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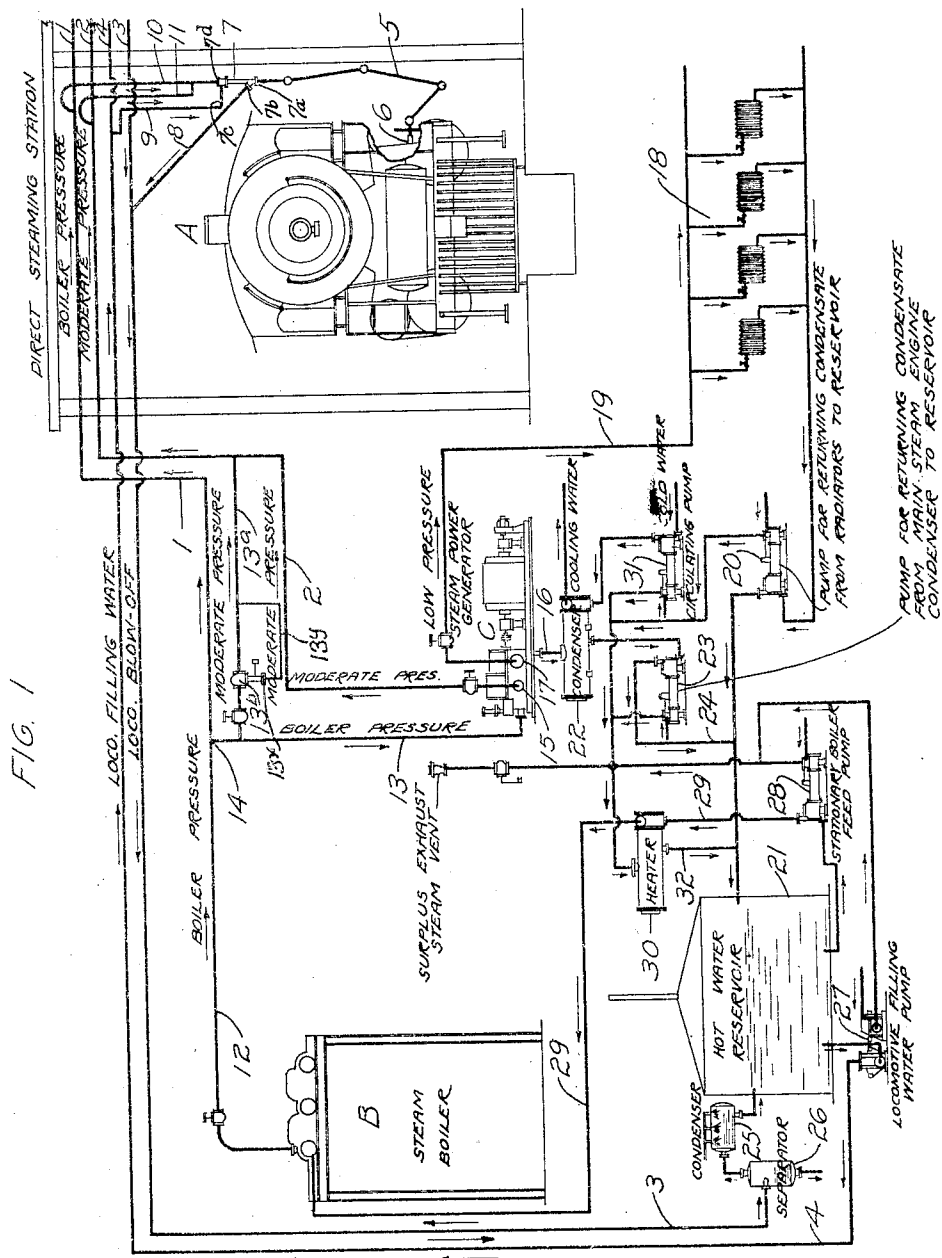
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1,896,765

