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DEMARCATION OF FLUIDS IN PIPE LINES

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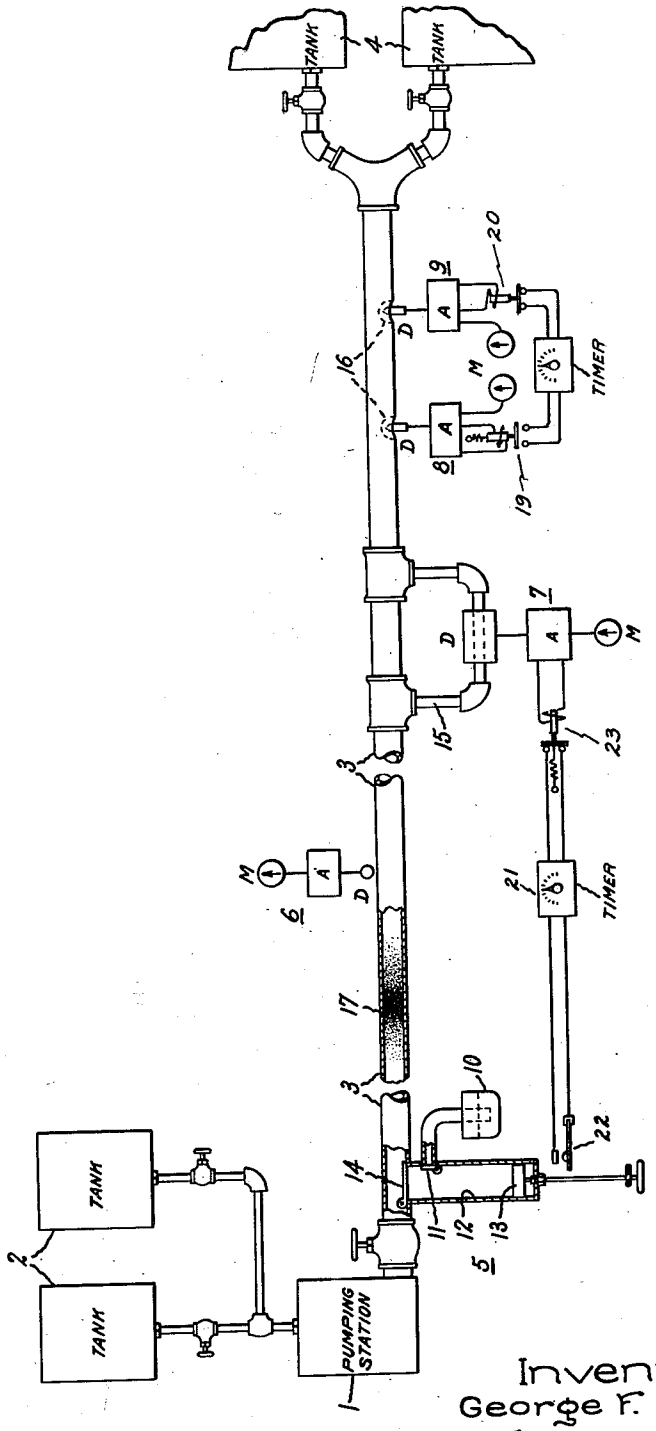


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## DEMARCATION OF FLUIDS IN PIPE LINES

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My invention relates to the demarcation of fluids in pipe lines.

The object of the invention is to provide a method and means for marking fluids in pipe lines whereby the boundary between two fluid bodies flowing in sequence through a pipe line can be located, its movement followed, and the condition of the boundary can be determined.

It is common practice to pipe oil and petroleum products of different grades or types in sequence through a single pipe line, and many attempts have been made to mark the boundary between, for instance, a body of oil of one grade and a body of oil of another grade flowing through the pipe. Solid or liquid foreign bodies have been introduced at the boundary but with little success, since solid objects tend to lodge at valve, bends or joints in the line, whereas liquids are hard to detect, and since both both solid objects and liquid bodies have characteristics differing in some respect from those of the oil, they tend to lag or lead the boundary and may mix through large volumes of the oil. In addition, the presence of foreign bodies in the oil may be objectionable.

It is accordingly a broad object of the invention to improve the marking of oil in pipe lines, and more specifically to provide a method which includes the use of a radioactive isotope as a marking means.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing, in the single figure of which is shown an oil pipe line representative of an embodiment of my invention.

