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G. D. POGUE

OIL PIPE LINE SYSTEM

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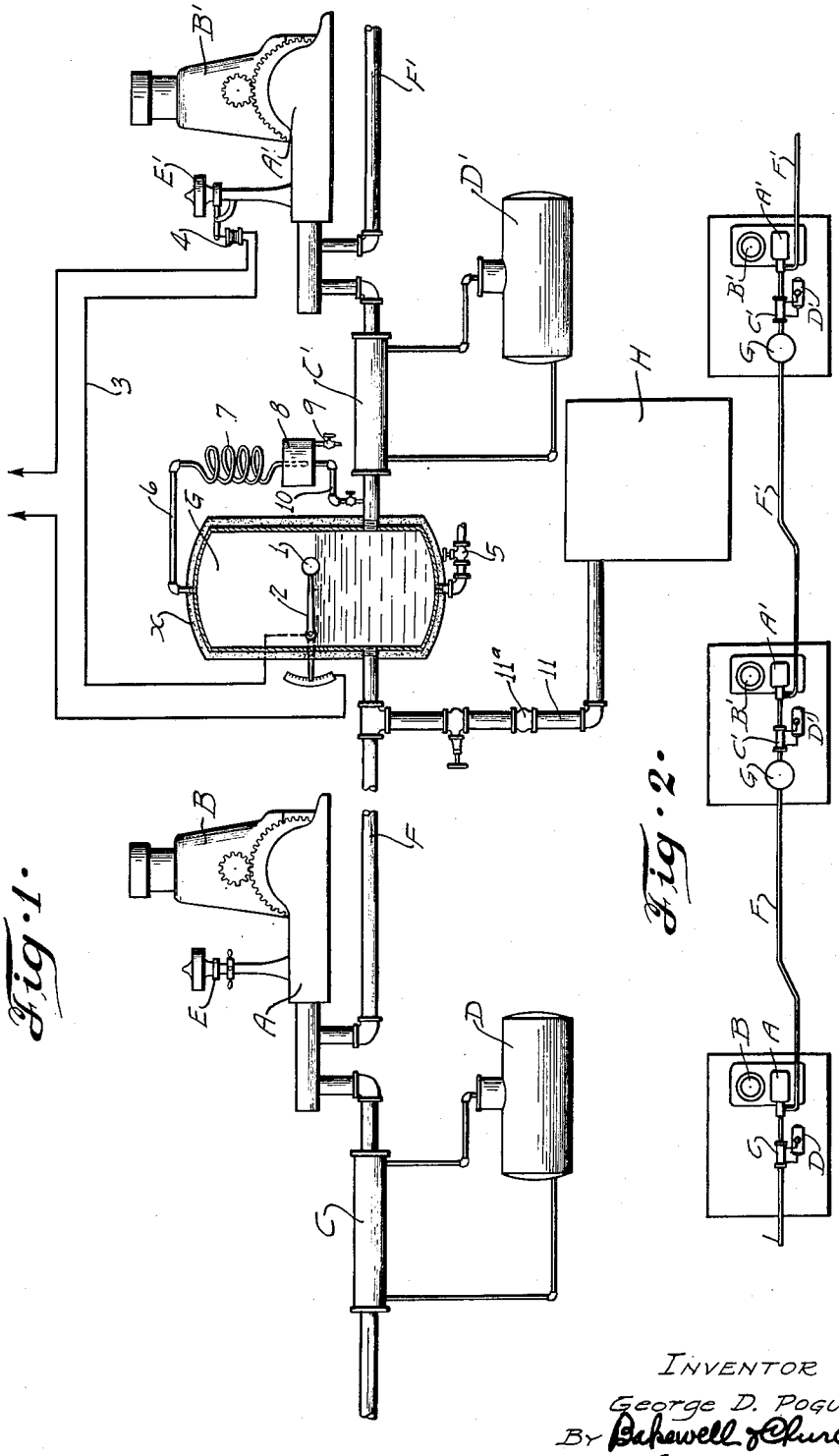


Fig. 1.

Fig. 2.