RAILWAY TERMINAL OF THE DIRECT STEAMING TYPE

Filed Feb. 20, 1931

4 Sheets-Sheet 1



WITNESS

W.H. Jury

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RAILWAY TERMINAL OF THE DIRECT STEAMING TYPE

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4 Sheets-Sheet 2

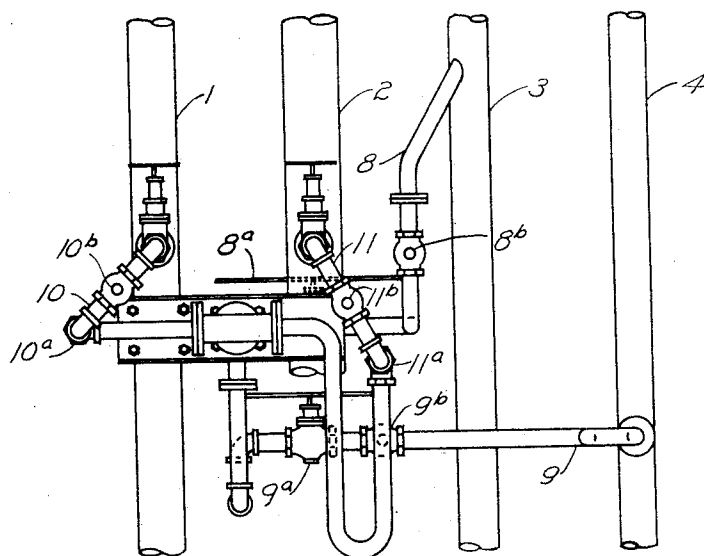


FIG. 3

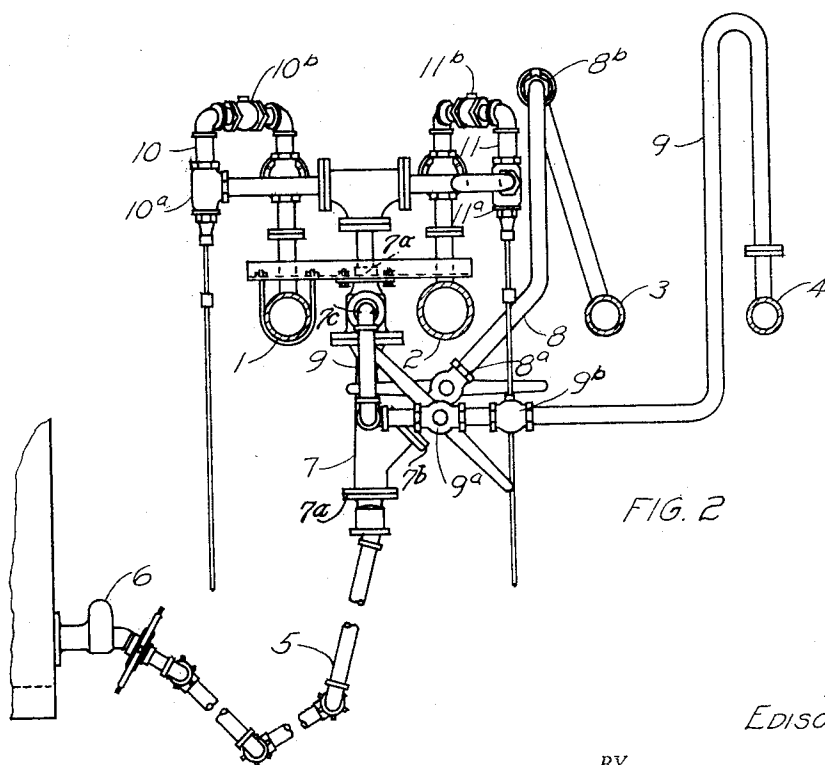


FIG. 2

WITNESS

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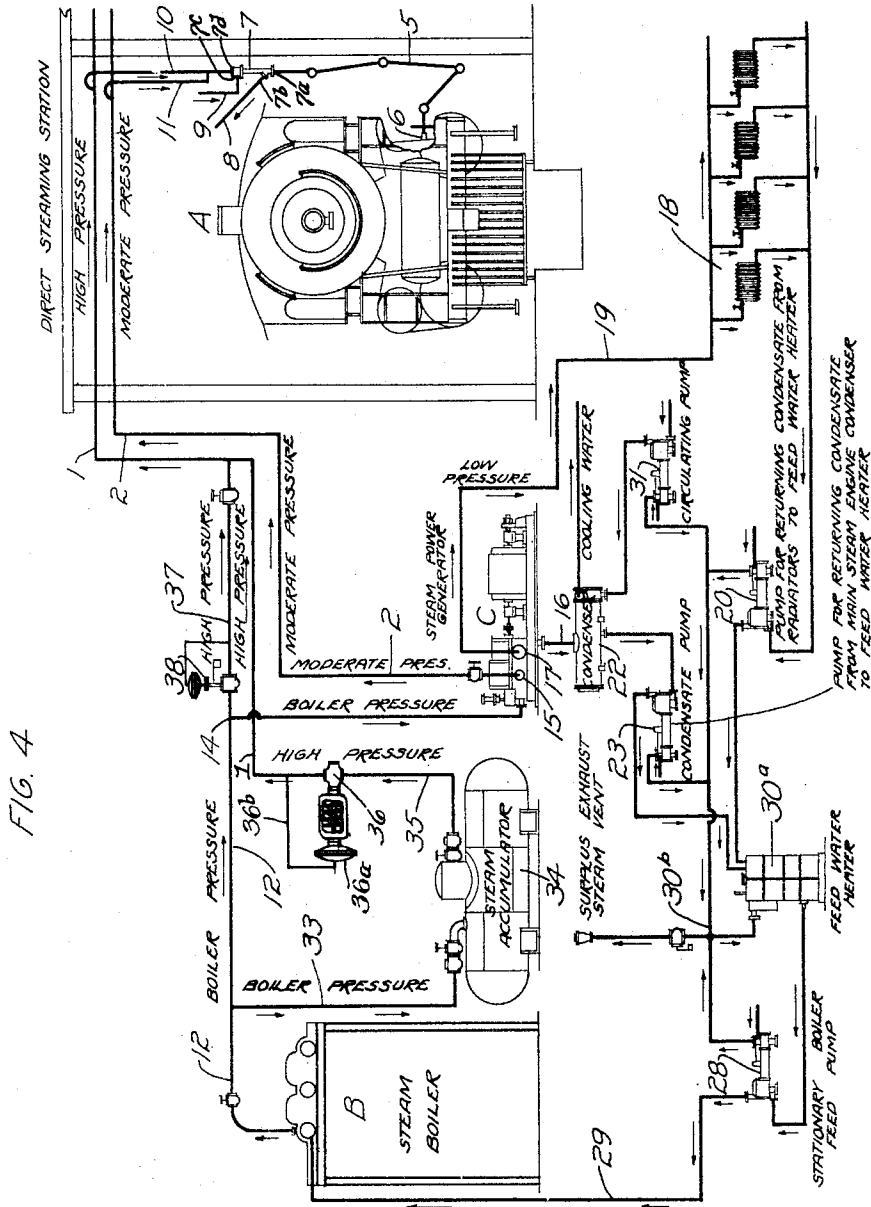
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RAILWAY TERMINAL OF THE DIRECT STEAMING TYPE