The drawing shows a pumping station 1 for supplying oil, or other liquid, from a selected one of tanks or reservoirs 2 under pressure to a pipe line 3 through which the oil may flow to a desired selected one of remote reservoirs or tanks 4. Pumping station 1 may, for instance, be located at a refinery or in a liquid storage area, and the tanks 4 may represent tanks on a ship or at a remote refinery or storage area. The connecting pipe 3, of course, may be of any desired length up to many miles. Suitable valves are employed for selecting the desired supply tank 2 from which the liquid material is to be drawn, for regulating the flow through the pipe

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line 3, and selecting the desired delivery tank 4.

Along the pipe line 3 from the pumping station are shown in order an insertion or injection pump 5, and detecting and indicating devices 6, 7, 8 and 9, which are sensitive to radioactive discharges. Only one of these indicating devices is necessary in accord with one feature of the invention, though more than one may be desired under circumstances to be later described.

Insertion pump or syringe 5 operates in the manner of a medical hypodermic syringe and is arranged so that a liquid may be sucked from a vessel 10 through a check valve 11 into a cylinder 12 by withdrawing piston 13 and injected into the pipe line 3 through a check valve 14 against the pressure of the liquid in the line by pushing piston 13 further into the cylinder. The fluid thus supplied in accord with the invention contains a radioactive isotope, the fluid including the isotope thus injected having, in accord with the invention, substantially the same physical properties and characteristics as the liquid into which it is introduced. The injected liquid or fluid may be an oil, soap or miscible compound which contains the radioactive isotope. Accordingly, a discrete volume of the liquid in the pipe line is made to include a radioactive isotope, and the isotope-bearing liquid has little tendency to spread in the liquid already in the line since it has the same viscosity, weight and other physical characteristics.

If the isotope selected is of the type emitting a substantial amount of gamma radiation, it may be possible to detect the presence of the radioactive portion of the mass of liquid in the line by the use of a detector and indicator 6 located entirely external to the pipe line since gamma radiations are not completely absorbed or shielded by steel or other metal of the type and thickness ordinarily used for pipes. Detector and indicator 6 may comprise a detecting element D, an amplifier A, and a meter M, it being understood that the detecting element is senstitive to gamma radiation.

If, on the other hand, the isotope yields primarily alpha or beta radiation, it will be necessary to provide a window in the pipe line pervious to such radiations. The detector and indicator 7 is arranged to detect alpha or beta radiations reaching the detector element D surrounding a small bypass pipe 15 through which a portion of the pipe line liquid flows. The pipe 15 has a thin wall and is of a material, such as aluminum, which readily passes alpha or beta

particles. If the wall is sufficiently thin, other materials may be found to be satisfactory. Since alpha radiation will not pass through more than a very thin layer of oil, beta or gamma radiations will be usually found more suitable, and it may be necessary to provide thin windows even for gamma radiations if the wall of the pipe is not sufficiently pervious thereto.

Indicators 8 and 9 represent a modified arrangement for detecting alpha or beta particles, two indicators being shown for a purpose later discussed. In this case, the window takes the form of a cup-like indentation 16 in the pipe line wall, the walls of the indentation 16 being of thin aluminum or other material pervious to the radiation. As a modification of this detector arrangement, the detector element itself may be located inside the pipe and suitable electrical connections thereto sealed through the pipe wall.

Each of the indicators 6, 7, 8 and 9 are shown as comprising a detector element D, an amplifier or pulse counter A, and an indicating meter M. The detector element D of indicator 6 may be conveniently arranged for portable use along the pipe line, whereby the location within the pipe line of the radioactive volume, represented by a shaded area 17 in the drawing, may be determined at any time. With this indicator, for gamma radiations, windows will, in most instances, be unnecessary. The amplifier and meter of device 6 may be portable with the detector or connected thereto through a long extension cord. Indicators 7, 8 and 9 are arranged to indicate the presence, and intensity, of radioactivity at the windows in the pipe line wall, although additional windows may be provided as desired.

The use of two indicators 8 and 9 with their associated detectors spaced apart a known distance along the line, as shown in the drawing, permits a ready determination of the rate of flow of the liquid. Thus, the time elapsed between the occurrence of a maximum deflection of the meter of indicator 8 and the occurrence of a subsequent maximum deflection of the meter of indicator 9 represents the time taken by the liquid to flow between the windows 16, and the rate of flow in feet or barrels per minute, knowing the size of the pipe, is readily calculated. To provide an automatic indication, a clock timer 18 may be arranged as shown with a starting connection to the amplifier of device 8 and a stopping connection to the amplifier of device 9. Any convenient means of starting and stopping may be employed. For example, a relay 19 connected for actuation by the amplifier of device 8 may be closed when the signal from the detector D of device 8 is of a predetermined intensity, to complete an energizing circuit for timer 18, and a similarly arranged relay 20 connected for actuation by the amplifier of device 9 may be used to open the energizing circuit as the signal in device 9 reaches a similar intensity. The timer 18 thus records the length of time for the passage between windows 16 of that part of the discrete radioactive volume of an emission intensity determined by the intensity of emission for which the relays are adjusted to respond. The timer may be calibrated in suitable units of time, or it may read directly in feet per minute, barrels per minute or the like.