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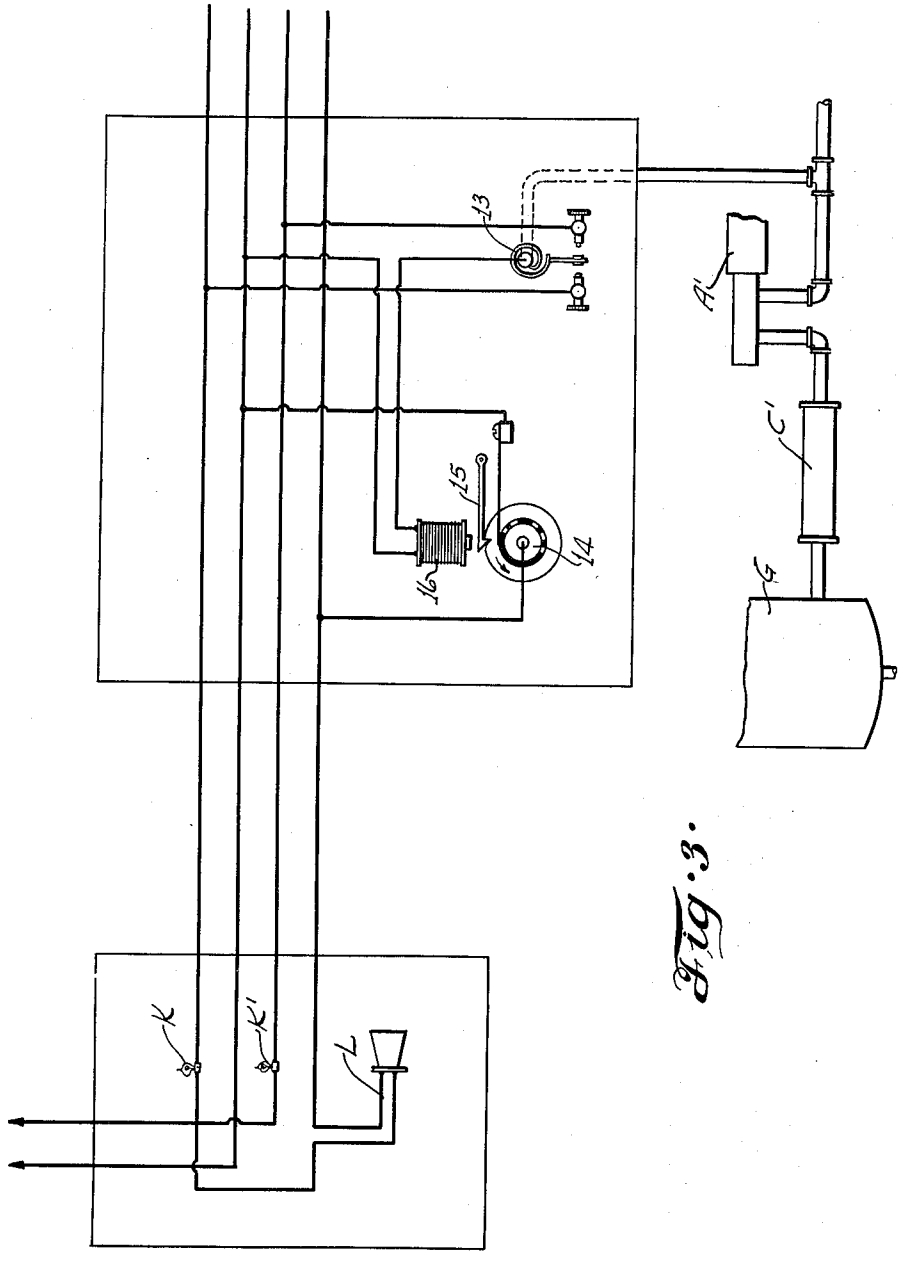


Fig. 3.

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UNITED STATES PATENT OFFICE.

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OIL-PIPE-LINE SYSTEM.

Application filed January 20, 1923. Serial No. 613,912.

This invention relates to oil pipe line systems that are used for transporting petroleum crude oil considerable distances, for example, from an oil field or point where crude oil is produced or gathered to an oil refinery, possibly hundreds of miles distant.

The conventional oil pipe line system is composed of a receiving station located at the point where the oil is produced or gathered, a number of intermediate stations arranged in tandem relation between the receiving station and the terminus of the line and usually located about forty to fifty miles apart, underground pipe lines for connecting the various stations together, a pumping apparatus located at each of the stations for forcing the oil through the line leading to the next succeeding station of the system and one or more storage tanks each of about 50,000 barrels capacity located at each of the intermediate stations. In operating the system the oil is forced from the receiving station or station No. 1 through the pipe line that leads from the pumping apparatus of station No. 1 and is discharged into one of the storage tanks of station No. 2. Thereafter the oil is drawn out of said storage tank by the pumping apparatus of station No. 2 and is forced by said pumping apparatus through the line that leads to the storage tanks of station No. 3. It will thus be seen that the complete system is composed of a number of separate and distinct sections or units, each of which comprises a pumping apparatus located at one station, a pipe line leading from said pumping apparatus, and a storage tank located at the next succeeding station of the system for receiving oil from said line. As it is the usual practice to provide each of the intermediate stations with storage capacity at least equal to the cubic contents of the line leading from the preceding station of the system so as to permit the oil in the line to be drawn by a suction pump into the storage means from either end of the pipe line connecting two adjacent stations in case the line breaks, it is not necessary to have a fixed relationship between the rate of pumpage of the various stations and in practice no attempt is made to actually unify the rate of delivery of the pumping apparatus at the various stations of the system. In the absence of absolute unification in the rate of pumpage of the various stations it is obviously necessary to determine the levels of the storage tanks at the various stations at frequent intervals. In actual practice these tanks are gauged hourly day and night to determine the approximate quantity of oil they contain, and this information is then transmitted by telegraph to a despatcher, who, in turn, issues instructions from time to time to the operators in charge of the various pumping stations of the system to increase or decrease deliveries, as the case may be.

