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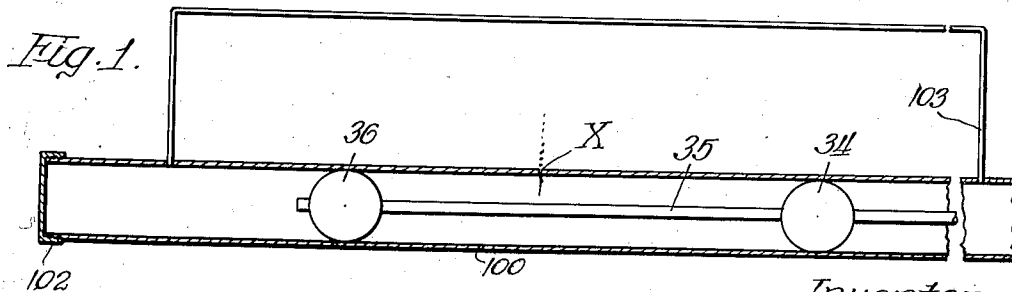
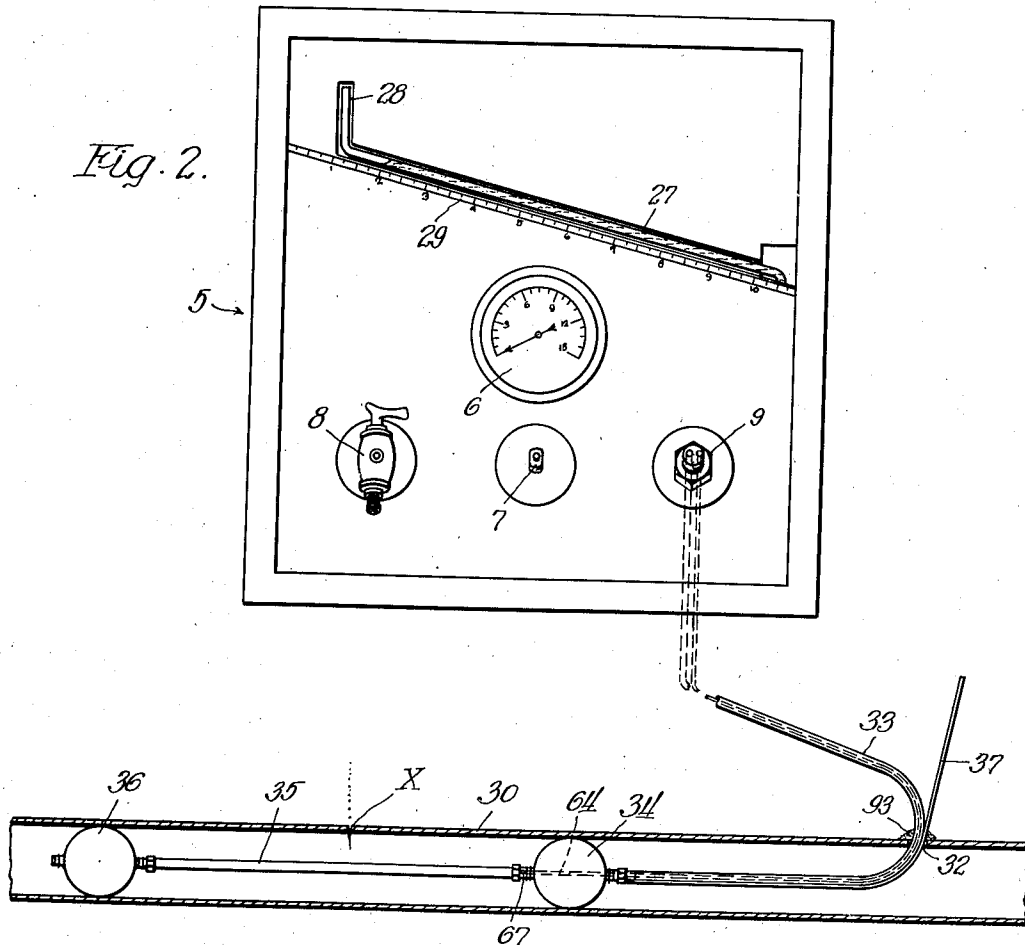
E. F. SCHULDT

2,192,155

METHOD OF AND MEANS FOR LOCATING LEAKS IN A GAS MAIN OR THE LIKE

Filed April 2, 1937

4 Sheets-Sheet 1



Inventor:
Elmer F. Schuldt.