A modified arrangement for indicating the rate of flow is also shown in the drawing. In this alternative arrangement, a timer 21 is arranged for starting in response to the closure of a switch 22 at the time of insertion of the isotope-bearing liquid by injection pump or syringe 5. The switch is shown positioned so as to be closed by an extension on the operating rod for piston 13, although any convenient arrangement may be employed. Timer 21 starts at the closing of switch 22 and operates until the intensity of radiation from the discrete volume of radioactive liquid 17, as it passes the detector D of device 7, reaches a predetermined intensity to operate a relay 23 connected for opening in response to a predetermined output voltage from the amplifier of device 7. The timer, accordingly, records the time taken by the volume 17 to reach device 7 after insertion by the syringe a known distance up the pipe line.

My invention is of particular utility in marking the boundary within a pipe line between liquids of different types or qualities that may be caused to flow in the line one after the other. As an example, if the tanks 2 contain oil of respectively different heat unit ratings, or different purities, or different viscosities, or the like, oil from one tank may be pumped into the line up to a desired volume, and at the end of the run of this first type of oil a small volume of an isotope of the oil is injected by the insertion pump 5. The valves are then adjusted to supply oil from the other of the tanks 2 to the line, and as the second type of oil follows the first through the line, the boundary between the two types contains or is marked by the discrete volume of radioactive isotope 17. As the boundary approaches any of the indicators 6, 7, 8 or 9, the indicators begin to indicate the presence of radioactivity until, approximately at the boundary itself, a maximum indication is obtained. A certain amount of mixing will occur, of course, and this will be accompanied by a spreading of the radioactive portion away from the boundary yielding broader indications on the indicators. The indicators are useful, accordingly, not only in detecting the presence of the boundary, but in giving an indication of the amount of intermixture of the two types of oil in the region of the boundary. This indication of the degree of intermixture may be very useful, as, for instance, if a low grade fuel oil is followed in the pipe line by a high grade oil, a radioactive isotope of the low grade oil inserted at the boundary and the low grade oil itself will mix with the following high grade oil at substantially the same rate, and the degree of contamination of the high grade oil at any point will be substantially proportional to the intensity of radioactivity present at that point. Proper segregation of the oils at the remote end of the line is thus possible without resort to the heretofore common necessity of extracting and testing samples to determine the extent of contamination and intermixture of the one oil with the other.

While I have shown only certain preferred embodiments of my invention by way of illustration, many modifications will occur to those skilled in the art and I therefore wish to have it understood that I intend, in the appended claims, to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An arrangement for measuring the rate of flow of a liquid in a pipe line comprising means for inserting into a discrete portion of said liquid, at a predetermined point in said line, a discrete volume of a second liquid containing a radio-

active material to be carried by the flow of said liquid, means located externally of said pipe line for later detecting the emission from said second liquid flowing past two predetermined spaced points in said line remote from said first point, and means for measuring the time lapse between the time of said detections at said predetermined spaced points comprising timing means rendered operative in response to detection of said emission at the first of said two points and rendered inoperative in response to detection of said emission at the other of said two points.

2. Apparatus for indicating the rate of flow of liquid in a pipe line comprising means for injecting a discrete volume of second liquid into said line, said volume of liquid having substantially the same density and viscosity as that flowing in said line and including a radioactive substance, a timer, means for starting said timer in response to operation of said first means, means for receiving emissions from said substance at a predetermined distance along said line in the direction of liquid flow from said first means, and means for stopping said timer in response to reception of said emissions of greater than a predetermined intensity.

3. Apparatus for controllably transporting oil from two sources through a common pipe to a receiving point comprising means for causing the oil from said sources to flow successively and continuously in said pipe toward said receiving point, an injecting pump for mixing into at least one of said oils, substantially at the boundary separating said oils, a discrete volume of a material similar in physical characteristics to the oil from at least one of said sources, said material containing a radiation emitting substance, and a radiation detector disposed at least partially within said pipe and separated from the oil only by a thin member penetrable to said radiation, and indicating means external to said pipe responsive to said detector.



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