Oct. 9, 1945. E. GRAY 2,386,679

LOCOMOTIVE

Filed June 22, 1942 3 Sheets-Sheet 3

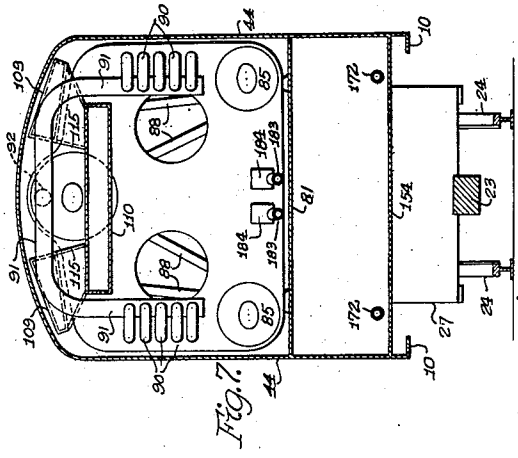

Fig. 7.

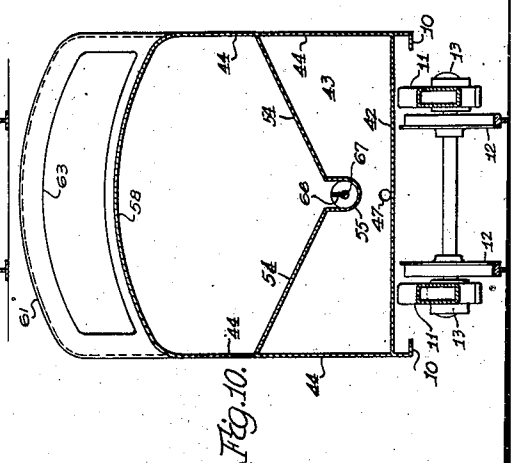

Fig. 10.

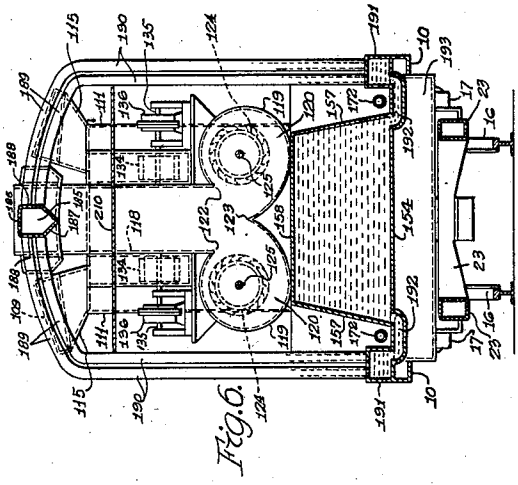

Fig. 6.

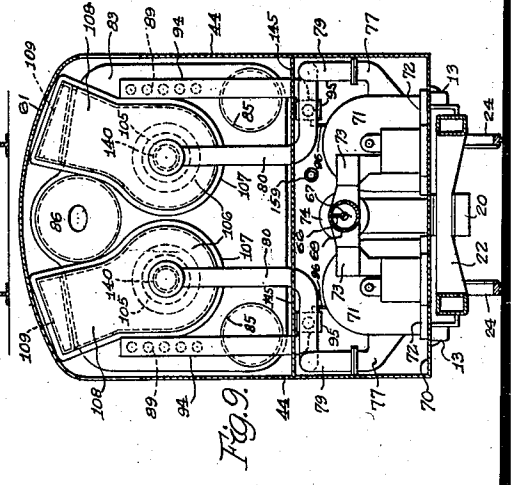

Fig. 9.

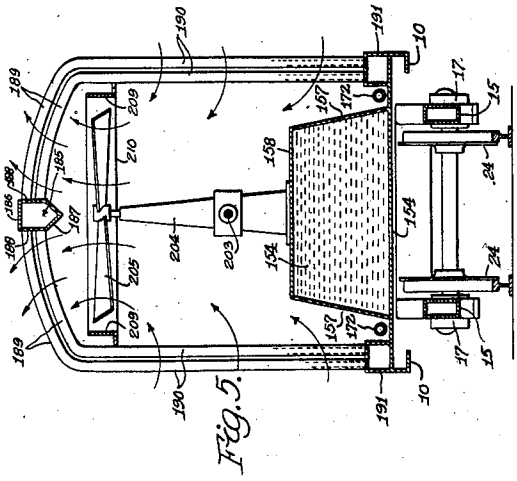

Fig. 5.

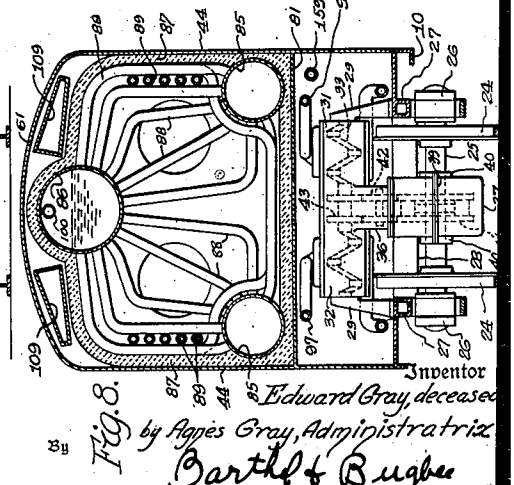

Fig. 8.