By *W. J. Jackson & Co., Inc.*

Attys.

Feb. 27, 1940.

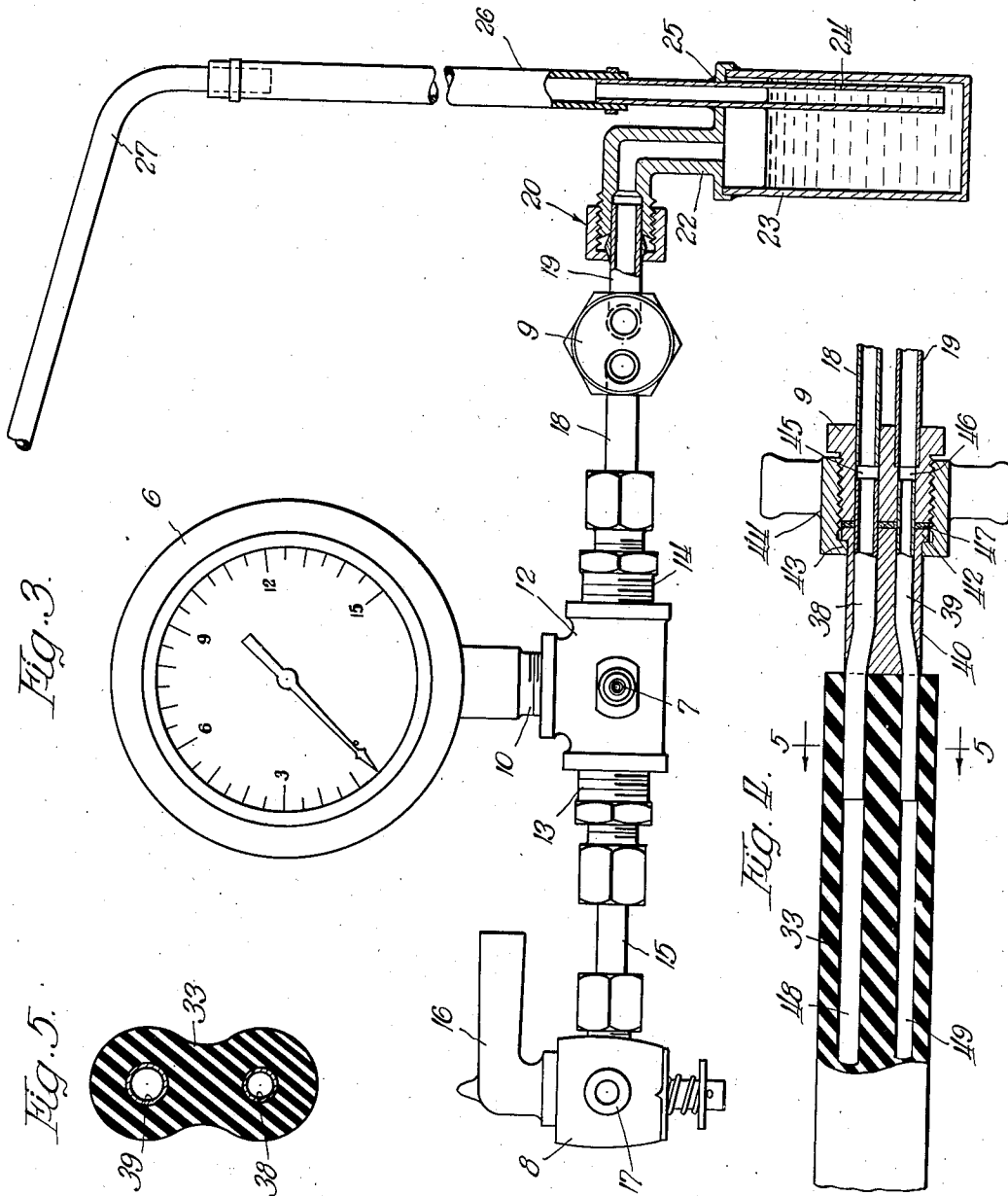
E. F. SCHULDT

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4 Sheets-Sheet 2



Inventor:
Elmer F. Schuldt.

By *Proffackson, Cortis, Dwyer*

Attys.

Feb. 27, 1940.