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4 Sheets-Sheet 3



WITNESS

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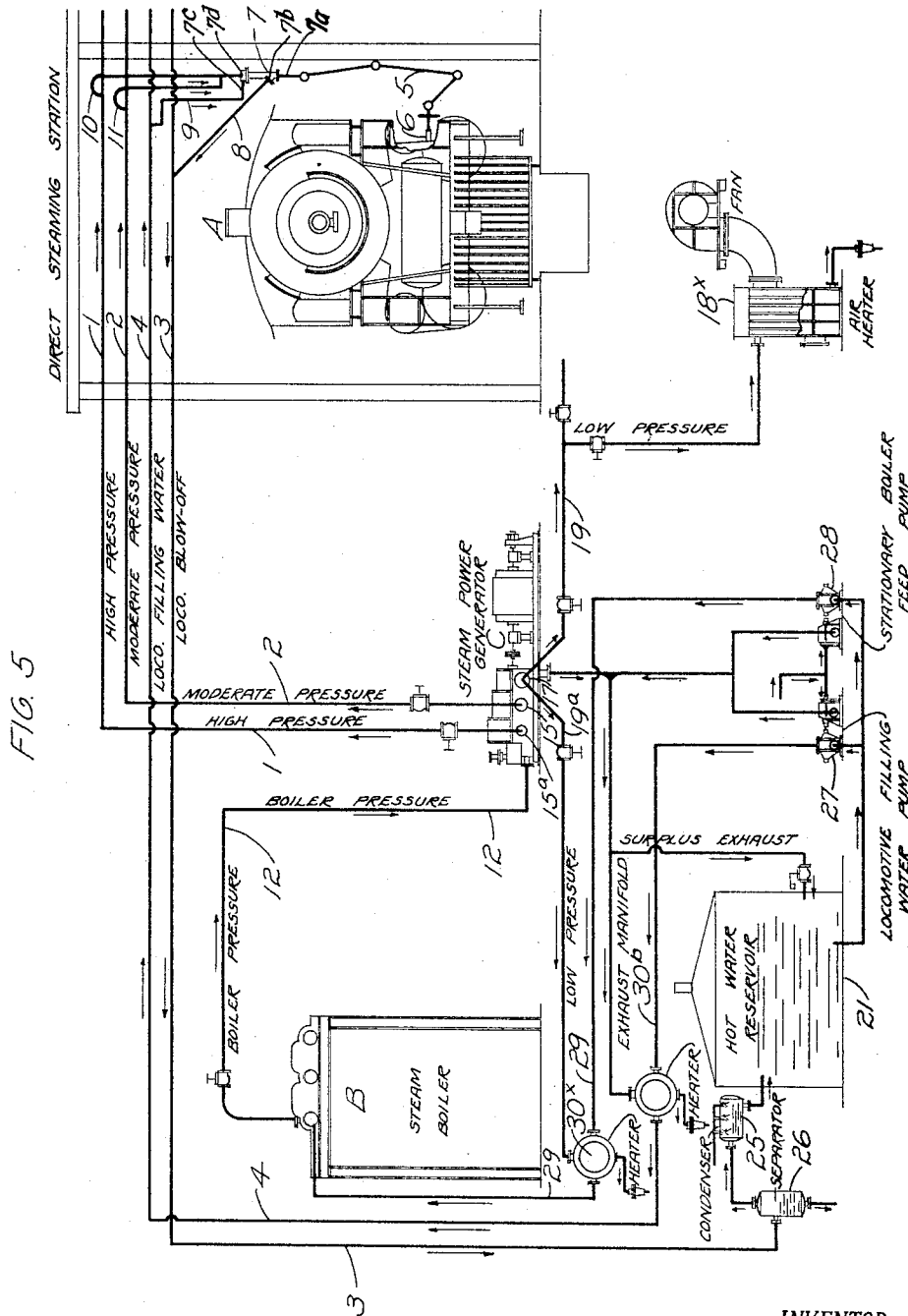
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RAILWAY TERMINAL OF THE DIRECT STEAMING TYPE

Filed Feb. 20, 1931

4 Sheets-Sheet 4



WITNESS

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UNITED STATES PATENT OFFICE

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RAILWAY TERMINAL OF THE DIRECT STEAMING TYPE

Application filed February 20, 1931. Serial No. 517,150.

