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FUEL FEED SYSTEM FOR SOLID FUEL BURNING ENGINE

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2 Sheets-Sheet 1

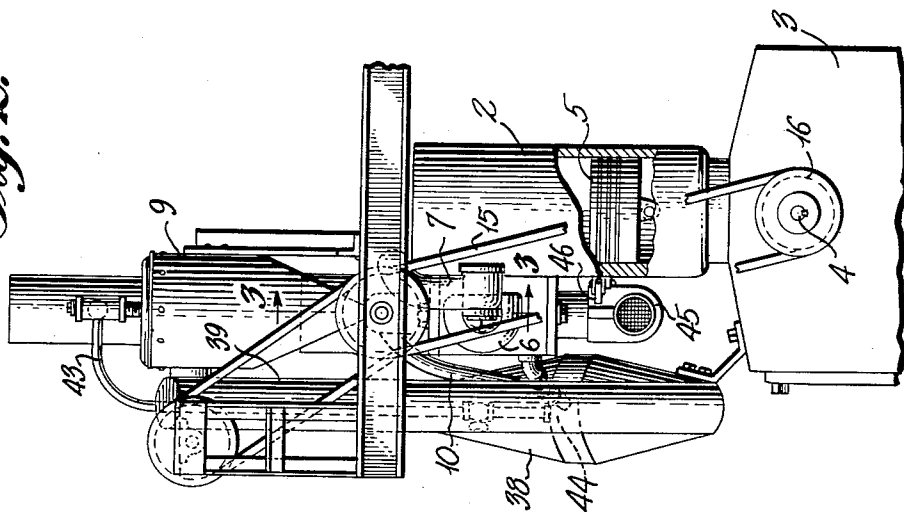
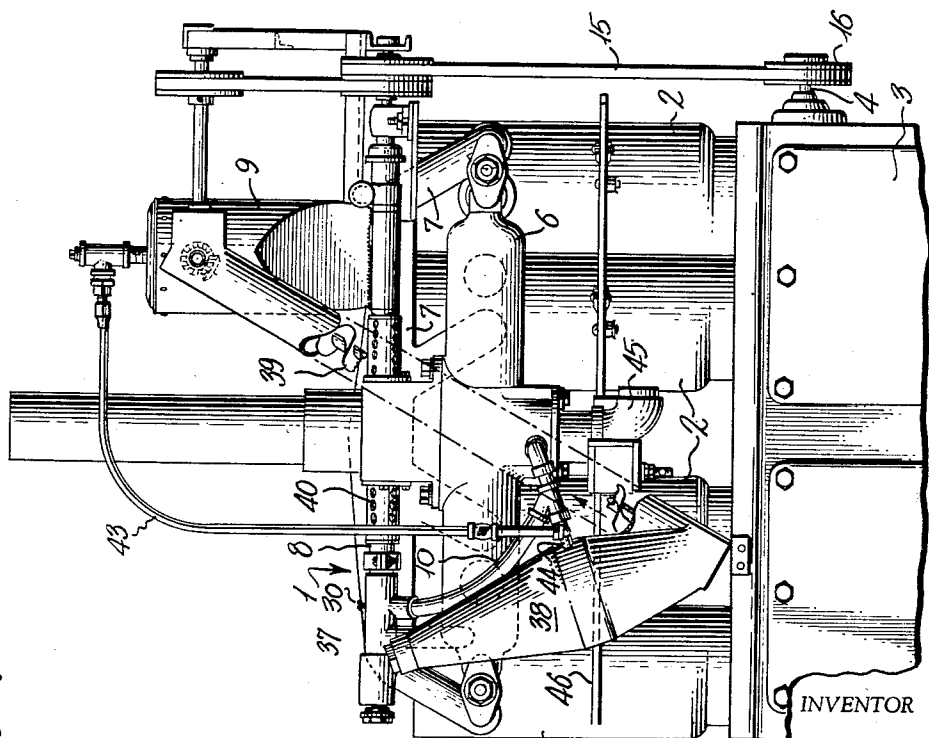


Fig. 1.