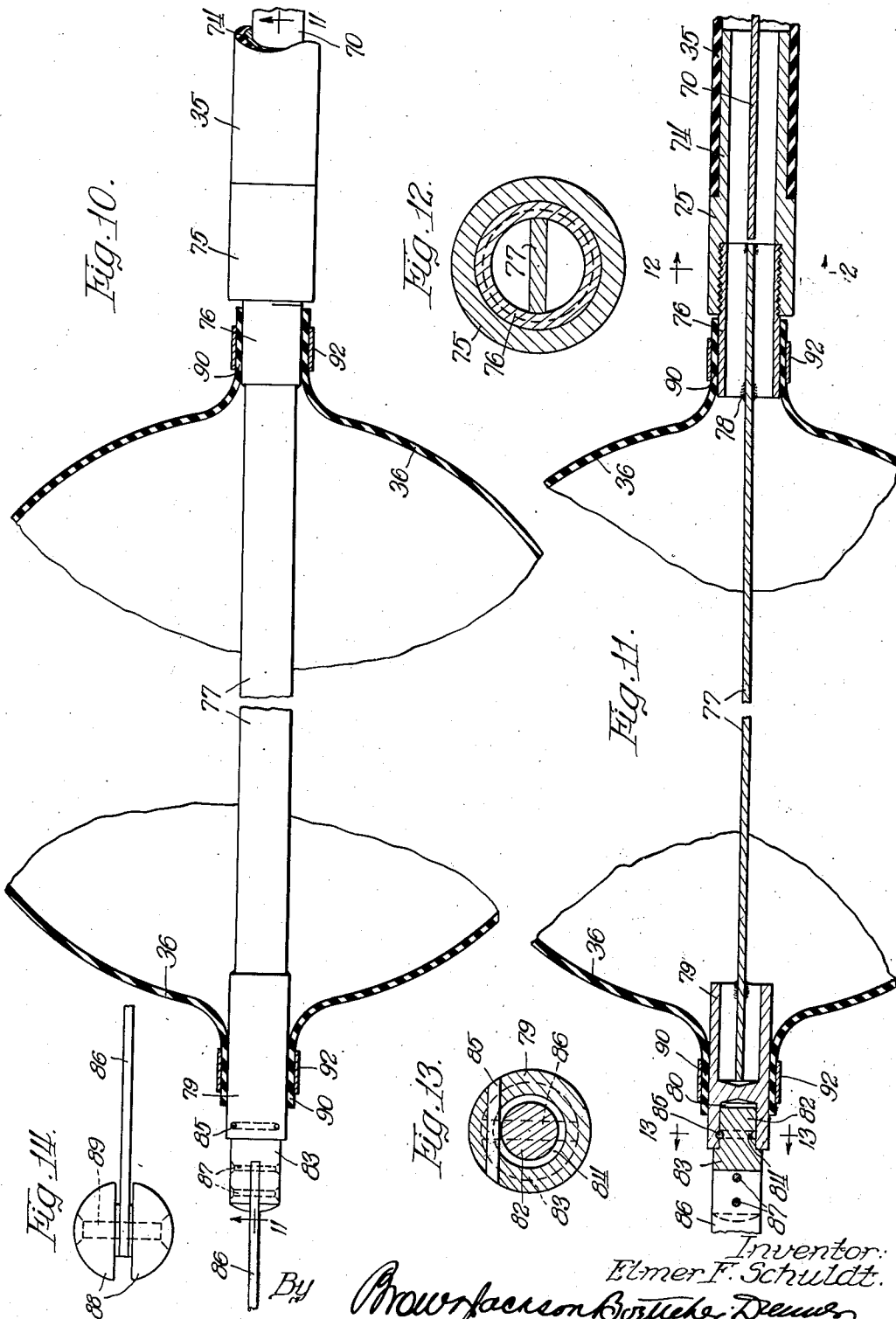
E. F. SCHULDT

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METHOD OF AND MEANS FOR LOCATING LEAKS IN A GAS MAIN OR THE LIKE

Filed April 2, 1937

4 Sheets-Sheet 4



Inventor:
Elmer F. Schuldt.

By *Morrison Bortels, Denver*

Attys

UNITED STATES PATENT OFFICE

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METHOD OF AND MEANS FOR LOCATING
LEAKS IN A GAS MAIN OR THE LIKE

Elmer F. Schultdt, Chicago, Ill.

Application April 2, 1937, Serial No. 134,563

26 Claims. (Cl. 137-77)

This invention relates to a method of and means for locating leaks in gas mains, underground fluid transmission conduits and the like, and more particularly is directed to the location of fluid leaks in low pressure distribution mains from within the conduit itself, to avoid the time, labor and expense of previously known methods of locating such leaks.