This invention relates to railway locomotive terminals of the direct steaming type, and particularly locomotive terminals having station buildings and other facilities consuming power, for instance, electric current. A railway locomotive terminal that has come to be known in the art as a direct steaming terminal is one in which facilities are provided for storing locomotives during their layover period (usually segregated from the positions at which fires are discharged by arriving engines and fresh fires are ignited on departing engines, and therefore commonly called "fireless engine houses"), as well as facilities for bringing to such locomotives, from an extraneous local source, either steam alone for maintaining the locomotives in a steamed condition without the aid of fire on their grates while being held over, or both steam and hot water from such local source in the terminal in proportions appropriate for establishing, without the aid of fire on the locomotive grates, a steamed condition in locomotive boilers that have been emptied. For maintaining steam pressure on locomotives held in so-called fireless engine houses at direct steaming terminals, only a moderate steam pressure is required, but for reestablishing a steamed condition in these locomotives as quickly as possible after they have been emptied a high steam pressure is desired; and for making certain tests on the locomotives, such as setting the safety valves, it is essential to supply steam to the locomotives from the extraneous source at a pressure in excess of the locomotive working pressure. The high steam pressure should also be available at fireless engine houses for steaming the locomotives up to a suitable operating pressure at which they can be dispatched after being held at a moderate pressure during the long layover period. One object of holding locomotives at a moderate steam pressure during such long layover period is to reduce the radiation losses that increase proportionally with the pressure at which the locomotive is held under steam. Continuous supply of high pressure steam to locomotives being held under steam during their layover period would be disadvantageous for the reasons, among others, that the safety valves on these engines would be opened too frequently, and the amount of steam condensation that would accumulate in the locomotive boilers would be excessive.

The usual practice in direct steaming terminals is to furnish steam at high pressure in a single steam main to the engine house and provide a small by-pass around the principal steam operating valve through which steam may flow from the high pressure supply line to each locomotive. When it is desired to hold a locomotive under steam for any length of time in the engine house, the valve in this by-pass is opened while the main steam operating valve is left closed, the effect being to admit enough steam to the locomotive boiler to maintain only a moderate steam pressure therein. This process is technically known as "floating" locomotives and is described and claimed both as to the method and the equipment for practicing the method in U. S. Patent No. 1,788,064 issued to George E. Murray under date of January 6, 1931.

The present invention does away with the use of the above-described by-pass floating arrangement for maintaining moderate steam pressure in locomotives during their holdover period, and in place of the single main serving a number of stations and having the by-pass arrangement at each station, substitutes two steam mains carrying differential pressures to all the stations served, and having at each station separately controlled connections through which they may supply to a locomotive at said station, high pressure or moderate pressure as required. The lower pressure carried in one of these mains is approximately that at which it is found most advantageous to hold locomotives during their layover period. The valve and connections from the moderate pressure steam main to the locomotive may be such as will allow an equalization of the pressure in the locomotive with that in said main, or may be throttled sufficiently to cause a lag in such equalization of pressure when found desirable. The higher pressure carried in the other steam main is sufficient for raising the

locomotive pressure to a suitable degree for dispatching the locomotive from the terminal or making certain tests on the locomotive requiring a pressure at or approximately
 5 equal to the full working pressure of the locomotive; and the connections from this steam main to the locomotive, together with the operating valve, are so proportioned that a rapid transfer of high pressure steam to
 10 the locomotive can be effected in steaming up the locomotive boiler from an empty condition or boosting the steam pressure in the boiler after the locomotive has been maintained at a moderate pressure during the
 15 layover period.

In combination with the delivery of steam to the locomotive engine house at two differential pressures for direct steaming purposes as above described, my invention includes a
 20 steam-driven engine, preferably of the turbine type, receiving steam at the higher of these differential pressures and exhausting steam at the lower of said differential pressures, this exhaust steam being conducted to
 25 the engine house through the lower differential pressure main and utilized for such phases of the direct steaming method as can be accomplished with this lower differential pressure. To facilitate the practical operation
 30 of this invention, in the practice of which a fluctuating load may occur in the use of the lower pressure steam, I prefer to employ a steam turbine of the so-called "bleeder" type, which is adapted to deliver its full
 35 load capacity when receiving steam at the higher differential and exhausting practically all of this steam at the lower differential pressure, but is also equipped for expanding steam from the higher differential pressure
 40 down to approximately atmospheric pressure or, if desired, a vacuum, and is so designed that the quantity of steam exhausted at the intermediate pressure may fluctuate from a maximum, approximating the total weight
 45 of steam delivered to the turbine, down to zero, at which stage all of the steam delivered to the turbine is expanded to approximately atmospheric pressure. Such fluctuations in the quantity of steam exhausted at the intermediate
 50 stage for delivery to the engine-house in the lower differential pressure line do not affect the capacity of this type of turbine for power generation as usually transmitted to an electric generator. Steam admitted
 55 to the turbine at the initial high pressure and expanded to the intermediate stage, from which it is exhausted at a pressure suitable for moderate pressure requirements of direct steaming in the engine house, is
 60 affected in virtually the same way as would result from its being run through a pressure reducing valve to obtain the lower pressure but in this instance it has performed useful
 65 work in being thus expanded to a lower pressure, so that in reality that portion of the

electric current produced or other work performed by the expansion of this steam in the turbine between the high and intermediate stages is obtained with very little steam in addition to the amount of steam that would
 70 otherwise have to be produced for such phases of direct steaming as can be accomplished with steam at a relatively low pressure.