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LOCOMOTIVE

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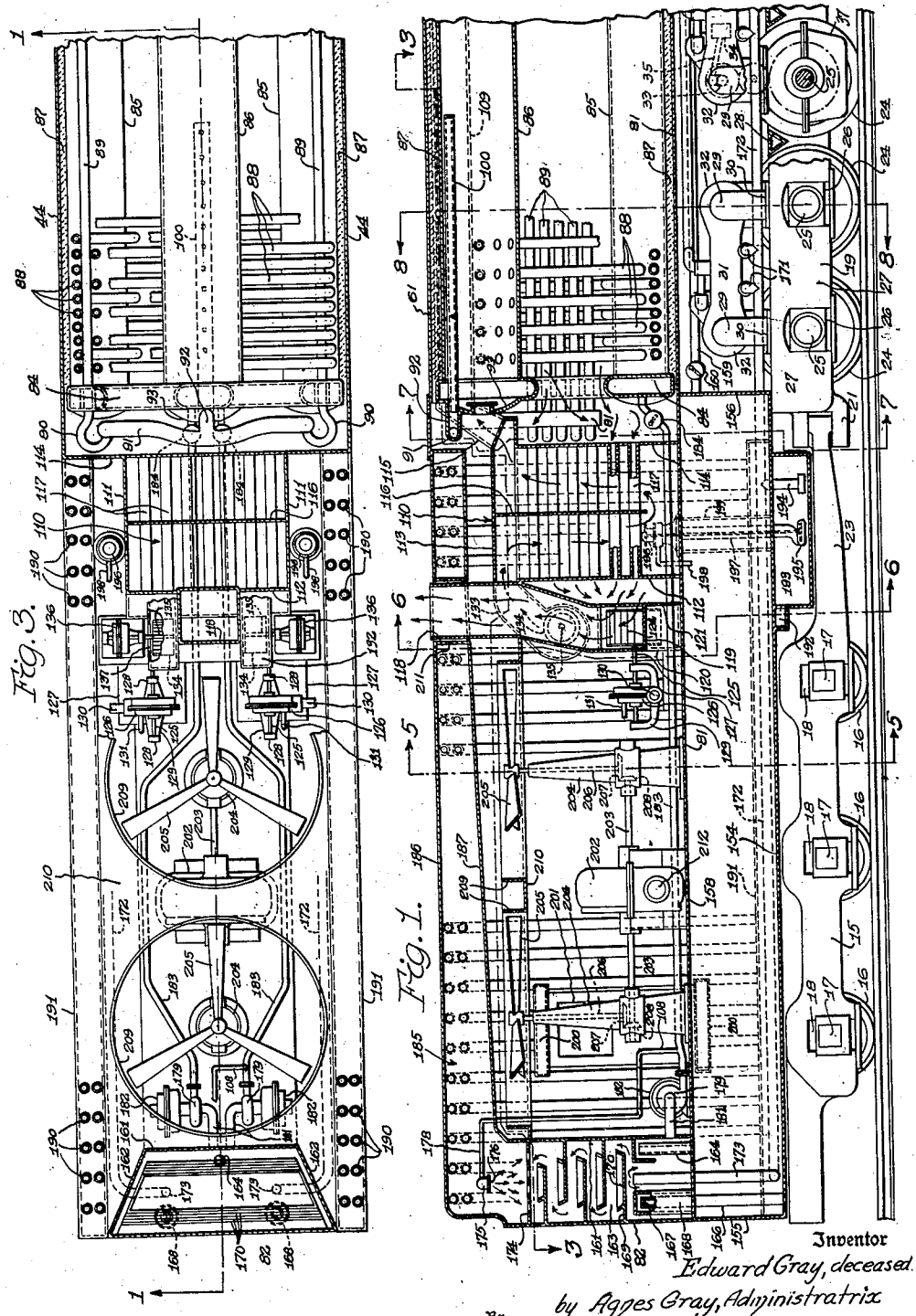

Fig. 3.

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LOCOMOTIVE

Filed June 22, 1942 3 Sheets-Sheet 2

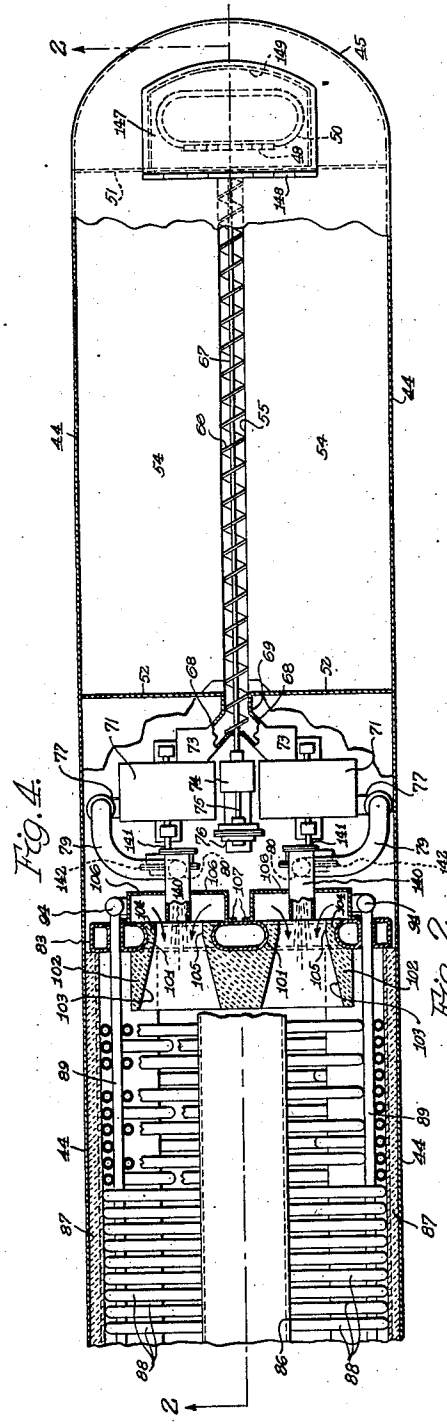

Fig. 4.

