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March 22, 1927. 1,621,683

G. D. POGUE

PIPE LINE SYSTEM

Filed Feb. 23, 1923 2 Sheets-Sheet 1

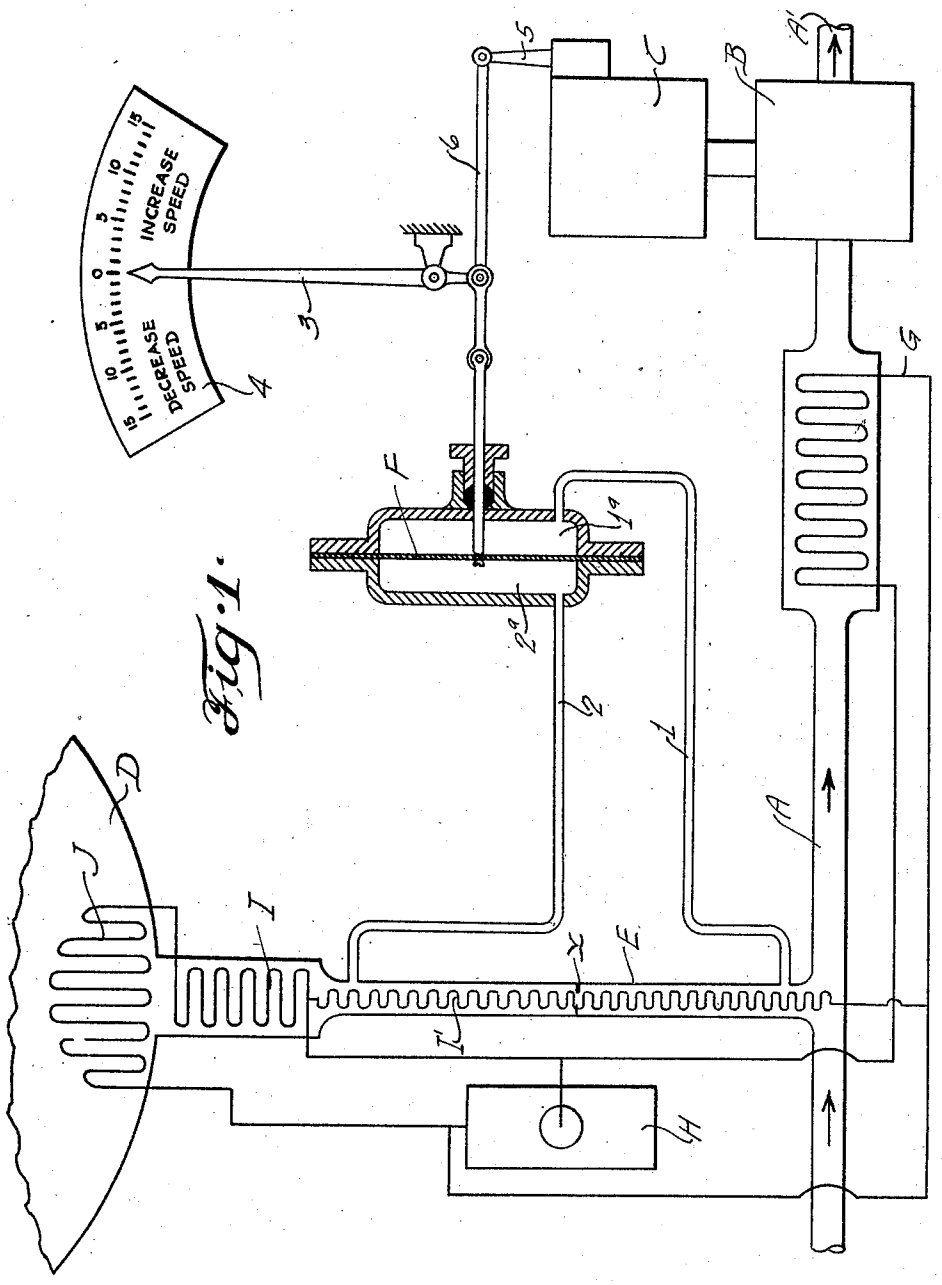


Fig. 1.