As most of the crude oil that is handled through long distance pipe lines is quite volatile, the evaporation loss in the conventional pipe line system is very high, as some of the volatile constituents of the oil escape at each of the receiving stations while the oil is standing in the storage tanks, and while it is being pumped into said tanks, it being practically impossible to construct a large sized storage tank in such a way as to prevent the oil in same from evaporating and also permit oil to be pumped into the tank and also withdrawn from same without liability of the volatile constituents of the oil escaping. With certain kinds of crude oil and in certain localities it is necessary to heat the oil during the winter months before it can be forced through the line connecting two stations, and when the system comprises a large number of stations, the cost of fuel for heating the oil adds considerably to the cost of operating the system, as it is necessary to heat the oil at each station to a temperature high enough to compensate for the loss of heat through the wall of the pipe line into the surrounding soil in which it is buried while the oil is being pumped from one station to another, the usual heat loss under normal rate of flow amounting to about 2° F. per mile of pipe line.

In addition to the evaporation loss and the heat loss above referred to, the conventional oil pipe line system makes it necessary for the company operating the system to have a continuous investment of from $50,000.00 to $100,000.00 at each intermediate station in oil that is used principally as a source of supply for the pumping apparatus which is used to force the oil to the next succeeding station of the system. Moreover, some States have ruled that oil in temporary storage at the intermediate stations of an oil pipe line system is not in transit, but is subject to local and State taxes, the same as oil that is in permanent storage.

One object of my invention is to provide

an oil pipe line system which eliminates the high evaporation loss of the conventional pipe line system.

Another object is to provide an oil pipe line system that can be operated in cold weather, when heating of the oil is required, at a materially lower cost than the conventional pipe line system.

Another object is to provide an oil pipe line system that overcomes the necessity of gauging storage tanks at the intermediate stations every hour and telegraphing information to a despatcher at a central point, who then sends instructions to the operators in charge of the pumping apparatus at the various stations.

And still another object is to provide an oil pipe line system that overcomes the necessity of keeping a large supply of oil at each of the intermediate stations of the system. Other objects and desirable features of my invention will be hereinafter pointed out.

To this end I have devised an oil pipe line system which is distinguished from the conventional system composed of a number of separate and distinct sections or units which are operated independently of each other, principally by the fact that it comprises a practically continuous conduit or practically closed oil circulating passage extending from the receiving station to the delivery terminus of the system, through which the oil travels practically continuously, under normal operating conditions, in such a way that it is not subjected to conditions at the intermediate stations which result in loss of the volatile constituents of the oil or cause the temperature of the oil to be materially reduced when heating of the oil is required in cold weather.

The complete system is composed of a receiving station and a plurality of intermediate stations arranged in series or tandem relation between the receiving station and the delivery terminus of the system and connected together by underground pipe lines, and a pumping apparatus at each of said stations. Instead of manually adjusting the speed control of the pumping apparatus at the intermediate stations, as is now the practice, I provide means for automatically controlling the speed or rate of pumpage of said pumping apparatus, so as to increase or decrease the rate of discharge from the pumping apparatus of a particular station, according to the quantity of oil that is being supplied to said station from the preceding station of the system. Various means can be used for automatically controlling the rate of delivery of the pumping apparatus of the various stations, but in most instances each of the intermediate stations will be equipped with an expansion tank or container arranged between the inlet of the pump of that station and the pipe line leading from the preceding station of the system, and a means associated with said expansion tank or container for automatically effecting a change in the condition of the pumping apparatus of that station when the level of the oil in said expansion tank or the pressure in said tank varies within certain limits. In my improved system the quantity of oil withdrawn from the expansion tank at each intermediate station is, by automatic means, maintained at substantially the same quantity as that entering the expansion tank. The oil in the expansion tank is allowed to remain only a sufficient length of time to cause the mill scale, sand, and other impurities to settle out and also allow for the separation of the entrained gases. Accordingly, said expansion tanks, in addition to providing some flexibility to the system, permit the mill scale and particles of foreign matter to settle out of the oil, and they also permit the gaseous products in the crude petroleum to separate from the oil upon entering the expansion tank. In order that these gaseous products may be utilized or recovered, I equip each expansion tank with a condensing or absorption apparatus.