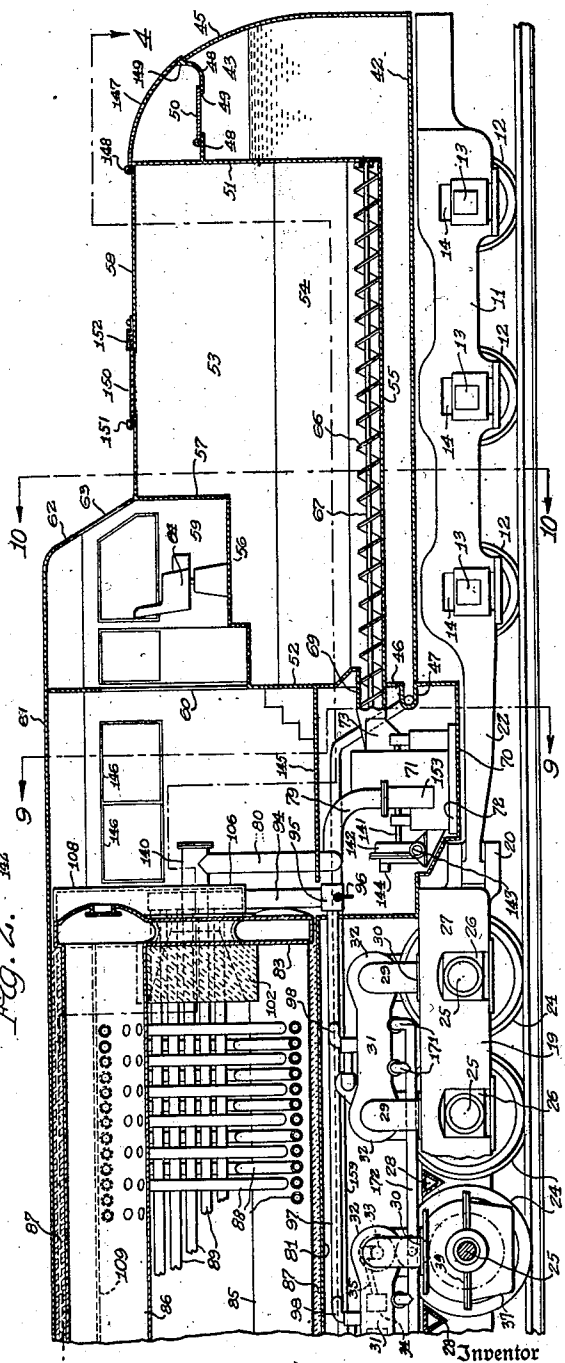

Fig. 2.

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UNITED STATES PATENT OFFICE

2,386,679

LOCOMOTIVE

Edward Gray, deceased, late of Detroit, Mich., by Agnes Gray, administratrix, Grosse Pointe Park, Mich.

Application June 22, 1942, Serial No. 447,977

3 Claims. (Cl. 105—37)

The present invention relates to locomotives, and more particularly to steam generative power plants therefor.

The primary object of the invention is to provide a locomotive for railways and the like capable of deriving its initial power from a heat source employing a pulverized fuel which fuel is pulverized in transit prior to its injection into the burner.

Another object of the invention is to provide a railway locomotive with a regenerative heating system, whereby the exhaust steam may be employed for preheating the boiler feed water and said exhaust steam may be condensed for re-use in the boiler feed.

Another object of the invention is to provide a railway locomotive having a forced draft heating unit, whereby regulation of the heating unit may be accomplished to increase or decrease the draft as desired, thereby eliminating to a great degree waste of fuel incident to the natural draft type heating unit.

Another object of the invention is to provide a railway locomotive power plant wherein the fuel pulverizer, condenser cooling fans and forced draft means is driven by individual turbines powered from the heating unit so that the locomotive will operate more efficiently and thereby eliminating the use of independent power sources such as electric motors and the like.

Another object of the invention is to provide a railway locomotive in which the fuel reservoir is mounted forwardly of the locomotive for rearward feeding of fuel to the heating unit after the fuel has been pulverized, thereby saving considerable space and causing considerable economy of fuel consumption.

Another object of the invention, is to provide a locomotive of the above mentioned type in which the engineer's cab is located forwardly of the boiler and smoke stack to insure better vision under all operating conditions.

Another object of the invention resides in providing a railway locomotive of the above mentioned character, the heating plant of which is adapted to burn finely pulverized fuel burned in supension thereby eliminating ash discharge devices and the accumulation of excessive clinker incident thereto.

Another object of the invention is to provide a railway locomotive having independent drive motors for the drive wheels mounted between the boiler and drive wheel trucks so that traction will be increased and extensive driving gear will be eliminated and the operative parts will be contained within the streamline of the locomotive.

Another object of the invention is to provide a railway locomotive of the above-mentioned type including a condenser mounted rearwardly of the boiler and heating unit to condense the exhaust steam and return the condensation product to the boiler feed.

Another object of the invention is to provide a railway locomotive of the above-mentioned type having a heating unit adapted to burn finely pulverized fuel in suspension in air, which air is preheated by being passed through a heat exchanger associated with the exhaust gases whereby increased efficiency of the heating unit is obtained.