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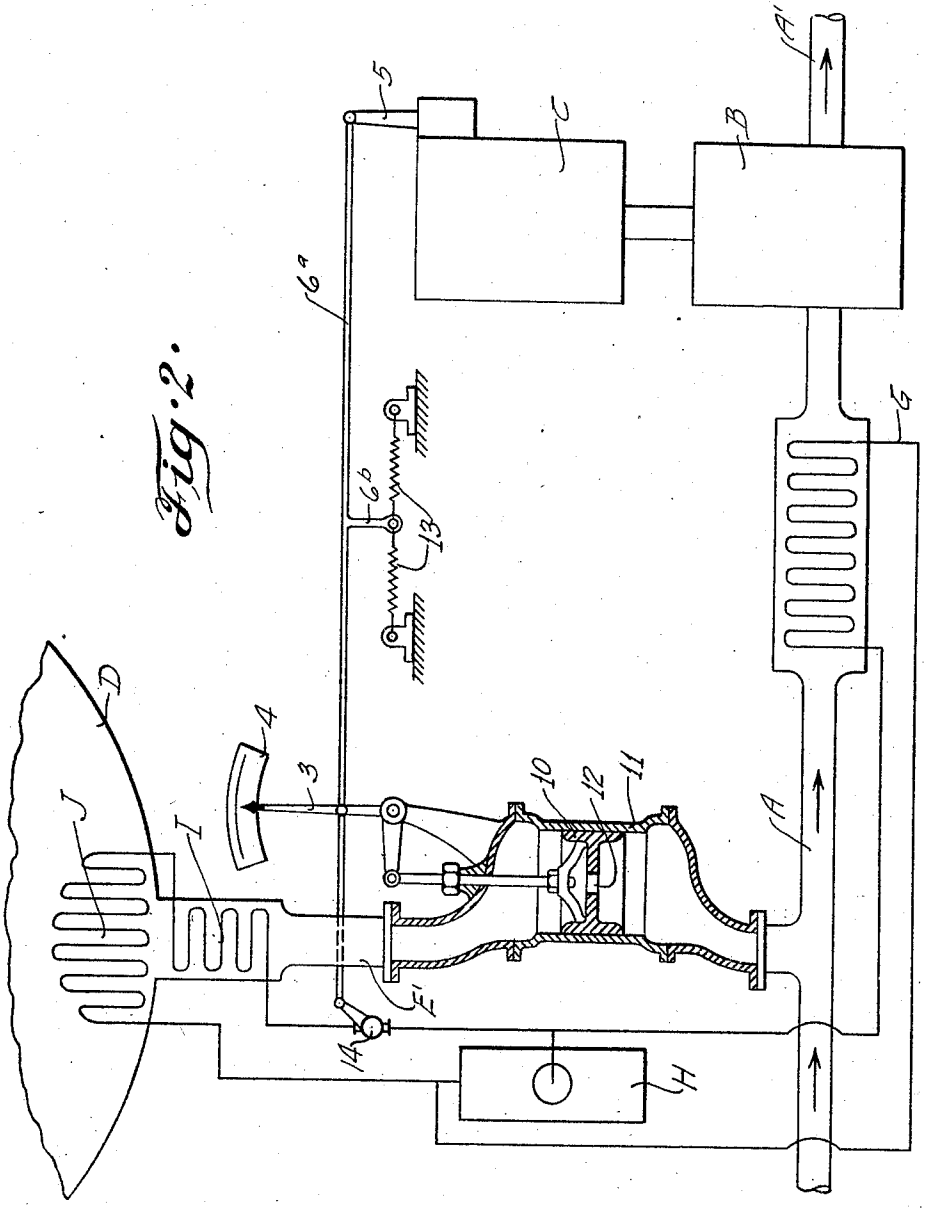
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Fig. 2.



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UNITED STATES PATENT OFFICE.

GEORGE D. POGUE, OF MOUNT VERNON, NEW YORK.

PIPE-LINE SYSTEM.

Application filed February 23, 1923. Serial No. 620,792.

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.

At the present time there are two types or kinds of oil pipe line systems in general use, both of which comprise a main line divided up into a plurality of sections arranged in tandem or series relation and each section equipped at its initial end with a pumping apparatus that discharges oil into the main line at about 700 lbs. pressure. In one of said systems the oil arriving at the delivery end of a section is discharged into a large storage tank which, in turn, is connected to the suction inlet of the pumping apparatus which forces the oil through the next succeeding section of the system, such a system having certain objectionable characteristics which are overcome or minimized by the invention that forms the subject-matter of my pending application for patent for oil pipe line system, Serial No. 613,912, filed January 20, 1923. In the other conventional pipe line system, the delivery end of one section of the main line is connected to the suction inlet of the pumping apparatus which discharges into the next succeeding section of the system. At a point in the main line near the delivery end of each section a lateral connection leads off to a storage tank, the arrangement being such that the various storage tanks of the system float on the main line.