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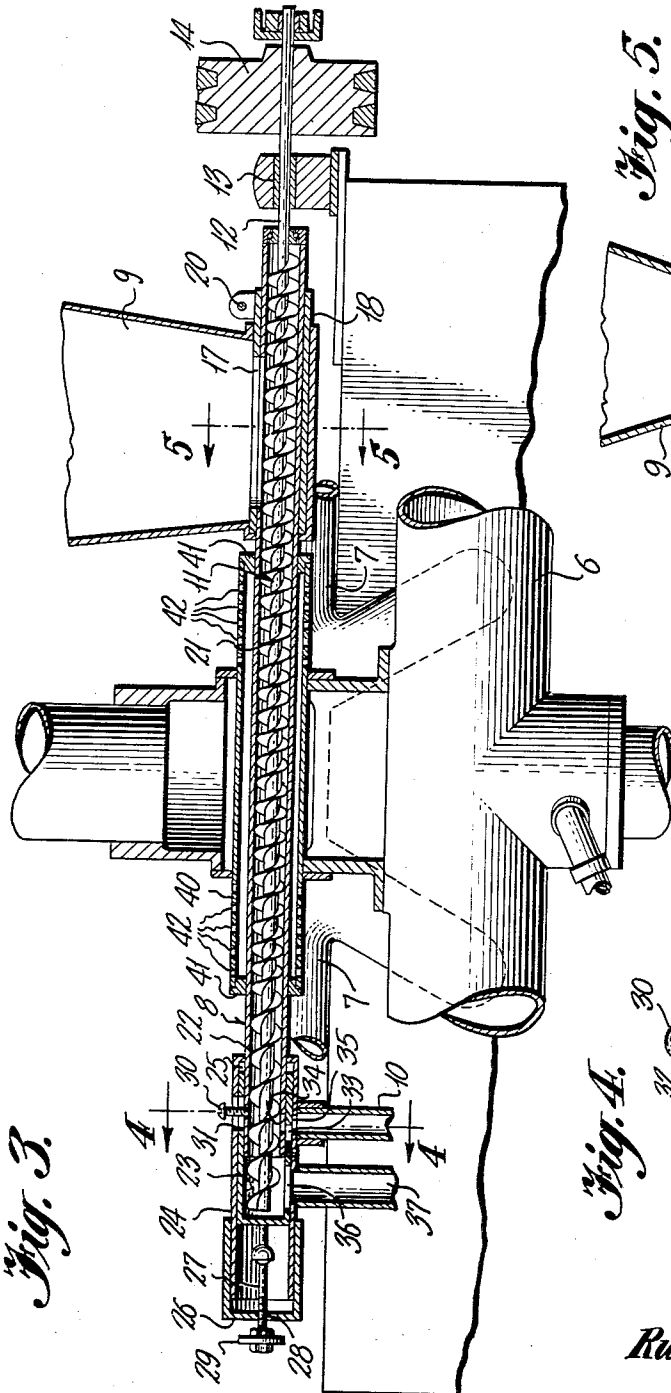
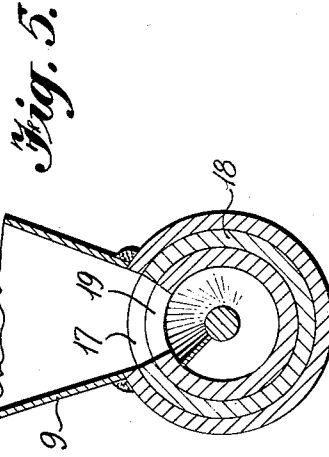
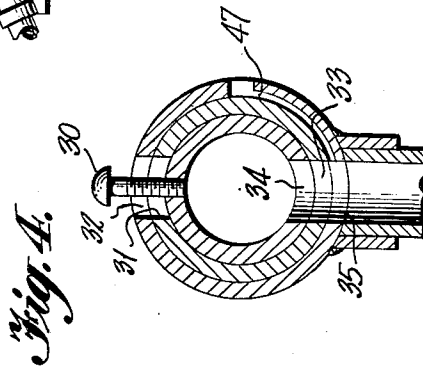
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FUEL FEED SYSTEM FOR SOLID FUEL BURNING ENGINE

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10 Claims. (Cl. 123—23)

This invention relates to coal burning engines, and more particularly to coal feeder systems for such engines.

While coal burning engines have been known, they have never come into general use due to the fact that difficulty has been encountered in obtaining a uniform and controllable feed for the coal. The coal has tended to coke from high temperature, or to clog in the feed lines, with the result that flow of pulverized coal to the engine is stopped.

The primary object of the present invention is to provide coal feeding means for coal burning engines which will be dependable to supply coal to the engine in predetermined quantities under the control of the operator.