Other objects and advantages of the invention will become apparent during the course of the following description of the accompanying drawings wherein:

Figure 1 is a longitudinal sectional view of the rear portion of the locomotive embodying the invention, showing in detail a portion of the boiler structure and the condenser unit therefor;

Figure 2 is a longitudinal cross-sectional, extended view of Figure 1 showing in detail the heating unit, fuel storage and pulverizer interposed therebetween;

Figure 3 is a horizonal longitudinal cross-sectional view taken on lines 3—3 of Figure 1 looking in the direction of the arrows further illustrating the rear portion of the boiler and condenser and showing the air circulating fans for the condenser to cause the cooling of liquid therein;

Figure 4 is a horizontal cross sectional view taken on lines 4—4 of Figure 2, and looking in the direction of the arrows, further illustrating the heating unit and boiler structure relative to the fuel pulverizer;

Figure 5 is a vertical cross-sectional view taken on lines 5—5 of Figure 1 looking in the direction of the arrows showing in detail one of the air circulating condenser cooling fans;

Figure 6 is a vertical cross-sectional view taken on lines 6—6 of Figure 1 looking in the direction of the arrows showing the forced draft circulating fans and the blower for the heating unit;

Figure 7 is a vertical cross sectional view taken on line 7—7 of Figure 1 looking in the direction of the arrows illustrating in detail the boiler manifold connecting the longitudinal boiler tubes with the transverse boiler tube header;

Figure 8 is a vertical cross sectional view taken on line 8—8 of Figure 1 looking in the direction of the arrows illustrating the construction of the

boiler and the arrangement of the driving motors therebeneath;

Figure 9 is a vertical cross sectional view taken on line 9—9 of Figure 2 looking in the direction of the arrows illustrating in detail the fuel pulverizer and showing the steam manifolds for connection with the motors; and

Figure 10 is a vertical cross-sectional view taken on line 10—10 of Figure 2 looking in the direction of the arrows showing the fuel and water reservoirs in detail.

General arrangement and construction

The invention comprises a railway truck supported frame on the front end of which is located a fuel and water reservoir for supplying a locomotive power plant. Likewise carried by the frame and positioned rearwardly of the fuel and water reservoir is a power plant, including a boiler, a heating unit and a condenser. A suitable driver's cab is located conveniently above the rear end of the fuel reservoir to increase vision, and interposed between the fuel reservoir and heating unit is a fuel pulverizer adapted to receive fuel from the reservoir and pulverize the same for being supplied to the heating unit, whereby said pulverized fuel may be burned in suspension, being initially mingled with preheated air and then burned in the burner entrance to the boiler. The invention also includes a condenser for utilizing the exhaust steam from the motors so that a portion of the steam can be re-directed to the boiler.

The motor drive comprises individual opposed piston motors for each pair of axles of the drive wheels, whereby increased traction and horse power will be developed, thereby further saving the fuel consumption and producing a locomotive of greatly increased efficiency. Further, the invention provides a forced draft for the products of combustion to eliminate excessive fuel consumption when the locomotive is standing and to produce maximum efficiency when the locomotive is driving.

The invention also includes many departures from present day structures in locomotives, all of which combine to produce a locomotive which is highly efficient, develops a maximum horsepower rating and operates on a minimum fuel consumption.

Detailed description of running gear

In the drawings, wherein for the purpose of illustrating the invention, and wherein like reference characters will be employed to designate like parts throughout the several views, the reference character 10 will generally be employed to designate a locomotive under frame comprising longitudinal side frame members connected at each end by transverse frame members. The under frame is supported in the front by means of a truck 11 having wheels 12 the bearings 13 of which are slidably mounted in openings 14 in the usual manner. A similar truck 15 is coupled to the rear end of the underframe by means of a suitable bolster and said truck is provided with wheels 16 mounted in suitable slide guide openings 18. An intermediate truck 19 is secured to the underframe by a suitable bolster connection and the intermediate truck is provided at each end with couplings 20 and 21 for receiving extensions 22 and 23 of the respective trucks 11 and 15, whereby the trucks will be connected and will be capable of articulation. The intermediate truck 19 is adapted to be provided with a series of drive wheels 24 mounted on axles 25 journaled in slide bearings 26.

Further, the intermediate truck is comprised of side beams 27 connected by spaced transverse members 28 extending between the drive wheels 24 as is best shown in Figures 1 and 2. This provides a relatively rigid structure upon which is supported individual drive motors for each drive wheel axle.

Extending upwardly from each side beam 27 and directly above each axle 25 is a series of motor supporting brackets 29 having flanged lower portions as at 30 for anchoring the brackets 29 to the side beams 27 such as by welding or suitable fastening elements. Secured between the upper ends of the motor supporting brackets 29 is a motor cylinder block 31 having crank case 32 at each end thereof in which is journaled a crank shaft 33 rotatably supported by suitable bearings (not shown). Opposed pistons 34 are reciprocably mounted in the cylinders of the cylinder block 30 and are connected to the throws of their respective crank shafts 33 by means of connecting rods 35. The upper ends of the brackets 29 may be welded or otherwise secured to the crank cases 32 so that a crank case will be supported directly above each axle 25. Formed integral with each crankcase and depending therefrom is a gear housing 36 connected to the upper end of an axle housing 37 divided by a separable flange 39 so that the axle 25 may have its ends suitably journaled therein as at 40 and extending into the axle housing so that gears 41 may be connected to the inner ends of the drive axle 25. Likewise, intermeshing gears 42 are carried by the gear housing on a suitable shaft for drivingly connecting gears 43 on the intermediate portion of the crank-shaft with the axle gears 41 so that each of the axles 25 will be independently driven by its corresponding positioned crank shaft. That is, there will be an independent or individual drive for each axle 25 to increase the driving power and likewise increase the traction.

The underframe structure including the channel irons 10 is built up and in the forward portion thereof the channel irons are connected by a suitable floor 42 which forms the bottom wall of a reservoir chamber generally designated as at 43. The reservoir chamber is provided with side walls 44 connected at the forwardmost portion by means of an arcuately curved and well rounded wall 45. The rear end of the reservoir 43 is closed by end wall 46 having tubular portions 47 adjacent each end thereof for communication with a secondary reservoir which will be hereinafter more fully described. The well-rounded front wall 45 is provided with a shelf 48 having a fill-opening 49 adapted to be normally closed by means of a hinged cover plate 50.