My present invention relates to an oil pipe line system of the type last referred to, namely, a system that comprises a number of intermediate stations arranged in tandem relation between the receiving station and the terminus of the line and usually located 40 to 50 miles apart, an underground pipe line composed of a number of sections that connect the various stations of the system together, a pumping apparatus at each of the intermediate stations having its suction inlet connected with the section of pipe line which leads from the preceding station of the system and its discharge outlet connected with the section of pipe line which leads to the next succeeding station of the system and storage tanks at the intermediate stations that are connected with the pipe line in such a way as to permit the oil being pumped through the system to flow into and out of the storage tanks at the stations, depending upon the rate of operation of the pumping apparatus at the intermediate stations. In the conventional pipe line system of this particular type if the quantity of oil arriving at any intermediate station through the section of the pipe line that leads from the preceding station is greater than the quantity of oil discharged by the pumping apparatus of said intermediate station into the next succeeding section of the pipe line, then the "overage" or excess quantity of oil flows from the main line into the storage tank at said intermediate station through the lateral connection between said storage tank and the main line. Conversely, if the quantity of oil arriving at any intermediate station of the system is less than the quantity of oil discharged by the pumping apparatus of said station into the next succeeding section of the main line, then oil will be drawn from the storage tank at that station into the main line through the lateral connection from the main line to said storage tank.

If the crude oil being handled by the system is of a viscous nature it is, in some cases, necessary to heat it before it enters each section of the line to facilitate the flow of the oil through the pipe line, and in a system of the particular type just referred to it has been necessary in such cases to provide means for maintaining the entire quantity of oil in the storage tank of each intermediate station in a heated condition, when heating of the oil is necessary.

Accordingly, the conventional pipe line system of the particular type to which my present invention relates has two very objectionable characteristics:

1st. It does not contemplate the use of a means for maintaining proper relationship in the rate of pumpage of the various stations. Consequently, the rate of flow of the oil through the various sections of the system is subject to continuous variation, producing continual changes in the level of the oil in the storage tanks at the intermediate stations that float on the main line and resulting in a relatively high evaporation loss, because an abnormal rise in level will force out of the storage tank the air above the oil which is saturated with the volatile constituents of the oil and an abnormal drop in

level will cause a large quantity of fresh air to be drawn into the tank and mixed with the vapors rising from the oil.

2nd. The practice of maintaining the entire quantity of oil in the storage tanks in a heated condition during the season when heating of the oil is necessary entails a considerable expenditure for fuel used to heat the oil, and moreover, tends to increase the evaporation loss, due, of course, to the fact that the volatile constituents of the oil will escape or be driven off to a greater degree when the entire body of oil in the tank is heated.

The main object of my invention is to provide an oil pipe line system of the general character referred to, namely, a system comprising storage tanks that float on the main line, which is so constructed that a practically constant or uniform rate of delivery from all of the intermediate stations of the system can be maintained, thereby reducing the evaporation loss by preventing an abnormal variation in level of the oil in the storage tanks, as occurs in the conventional pipe line system of this particular type.

Another object of my invention is to provide an oil pipe line system of the general type referred to which is so constructed that heating of the entire quantity of oil in the storage tanks at the intermediate stations is not necessary, thereby effecting a considerable saving in the quantity of fuel used to heat the oil in cold weather and also reducing the evaporation loss. Other objects and desirable features of my invention will be hereinafter pointed out.

To this end I have devised an oil pipe line system in which each intermediate station of the system is equipped with means that will either automatically control the speed or delivery of the pumping apparatus of that particular station, or indicate to the operator in charge of said station how to govern the pumping apparatus so as to maintain same in such a condition that the pumpage rate of that particular station will correspond to the net quantity of oil being received from the immediately preceding station of the system, thereby producing a system in which the oil will flow practically continuously through the main line from the receiving station to the terminus of the line.

Owing to the fact that there is no flow or a relatively small flow of oil from the main line into the storage tanks and back into the main line under normal conditions, it is only necessary to maintain a relatively small quantity of oil in the storage tank at each intermediate station in a heated condition in cold weather. Accordingly, in my improved system each intermediate station is equipped with a heating device arranged so that it will heat either a zone of the lateral connection between the main line and the storage tank or a zone of the storage tank in proximity to said lateral connection. If desired, means can be provided for automatically controlling the quantity or intensity of the heat supplied to said zone or zones so as to turn on the supply of heat when the oil starts to flow from the storage tank into the main line and automatically increase the intensity or the quantity of heat supplied in approximate proportion to the rate of flow of the oil into the main line, or automatically reduce or cut off the supply of heat to said zone or zones when the direction of flow of the oil through said lateral connection is reversed, or, in other words, when the oil starts to flow from the main line into the storage tank.