The practice of generating electric current or performing other useful work by expanding steam from a high initial pressure to a moderate pressure at which it is required for various processes, has long been
 75 practiced where, as in paper mills, etc. there is a continual demand for this low pressure process steam as well as for generating electric current. Also, this procedure has been often employed for generating electric current and utilizing exhaust steam from the
 80 engine generator for heating purposes, but at locomotive terminals there has been no constant demand for moderate or low pressure steam except for heating purposes, and as this is a periodic requirement which at
 85 some terminals applies for only a few months out of the year, the opportunity for economy in generating electric current in connection with the use of low pressure steam is limited. But with differential steam pressure mains
 90 throughout the engine house having separate direct steaming connections to each locomotive as proposed in my invention, I am able to obtain a substantial moderate pressure steam load throughout the entire year at
 95 locomotive terminals of the direct steaming type and employ this load in conjunction with a steam engine or turbine receiving steam at a high pressure at least equal to that supplied to the higher pressure main
 100 in the engine house and exhausting all or a portion of this steam in sufficient quantities to supply all of the direct steaming functions that can be accomplished at a moderate pressure.

If a single steam main is used in fireless
 110 locomotive terminals with a sufficiently high pressure to bring an emptied locomotive boiler to steamed condition or to develop the high pressure with which it is desired to dispatch a locomotive for duty, and this
 115 single main is made to supply steam through a by-pass at a rate appropriate to "floating" locomotives or keeping them steamed to a moderate pressure while they are held over, the hold over pressure on a relatively large locomotive, or one subject to high radiation
 120 losses, will drop until the difference between the locomotive pressure and the pressure in the steam supply main induces a steam flow of sufficient heat content to compensate for the heat losses through such radiation. Conversely, the pressure on a smaller locomotive connected to the steam supply main through
 125 a by-pass of the same size builds up as the pressure difference between the locomotive
 130

and the steam supply main diminishes, and steam flow through the by-pass is retarded until the heat content from steam thus admitted to the locomotive is equal to the lower radiation loss on the smaller locomotive. It has been found in practice that large and small locomotives held under steam at direct steaming stations by means of this by-pass floating arrangement now in use, may range in pressures maintained from 75 to 150 pounds, dependent upon the size and radiation tendency of the locomotive. This is due to the fact that when steam is supplied from one and the same high pressure main, through identical by-passes, to the drop connections leading to large and small locomotives alike, heat loss and consequent pressure drop is not so fully restored in larger locomotives having greater heat dissipating surfaces, as in smaller locomotives with lesser heat dissipating surfaces.

The primary object of the present invention is to provide means whereby large and small locomotives may be maintained alike at a desired pressure while being held over at direct steaming stations, without fires on their grates; and the invention proceeds upon the principle of using for this purpose a moderate pressure steam supply main that is separate and distinct from the high pressure steam supply, so that all locomotives so held may take steam until a pressure equal to or bearing a predetermined relation to the moderate pressure steam main is attained in the locomotive boiler, regardless of its size and radiation losses.

A collateral object is to provide a system whereby the principle of dual supply pipes furnishing, respectively, high pressure steam and moderate pressure steam to direct steaming stations in a railway terminal may be realized in a rational and economical manner. Except where stationary boilers of two different pressure capacities are already available, it would not economically be desirable from the standpoint of stationary power plant engineering and operation to build a stationary power plant with the intention of operating the boilers therein at different pressures, in order to supply to direct steaming stations one pressure for steaming up locomotives to their full working pressure, and another pressure suitable for holding locomotives without fires during their lay-over period; and this is true even though the phases of the direct steaming method which can be performed at the moderate pressure may normally equal one-half or even a larger proportion of the total steam required for direct steaming purposes in a fireless engine house. Hence, where the system is originally constructed on the dual steam supply plan, the use of a single steam source with pressure at least equal to that required for the high pressure steam main is a desideratum, and this in

turn imposes the requirement of some practicable means for stepping down the steam pressure to that appropriate for the moderate pressure supply main.

One means for obtaining two differential pressures in two different supply mains, without operating stationary boilers at two different pressures, would be to draw off a portion of the steam from a single high pressure steam source and deliver the same to the moderate pressure supply main through a pressure reducing valve. But this method is open to serious objection where the volume of steam delivered, the duration of delivery and the variations in steam flow are large as in the moderate pressure steam main used for hold over purposes in direct steaming stations, for the reason that the pressure reducing valves may fail to function properly, particularly if not carefully maintained; also that they have a limited range of capacity for the quantity of steam delivered from the high pressure source to the moderate pressure main. If these valves are made large enough to deliver the maximum quantity of steam that may be required for supplying the moderate pressure main, and this requirement should drop to a minimum below the capacity of the reducing valve, the effect will be to damage this valve by cutting out its seating surfaces.