In order to prevent damage to the system, in the event the pumping apparatus at a particular station should become inoperative, and in order that the pipe lines between the respective stations may be drained, I equip each intermediate station with one or more emergency storage tanks similar to those now used, into which oil can be discharged from the line leading from the pumping apparatus of the preceding station, the passage of the oil from said line to said storage tank being preferably governed by a valve that will open automatically under certain conditions, such, for example, as an abnormally high pressure in the line, or an abnormally high oil level in the expansion tank of that particular station.

Owing to the fact that the various stations of the system are combined in such a way that the entire system is operated as a single unit, instead of as a plurality of separate and distinct independently-operated units, as is now the usual practice, it is desirable that means be provided whereby a general supervisor in charge of the entire system will be notified automatically of an abnormal condition that exists in the system, such, for example, as a break in the line between two stations, or the breaking down of the pumping apparatus at a particular station. Accordingly, I have constructed the system in such a way that when the discharge pressure at any station increases or decreases beyond certain predetermined limits, this fact will be indicated automatically to a general supervisor at a central station, who will then take steps to control

the system in such a way as to prevent the least loss or damage.

Figure 1 of the drawings is a view partly in elevation and partly in section of station No. 1 and station No. 2 of my improved oil pipe line system.

Figure 2 is a diagrammatic view, illustrating several stations of the system; and

Figure 3 is a diagrammatic view, illustrating the operation of the means that is used for automatically notifying the general supervisor of an abnormal condition that exists at a particular station of the system.

Referring to Figure 1 of the drawings, A designates a pump of any suitable kind at the receiving station or station No. 1 of the system to which oil is supplied by a pipe 1 leading from any suitable source of oil supply, such, for example, as oil storage tanks, B designates a means for operating said pump which may consist of any suitable pump or kind of prime mover, herein illustrated as a Diesel engine, C designates a device for heating the oil that is supplied to the pump A and D designates a boiler that is used for generating steam to operate the heating device C. The pumping apparatus at the receiving station, composed of the pump A and the means B for operating said pump, is governed preferably by a manually-adjustable speed governing device E which may be of any preferred form.

The complete system is composed of a number of intermediate stations arranged in tandem or in series between the receiving station No. 1 and the delivery terminus of the system, said intermediate stations under ordinary conditions being located approximately forty or fifty miles apart and connected with each other by underground oil lines or sections of a long pipe line, the pipe line that leads from station No. 1 to station No. 2 being indicated in Figure 1 by the reference character F. Station No. 2 is equipped with a pumping apparatus composed of a pump A′ and an operating means B′ for said pump, a heating device C′ for heating the oil before it is admitted to said pump and a boiler D′ for generating steam to operate said heating device. Instead of adjusting the governing means of the pumping apparatus of station No. 2 manually and supplying the oil to said pumping apparatus from large oil storage tanks into which oil is discharged from the pipe line F leading from station No. 1, as is now the usual practice, I combine the oil line F leading from station No. 1 with the pumping apparatus of station No. 2 in such a way that a practically closed circuit or passageway for the oil is provided through which the oil will flow practically directly from the pipe line F leading from station No. 1 into the pump A′ located at station No. 2. I also provide station No. 2 with means for automatically controlling the operation of the pumping apparatus of station No. 2 according to the rate of discharge of oil from the line F leading from station No. 1 so as to automatically increase the speed of operation of the pump at station No. 2 when the oil is being discharged from the line F leading from station No. 1 at a high rate and for automatically decreasing the speed of operation of said pump when the oil is being discharged from said line F at a low rate. Various means can be used for this purpose, such, for example, as an electrically-controlled speed governor or speed regulator E′ for the operating means B′ of the pump A′. In the system shown in Figure 1 an expansion tank or container G is arranged between the pipe line F leading from station No. 1 and the inlet to the pump A′ of station No. 2 so as to impart some flexibility to the system and also provide for the escape of the gaseous constituents, mill scale, sand and other particles of foregin matter in the oil before the oil enters the pump A′ of station No. 2. The expansion tank G can be of any preferred size and construction, but it is preferably large enough to be capable of receiving and holding the oil discharged from the line F for a short period in the event the pumping apparatus of station No. 2 breaks down or the operation of same is discontinued for a short period.