It is immaterial what means is used for automatically controlling the pumping apparatus at the various stations or for indicating to the operators in charge of the stations how the pumping apparatus should be governed so as to unify the rate of delivery of all of the pumping stations, but I prefer to utilize the flow of the oil through the lateral connections leading from the main line to the storage tanks so as to operate devices at the intermediate stations that actuate indicators or automatic speed governors associated with the pumping apparatus. If each station is equipped with an indicator, said indicator will preferably be constructed in such a manner that it will show continuously the direction and quantity of flow of the oil through the lateral connection that joins the storage tank at said station with the main line, in order that the operator in charge of the station may be kept informed as to the actual condition existing at said station, and thus be able to manually adjust the pumpage rate at that station to correspond to the net quantity of oil being received from the immediately preceding station of the system. Said indicator or indicating means is preferably constructed in such a way that if there is no flow of oil through the lateral connection in either direction, then the indicator will stand at zero, but if oil is arriving at said station at the rate of, say, 500 barrels per day in excess of the rate at which the pumping apparatus at said station is supplying oil to the next succeeding station, the movable element of the indicator will move into such a position on a dial that the operator will understand that in order to maintain equilibrium on the line he must increase the discharge rate of the pumping apparatus at said station 500 barrels per day. Or if the oil is arriving at that station at the rate of, say, 300 barrels per day less than the rate at which the pumping apparatus at said station is discharging oil into the section of the pipe line leading to the next succeeding station of the system, the movable element of the indicator will move into such

a position on the dial as to notify the operator that he must decrease the speed of the pumping apparatus so as to decrease the pumpage rate 300 barrels per day.

If each intermediate station is equipped with a means for automatically increasing or decreasing the speed or rate of delivery of the pumping apparatus at the station, depending upon the direction and rate of flow of oil through the lateral connection that joins the storage tank at the station with the main line, the rate of discharge of all of the pumps on the system will be automatically maintained substantially equal, of course, making allowance for line leakage, evaporation, leakage from tanks and withdrawals made from the line at various points for fuel or other purposes. Irrespective of whether the stations are equipped with automatic indicators or automatic controlling means for the pumping apparatus, the surge of oil into and out of the storage tanks is materially reduced, thereby decreasing the evaporation losses, and under certain conditions, heat losses.

Figure 1 of the drawings is a diagrammatic view, illustrating one of the intermediate stations of a pipe line system constructed in accordance with my invention; and

Figure 2 is a similar view, illustrating a different form of device for utilizing the flow of the liquid into or out of the storage tank of the station for actuating an indicator or a means for controlling the speed of the motor or other prime mover of the pumping apparatus of the station.

In the form of my invention shown in Figure 1 A designates one section of an underground pipe line that leads from one station of the system to the next succeeding station of the system, and arranged so that it will discharge into a pump B that delivers the oil to the section A′ of the main line that leads to the next succeeding station of the system, the pump B being driven by a motor or other suitable prime mover C. The station at which the pump B is located is provided with a storage tank D that is joined to the section A of the main line by a lateral connection E that is tapped onto said main line at a point in proximity to the suction inlet of the pump B. At two points on the lateral connection E, preferably a considerable distance apart to insure sufficient pressure differential, are connected two pressure lines 1 and 2 which lead to chambers 1^a and 2^a arranged on opposite sides of a flexible diaphragm F. If there is a flow of liquid through the lateral connection E from the main line towards the storage tank D, then the pressure in said lateral connection at the inlet to the pressure line 1 will be higher relatively than the pressure in said lateral connection at the inlet to the pressure line 2, and the diaphragm F will be deflected to the left. Likewise, if there is a flow of liquid through the lateral connection E from the storage tank D towards the main line, the pressure in said lateral connection at the inlet to the pressure line 2 will be higher relatively than the pressure at the inlet to the pressure line 1 and the diaphragm F will be deflected to the right.

The diaphragm F is operatively connected either with the movable element of an indicating device or with a mechanism for automatically controlling the speed of the motor or prime mover C which drives the pump B, or, if desired, the diaphragm F can be operatively connected with a speed governing device for the motor C or with an indicator and speed governing device. In the form of my invention shown in Figure 1 the diaphragm F is connected with an indicator needle 3 that co-operates with a stationary dial or scale 4. When the diaphragm F flexes to the right, the indicator needle 3 will move over the dial 4 towards the left, and when the diaphragm F flexes to the left, the indicator needle 3 will move over the dial towards the right. It is immaterial how the dial 4 is marked, but I prefer to provide said dial with a neutral point, designated by 0, at which the indicator needle 3 stands when no liquid is flowing through the lateral connection E in either direction and provide said dial with suitable indicia arranged at opposite sides of said neutral point, for example, the words "increase speed" to the right of said neutral point and the words "decrease speed" to the left of said neutral point, so as to indicate to the operator in charge of the pump B that he should increase the speed of the motor C when the indicator needle swings to the right and should decrease the speed of said motor when the indicator needle swings to the left. If desired, the dial 4 can also be provided with indicia that co-operates with the indicator needle 3 to denote the approximate rate of flow of liquid through the lateral connection E in either direction. As previously stated, the movement of the diaphragm F can be used to actuate a speed governing device 5 that is associated with the motor C which drives the pump B so as to automatically control the speed of the pump, the device 5 being herein illustrated as connected by a link 6 with the lower end of the indicator needle 3, thereby producing a mechanism, which, in addition to automatically controlling the speed of the pumping apparatus, will also indicate continuously to the operator in charge of said apparatus the direction and quantity of flow through the lateral connection E that joins the main line with the storage tank D at that particular station. When the diaphragm F