The methods used heretofore with which I am familiar, in locating leaks in low pressure gas distribution systems and the like, have been relatively crude and uncertain. The sense of smell has been the most important aid in locating the source of escaping gas. The judgment and experience of the street foreman, and his familiarity with structures in the street adjacent to the gas system, is next in importance. Bar-holes, made by driving a crowbar or the like through the ground to the conduit, are used to advantage, but their value is limited by the type of soil in which the main is laid. Porous soil, such as cinders or the like, will form a gas reservoir under pavement which may extend for more than one hundred feet away from the point at which gas is escaping. Wet clay soil sometimes gives no indication of a leak, even though the bar-holes are driven within a few inches thereof. Bar-holes cannot be readily made when there is frost in the ground.

The gas indicator has been used to excellent advantage to indicate gas concentrations. Bar-holes, pavement cracks, sewers, duct lines, vaults and the like in the vicinity of the gas leak are tested with the indicator. The street opening is made where gas of the highest concentration is found. However, in porous soils, 100% gas may be found in bar-holes extending many feet away from the actual point of leakage.

The gas stethoscope is probably one of the greatest aids developed in recent years for locating service leaks, and aids in locating main leaks between adjacent services. The value of the stethoscope depends largely upon the judgment and experience of the operator, as his ear must be trained to remember and distinguish the various sounds and eliminate those sounds other than gas leak sounds. The instrument has been used with some degree of success in situations where noises are limited, such as an outlying district as distinguished from congested districts.

Use has been made of all of the above mentioned methods in locating leaks, and after a thorough survey, a street opening is made at the most likely spot. Many times the first opening is successfully chosen, and the gas leak is found

in the opening. However, it quite often happens that the first opening is not where the leak is located, and although location of the leak can sometimes be determined by tunneling each way along the main, the limits of a tunneling operation are about five feet, under the best of conditions, and tunneling is impossible during the winter, when frost is down to the top of the main. After more consideration, another opening may be made which may, or may not, be successful. Under some conditions it may sometimes be nothing more than mere luck in locating a leak where gas is leaking into a duct line or the like. In many instances three, four, five or more openings may be necessary to locate a leak. These street openings are wasteful and expensive, and consume much time and labor, especially during colder weather.

Time is also an important element in the location of street leaks. When it takes more than one or two street openings to locate and repair a leak, it naturally takes longer to eliminate the potential hazard. This may be serious when gas is leaking into a building, a sewer, or an underground vault. Present methods have not proved adequate for the location of leaks with a minimum of expense and time.

It has been considered to locate gas leaks from the inside of the main rather than from the outside. The use of a small anemometer has been considered, this being used by stopping the flow of gas in the main from one direction, and any flow to the leak must therefore come from the other direction. By pushing the anemometer through the main to a point just beyond the leak, the flow of gas should be able to actuate the anemometer to give an indication. However, while this device might be used to locate an unusually large leak in a small main, it is necessarily a delicately balanced instrument, which is difficult to manipulate through a main, and for low pressure leaks has not been of any considerable value.

Another attempted solution of this problem was the use of a small microphone pushed along inside the main and employing the principle of the stethoscope. Vibrations set up by the gas leak would be caught by the microphone and transmitted to suitable amplifying means where the intensity could be determined with an indicating meter. Preliminary experiments indicated that it was impossible to differentiate between the sounds caused by a leak of the same magnitude anywhere along a test pipe of some 25 feet in length.

As another attempted solution of this problem, a long rubber bag could be inserted into the main and inflated and deflated in successive sections of the main. When the bag was located where the leak was occurring, it would seal off the leak and surface indications thereof would stop. However, in some cases, it is necessary to keep the section "bagged off" for an hour or more in order to be sure that the leak is in the section isolated, because the ground under the pavement sometimes makes an excellent reservoir or pocket for the gas, and the odor persists long after the leak is blocked off. Such a method therefore is not desirable, because of the time element involved, and other disadvantages which have arisen in practical use.