Accordingly, in realizing the purposes of the present invention, the system contemplates the use of a single high pressure boiler source from which steam is drawn for both high pressure and moderate pressure mains, and a steam actuated engine is interposed between this single source and the moderate pressure main and adapted to utilize steam from the single source in the generation of power by expansion of such steam, and deliver the expanded steam at a residual pressure adequate for the purposes served by the moderate pressure main. One type of steam engine appropriate for such service is the turbine of the so-called "bleeder" type, which not only avoids the disadvantages of the aforesaid reducing valve method of stepping down steam pressures, but enhances the economic value of the system and, by its generation of power, compensates for the cost of the dual system of steam mains as compared with the single steam main system.

In the accompanying drawings, in which several embodiments of the invention are shown by way of illustration—

Figure 1 is a schematic representation of one embodiment of the invention, including one locomotive direct steaming station, of which there may be any desired number.

Figure 2 is an elevational view of the connections and controls employed at a direct steaming station whereby selective communication with the dual system of steam mains, in addition to the connections normal-

ly made at such a station, may be effected at will.

Figure 3 is a plan view of parts shown in Figure 2.

Figure 4 is a view similar to Figure 1 showing a modified embodiment of the invention, according to which, the steam generating source may be operated at a pressure in excess of that required in the high pressure steam supply main to direct steaming stations, as when such higher pressure is desired for more economical operation of the steam power generator; pressure control mechanism such as a reducing valve and an accumulator being added to automatically reduce the pressure of steam supplied to the high pressure direct steaming supply main from the source pressure to that pressure desired in said high pressure main, in addition to a steam power generator, as in Figure 1, employed for stepping down the source pressure of steam to that appropriate for the moderate pressure direct steaming supply main; and

Figure 5 is a similar view showing still another modified embodiment of the invention, in which the steam generating source is operated at a pressure in excess of that required in either of the dual steam supply mains to direct steaming stations, steam from said source being expanded down to two different stages in the steam power generator, from one of which stages steam is released to the higher pressure supply main at an appropriate pressure therefor, and from the other of said stages steam is released to the moderate pressure supply main at the desired moderate pressure to be maintained therein.

A represents a direct steaming station typical of any number of stations that may be required in a fireless engine house or elsewhere, and which require the furnishing of steam at both high and moderate pressures for their operation; such stations including a high pressure steam pipe main 1, a moderate pressure steam pipe main 2, and other equipment as may be desirable, such, for instance, as a locomotive blowoff pipe main 3 and a filling water pipe main 4. This station is also provided with a flexible connection 5, usually referred to as the "steaming drop," adapted for convenient attachment to the locomotive boiler, for instance, at its blowoff cock 6, and for selective communication with any of the pipes 1, 2, 3 and 4, through a booster fitting 7 of ordinary construction having a bottom outlet 7a leading through pipe 5 to the locomotive blowoff cock 6; a lateral outlet 7b communicating through branch 8 with the blowoff pipe 3; a side inlet 7c from the filling water main 4; and a single top inlet 7d communicating with both of the steam mains 1 and 2, through which inlets steam and hot water can be ad-

mitted and delivered to an empty locomotive boiler in the requisite proportions for establishing a steamed condition therein; 8 being the connection through which the booster fitting 7 communicates with the blowoff pipe 3; 9 the connection through which it receives refilling water from pipe 4; 10 the connection leading from the high pressure main 1; and 11 the connection leading from the boiler pressure main 2. These connections may be better observed upon reference to Figures 2 and 3, where they will be found identified by the numerals above given and associated with other features now conventional in direct steaming station equipment, such, for instance, as valve 8a controlling the blowoff connection 8; valve 9a controlling the filling water connection 9; check valve 8b preventing back flow from the blowoff main 3 to the booster fitting 7; and check valve 9b preventing flow from the booster fitting 7 back through connection 9 to the filling water main 4.

In addition to the equipment thus far described at direct steaming stations, the present invention contemplates the use of an operating valve 10a in the connection 10 which leads from the high pressure steam main 1; an operating valve 11a in the connection 11 leading from the moderate pressure steam main 2; and two check valves 10b and 11b, respectively, in said connections 10 and 11, each designed to prevent back flow of steam from booster fitting 7 to the supply main, or interflow from one steam main to the other steam main.