is operatively connected with the speed regulating device 5 the movement of the diaphragm F to the left, produced by the passage of liquid through the lateral connection E from the storage tank into the main line, causes the speed of the pump B to be increased automatically until equilibrium is reached or until the amount of oil delivered by the pump B to the section A′ of the pipe line that leads to the next succeeding station of the system equals the quantity of oil being delivered through the section A of pipe line leading from the preceding station of the system. On the other hand if the net quantity of oil received through the section A of the pipe line from the preceding station should be less than the quantity of oil being delivered by the pump B into the section A′ of the pipe line that leads to the next succeeding station, then the flow through the lateral connection E would be from the storage tank D into the main line, in which case the pressure in the lateral connection E at the inlet of the pressure line 2 would be higher than the pressure in said lateral connection at the inlet to the pressure line 1, and the diaphragm F would be deflected to the right, thus moving the indicator needle to the left and also causing the speed of the motor C to be decreased automatically until equilibrium is again reached or until the amount of oil delivered by the pumping apparatus at this particular station to the succeeding station of the system equals the quantity of oil received at said station from the preceding station of the system. If the lateral connection E is unusually short it may be necessary to provide said connection with a constrictive means, indicated by the reference character x, to increase the pressure differential in that part of the lateral line for any given rate of flow.

In order that crude oil that is of a viscous nature may be handled by the system in cold weather, a heating device G, indicated diagrammatically, is arranged in the main line in proximity to the pump B, as shown in Figure 1, said heating device usually consisting of a coil to which steam is supplied from a boiler H. Such heating devices are in common use, but in the conventional pipe line systems of the kind in which the intermediate stations are equipped with storage tanks that float on the main line additional heating devices are also employed to maintain the entire quantity of oil in the storage tanks in a heated condition.

One object of my invention is to overcome the necessity of heating the entire quantity of oil in the storage tank at each intermediate station and to this end I have provided the lateral connection E between the storage tank D and the main line with an auxiliary heating device I arranged preferably in the connection E at a point in proximity to the storage tank D. I also prefer to arrange a zone heater J inside of the storage tank D in close proximity to the auxiliary heater I so as to cause a relatively small quantity of oil in the storage tank D to be heated by said zone heater. Neither the auxiliary heater I nor the zone heater J are required to be in continuous operation, even during the winter months, because the automatic means for unifying the rate of delivery for all of the pumping stations of the system results in an absence of movement of oil through the lateral connections E at the respective stations under normal conditions. It is immaterial what particular type or kind of auxiliary heater I and zone heater J is used, but in most instances said heaters will consist of steam coils to which steam is supplied from the boiler H, the auxiliary heater I being herein illustrated as connected in series with the zone heater J. In some instances it may be necessary to provide means for heating the oil in the lateral connections leading from the main line to the storage tanks, and therefore, in Figure 1, I have illustrated a heating device I′ arranged in the lateral connection E between the main line and the auxiliary heater I.

In Figure 2, I have illustrated another form of my invention, wherein the lateral connection E′ between the storage tank D and the section A of pipe line that leads to the pump B is provided with a piston 10 reciprocatingly mounted in a cylinder 11 and equipped with an orifice 12. The piston 10 may be connected either with the movable element of an indicating device, for example, with an indicator needle 3, or it may be connected with a speed governing device 5 associated with the motor D so as to automatically regulate the speed of the pump B. In the form of my invention shown in Figure 2 the piston 10 is operatively connected with the indicator needle 3, which, in turn, is connected by means of a link 6^a with the speed controlling device 5 of the motor C, said rod 6^a having a portion 6^b to which stabilizing springs 13 are connected. When the oil flows through the lateral connection E′ in one direction, for instance, from the main line A towards the storage tank D, the piston 10 will move upwardly, thus causing the indicator needle 3 to swing to the right, and thus indicate that the speed of the pump B should be increased if the piston 10 is merely associated with an indicating device. If the piston 10 is associated with a speed controlling device 5, as herein shown, the speed of the pump will be increased automatically when said piston moves upwardly. This new condition would continue until equilibrium is reached or until the flow through the lateral connection E′ ceases, when the stabilizing springs will return the

piston 10 to its central position in the cylinder 11.