In actual practice the expansion tank G will consist of a small storage tank, say, of 1000 barrels capacity, arranged at a suitable level with reference to the pump A′ and provided with a sheathing of heat insulating material x so as to prevent the oil in said tank from being subjected to excessive heat in the summer months and from being subjected to excessive cold in the winter months when heating of the oil is required to facilitate the flow of the oil through the line and through the pumps. One convenient way of automatically governing the operation of the pumping apparatus of station No. 2 is to equip the expansion tank G with a float 1 that operates a device 2 which controls an electric circuit 3 equipped with a device 4 for controlling the speed regulator E′ of the actuating means B′ of the pump A′, the rise and fall of the float 1 in said expansion tank causing the speed of the pump A′ to vary automatically as the rate of discharge of the oil from the pipe line F into the expansion tank G varies. Any mill scale or particles of sand or other foreign matter in the oil that enters the expansion tank G settles to the bottom of said tank, from which point it can be removed by opening a drain cock 5, and the gaseous constitutents in the oil that are liberated by the discharge of the oil from the line F into the expansion tank collect in the upper por-

tion of said tank. In order that these gaseous constitutents may be utilized, I provide the expansion tank G with a vapor outlet 6 that leads from the upper end of said tank to a condenser 7 that discharges into a container 8, thereby causing the vapors which are collected in the upper portion of the expansion tank G to be liquefied or converted into a condensate that is collected in the receiver 8. Said condensate can either be withdrawn from the receiver 8 through a discharge valve 9 at the lower end of said receiver, or it can be returned to the pipe line through a conduit 10 that leads from the lower end of the receiver 8, as shown in Figure 1.

As previously stated, each of the intermediate stations of the system is provided with one or more emergency storage tanks into which the oil flowing through the pipe line can be discharged in the event of a break in the pipe line between two stations, or in the event that the pumping apparatus of a particular station becomes inoperative. As shown in Figure 1, station No. 2 is equipped with an emergency storage means formed by one or more tanks H similar to the storage tanks used at the intermediate stations of the conventional oil pipe line system and having a capacity at least equal to the cubic contents of the pipe line F leading from station No. 1. Said emergency storage means is connected with the pipe line F leading from station No. 1 by a conduit 11, and said conduit is equipped with a valve 11^a that is normally closed but which opens automatically under certain conditions, such, for example, as when an abnormal pressure exists in the line, and thus permits the oil to pass from the line into the emergency storage means H. It is obvious that various other means could be used for diverting the oil from the line into the emergency storage means, such for example, as a means rendered operative by an abnormal rise in level of the oil in the expansion tank or an abnormally high pressure in said tank. From the foregoing it will be seen that in my system the breaking down of the pumping apparatus of station No. 2 or a failure of said pumping apparatus to withdraw oil from the expansion tank G at a sufficient rate to maintain the approximate normal level in said tank, cannot result in damage or injury to the system, because station No. 2 is equipped with an emergency storage means normally cut off from the pipe line leading from station No. 1, but combined with said pipe line in such a way that direct communication between said pipe line and said emergency storage means will be established automatically by an abnormal pressure in the line or an abnormally high oil level or abnormally high pressure in the expansion tank G of station No. 2.

In the foregoing description I have merely referred to station No. 2 and station No. 1, but it will be understood that each intermediate station of the entire system is equipped with elements of the kind specified in connection with the description of station No. 2, and as illustrated in Figure 2 of the drawings, the various intermediate stations of the system being arranged in series or in tandem relation, as shown in Figure 2.

In an oil pipe line system of the character above described it is desirable that means be provided for notifying a general supervisor in charge of the entire system whenever the pumping apparatus of a particular station breaks down or whenever the pipe line between two stations breaks so that he can take steps to control the system in such a way as to prevent the least loss or damage. Accordingly, I propose to equip the system with an automatic indicating means composed of signals or signalling devices located at a particular point on the system where a general supervisor is stationed, and signal operating devices arranged at the receiving station and at the various intermediate stations of the system and constructed in such a way that they will become operative, thus causing said signals to act, whenever the discharge pressure of the pumping apparatus at any of said stations increases or decreases beyond a certain predetermined amount. In Figure 3 I have shown diagrammatically one kind of automatic indicating means that may be used for this purpose, composed of two electrically-operated visual signals K and K′, one of which is used to indicate an abnormally high pressure, and the other an abnormally low pressure, and an audible signal which may consist of an electrically-operated horn L. Said signals are located at the point where the general supervisor in charge of the entire system is stationed and they are connected with separate electric circuits that extend the entire length of the system. The receiving station and each of the intermediate stations of the system is equipped with signal operating devices that are combined with the pumping apparatus of the station and with the signal circuits in such a way that when the discharge pressure of the pumping apparatus at that particular station increases beyond a certain predetermined amount, the signal K will operate, and the audible signal L will operate in such a way as to indicate to the supervisor the number of that particular station. Likewise, if the discharge pressure of the pumping apparatus at that particular station decreases beyond a certain predetermined amount, the signal K′ will become operative