Connecting the side walls 44 at the forward portion thereof is a vertical partition 51 while rearwardly thereof is a similar vertical partition 52 forming a chamber 53 having a bottom wall 54 provided with a longitudinally extending trough 55 as clearly shown in Figs. 2 and 4. The bottom wall 54 connects the side wall 44 thereby providing a closed chamber or reservoir for containing lump coal. The upper portion of the rear partition 52 projects forwardly as at 56 and terminates in an upwardly extending partition 57 and the partitions 51 and 57 are adapted to be bridged by a top wall 58 likewise connecting the sidewalls 44. The partition plates 56 and 57 provide an operator's compartment 59 which is accessible through a door 60 in the vertical rear

partition 52. The top wall 61 of the locomotive extends forwardly as at 62 and is provided with a windshield 63 so that the operator in the seat 64 will have a relatively clear vision of the trackway directly ahead. It is to be noted that the chamber 43 provides a water reservoir while the chamber 53 nested therein provides a chamber or reservoir for receiving coal to supply the heating unit of the locomotive. The side walls 44 extend rearwardly a distance equal to the length of the boiler and as shown in Figs. 3 and 4 said walls are continuous and are connected by the top wall 61 which likewise extends the length of the boiler.

The longitudinal trough 65 is provided with a screw conveyor 66 mounted on a rotary shaft 67 the ends of which are suitably journaled for accommodating rotation of the conveyor. One end of the shaft is journaled in the partition 51 and at the opposite end is journaled in a branch pipe 68 formed on a tubular extension 69 through which one end of the screw conveyor passes for conducting the coal to the heating unit.

The bottom wall 42 of the locomotive is dropped as at 70 rearwardly of the reservoirs 43 and 53 and supported on said dropped bottom 70 is a pair of coal pulverizers 71 mounted on suitable bases 72 anchored in place to prevent shifting thereof. The branch pipe 68 is provided with hoppers 73 which communicate with the tubular extension 69 so that coal or other fuel may be fed by the screw conveyor to the pulverizers 71. The shaft 67 projects between the pulverizers 71 and is connected to a gear reduction box 74 having a drive shaft 75 connected with a turbine or other motor 76. Each of the pulverizers 71 is provided with an exhaust 77 to which is connected an elbow fitting as at 79 for connection with vertical burner feed pipes 80.

Directly rearward of the dropped bottom 70, the bottom wall of the locomotive is elevated as at 81 and continues rearward to the end wall of the locomotive as at 82. The space defined by the side walls 44, top wall 61 and bottom wall 81 is adapted to provide for a boiler construction including end headers 83 and 84 connected by a pair of spaced longitudinally extending boiler tubes 85. Likewise, a longitudinally extending boiler tube 86 connects the top of the headers 83 and 84. The space surrounding the boiler tubes 85 and 86 and the side walls 44 is filled with a refractory lining 87 so as to withstand high temperature conditions created within the boiler. The longitudinally extending boiler tubes 85 and 86 are connected by transverse boiler tubes 88 variously arranged so as to extend transversely with respect to the boiler chamber.

A series of longitudinally extending super heater boiler tubes 89 are supported between certain pairs of transverse boiler tubes 88 and one end of each of the tubes projects through the header 84 and is hooked as at 90 so as to establish communication with a manifold 91 having a branch pipe 92 connecting the end wall 93 of the boiler tube header 86. The opposite ends of the superheater tubes 89 are connected to a vertical manifold 94 the lower end of which is provided with a suitable valve 95 having a control 96 for throttling the flow of steam through the manifold 94. Extending along each side of the locomotive is a steam pipe 97 having elbow fittings 98 connecting the valve chambers 99 of the motors 30 to supply motive fluid under pressure thereto in the form of steam. By controlling the throttle 96, the steam may be increased or decreased so that the speed of the motors may be likewise increased or reduced. The manifold extension 92 is provided interiorly with an elongated apertured pipe 100 extending well into the upper boiler tube header 86 so that steam in the top thereof will be collected for conduction to the manifold 94 and thence to the motors 30.

The header 83 is provided with a pair of spaced openings 101 which are preferably formed circular and carried inwardly of the header is the refractory hearth 102 having convergent openings 103. The refractory hearth 102 is slightly smaller than the header 83 and is provided with tubular projections 104 which pass through the openings 101 in the header and assist in securing the hearth in place. The outer ends of the openings 103 are formed cylindrical as at 105 and are covered by suitable circular casings 106 the marginal flanges of which as at 107 are welded or otherwise secured to the header. Extensions 108 are formed on the circular casings 106 and project upwardly to the top wall 61 of the locomotive frame structure and are connected to passageways 109 on opposite sides of the upper longitudinal boiler header 86. The ductways 109 are suitably connected to the upper ends of extensions 108 and project rearwardly to a heat exchanger casing 110 which will be hereinafter fully described.

The heat exchanger casing 110 includes side walls 111 having a rear wall 112 and a top wall 113. The front wall is formed by the end partition wall 114 forming the rear end of the boiler chamber which connects the side walls 44 of the locomotive and likewise connects with the bottom wall 81 thereof so as to provide a substantially closed chamber. The top wall 113 of the heat exchanger 110 is provided with passageways 115 at each end thereof for connection with the longitudinally extending ductways 109 to thereby establish communication between the casing 110 and the circular casing member 106. Extending downwardly from the top wall 113 and connecting the side walls 111 is a partition plate 116 terminating a short distance from the floor or underframe 81 so as to allow the passage of air therethrough.