As previously stated, one object of my invention is to provide means for automatically controlling the quantity or intensity of heat that is supplied to the heater or heaters which are used for heating a small quantity of oil in the storage tank or in a portion of the lateral connection between the storage tank and the main line. This can be accomplished by arranging a valve 14 in the steam supply line that leads to the auxiliary heater I and the zone heater J and connecting said valve with the rod 6ª, as shown in Figure 2. As previously stated, there is very little movement of oil through the lateral connection between the storage tank and the main line, but if some special condition requires that oil be drawn from the storage tank, then the zone heater and auxiliary heater will be immediately thrown into operation automatically by the movement of the piston 10 in the lateral connection E′, and the portion of the oil in the storage tank in proximity to the zone heater J will be heated sufficiently to facilitate its flow into the main line. When the supply of the heating medium to the heaters I and J is controlled automatically in the above manner the flow of oil from the storage tank through the lateral connection E′ causes the heating devices I and J to become operative automatically and the quantity of heat supplied to said devices to be varied automatically in approximate proportion to the rate of flow of the oil passing to the main line. If the oil flows in the opposite direction through the lateral connection E′, namely, from the main line to the storage tank, then the heat supplied to either or both of the heaters I and J will be automatically cut off, or at least, reduced to a certain desired minimum. While steam is generally employed for operating the auxiliary heater and the zone heater, it is of course obvious that any other type or kind of heater could be used without departing from the spirit of my invention. It is also obvious that by increasing the capacity of the zone heater J located in the storage tank that the auxiliary heater I could be omitted, but if the zone heater is of extensive capacity, then the natural circulation set up in the storage tank will carry off and dissipate heat uselessly, thereby defeating one of the important objects of my invention, which is to supply only sufficient heat to start the oil into the lateral connection E′ of which the auxiliary heater I virtually forms a part.

Instead of controlling the speed of the pumping apparatus by a means operated directly from a part that is actuated by the movement of the oil through the lateral connection between the main line and the storage tank, various other means could be employed for controlling the speed of the pumping apparatus without departing from the spirit of my invention.

While I have herein illustrated two forms of my invention, I wish it to be understood that various other devices operated by the flow of the liquid through the lateral connection between the main line and the storage tank could be used to operate an indicating mechanism or a speed regulating mechanism, and further, that it is immaterial, so far as my broad idea is concerned, whether the means that is used for unifying the rate of delivery of all of the pumping stations of the system consists of automatically operating indicators that will indicate continuously to the operators in charge of the pumping stations how to control the pumping apparatus to maintain a practically constant flow of oil through the main line, or consists of a mechanism for automatically increasing or decreasing the speed or delivery of the pumping apparatus.

While I prefer to use a diaphragm, as shown in Figure 1, or a perforated piston, as shown in Figure 2 to actuate a means that automatically regulates or assists in the proper regulation of the pumping apparatus of each station, it will be obvious that said pumping apparatus could be regulated in various other ways without departing from the spirit of my invention.

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.

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

1. A pipe line system, comprising pumping stations equipped with pumping apparatus arranged in series with the main line of the system through which the liquid is pumped, storage tanks at intermediate pumping stations joined to lateral connections on the main line, and means associated with said lateral connections for maintaining or assisting in maintaining the pumping apparatus of said stations in such condition as to tend to unify the rate of delivery from the respective stations.

2. A pipe line system, comprising a number of intermediate stations arranged between the receiving station and the terminus of the system and each provided with a pumping apparatus arranged in series with the main line through which the liquid is pumped, a storage tank at each of said intermediate stations, joined by a lateral connection with the main line at a point in proximity to the inlet end of the pumping apparatus of the station, and means at each of said intermediate stations for assisting in maintaining a practically constant flow

of the liquid through the main line, comprising elements operable by the flow of liquid through said lateral connections in either direction.

3. A pipe line system, comprising pumping stations equipped with pumping apparatus arranged in series with the main line of the system through which the liquid is pumped, a storage tank at each intermediate station joined by a lateral connection with the main line at a point in proximity to the inlet end of the pumping apparatus, and an element at each of said intermediate pumping stations associated with the lateral connection between the main line and the storage tank of said station in such a way that it will be rendered operative by the flow of liquid through said lateral connection in either direction.