and the signal L will operate in such a way as to notify the supervisor which station on the system is not operating normally. Various kinds of signal operating devices can be used at the various stations, but I prefer to equip each station with a Bourdon tube 13 combined with the pumping apparatus of the station in such a way that it will flex in one direction, and thus close the circuit in which the signal K is arranged when the discharge pressure of said pumping apparatus exceeds a certain amount and will flex in the opposite direction, and thus close the circuit in which the signal K′ is arranged when said discharge pressure falls below a certain amount. In addition to the signal operating device 13, each station is equipped with a rotatable circuit closing device 14 that is normally inoperative, but which is so constructed that when it is in operation it will cause the audible signal L to indicate the number of the station at which said device 14 is located. For example, the device 14 used at station No. 23 would be constructed in such a way that when it is in operation the signal L will produce two short blasts, an interval and then three short blasts and repeat these blasts at intervals while the device 14 continues in operation. The device 14 can be driven by a spring, weight or motor and it is normally maintained in an inoperative condition by a hook 15 that is associated with an electric magnet 16 which is connected with the visual signal circuits in such a way that said hook will be moved in a direction to release the device 14, whenever the Bourdon tube 13 closes either of the circuits in which the visual signals K and K′ are arranged.

While I prefer to equip each intermediate station with an expansion tank arranged between the inlet of the pumping apparatus of the station and the pipe line leading from the preceding station of the system it is obvious that the delivery end of any section of the line could be connected directly to the suction end of the pump discharging into the next succeeding section of the line and use a pressure controlled means for regulating the rate of discharge into said next succeeding section. Moreover, while I have described my invention as applied to a system for conveying crude petroleum from one point to another, it is obvious that the invention is applicable to systems for handling other kinds of liquids. The principal use of the invention, however, is for oil pipe lines, as it cuts down the high evaporation loss of the conventional pipe line system, and it effects a considerable saving in the quantity of fuel required to heat the oil in cold weather, due to the fact that the oil, when it reaches each intermediate station, is not discharged into a large body of cold oil stored in a tank arranged above the surface of the ground, as in the conventional oil pipe line system.

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

1. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations arranged in series and combined in such a way as to form a practically continuous passageway for the oil while it is traveling from the receiving station to the terminus of the system, and an emergency storage means at each of said intermediate stations into which the oil traveling from a preceding station can be diverted under certain conditions.

2. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations arranged in series and combined in such a way as to form a practically continuous passageway for the oil while it is traveling from the receiving station to the terminus of the system, an emergency storage means at each of said intermediate stations, and an automatically operating means for permitting the oil to travel from said passageway into said storage means under certain conditions.

3. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations arranged in series and combined in such a way as to form a practically continuous passageway for oil that flows practically continuously from the receiving station to the terminus of the system, a pumping apparatus located at each of said intermediate stations, and a means located at each of said intermediate stations and governed by the rate of discharge of oil from the preceding stations for automatically controlling the particular pumping apparatus with which said means is associated, thereby causing the quantity of oil delivered by each intermediate station to the next succeeding station of the system to vary according to the supply of oil delivered to said station by the pumping apparatus of the preceding station of the system.

4. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations arranged in tandem relation and each equipped with a pumping apparatus for delivering the oil received at same to the next succeeding station of the system, and means associated with the pumping apparatus of each of said intermediate stations and controlled by the oil discharged from the preceding station for automatically regulating the operation of the particular pumping apparatus with which said means is associated according to the rate of supply of oil to said station from the preceding station of the system, whereby the oil will be caused to remain in practically constant mo-

sion in traveling from the receiving station to its point of destination.

5. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations arranged in tandem relation and each equipped with a pumping apparatus for delivering the oil to the next succeeding station of the system, means associated with the pumping apparatus of each of said intermediate stations for automatically regulating the operation of same according to the rate of supply of oil to said station from the preceding station of the system, an emergency storage means at each of said intermediate stations which is normally out of service, and means whereby an abnormal condition existing in a zone of the system in proximity to one of said storage means cuts said storage means into service automatically.

6. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations connected in series and each equipped with a pumping apparatus, a closed expansion tank at each of said intermediate stations arranged between the inlet of the pumping apparatus of said station and the oil line leading from the preceding station of the system and so proportioned and constructed that it virtually forms part of the oil circulating passageway of the system, and means at each of said intermediate stations for automatically regulating the operation of the pumping apparatus of said stations according to the rate of supply of oil to said station from the preceding station of the system so as to cause the oil to remain in practically constant motion in traveling through the system.

7. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations connected in series and each equipped with a pumping apparatus, a closed expansion tank at each of said intermediate stations arranged between the inlet of the pumping apparatus of said station and the discharge end of the oil line leading from the preceding station of the system, means for condensing and recovering the gaseous constituents that are thrown off from the oil which enters said tank, and a device associated with each of said expansion tanks and operated by the rise and fall of the oil therein for automatically controlling the pumping apparatus of the next succeeding station of the system so as to cause the oil to remain in practically constant motion in traveling through the system.

8. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations connected in series and each equipped with a pumping apparatus, a closed expansion tank at each of said intermediate stations arranged intermediate the inlet of the pumping apparatus of said station and the oil line leading from the preceding station of the system so as to cause the oil that is supplied to the next succeeding station of the system to pass through said tank, and a speed regulating device for the pumping apparatus of each of said intermediate stations controlled by the rise and fall of the oil in the expansion tank of said station for maintaining the oil in practically constant motion while it is traveling from the receiving station to its point of destination.

9. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations connected in series and each equipped with a pumping apparatus, an expansion tank at each of said intermediate stations arranged intermediate the inlet of the pumping apparatus of said station and the oil line leading from the preceding station of the system, a speed regulating device for the pumping apparatus of each of said intermediate stations controlled by the rise and fall of the oil in the expansion tank of said station, an emergency storage means at each of said intermediate stations, and means whereby the emergency storage means of a particular station will be cut into service automatically so as to receive the oil flowing from the preceding station of the system in the event the discharge of oil from said station ceases or falls below a certain approximate rate of discharge.

10. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations connected in series and each equipped with a pumping apparatus, a means at each of said intermediate stations, governed by the oil discharged from the preceding station, for automatically regulating the rate of pumpage to the next succeeding station of the series so as to cause the oil to remain in practically constant motion in traveling through the system, and means at each of said intermediate stations for collecting the liberated gases in the oil that is delivered to said station and for permitting the mill scale and other particles of foreign matter in said oil to be removed before said oil enters the pumping apparatus at said station.

11. An oil pipe line system, comprising a plurality of underground oil lines arranged in series between the various stations of the system, and means located at the delivery end of each of said oil lines in the direct path of travel of the oil being supplied to the next succeeding station of the system for automatically regulating the rate of pumpage into the oil line of said succeeding station so that the pumpage of each oil line will correspond substantially in quantity with the quantity of oil issuing from the delivery end of the oil line of the immediately preceding station of the sys-

tem and thus result in the oil flowing practically continously while traveling through the system.

12. An oil pipe line system, comprising a series of sections of pipe line, a pump at the receiving end of each of said sections for forcing the oil through the same, an air chamber or expansion tank at the delivery end of each of said sections for the purpose described, means for condensing or absorbing the gas that collects in each of said chambers, and means whereby the condensate can either be withdrawn from the system or reintroduced into the pipe line.

13. An oil pipe line system, comprising a series of sections of pipe line, a pump at the receiving end of each of said sections for forcing the oil through the same, a heat insulated expansion tank arranged in tandem relation with the delivery end of each section and the intake of the pump of the next succeeding section, and means associated with each of said expansion tanks for regulating the speed or rate of pumpage of the pump of the succeeding section of the system, so as to cause the oil to remain in practically constant motion in traveling through the system.

14. An oil pipe line system, comprising a series of sections of pipe line, a pump located at the receiving end of each of said sections for forcing oil through said section towards the delivery end of same, and means arranged in proximity to the delivery end of each of said sections and operated by the oil discharged from same for automatically controlling the speed or rate of discharge of the means which delivers the oil into the next succeeding section of pipe line of the system so as to maintain the oil in practically constant motion while it is traveling through the system.

15. An oil pipe line system, comprising a plurality of sections of pipe line arranged in series and each provided at its receiving end with a pumping apparatus for forcing oil through the same, and means controlled by the rate of discharge of oil from the delivery end of each of said sections for automatically controlling the rate of pumpage for the next succeeding section of pipe line of the system so as to maintain the oil in practically constant motion while it is traveling through the system.