A series of horizontal heat exchanger tubes 117 connect the end walls 112 and 114 of the heat exchanger casing and one end of the tubes is in communication with the interior of the boiler chamber to receive the combustion products and flue gases so that said flue gases will pass rearwardly through the tubes to be conducted to a stack 118. The lower portion of the stack 118 is provided with oppositely disposed circular casings 119 having side walls 120 and 121 connected by a curved peripheral wall connecting the stack as at 122 and terminating in an apex 123 immediately below the stack. Housed within the circular casing 119 is a blower impeller 124 mounted on a shaft 125 suitably journaled in the side walls 120 and 121 of the circular casing. The shaft 125 projects through the casing wall 120 and is rigidly secured to the rotor mounted in a turbine 126. The turbine is supported on a suitable base 127 mounted on the floor 81 of the locomotive. Bearings 128 are provided for further supporting the shaft 125 and said bearings are connected by a bracket 129 upon which the turbine 126 rests and is secured. An inlet pipe 130 may connect to a suitable source of steam pressure for driving the turbine and an exhaust pipe 131 is provided for each turbine for the disposal of the exhaust steam after passing through the turbine. Open-

ings are formed in the wall 121 in axial alignment with the impellers 124 so that the flue gases from the boiler chamber will be drawn through the heat exchanger tubes 117 and will be forced by said impellers upwardly through the stack 118.

Mounted on each side of the stack 118 is a blower casing 132 having an exhaust port 133 connected to the end wall 112 of the casing 110 for forcing air therethrough in the direction of the arrows. The passageway 133 allows communication between the blower casing 132 and the interior of the casing 110 so that air will be forced downwardly over the heat exchanger tubes 117 on one side of the partition 116 and will then be forced upwardly on the other side of the partition so as to exhaust through the oppositely disposed ductway 115 communicating with the longitudinal ductways 109. In this manner, heated air under pressure is forced into the circular casing 106 and thence into the boiler chamber through the convergent hearth openings. 103. Each of the blower casings 132 is provided with an impeller 134 mounted on a shaft 135 connected to a turbine 136. An opening 137 is formed in each of the blower casings 132 to allow the entrance of air to the casing whereupon the impeller will force said air through the above-mentioned ductways 133 and into the heat-exchanger casing 110. A suitable source of steam pressure may be provided for driving the turbines 136 in the same manner as the turbines 126 are supplied and if desired, all of the turbines may be connected to a single source of steam pressure. Powdered fuel or finely pulverized coal is admitted to the hearth 103 by means of concentrically mounted feeder pipes 140 connecting the vertical pipe 80 and said feeder pipes project through an opening in the circular casing 106 and have their inner end terminating in alignment with the outer wall of the header 83 and in concentric registry with the circular opening 105 in the divergent hearth openings 103 whereby the fuel in finely powdered form will be picked up by the incoming heated air and burned in suspension or on the hearth 103. The pre-heated air causes the finely divided fuel to be more easily ignited by reason of its increased temperature and suitable means may be provided for initially igniting the burner.

Each of the fuel pulverizers 71 is provided with a shaft 141 which is connected to the rotor of the pulverizer and projects through one side of the pulverizer for connection with a turbine 142. The turbine is provided with an inlet 143 which may be connected to a suitable source of steam pressure and the exhaust side of the turbine as at 144 may be connected to a recirculatory system which will be described more in detail in the following specification.

The space between the partition 52 and the header 83 is adapted to provide a compartment for the fireman and mounted directly above the fuel pulverizer 71 is a platform 145 which extends between the walls 44 and between the partition 52 and the header 83. The platform 145 enables the fireman to keep a constant watch on the condition of the heating unit and the operative parts incident thereto. Windows or the like 146 are provided in the side walls 44 of the locomotive to allow the fireman sufficient ventilation while performing his duties on the platform 145.

Hinged to the forward portion of the top wall 58 of the compartment 53 is a closure 147 mounted on a suitable hinge 148 to swing in a horizontal arc and said closure 147 is adapted to close an opening 149 in the curved front wall 45 of the locomotive so as to obtain access to the fill closure 50. The hinged closure 147 is slightly arcuate in cross-section so that the continuity of the front wall 45 will not be broken and a perfect stream-line effect can be had. A hinged closure 150 is mounted on the top wall 58 for the purpose of filling the compartment 53 and said closure is mounted on suitable hinges 151 and may be provided at the unhinged end with a latch or keeper 152.

Further, each of the fuel pulverizers 171 is provided with a blower 153 on the outlet side 77 of the pulverizer for the purpose of conveying or blowing the powdered fuel to the burner tube 140. Applicant has used a conventional fuel pulverizer as is well known in the art; such fuel pulverizers usually include a four-speed fan on the discharge end of the pulverizer capable of disposing of the pulverizing material as quickly as it is fed to the pulverizer to prevent jamming and clogging of the pulverizer.