The present invention contemplates an improved method of and means for locating leaks in low pressure transmission mains by employing the principle of locating the point at which a pressure drop in the main occurs. The location of such a pressure drop would indicate that there is a leakage of gas from an opening in the main at the point at which the pressure drop occurs. However, the fact that most leaks are slight in rate of flow as compared with the large volume of gas always available would ordinarily render it difficult to measure this pressure drop correctly. It is therefore an object of the present invention to provide means for interrupting the supply of gas to the section of main being tested, so that the pressure drop can be easily measured, because it would be of an appreciable value as compared to the static pressure in the main.

In carrying out the present invention, an opening is made in the main as closely adjacent the leak as can reasonably be determined by the experience and judgment of the operator. Through this opening a pair of gas main bags are inserted, carried on suitable means spacing the bags apart and also providing for inflation of the bags from conduit means extending through the opening. The bags are then inflated and, by suitable means located between the bags, the pressure between the bags is determined upon suitable gauge means disposed at or adjacent the opening. If no appreciable pressure drop occurs in the section of the main under test, the bags are deflated, moved to a next succeeding position slightly overlapping the previous position, and again inflated. By successively moving the bags along the interior of the main and stopping off flow between the bags while testing the pressure therebetween, the location of the leak can be readily determined by the indication of the pressure gauge. Tests with this apparatus provide a definite indication on the differential gauge with a leakage as low as $\frac{1}{4}$ cu. ft. per hour. With larger leakages, differentials approaching the main pressure were obtained. By the use of this method, in which the means which carries the bags and permits inflation thereof is also provided with suitable length indicating means for determining the position of the bags with respect to the opening, the sections of the main extending in both directions away from the opening can be successively tested until the point at which the leak is located has been determined. After the leak has once been located, the apparatus can be shifted in smaller increments of movement until the exact position of the leak is located, after which a street opening can be made and the leak repaired. Thus, at the most, only two street openings are required in order to provide for

definite location and repair of gas leaks in distribution systems of this type.

In tests, the apparatus was used and successfully located leaks spaced from the opening a distance of from 100 to 200 feet. Longer distances could, of course, have been obtained without departing from the principles involved in the present method of locating leaks of this type.

Another feature of the present invention resides in the provision of apparatus whereby the tests can be successively made along the section of the main under test with relatively no appreciable time interval between tests, whereby a substantially continuous testing of the successive sections of the mains is obtained, which greatly reduces the time required for locating and repairing the leak.

Still another feature of the present invention is the provision of apparatus which is simple in design and assembly, economical in manufacture, and which can be easily set up in operation by any street foreman or similar employee.

The present invention also contemplates the method of locating gas leaks where the leak is located in a dead-ended main, wherein the pressure to the leak is from one side of the main only, which has heretofore been extremely difficult with previous types of testing and locating apparatus.

Other objects and advantages of the present invention will appear more fully from the following detailed description which, taken in conjunction with the accompanying drawings, will disclose to those skilled in the art the particular construction and operation of a preferred form of the present invention.

In the drawings:

Figure 1 is a diagrammatic view showing one manner in which a test on a gas main is accomplished by means of the present invention;

Figure 2 is a view diagrammatically illustrating the control panel and the testing apparatus in position within a main;

Figure 3 is a detail view of the connections at the control panel;

Figure 4 is a view, partly in section, showing the connection from the panel to the apparatus to be disposed within the main;

Figure 5 is a sectional view through the flexible conduit member taken substantially on line 5-5 of Figure 4;

Figure 6 is a sectional view of the connection to the first gas main bag;

Figure 7 is a sectional view taken substantially on line 7-7 of Figure 6;

Figure 8 is a sectional view through the connection from the forward end of the first gas bag to the conduit extending between the bags;

Figure 9 is a sectional view taken substantially on line 9-9 of Figure 8;

Figure 10 is a view, partly in elevation, of the forward gas bag connection;

Figure 11 is a sectional view taken substantially on line 11-11 of Figure 10;

Figure 12 is a sectional view taken substantially on line 12-12 of Figure 11;

Figure 13 is a sectional view taken substantially on line 13-13 of Figure 11; and

Figure 14 is a view showing a guiding member for the forward end of the testing apparatus.

Referring now in detail to the drawings, and more particularly to Figures 2 to 14, inclusive, I have provided a control panel indicated generally at 5, which panel is preferably mounted in a housing in such manner as to be inclined for

facilitating reading of the same when it is set on the street or in a similar location adjacent the point at which the test is being made. This panel is provided with a pressure gauge 6, which
 5 gauge is provided for indicating the pressure within the bags located within the gas main, and is also provided with a pressure connection 7 to which may be attached any suitable type of pump or the like for producing a pressure within the
 10 system. A suitable exhaust valve 8 is also provided on the forward edge of the panel, for releasing the pressure within the apparatus, the valve 8 being provided with suitable means whereby an exhauster may be attached thereto
 15 if it is desired to provide some means of rapidly exhausting the fluid within the system.