A more specific object is the provision of means to feed an over supply of fuel from a source, taking from the over supply the amount desired and returning the remainder to the source of supply.

Another object is to provide means for feeding the coal which will ensure the coal being in a loose "flowable" condition at the time of delivery to the quantity or charge metering valve so that uniformity and continuity of flow can be maintained.

Still another object of the present invention is to provide a feeder system wherein the coal is preheated, but the temperature controlled to prevent coking, and the gases formulated during heating are entrained with the solid fuel.

Other objects of the invention will become apparent from the following description of a practical embodiment thereof, when taken in conjunction with the drawings which accompany, and form part of, this specification.

In the drawings:

Figure 1 is a side elevation of a coal burning engine incorporating a coal feeder system having the principles of the present invention;

Figure 2 is an end view of the engine;

Figure 3 is a vertical section through the coal feeder and control mechanism, and is taken on the line 3—3 of Figure 2;

Figure 4 is a transverse section taken on the line 4—4 of Figure 3 through the feed line at the valve position; and

Figure 5 is a transverse section through a portion of the coal storage hopper and the valve controlling the entrance of coal into the feed line, and is taken on the line 5—5 of Figure 3.

In general, the invention consists of a coal feeder system for coal burning engines wherein means are provided for moving a supply of pulverized coal from a source of supply to a controlled intake for solid fuel at a rate in excess of that required to supply the engine, and taking coal from the supply in desired amounts. The coal in moving from the source of supply to the controlled intake is moved at progressively increased speeds to maintain it loose, unpacked and free flowing. The amounts of coal passed from the source of supply to the feed line and from the feed line to the intake pipe are

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controlled and can be varied, and the excess fed past the controlled intake is delivered back to the source of supply.

Referring to the drawings in detail, there is shown a coal burning engine 1 having the usual cylinders 2, crankcase 3 in which is mounted the crankshaft 4, connected to pistons 5 reciprocally mounted in the cylinders 2. An intake manifold 6 and an exhaust manifold 7 are mounted on the side of the engine block in usual fashion and have communication with each of the cylinders. The present invention is concerned primarily with means for feeding solid fuel to the intake manifold.

Extending substantially the length of the engine block at the top thereof is a coal feeder tube 8, positioned horizontally and arranged to feed pulverized coal from a bunker 9, mounted above the tube near one end, to a feed pipe 10 communicating with the opposite end of the tube and connected to the intake manifold. A feed screw 11 is mounted for rotation in the tube and extends substantially the length of it. The screw shaft 12 projects beyond the tube end, is journaled in a bearing 13 and carries a pulley 14 on its end. A belt 15 around pulley 14 and a pulley 16 on crankshaft 4 drives the feed screw whenever the crankshaft is rotated.

Tube 8 is provided with an elongated opening 17 in its top beneath the bunker 9 to permit coal stored in the bunker to flow down into the feeder tube. The amount of coal flow into the tube is controlled by a cut-off tube 18, which is in the form of a sleeve surrounding the tube 8 in the region of the opening 17. The cut-off tube is provided with an opening 19, similar to opening 17 in tube 8, and tube 18 is rotatable relative to tube 8 to bring the two openings into complete or partial registry as feed requirements demand. Any convenient means, such as the screw 20, may be used for adjusting the cut-off tube 18.

Feed screw 11 is provided with sections of different pitch. The major portion 21 of the screw is of slow pitch, whereby fuel fed from the coal bunker 9 will be fed at a rather slow and uniform rate from its entrance into the feed tube to a point just short of the connection of feed pipe 10 with the feeder tube. From that point outward to the end of the screw a fast thread 22 is employed to move the fuel rapidly. This arrangement will cause the fuel particles to separate so that the coal fed in the area of the entrance to the feed pipe 10 will be loose and unpacked to prevent caking at the entrance to the feed pipe.

The outer end of the feeder tube, that is the end farthest removed from the bunker 9, is capped by a throttle 23. This member is cylindrical, closed at one end, and slides over the end of feeder tube 8. An outer housing 24, which is also cylindrical, is carried by the feeder tube and surrounds the throttle 23. The throttle slides axially of the tube in the annular chamber 25 formed between the tube and housing 24. A cap 26 closes the end of the housing. Throttle 23 is caused to slide relative to the tube by means of a threaded rod 27 connected to the closed end of throttle 23 and projecting outwardly through an opening 28 in cap 26. A control knob 29 is threaded onto the end of rod 27 and rotation of the knob will cause movement of the throttle.