Mounted rearwardly of the boiler compartment is a tank 154 adapted to contain water for feeding the boiler and said tank comprises end walls 155 and 156 connected by side walls 157. The top wall 158 is co-extensive with the floor 81 of the boiler compartment and as shown in Fig. 1, the tank is dependent and extends downwardly to the bottom wall 154 which connects the underframe channel irons 10. A suitable pipe 159 is adapted to extend along opposite sides of the locomotive for the purpose of connecting the tank thus described with the reservoir 43 by being connected to the outlet thereof as at 46. A check valve 160 may be interposed in the pipe 159 to allow the tank 154 to be fed by gravity from the reservoir 43. It is to be noted that the rear wall of the tank 155 is co-extensive with the rear wall of the locomotive 82 and said wall 82 is adapted to form a compartment directly forward thereof and between a transversely extending wall 161. Side walls 162 connect the rear wall 82 to the vertical and transverse partition 161 thereby forming a vertical steam well chamber 163. Projecting upwardly into the steam well 163 from the top wall 158 of the water tank is a feed pipe 164 adapted to allow the overflow of the tank to fill the steam well 163 to a height equal to the height of the overflow 164. A baffle 165 projects rearwardly from the partition 161 and extends over the overflow pipe 164 to prevent excessive spilling of liquid. An overflow pipe 166 extends through the bottom and top walls 154 and 158 respectively of the water tank and has its upper end as at 167 terminating adjacent the upper end of the overflow 164 and surrounding the overflow pipe 166 is a casing or cage 168 for preventing excessive splashing and overflowing of the water from the steam well.

Extending inwardly from the wall 82 and the partition 161 is a series of superposed baffle plates 169 arranged alternately as shown in Fig. 1 and each of said baffle plates is provided with a dish-shaped portion 170 adapted to retain the steam condensate and allow it to overflow as it is collected in the dish-shaped trough 170. Connecting the exhaust 171 of each motor 30 is an exhaust pipe 172 and as shown in Figs. 1 and 2, the exhaust pipe 172 is connected to the opposite ends of the exhaust manifold 171 so that said exhaust pipes will extend rearwardly on opposite sides of the engine and on opposite sides of the rear water compartment formed by the walls 154, 157 and 158. The rear end of each exhaust pipe 172 extends upwardly as at 173 and projects into

the steam well compartment 163 to a height substantially equal to the height of the baffle 165 whereby steam will be admitted to the steam well after being exhausted from the motors or engines 30.

As the steam enters the steam well 163, portions thereof are condensed which condensate is returned to the steam well for being fed to the boiler head 84 in a manner which will be presently herein described. The continued travel of the steam upwardly through the steam well 163 and past the baffles 169 causes a great portion of the steam to be condensed and directly above the steam well there is provided a reticulated screen 174 to filter the screen and remove foreign particles therefrom. Mounted directly above the screen 174 is a spray pipe 175 which extends transversely of the locomotive and is provided at its free end with suitable spray orifices 176 so that a constant stream of water will oppose the upwardly travelling steam to thereby assist in condensing the steam for use in the system. A pipe 178 may be connected to the spray pipe 175 and may have its lower end connected to the outlet side of a pump 179 as at 180 so that said pump 179 will receive water from the lower portion of the steam well through the intake pipe 181 and continually circulate the water through the steam well. As shown in Fig. 3 there is provided two such pumps each of which is adapted to be driven by means of a suitable steam turbine 182 supplied from a suitable source of steam pressure from the boiler system. The exhaust pipe 183 of each pump 179 extends forwardly along opposite sides of the top wall 158 of the water tank so that the forward end of said pipe 183 may be connected to the lower portion of the rear header 84. A check valve 184 may be interposed between the pump 179 and the header 84 to prevent back pressure from the header 84.

The top portion of the steam well 163 is tapered inwardly and terminates in a forwardly extending header 185 including a top wall 186 connected to a bottom wall 187 by means of side walls 188. The header 185 is considerably reduced in size from the upper portion of the steam well 163 to the boiler header 84 as is clearly shown in Fig. 1 and connecting the side walls 188 of the header 185 is a series of oppositely extending pipes 189 terminating in downwardly extending pipes 190 the extreme lower ends of which are connected to lower headers 191 on opposite sides of the water tank 154 and extending longitudinally thereof. The longitudinally extending headers 191 are mounted along the extreme outer edge of the under-frame channel members 10 and are adapted to collect the steam condensate so that it may be returned to the tank 154 for re-circulation through the system. Connection is established between the headers 191 and the rear water tank 154 by means of suitable connecting pipes 192 as is clearly shown in Fig. 6.

Extending directly underneath the forward portion of the water tank 154 is a collection chamber 193 and projecting into the collection chamber is a pipe 194 connected with the exhaust pipe 172. Considerable steam condensate will be collected in the collection chamber 193 and may be returned to the water tank 154 by means of a suitable water pump 195 projecting and supported within the collection chamber and operated by a motor or steam turbine 196 on the upper end of the outlet pipe 197. The drive shaft (not shown) of the motor 196 extends through the discharge pipe 197 of the pump so that the upper end thereof may be provided with a return pipe 198 connected to the water tank 154. The discharge pipe 197 extends through a passageway provided by a circular sleeve 199 connecting the lower and top walls of the water tank 154.

It is to be noted that the condenser pipes 189 and 190 are spaced to allow the passage of air therethrough and on each side of the locomotive certain pipes are interrupted by headers 200 for the interposition of a door or the like 201 to facilitate the easy entrance to the chamber formed by the condenser pipes so that repairs may be made to the various pieces of equipment.

Mounted on the top wall 158 of the water tank 154 is a steam turbine 202 having its turbine shafts 203 extending therefrom in opposite directions whereby said shafts may extend into the base portion 204 of a circulating fan 205. The fans 205 are mounted in spaced relation so as to draw air inwardly between the interstices of the pipes 190 and force the same upwardly in the direction of the arrows as shown in Fig. 5. Each of the fans 205 is mounted on a shaft 206 extending vertically through the base 204 and the lower end of each shaft is provided with a bevel gear 207 adapted to mesh with a bevel gear 208 on the free end of the turbine shaft 203. It is to be noted that the gears 208 are located with respect to the bevel gears 207 to cause rotation of the fans 205 in a single direction.