On the opposite side of the inlet 7 from the exhaust valve 8, I preferably provide a connection indicated generally at 9, to which is attached the
 20 conduit for conducting the fluid under pressure from the control panel through the gas main opening and into the bags disposed in the opening.

Considering now in detail Figure 3, it will be
 25 noted that the pressure gauge 6 is provided with an extension 10 whereby it may be connected to the T member 12, which T member is provided with oppositely extending fittings 13 and 14, and is also provided with the tapped pressure inlet
 30 connection 7, this preferably being in the form of a valve stem or the like to which a pump may be connected in any suitable manner. From the fitting 13, a conduit is extended, as indicated at 15, leading to the exhaust valve 8, which valve is
 35 provided with a manually operable valve plug 16, whereby it may be closed, or may be opened to allow exhaust of pressure through the outlet 17. From the opposite fitting 14, a conduit 18 is extended into the bushing connecting member 9,
 40 which is mounted on the control panel as indicated in Figure 2, this bushing 9 also being provided with a second conduit 19 leading into the coupling indicated generally at 20, which connects through the cap member 22 to the interior of a tank 23 adapted to contain alcohol or a
 45 similar indicating fluid. The tank 23 is provided with a conduit 24, which extends down to a point adjacent the lower end thereof and is suitably sealed to the cap member 22, as indicated at 25.
 50 The conduit 24 is connected through the member 30 to an angularly extending glass tube 27 which is supported in an inclined position on the control panel 5, as indicated in Figure 2, and has its outer end bent upwardly, as indicated at 28. A
 55 suitably graduated scale 29 is provided on the panel 5, whereby the level of the fluid within the tube 27 is indicated on the scale, and the relative drop or rise in this level can readily be determined by means of the graduations on the scale.
 60 It will thus be apparent that the effective pressure in the conduit 19 will cause a corresponding pressure on the surface of the liquid in the tank 23, and consequently produce a certain head of liquid in the member 26 and tube 27, which level
 65 will vary with the pressure in the conduit 19 to give an indication in the testing of a gas main for leaks.

Considering now Figure 2 in further detail, a gas main is indicated generally at 30, and at a
 70 suitable point in the main, which can be determined by the skill and experience of the operator, an opening is made as indicated at 32, through which opening a flexible conduit member formed of molded rubber or the like, indicated at
 75 33, may be extended. This conduit 33 is con-

nected at its far end with a first gas bag member 34, and thence through the spacing conduit 35 to the forward gas bag member 36. Preferably a steel tape 37 is secured to the rear end of the first
 5 gas bag member 34, and is suitably graduated so that upon pushing of the tape the bags 34 and 36 are moved longitudinally along the interior of the main a distance determined by the graduations on the tape 37. The connection 35 between
 10 the two bags is sufficiently rigid to maintain the spacing approximately the same throughout the movement of the bags.

In Figure 4 I have illustrated in detail one manner in which the conduit 33 may be con-
 15 nected to the conduits 18 and 19 and the bushing 9. As will be noted, the conduit 33, which is preferably formed of molded rubber or the like, is provided with spaced tubes therein, indicated at 38 and 39, which preferably in the form of copper or similar flexible tubes, which are embedded in
 20 the rubber of the member 33 and project from one end thereof, as shown in detail in Figure 4. The tubes 38 and 39 preferably extend into a suitable connection member 40, having a flange 42 at one end thereof which is engaged within
 25 the flanged end 43 of a wing nut 44. The wing nut 44 is threaded over bushing 9 to bring the ends of the tubes 38 and 39 into cooperative relationship, through the passageways 45 and 46, with the ends of the conduits 18 and 19 carried by the
 30 bushing 9. Suitable gasket means 47 is preferably provided for sealing the connection between the members 40 and 9, to prevent any leakage of fluid around the openings 45 and 46 between the two members. The conduit 33 extends from the con-
 35 trol panel connection provided by the wing nut 44, and throughout the major portion of its length is provided with the molded recesses 48 and 49 communicating, respectively, at the control panel end of the tubing with the tubes 38
 40 and 39, and at the opposite end having communication with a pair of tubes 50 and 52 carried by a coupling member 53 corresponding somewhat to the member 40 of Figure 4, having a flanged end 54 engaged by the flanged end of
 45 the coupling nut 55.