16. An oil pipe line system, comprising a plurality of sections of pipe line arranged with the delivery end of one section in proximity to the receiving end of the next succeeding section, a pump at the receiving end of each of said sections, a variable means for regulating the speed or rate of discharge of the pump which forces the oil through the first section of pipe line of the system, means located in proximity to the discharge end of said first section and operated by the oil discharged from same for automatically controlling the speed or rate of discharge of the pump which forces the oil through the second section of pipe line of the system, and a similar means located in proximity to the discharge end of said second section for automatically controlling the speed or rate of discharge of the oil into the third section of pipe line of the system and so on, thereby causing the oil to remain in practically constant motion in traveling through the system.

17. An oil pipe line system, comprising a plurality of sections of pipe line arranged with the delivery end of one section in proximity to the receiving end of the next succeeding section, pumps for forcing oil through said sections, a closed expansion tank at the discharge end of each of said sections arranged in tandem relation with the intake of the pump of the next succeeding section for collecting the liberated vapors and the foreign matter contained in the oil pumped through the section with which the tank is associated, a device associated with each of said expansion tanks for regulating the operation of the pump whose intake communicates with said tank, so as to cause the oil to remain in practically constant motion in traveling through the system, means for permitting the sediment or precipitated foreign matter that settles in said tank to be removed therefrom, and means for condensing the vapors that are collected.

18. An oil pipe line system, comprising a plurality of sections of pipe line arranged with the delivery end of one section terminating in proximity to the receiving end of an adjacent section, pumps arranged in tandem relation with said sections for forcing oil through said sections, and a device arranged in proximity to the delivery end of each of said sections and operated by the oil discharged from same for controlling the speed or rate of discharge of the pump that forces the oil through the next succeeding section of the system according to the rate of supply of oil through the preceding section and for causing the oil flowing through the system to remain in practically constant motion.

19. An oil pipe line system, comprising a plurality of sections of pipe line arranged with the delivery end of one section in proximity to the receiving end of the next succeeding section, pumps for forcing oil through said sections, a heat insulated expansion tank connected to the delivery end of each of said sections except the final section of the series, an emergency storage means associated with each of said sections and having a cubic capacity approximating the cubic contents of said section, and means for causing the oil in the pipe line section

with which said tank is connected to be diverted into the emergency tank of said section under certain conditions.

20. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations arranged in series and each equipped with a pumping apparatus, a signalling means arranged at one point on the system, and operating devices for said signalling means located at the various stations and combined with the pumping apparatus of said stations in such a way that said signalling means will become operative in the event of a material change in the discharge pressure of the pumping apparatus at any of said stations.

21. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations arranged in series and each equipped with a pumping apparatus, signals arranged at the point where the general supervisor in charge of the system is located, and signal operating devices located at said stations and combined with the pumping apparatus of said stations in such a manner that an abnormal change in the discharge pressure of the pumping apparatus at a particular station causes said signals to operate, and thus advise the supervisor of the approximate conditions existing at that particular station.

22. An oil pipe line system, comprising a plurality of pumping stations which work in series, each of the intermediate stations being equipped with a tank that supplies oil to the pumping apparatus of that station and which, in turn, receives oil from the preceding station of the system, means associated with the pipe line in proximity to the pumps of the various stations for indicating at a distant point that a change in the discharge pressure of any pump of the series has occurred, and means for indicating at said distant point which of the pumps has changed with respect to discharge pressure.

23. An oil pipe line system, comprising a plurality of power driven pumps which work in series, the discharge from one pump being connected to the inlet of the next succeeding pump, means connected with the line in proximity to the discharge side of each pump for indicating at a distant point that the discharge pressure of one of the pumps of the series has either increased or decreased beyond a certain predetermined amount, and means for indicating at said distant point which of the pumps has thus changed with regard to its discharge pressure.

24. An oil pipe line system, comprising a receiving station and a plurality of intermediate stations arranged in series, and each provided with a pumping apparatus, an expansion tank or air chamber at each of said intermediate stations arranged between the inlet of the pumping apparatus at said station and the discharge line leading from the preceding station, means controlled by the rise and fall of the oil in said expansion tank for automatically controlling the speed or rate of discharge of the pumping apparatus which receives its supply from said expansion tank, a signalling means located at a particular point on the system, and means for causing said signalling means to become operative when the discharge pressure of the pumping apparatus at any particular station has either increased or decreased beyond a certain predetermined amount, said signalling means being of such a character that it will indicate whether the pressure has increased or decreased and also the number of the particular station where the abnormal condition exists.

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