Encircling each fan is an annular band 209 and said bands are connected to a horizontal partition 210 extending from the vertical rear partition 161 to the vertical partition 120 adjacent the stack 118. The partition 210 thus provides openings within the annular band 209 through which air may pass as shown in Fig. 5 to insure the circulation of air in the proper manner so that the lower portions of the condenser pipes 190 will be cooled first and then the pipes 189 will be cooled secondly.

An opening 211 is formed in the header 185 to accommodate the passage of the stack 118 and said opening may be formed by a suitable bushing which will not interrupt the passage of steam forwardly to the forwardmost condenser pipes 189 and 190. The turbine 202 may be provided with a suitable inlet opening 212 capable of being attached by piping to a source of steam pressure such as from the boiler at one of the headers 83 or 84. Similarly, the turbines 142, 126, 136 and 179 may be connected to the steam boiler by connecting a suitable pipe to said turbines from one of the headers of the boiler. A link leverage system may be provided for connecting the throttle valve control lever 96 to a throttle lever in the driver's compartment 59 and since such linkage is well known in the art it has been omitted to avoid confusion with the piping connecting the pulverizer with the burner.

For a consideration of the operation of the invention, attention is directed to Figs. 1 and 2 wherein it will be assumed that the locomotive is at rest and is unfired. The burner may be started in the manner of conventional finely divided fuel burners whereupon the water in the boiler pipes 88 will be heated to a temperature to be converted into steam. After a sufficient steam head has been obtained, the turbines 76 may be started to cause the automatic feeding of lump coal from the reservoir 53 to the pulverizer 71. Simultaneously, the turbines 126 and 136 may be started to cause the forced draft through the boiler and burner and to likewise sup-

ply heated air to the circular casing 106. The finely divided fuel will be discharged from the pulverizer 71 and will be blown into the burner pipe 140 by means of the blower 153 whereupon continuation of the burner will create sufficient steam head to operate the steam motors 30. The driver in the cab 69 may control the valve 96 to regulate the amount of steam pressure to the motors and thereby increase or decrease the speed as desired. The exhaust from the motors passes from the manifolds 121 to a steam exhaust pipe 172 so that a portion of the steam may be condensed within the well 163 which water condensate is returned to the header 84 by means of the pump 179. Since there will not be a 100 per cent return of the steam to water the remaining steam will find its way to the header 185 wherein it will be further condensed by flowing downwardly through the pipes 189 and 190 so that when it reaches the lower headers 191 it may be returned to a rear storage tank 154. Cooling of the condenser pipes 189 and 190 is accomplished by the air circulating fans 205 so that the main portion of the steam condensate will find its way back to the rear water chamber or compartment 154 and will likewise be returned to the boiler 84 by means of the pump 179.

As the water in the rear reservoir 154 is used, it may be replenished from a water reservoir 43 carried by the forward end of the locomotive so that the rear water chamber or reservoir may always be maintained full or at least to a height to cause an overflow to the pipe 164 in the lower portion of the steam well 163.

It is obvious that regulation of the pulverizers 71 and fuel feed screw 66 may control the temperature within the boiler by increasing or decreasing the amount of fuel consumption and the resultant heat therefrom.

It is obvious that various changes in the details of construction may be resorted to as well as details of control units and that the form of the invention herewith shown and described is to be taken as a preferred embodiment of the same and that various other changes may be made without departing from the spirit of the invention or the scope of the subjoined claims.

What is claimed is:

1. A combined locomotive and fuel tender, comprising a wheeled underframe, a boiler centrally of said frame having transversely disposed water tubes, a burner in the forward end of the boiler, a fuel reservoir spaced from and located forwardly of the boiler, means for feeding fuel directly to said burner including a screw conveyor, means interposed between the rear end of the screen conveyor and boiler and below the level of the conveyor for pulverizing the fuel before admission to the burner, top and side enclosure walls connecting the fuel reservoir and boiler, and a platform above the pulverizer extending between the boiler and fuel reservoir for providing a cab compartment space therebetween.

2. A combined streamlined locomotive, comprising a wheeled frame having a dropped bottom portion and a series of drive wheels centrally located with respect to the frame, a boiler having transversely disposed water tubes connecting longitudinal headers, a burner in the forward end of said boiler, said boiler being mounted above the drive wheels, a fuel reservoir carried by the front of the locomotive and spaced from the boiler to provide an intermediate cab space, means in the fuel reservoir for feeding the fuel rearwardly to the burner, a fuel pulverizer located in said dropped bottom portion forwardly of the boiler and rearwardly of and below said feeding means to pulverize the fuel prior to its entrance to the burner, a condenser located on the other end of the wheeled frame rearwardly of the boiler to return the steam condensate to the boiler, said condenser comprising tubular conduit members arranged in the air stream of said locomotive, and top, bottom and side enclosure walls for said cab space disposed above said pulverizer.

3. A combined locomotive and fuel tender, comprising a wheeled underframe, supporting and drive wheels for the underframe, an engine on the underframe, a boiler having longitudinally extending headers, said boiler being centrally located on the frame and having transversely extending water tubes connected to said longitudinally arranged headers, a burner in the forward end of the boiler directly presented to the water tubes, a fuel reservoir for feeding fuel to said burner in the front of the locomotive spaced from the boiler to provide a driver's compartment therebetween, a conveyor for feeding fuel from the reservoir to the burner, a fuel pulverizer positioned rearwardly of and below the fuel feeding conveyor and located beneath said driver's compartment, and a condenser mounted on the rear end of the combined locomotive and tender underframe adapted to condense and return the exhaust steam from the engine motor to the boiler, said condenser comprising a series of tubular members arranged along the walls of the locomotive and disposed in the air stream thereof.

AGNES GRAY,
Administratrix of the Estate of Edward Gray, Deceased.