produced from the passage 45, which like the passage 44 may be considered as an expanding nozzle, a thin expanding stream of air in underlying relation to the fuel stream. This underlying stream of air acts as a support for the fuel stream preventing any particles of coal which might otherwise drop by gravity from leaving the burning stream, wherefore such particles are contained in the intense heat zone until they are entirely

consumed, while the underlying stream of air provides an additional supply of oxygen to cause complete combustion of the fuel.

The pipe 41 has been described as provided with a flexible section 42. The pipe 14 may have a similar flexible section 46, so that the pipes 14 and 41 extending between the tender and locomotive may yield suitably to the differences of motion between the two vehicles.

If it be assumed that the locomotive boiler is cold and it is desired to raise steam, air is driven into the injector apparatus, thus conveying the pulverized coal or coal dust to and directing it through the burner 43 by way of the passage 44. The flame is readily started by placing a small lighted piece of waste or other combustible material in the path of the stream of coal dust when the flame is started and maintained. At the same time the stream of air issuing from the lower outlet passage 45 of the burner serves to sustain the first stream and to contribute toward the complete combustion of all of the fuel.

As the steam is generated and the pressure rises in the boiler, steam is directed into the chambered head 32 and when the pressure has increased to a sufficient amount the diaphragm 31 is moved under the steam pressure sufficiently to ultimately close the valve 21, or to so cut down the flow of air that the intensity of the flame is correspondingly diminished, and the heat is lessened so that the production of steam falls and consequently the pressure of steam is lowered. When this occurs the spring 29 overcomes the steam pressure on the side of the diaphragm 31 toward the head 32 and the valve 21 is again opened correspondingly.

By this means the steam pressure may be maintained with sufficient constancy for all practical purposes.

The fuel container within the tender may be a closed container, so that the fuel, which is preferably pre-dried, is maintained in such dried condition, and there is no loss of heat in the furnace in drying out the fuel.

The regulation of the supply of fuel to the furnace is automatic being due to the steam pressure, but this may be varied as desired by removing the cap nut 28 and screwing the plug 26 in the proper direction.

With the present invention pulverized coal may be utilized much after the manner of liquid fuel, and an intense, uniform and sustained fire-box temperature may be obtained. The stoking of the fuel is automatic and continuous and the fuel is burned in suspension.

Because of these conditions, to which may be added the reduction of clogging and leakage of flues, a locomotive may be run

for a relatively long continuous mileage, this being one of the advantages of oil burning locomotives and is accomplished with the present invention where pulverized or powdered fuel is substituted for oil. Despite the fact that coal is employed, no smoke, soot, cinders, or sparks are produced, and there is a corresponding reduction in cylinder back pressure because the exhaust passages may be greatly enlarged. Again, the elimination of ash pans, grates, smoke box, diaphragm, baffles and nettings brings about a substantial reduction in the retardation of the products of combustion through the boiler. The exhaust passage may be enlarged from one hundred to two hundred per cent. in area.

In fact, all the advantages which are found in the use of oil as a fuel are obtained by the present invention by the use of coal as a fuel with a very pronounced saving in the cost of running the engine, because the cheapest grades of fuel may be employed, the up-keep of the engine is greatly reduced, losses due to various causes are eliminated, and the fireman's duties so far as firing the locomotive is concerned, are such that the fireman may give most of his time to assisting the engine-man in the observation of the road.

It will be understood, of course, that while only one injector structure is shown, as many may be used as conditions may require.

While the invention has been stated as being peculiarly applicable to locomotives, it is understood that it may also be applied to any steam boiler fire box.

No claim is made herein to the burner structure in itself, since such structure with some improvements is shown, described and claimed in another application, Serial No. 105,473, filed by me on the 23rd day of June, 1916, for pulverized-coal burner.

What is claimed is:—

1. A means for burning pulverized coal in boiler furnaces, comprising a burner with two superposed outlets, means common to both outlets for directing air under pressure thereto, means for feeding pulverized coal to the upper burner outlet by the air stream directed thereto, and means in the air directing means common to both outlets of the burner for simultaneously controlling the air to both outlets by and in accordance with the boiler pressure.

2. A means for burning pulverized coal in locomotives, comprising a burner, an air duct to be connected to a source of air under pressure, an injector structure connected to the air duct and leading to the burner for directing a stream of air and fuel through the burner into the fire chamber of the locomotive, a steam controlled valve included in the air duct for varying the flow of air in accordance with the steam pressure in the

locomotive, and means for directing a stream of air from said duct on the burner side of the steam controlling means into underlying relation to the stream of air and fuel within the fire chamber of the locomotive.

5 3. A means for burning pulverized coal in locomotives, comprising a burner with adjacent passages one above the other in the installed position of the burner, the upper
10 passage being provided to direct a stream of air and pulverized coal into the fire chamber of the locomotive, and the lower passage being provided to direct a stream of air in
underlying relation to the first-named
15 stream, an injector structure coupled to the upper passage of the burner, an air pipe

connected to the injector structure and to the lower passage in the burner for supplying air under pressure to both passages, and a valve structure in the air pipe having a steam chamber adapted to be connected to the boiler of the locomotive with said steam chamber associated with the valve to control the passage of air through the valve in accordance with the steam pressure.

In testimony that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

AUGUST KIRCHHOFER

Witnesses:

C. A. GARDNER,
HUGH BUMPAS.