The movement of the throttle is limited by means of a stud 30 projecting upwardly through elongated openings 31 and 32 in the throttle and housing. Movement of the throttle causes an intake port 33 in the throttle to be brought into or out of registry with the aligned openings 34 and 35 in the tube and housing. This will control the degree to which the opening 34 in the tube is uncovered and, therefore, the amount of coal which can flow through the opening into the feed pipe 10 which is in communication with the opening 35 in the housing. Stop stud 30

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striking the sides of the opening 31 in the throttle will determine throttle open and closed positions.

It will be understood that the feed of solid fuel through the feeder tube will be constant so long as engine speed remains constant and no adjustment is made to the cut-off tube at the entrance end of the feeder. The tube delivery will usually be adjusted to feed coal in greater quantity to the throttle than will be required or permitted to pass into the intake. The adjustment of the throttle, of course, will determine the amount of fuel passed to the intake. The remainder will be fed forward and out of the tube through an opening 36 in the throttle into an overflow pipe 37 connected to the housing 24. The opening 36 is made sufficiently large so that it will not interfere with the free flow of excess fuel through the overflow pipe, 15 irrespective of the position of the throttle.

Coal which enters pipe 37 falls into an overflow bunker 38, from which it is carried back to the storage bunker by means of a screw conveyor 39. The overflow bunker 38 and conveyor 39 have capacities in excess of the capacity of feeder tube 8 to prevent any possibility of clogging or jamming and causing a back pressure on the fuel in the feeder tube.

Feeding more fuel to the throttle than will be passed into the intake achieves a two-fold purpose. It assures an adequate supply of fuel at all times and it serves to preheat the fuel in the supply bunker 9. This is accomplished by arranging a heater around the feeder tube between the bunker 9 and the throttle. The heater consists of a sleeve 40, of larger diameter than the tube, surrounding the tube and being connected into the engine exhaust line so that the hot exhaust gases flow around the tube and heat it. The ends of the sleeve are closed by plugs 41. In order to prevent the heater from causing the tube to become so hot that the fuel will coke, the sleeve 40 is provided with a plurality of small holes 42 so that the escaping exhaust gases will draw air into the heater through the openings. The incoming cool air will mix with the hot exhaust gases, and the resulting mixture will be warm enough to properly preheat the coal moving to the intake. Of course, all of the coal moving through the feeder tube will be heated, and the excess or overflow will go back to the storage bunker, retaining enough heat to partially heat the mass of coal in the bunker. The heating of the coal will cause the formation of some "coal gas" in the overflow bunker and the supply bunker. Advantage is taken of this gas for its high combustion properties and it is led from the bunker 9 to the feed pipe 10 by means of pipe 43 and from the overflow bunker to pipe 10 by means of pipe 44.

The engine is designed to operate on a combination solid and highly volatile liquid fuel, such as gasoline. Excellent results have been obtained from a combination 80% solid and 20% liquid fuel. To handle the liquid fuel, a carburetor 45 of the updraft type is connected to the intake manifold and is supplied by a gas line 46.

In operating the engine, the bunker 9 is loaded with coal, the cut-off tube 18 adjusted to provide the desired flow opening from the bunker into the feeder tube. The engine is cranked in any conventional manner, and as the crankshaft is turned fuel is fed along the feeder tube. The flow will be uniform through the heater 40, but when the fuel approaches the throttle position the increased pitch of the feed screw 11 will speed up the feed, loosening the coal to move it in unpacked condition over the intake port in the bottom of the tube. Coal will flow through the port in accordance with the throttle setting and into the pipe 10. As pipe 10 is connected into the intake manifold, the vacuum in the manifold will exert a pull on the coal drawing it into the pipe. At the same time, air will be drawn into pipe 10 to be mixed with the coal prior to entry into the intake manifold. The suction from the manifold will pull air into the stop stud opening 32 in the housing and around an annular channel 47 cut in the under surface of the housing to the pipe 10. Thus,

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the air is drawn into the pipe line without being drawn into the feed chamber. This prevents packing of coal at the intake entrance in the feed tube, and the particular placement of the air passage causes the air to pass over the intake port to entrain coal. The preheated coal, mixed with air and the coal gases led in through pipes 43 and 44 enters the intake manifold ahead of the liquid fuel. The two fuels are mixed in the manifold and enter the cylinders and fired in the usual manner. The coal fed to the throttle position but not used will pass out of the feeder tube through pipe 37 into the overflow bunker. From there it is carried back to the storage bunker by the conveyor 39. The amount of fuel fed to the engine and consequently the engine speed are controlled by the adjustment of throttle 23. Operation of the knob 29 will either increase or decrease the throttle opening as desired.