B represents a generating source of high pressure steam, for instance, a conventional steam boiler from which steam at or near boiler pressure may be withdrawn through a pipe header 12. In the layout illustrated in Figure 1, high pressure steam supply main 1 forms a continuation of boiler header 12 and delivers to the direct steaming station A steam received from the boiler substantially at boiler pressure, inasmuch as this particular embodiment contemplates operating the boiler at the highest steam pressure required for direct steaming purposes. Moderate pressure steam supply main 2 receives steam drawn off from a steam power generator C, which is furnished with steam at substantially the operating pressure of boiler B, through a pipe 13 branching from header 12 at 14; steam power generator C being in the nature of a steam turbine having a draw-off outlet 15 through which it delivers to the moderate pressure steam supply main 2 at an expansion stage in the turbine which renders the drawn off steam appropriate in pressure for maintaining locomotives in a steamed condition at direct steaming stations supplied by the moderate pressure steam main 2. If at any time the demand for moderate pressure steam supplied to direct

steaming stations through main 2 exceeds that which is obtained through draw-off outlet 15, said moderate pressure main 2 may also receive steam through a cross-over pipe 13a leading from the source pressure steam supply pipe 13, a valve 13b of the type commonly designated as "pressure reducing", wherein the degree of opening is governed by a diaphragm 13x acted upon through pipe 13y by the pressure in the pipe 13a, to the effect that as the pressure in 13a drops below a predetermined degree, the pressure upon the diaphragm 13x is correspondingly lowered and the opening of valve 13b thereby enlarged by the counteracting force of a weight or spring until the additional steam flow through said valve is sufficient to restore the pressure in the pipe 13a to said predetermined degree. Conversely, if the pressure in pipe 13a rises above the desired degree, the effect upon the diaphragm 13x is to throttle the steam flow through said valve until the pressure in pipe 13a has been restored to its desired degree. Steam not drawn off at 15 continues through the turbine either to final exhaust 16 or to such additional draw-off connections as typified by 17, whence steam may be released at appropriate pressures for other uses, for instance, supplying the battery of heating radiators 18 through pipe 19, and which additional draw-off connections may be in addition to the conventional final exhaust 16 usually found in such turbines. By the means thus far described, the direct steaming station A is provided with steam at two different pressures appropriate the one to its high pressure requirements and the other to its moderate pressure requirements through a dual system of pipe mains which are independent one of the other, with the advantages already herein described.

The steam power generator C lends itself with peculiar advantage for the service of direct steaming stations as herein described, for the additional reason that it may deliver steam at reduced pressures through additional draw-off connections, typified by 17, to radiators such as 18, from which the residual heat units derived from such steam in the form of condensate may be returned by pump 20 from said radiators to a hot water reservoir 21; while steam finally exhausted from the power generator C through connection 16, after condensation in condenser 22, may have its residual heat delivered in the form of condensate by pump 23 through connection 24 to the said reservoir, thus augmenting the supply of hot water received by said reservoir from the condenser 25 and separator 26, representing facilities of a conventional type for obtaining hot water by means of steam heat content in locomotive boiler blowoffs received from direct steaming stations through the blowoff main 3.

Hot water reservoir 21 in such a system may be used as a source of hot water for filling locomotive boilers at station A, through pipe 4 by means of pump 27 and also as a source of hot water for feeding boiler B by means of pump 28 and pipe 29; the heat of the water supplied through the last-named delivery being, if desired, augmented by interposing in said pipe 29, feed water heater 30 deriving its heat from exhaust of steam actuated auxiliaries such as pumps 20, 23, 28 and other pumps, as 31, used for forcing cooling water through condenser 22. Condensate from said boiler feed water heater through pipe 32, and from other sources if available, may advantageously be delivered to the hot water reservoir 21.

According to Figure 4, the dual pressure steam supply mains 1 and 2, to be connected with the locomotive through parts substantially the same as described in and bearing reference characters similar to Figure 1, are here supplied from a steam boiler B which is operated at a pressure materially higher than the highest pressure desired for direct steaming purposes at station A, necessitating both a reduction in the pressure of steam from the boiler source to the high pressure supply main 1, and a further reduction from source pressure in the steam delivered to the moderate pressure supply main 2. To this end, boiler header 12 delivers steam at source pressure and at a relatively uniform rate through pipe 33 to a steam heat accumulator 34, from which accumulator steam can be drawn off through pipe 35 and supplied to the high pressure steam supply main 1, at either a uniform or relatively fluctuating rate in sufficient amount, governed by a control valve 36 of known type, having diaphragm 36a subjected to the pressure of steam in pipe 1 through branch pipe 36b which functions in the usual way, to maintain the pressure desired for direct steaming at station A.

The cross connection 37 shown in Figure 4 is adapted to supply steam direct from the boiler source to the high pressure steam supply main 1 through a pressure reducing valve 38 which functions in the usual way to govern the amount of steam flowing through the connection 37, so that the highest steam pressure desired for direct steaming at station A will be maintained in main 1; this connection being useful as an alternative source of steam supply to the high pressure main or as a supplement to the accumulator for either continuous or emergency use, in which case the valve 38 automatically functions to feed steam from source B direct to main 1 as required to maintain the desired high pressure in said main whenever the amount of steam received from the accumulator is deficient for this purpose. As in Figure 1, steam for the moderate pressure supply main 2 in Figure 4 is supplied at the desired pressure to main 2

from the draw-off outlet 15 in the power generator C.