The member 53 is also provided with a pair of spaced openings adapted to receive the screw members 56 for securing the steel tape 37 to the member 53, as shown in detail in Figure 7, where-
 50 by the tape is rigidly secured to the coupling member and extends longitudinally alongside the conduit 33.

The coupling nut is threaded over a bushing member 58, there being suitable gasket means
 55 59 disposed between the end of the bushing and the flanged end 54 of the member 53. The tubes 50 and 52 extend into suitable recesses in the bushing member, and the tube 50 is adapted to have communication through the bushing mem-
 60 ber with a tube 60 extending through the sleeve 62, this sleeve being provided with a transverse partition member 63 preferably formed of spring material and extending into the gas bag 34 beyond the sleeve member 62. The sleeve member
 65 62 opens into the bushing 58 in communication with the tube 52, whereby fluid under pressure passing from the conduit 18 through the bushing 9 and through the tube 38 and passageway 48 to the tube 52 enters the interior of the bag
 70 34 and produces inflation thereof to the form shown in Figure 2. The tube 60 is provided, adjacent its opposite end, with a flexible conduit member 64 which may be cemented thereto, the member 64 connecting with a tube 65 as
 75 76

shown in Figure 8, leading outwardly through the sleeve member 66 as indicated at 67 to a point intermediate the bags 34 and 36, such as indicated in Figure 2. The sleeve member 66 is provided with an open passageway which communicates on opposite sides of the spring member 63 with the interior of a coupling member 68 threaded over the outer end of the sleeve 66 and forming a continuation thereof. The coupling member 68 is also provided with a resilient steel spring member or the like, indicated at 70, which may be either a flat spring member or may be a helically coiled spring member, as desired, which extends within the conduit 35 and is cemented over a reduced portion 72 of the member 68. Fluid under pressure from the interior of the bag 34 therefore passes through the port 73 of the sleeve member 66 and through the coupling member 68 into the interior of the conduit 35, which is preferably a flexible conduit such as reinforced rubber tubing or the like.

At its opposite end, the tubing 35 is secured to the reduced portion 74 of a coupling member 75 threaded to the outer end of a sleeve 76 to which the bag 36 is connected. The member 70 is preferably spot welded or otherwise secured to the interior of the coupling member 75, and therefore forms a resilient connection between the coupling members 68 and 75. Fluid under pressure therefore enters the interior of the bag 36 to inflate the same. The sleeve member 76 is also provided with a resilient spring member 77, welded or otherwise suitably secured thereto as indicated at 78, which extends through the bag 36 and is secured at its opposite end to the interior of the end member 79 to which the opposite end of the bag 36 is secured.

The member 79 closes off the forward end of the bag 36, so that no further transmission of fluid outwardly from the bag 36 is possible.

At its outer end, the member 79 is recessed as indicated at 80, to receive the reduced end 82 of a guide supporting member 83. The member 83 has a groove 84 formed in its reduced end, which is clamped in position by the transverse pin 85 extending through the member 79. This allows the member 83 to rotate with respect to the member 79, but prevents any relative longitudinal movement therebetween. Secured to the forward end of the member 83 is a resilient arm member 86, which enters into a slotted portion in the end of the member 83 and is secured therein by means of rivet members 87. The arm 86, at its forward end, is provided with a suitable pivot pin 87 upon which two oppositely disposed semi-spherical roller members 88 are mounted for free rotation. By the provision of this guiding member, as the testing assembly is pushed through the gas main, the rollers 88 will guide the same around bends or the like in a gas main, especially when an offset is provided to clear a vault or underground manhole, in which case the apparatus must be guided through 45° elbows and by the provision of the rollers 88, this can be accomplished without any substantial buckling or distortion of the assembly.

The gas bags 36 and 34 are preferably made of a material such as rubber or the like, which may be treated to provide a wear-resisting surface, and which, at opposite ends, are provided with projecting nipple portions indicated generally at 90. These nipple portions are suitably cemented to the external surfaces of the respective sleeve members 62, 66, 76 and 79, and if

desired, in order to assist in retaining the nipples in sealing contact with the external surfaces of the sleeves, to prevent air leaking therepast, suitable clamping rings 92 may be provided encircling the nipples 90 and holding the same firmly against the external periphery of the sleeve.