While in the above one practical embodiment of the invention has been disclosed, it will be understood that the details of structure described and shown are merely by way of example and the invention may take other forms within the scope of the appended claims.

What is claimed is:

1. A fuel feeding system for solid fuel burning engines having a fuel intake comprising, means to contain a supply of solid pulverulent fuel and having an outlet, conveyor means having one end adjacent said outlet and having a discharge outlet adjacent its other end adapted to be connected to said engine intake to receive fuel from said supply and convey it to said discharge outlet, means to control the amount of fuel admitted to said discharge outlet from said conveyor means, and means to return to said supply quantities of fuel on said conveyor means in excess of the quantity admitted to said discharge outlet, said conveyor means comprising two stages, a first stage adjacent said supply outlet having a feeding rate of predetermined amount and a second stage adjacent said discharge outlet having a more rapid feeding rate than said first stage.

2. A fuel feeding system for solid fuel burning engines having a fuel intake comprising, means to contain a supply of solid pulverulent fuel and having an outlet, conveyor means having one end adjacent said outlet and having a discharge outlet adjacent its other end adapted to be connected to said engine intake to receive fuel from said supply and convey it to said discharge outlet, means to control the amount of fuel admitted to said discharge outlet from said conveyor means, and means to return to said supply quantities of fuel on said conveyor means in excess of the quantity admitted to said discharge outlet, said conveyor means comprising two stages, a first stage adjacent said supply outlet having a feeding rate of predetermined amount and a second stage adjacent said discharge outlet having a more rapid feeding rate than said first stage, and an inlet for air opening into said discharge outlet.

3. A fuel feeding system for solid fuel burning engines having a fuel intake comprising, means to contain a supply of solid pulverulent fuel and having an outlet, conveyor means having one end adjacent said outlet and having a discharge outlet adjacent its other end adapted to be connected to said engine intake to receive fuel from said supply and convey it to said discharge outlet, means to control the amount of fuel admitted to said discharge outlet from said conveyor means, and means to return to said supply quantities of fuel on said conveyor means in excess of the quantity admitted to said discharge outlet, said conveyor means comprising a feeder tube and a screw conveyor within said tube, said screw conveyor having convolutions of one pitch adjacent said supply outlet and convolutions of a faster pitch adjacent said discharge outlet.

4. A fuel feeding system for solid fuel burning engines having a fuel intake comprising, a bunker to receive a supply of pulverulent fuel and having an outlet in the

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bottom thereof, a feeder tube having one end beneath said bunker outlet, and a discharge outlet near the other end but short of that end adapted for connection to the engine intake, said tube having an opening in communication with the outlet in said bunker, a screw conveyor in said tube extending from the end of said tube adjacent said bunker to a point adjacent the discharge outlet, means to control the quantity of fuel admitted through the discharge outlet, and means to return to said bunker fuel fed by said conveyor in excess of said quantity admitted through the discharge outlet.

5. In a fuel feeding system as claimed in claim 4, means to control the rate of fuel flow from said bunker to said feeder tube.

6. In a fuel feeding system as claimed in claim 4, means to heat said feeder tube intermediate said bunker and said discharge outlet, and means to extract gases from said bunker for feeding to said engine intake.

7. In a fuel feeding system as claimed in claim 4, said means to return excess fuel to said bunker comprising an overflow pipe connected to said feeder tube beyond said

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discharge outlet in the direction of fuel feed, an overflow bunker connected to said overflow pipe, and a conveyor from said overflow bunker to said supply bunker.

8. In a fuel feeding system as claimed in claim 7, means to heat said feeder tube intermediate said supply bunker and said discharge outlet, and means to extract gases from said supply bunker and said overflow bunker for feeding to said engine intake.

9. In a fuel feeding system as claimed in claim 4, said screw conveyor having convolutions of one pitch adjacent said bunker, and convolutions of a faster pitch adjacent said discharge outlet.

10. In a fuel feeding system as claimed in claim 9, an air inlet opening into said discharge outlet.

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