The elements illustrated in Figure 4 and not included in the foregoing description may be understood by applying the description of parts similarly numbered in Figure 1. In Figure 4, however, the feed water supplied to boiler B through pipe 29 is heated to an economical degree in a feed water heater 30 supplied with condensate from various sources, such as the heating elements 18 and condenser 22 and receiving the exhaust steam of pumps 20, 23, 29, 31 and such other steam actuated auxiliaries as desired through the exhaust header 30b.

According to Figure 5, the steam generating boiler B is operated at a pressure in excess of the highest pressure desired for direct steaming purposes, and the steam power generator C is utilized for stepping down the pressure of steam from the boiler source by successive stages of expansion to both the higher and lower pressures desired for direct steaming purposes, steam at a lower pressure desired for supplying the moderate pressure main 2 being drawn off from the power generator through outlet 15, while steam at the highest pressure desired for direct steaming is drawn off from the power generator through a prior stage outlet 15a, and thence supplied independently to the high pressure main 1. That is to say, the steam power generator C which receives its steam at relatively high boiler pressure, delivers steam after one stage of expansion, to high pressure main 1, and, after a succeeding stage of expansion to moderate pressure main 2; the steam being taken off at these two stages through the draw-off outlets 15a and 15.

In Figure 5 the parts not specifically mentioned may be identified by applying the description of similarly numbered parts in Figure 1. A feature shown in Figure 5 in addition to those shown in either of the Figures 1 or 4, is the provision of pipe 19a leading from the low pressure draw-off outlet 17 in the steam power generator C to a water heater 30x, which is in addition to the pipe 19 leading from the draw-off outlet 17 to an air heater 18x typifying a means for the seasonal use of low pressure steam so that the expanded steam issuing at 17 may either be used for air heating and other seasonal requirements, or may have its residual heat content transmitted in heater 30x to feed water flowing through pipe 29 to boiler B.

I claim:

1. In a railway terminal, a locomotive direct steaming station, a steam generating source supplying steam at a pressure at least equal to the maximum pressure required for direct steaming of locomotives, two steam supply pipes leading independently to said station and each adapted to deliver steam of

said source to a locomotive thereat, and a steam actuated engine interposed between said source and said station, producing power by the expansion of steam on its way to said station, and releasing steam to one of said supply pipes at a pressure which is lower than that of the steam received by the other of said pipes, whereby two distinct supplies of steam are made available to the locomotive at constant pressures, respectively, appropriate to two different phases of direct steaming practice.

2. A railway terminal as described in claim 1, in which only a portion of the steam expanded in the interposed engine is made available to the locomotive.

3. In a railway terminal, a locomotive direct steaming station, a steam generating source supplying steam at a pressure at least equal to the maximum pressure required for direct steaming of locomotives, two steam supply pipes leading independently to said station, each adapted to deliver steam of said source to a locomotive thereat, and a steam actuated engine interposed between said source and said station, producing power by the expansion of steam on its way to said station and releasing steam to both of said supply pipes, to one at a higher and to the other at a lower pressure, whereby two distinct supplies of steam are made available to the locomotive at constant pressures, respectively, appropriate to two different phases of direct steaming practice.

4. A railway terminal as described in claim 3, in which only a portion of the steam expanded in the interposed engine and delivered to the two supplies of steam is made available to the locomotive.

5. In a railway terminal, a locomotive direct steaming station, two steam supply pipes at said station, means for delivering steam from one or the other of said supply pipes at will to a locomotive at said station, a steam generator at said terminal, a multi-stage steam turbine receiving steam through a supply pipe from said generator, a steam exhaust pipe taking off from an intermediate expansion stage of said turbine, a by-pass from said steam turbine supply pipe into the intermediate stage exhaust pipe, a valve in said by-pass adapted to function in response to the steam pressure in said exhaust pipe so as to open when the steam therein drops below a predetermined pressure or close when this predetermined pressure is exceeded, a communicating steam main leading from both said exhaust pipe and said by-pass to one of said steam supply pipes at the direct steaming station, and another communicating steam main leading from said steam generator to the other of said steam supply pipes at the direct steaming station.

6. In a railway terminal, a direct steaming

station, two steam supply pipes at said station, an outlet branch from each of said pipes communicating through a single pipe connection with a locomotive at said station, an
5 operating valve in each of said branches for admitting steam from one or the other of said supply pipes to the locomotive, at will, a check valve in each branch preventing back-flow into either one of said supply pipes from
10 the other or from the locomotive, a steam generator at said terminal, a multi-stage steam turbine receiving steam through a supply pipe from said generator, a steam exhaust pipe taking off from an intermediate expansion stage of said turbine, a by-pass from
15 the steam turbine supply pipe into the intermediate stage exhaust pipe, a valve in said by-pass adapted to function in response to steam pressure in said exhaust pipe so as to
20 open when the steam therein drops below a predetermined pressure or close when this predetermined pressure is exceeded, a communicating steam main leading from both said exhaust pipe and said by-pass to one of
25 said steam supply pipes at the direct steaming station, and another communicating steam main leading from said steam generator to the other of said steam supply pipes at the direct steaming station.

30 Signed at Cincinnati, Ohio, this 16th day of February, 1931.

EDISON BROCK.

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