4. A pipe line system, comprising pumping stations equipped with pumping apparatus arranged in series with the main line of the system through which the liquid is pumped, a storage tank at each intermediate station joined by a lateral connection with the main line at a point in proximity to the inlet end of the pumping apparatus, and an element at each of said intermediate pumping stations associated with the lateral connection between the main line and the storage tank of said station and arranged in such a way that it will be maintained at rest or will move in opposite directions for different distances, according to whether no liquid is flowing through said lateral connection or whether the liquid is flowing into or out of the storage tank.

5. A pipe line system, comprising a main line composed of a plurality of sections, pumping apparatus arranged in series with said sections, storage tanks joined by lateral connections to said main line in such a manner that the liquid flowing through any section of the system can enter the storage tank associated with said section in the event the pumping apparatus of the next succeeding section of the system is not operating at a sufficiently high rate to handle the liquid that is supplied to same, and means associated with said lateral connections for maintaining or assisting in maintaining the various pumping apparatus of the system in such condition as to tend to cause a practically constant or uniform rate of discharge from said pumping apparatus.

6. In a pipe line system, a main line, a pumping apparatus arranged in series with said main line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of said pumping apparatus, and means associated with said lateral connection for indicating whether liquid is flowing through said connection and if so in what direction the liquid is flowing.

7. In a pipe line system, a main line, a pumping apparatus arranged in series with said main line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of said pumping apparatus, and an actuating means for an indicator or governor associated with said lateral connection and operable by the flow of liquid through same.

8. In a pipe line system, a main line, a pumping apparatus arranged in series with said main line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of said pumping apparatus, and means associated with said lateral connection for indicating the direction of flow and the approximate quantity of liquid flowing through said connection.

9. In a pipe line system, a main line, a pumping apparatus arranged in series with said main line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of said pumping apparatus, an element adapted to be operated by the flow of liquid through said connection, and a part controlled by said element.

10. In a pipe line system, a main line, a pumping apparatus arranged in series with said main line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of said pumping apparatus, and a means associated with said lateral connection and operated by the flow of liquid through same for indicating whether the speed of said pumping apparatus should be increased or decreased.

11. In a pipe line system, a main line, a pumping apparatus arranged in series with said main line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of said pumping apparatus, a speed regulating device for said pumping apparatus, and means operable by the flow of liquid through said lateral connection for actuating said speed regulating device.

12. In a pipe line system, a main line, a pumping apparatus arranged in series with said main line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of said pumping apparatus, an indicating mechanism, a speed regulating device for said pumping apparatus, and means operable by the flow of liquid through said lateral connection for actuating said indicating mechanism and said speed regulating device.

13. In a pipe line system, a main line, a pumping apparatus arranged in series with said main line, a storage tank joined by a lateral connection with said main line

at a point in proximity to the inlet end of said pumping apparatus, and means associated with said lateral connection for automatically indicating whether the speed of said pumping apparatus should be increased or decreased and also the approximate rate of flow of liquid through said connection.

14. In a pipe line system, a main line, a pumping apparatus arranged in series with said main line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of said pumping apparatus, and means for automatically increasing the speed of said pumping apparatus when liquid flows through said connection into said storage tank and for automatically decreasing the speed of said pumping apparatus when said apparatus is drawing liquid from said tank through said lateral connection.

15. A pipe line system, comprising a plurality of sections of pipe line arranged in series, a pumping apparatus for forcing a liquid through each section towards an ultimate delivery point, a lateral connection leading from each of said sections near its delivery end to a storage tank, and means associated with each of said lateral connections for indicating the direction of flow and quantity of liquid flowing through said connection.

16. A pipe line system, comprising a plurality of sections of pipe line arranged in tandem relation, with the delivery end of one section connected to the receiving end of the next succeeding section, a pumping apparatus located in proximity to the receiving end of each section for forcing liquid through said section, a lateral line connected with each section in proximity to its delivery end and leading to a storage tank, and means associated with each of said lateral lines for indicating the absence of flow, the direction of flow, if any, and the approximate quantity of liquid flowing through said lateral line.

17. A pipe line system, comprising a plurality of sections of pipe line arranged in series with the delivery end of one section connected to the receiving end of the next succeeding section, a pumping apparatus for forcing liquid through each of said sections, a lateral line leading from each of said sections near its delivery end to a storage tank, and means associated with each of said lateral lines for controlling the rate of discharge of the pumping apparatus which delivers liquid into the next succeeding section of the pipe line.

18. A pipe line system, comprising a plurality of sections of pipe line arranged in series, with the delivery end of one section connected to the receiving end of the next succeeding section, a pumping apparatus for forcing liquid through each of said sections, a storage tank associated with each of said sections and joined by a lateral connection with the section adjacent the discharge end of same, a means associated with each of said lateral connections and actuated by the pressure drop set up by the liquid flowing through said connection for indicating the condition existing in the connection, and means whereby the pressure drop for any given flow through the lateral connection may be increased beyond normal.

19. A pipe line system, comprising a plurality of sections of pipe line arranged in series with the delivery end of one section in proximity to the receiving end of the next succeeding section, a pumping apparatus for forcing liquid through each of said sections arranged in such a way that it receives its supply of liquid from the delivery end of the preceding section, a storage tank joined by a lateral connection with each of said sections in proximity to the delivery end of same, an element associated with each of said lateral connections and constructed in such a way that it will move in one direction or the other, depending upon the rate and direction of flow of the liquid through said lateral connection, and means for utilizing the movement of said element to cause a change in the speed of the pumping apparatus which forces the liquid through the next succeeding section of the pipe line.

20. A pipe line system, comprising a plurality of sections of pipe line arranged in series with the delivery end of one section in proximity to the receiving end of the next succeeding section, a pumping apparatus for forcing liquid through each of said sections arranged in such a way that it will receive its supply of liquid from the delivery end of the preceding section, a storage tank associated with each of said sections and joined by a lateral connection with the section at a point in proximity to its delivery end, an element associated with each of said lateral connections and adapted to be moved in one direction or the other by the flow of the liquid through said connection, and a means governed by said element for indicating to the operator in charge of the pumping apparatus the direction of flow of the liquid through said lateral connection.

21. A pipe line system, comprising a main line, pumping apparatus arranged in series with said main line, storage tanks joined to said main line by lateral connections that are tapped onto said line at points in proximity to the inlet ends of said pumping apparatus, means associated with each of said lateral connections for maintaining or assisting in maintaining the pumping apparatus in such condition as to tend to unify the rate of delivery from said pumping apparatus, and heating devices associated with

said storage tanks for maintaining a relatively small quantity of oil in each of said tanks or a quantity of oil in the lateral connection leading from the tank in a heated condition.

22. In a pipe line system, a main line, a pumping apparatus for forcing liquid through said line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of the pumping apparatus, a means associated with said lateral connection and operated by the flow of liquid through said connection that is used for maintaining or assisting in maintaining said pumping apparatus in such condition as to tend to cause the liquid to flow through the main line without entering said storage tank, and a heating means arranged in proximity to the point where said lateral connection is joined to said tank.

23. In a pipe line system, a main line, a pumping apparatus for forcing liquid through said line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of the pumping apparatus, a means associated with said lateral connection and operated by the flow of liquid through said connection that is used for maintaining or assisting in maintaining said pumping apparatus in such condition as to tend to cause the liquid to flow through the main line without entering said storage tank, and an automatic means for rendering said heating means operative and inoperative.

24. In a pipe line system, a main line, a pumping apparatus for forcing liquid through said line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of the pumping apparatus, a means associated with said lateral connection and operated by the flow of liquid through said connection that is used for maintaining or assisting in maintaining said pumping apparatus in such condition as to tend to cause the liquid to flow through the main line without entering said storage tank, and means for automatically varying the quantity of heat or intensity of heat produced by said heating means.

25. In a pipe line system, a main line, a pumping apparatus for forcing liquid through said line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of the pumping apparatus, a means associated with said lateral connection and operated by the flow of liquid through said connection that is used for maintaining or assisting in maintaining said pumping apparatus in such condition as to tend to cause the liquid to flow through the main line without entering said storage tank, and means whereby the flow of liquid from said tank through said lateral connection causes said heating means to be rendered operative.

26. In a pipe line system, a main line, a pumping apparatus for forcing liquid through said line, a storage tank joined by a lateral connection with said main line at a point in proximity to the inlet end of the pumping apparatus, a means associated with said lateral connection and operated by the flow of liquid through said connection that is used for maintaining or assisting in maintaining said pumping apparatus in such condition as to tend to cause the liquid to flow through the main line without entering said storage tank, and means whereby the flow of liquid through said connection into said tank causes the heat produced by said means to be diminished and the flow of oil from said tank through said lateral connection causes the heat produced by said means to be increased.

27. A pipe line system, comprising a plurality of sections of pipe line arranged in series, with the delivery end of one section connected to the receiving end of the next succeeding section, a pumping apparatus for forcing liquid through each of said sections, a lateral line connected to each of said sections near its delivery end and leading to a storage tank, a heating means arranged in proximity to the point where said lateral line is connected to said tank, means associated with said lateral line for varying the quantity or intensity of heat produced by said heating means in approximate proportion to the rate at which the liquid flows from the storage tank through the lateral line towards the pipe line, and means for stopping or materially reducing the quantity or intensity of heat produced by said heating means if the flow of liquid through said lateral line ceases or if the direction of flow of the liquid is from the pipe line into the storage tank.

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