In the operation of the structure thus far described, the system is inserted through the opening 32 in the gas main in a deflated condition, that is, with the bags 34 and 36 deflated. It is initially set up with the bag 34 adjacent the opening 32, and the bags are then inflated by applying a pump or the like to the pressure inlet 7 and developing a pressure in the system which will be indicated by the gauge 6. This fluid under pressure is transmitted to conduit 18 extending from the T fitting 12 and through the tube 38 and conduit 48 of the flexible tubing 33 to the interior of the first bag 34 through the sleeve 62. This bag is thereupon inflated, and the remaining pressure transmitted through the conduit 35 into the interior of the bag 36 through the sleeve 76. The bags are preferably inflated to a pressure of approximately 6 lbs. as indicated on the gauge 6, the normal gas pressure within the main being tested being of the order of $\frac{1}{4}$ lb. per square inch. Upon inflation of the bags, if there is any leak between the two bags 34 and 36, the port 67 of the tube 65 will indicate a decrease in pressure between the bags, this decrease in pressure being transmitted through the conduits 68 and the tube 50 to the tubing 33, and from this tubing through the conduit 19 to the tank 23. A decrease of pressure will result in falling of the liquid level in the tube 27, as indicated upon the scale 29, and the rate of fall of this liquid will determine the quantitative amount of gas issuing from the leak. With the apparatus as thus operated, a leak of $\frac{1}{4}$ cu. ft. per hour has been indicated upon the gauge 27. If there is no leak between the bags 34 and 36, indicating no leak in that section of the main, there will be no decrease of pressure, sensed by the apparatus, and consequently the level of the fluid in the tube 27 will remain stationary.

Preferably the bags 34 and 36 are spaced apart a distance of approximately 9 ft. by the conduit 35 and the steel spring member 70. The tape 37 may be graduated in any suitable manner, and preferably the bags are successively moved along the line in steps of approximately 8 feet, to insure that there will be an overlapping of the respective positions of the bags, in order to insure the detection of any leak approximately at the point where the bags may be located.

If no drop of pressure in the main between the bags is sensed after the initial set-up, the pressure is released by opening the valve 8, and the bags then deflated and moved further along the main by the tape 37 to a point in which the rear bag occupies a position slightly behind the initial position of the forward bag. The bags are then again inflated, and a test is made to see whether there is any drop of pressure therebetween within the main. For example, supposing a leak at the point indicated at X in Figure 2, the decrease of pressure caused by gas escaping from this leak will be signified by a drop in liquid level on the gauge 27, and consequently the fact that a leak between the position of the bags is present will be obvious. By then shifting the assembly forwardly and rearwardly to a point where the bags are located closely adjacent the

leak, the exact position of the leak with respect to the opening 32 can be determined by the graduations on the tape 37. It is then only necessary to dig down to the main at this point and to repair the leak. It is to be understood, of course, that when the assembly is inserted through the opening 32 and inflated in position, soap or the like, as indicated at 93, is applied about the opening to prevent the escape of gas therepast. The bags preferably are maintained in position during the repair of the leak to prevent any further leakage of gas. The spaced bags may also be used to determine the condition of a main independently of location of leaks, and can be used to shut off sections of a main in case of fire at a service where the shut-off valves are inaccessible.

It will thus be apparent that the system is extremely accurate in locating the precise position of leaks within a main, and by the provision of a suitable length of tubing 33 and tape 37, the apparatus may be employed for locating leaks at any distance from the initial opening 32. Further, by means of the guiding member indicated in Figure 14, the apparatus can be successfully pushed around offsets or elbow turns in the main.

In making a test on a section of gas main which is suspected of leakage, it is of course necessary to shut off the service connections at the different sections being placed under test. However, by the use of the present invention, it is possible to maintain service at all connections except approximately a distance of say 25 or 30 feet, corresponding to a building lot, in which the test is being conducted. After this section of the main has been tested the service can be again connected, and the next service connection can be closed off for testing of the main adjacent that service connection.

If the apparatus indicates a leak at the service connection, it is of course necessary to then test the service connection itself, since obviously the leak is not in the distribution main proper.

By the present system it is therefore possible to locate gas leaks without the necessity of making more than two openings in the street or pavement, and it is also possible to locate precisely the point at which the gas is escaping prior to making the second opening, so that the opening can be made at the point which will to the greatest extent facilitate repair of the leak.

It sometimes happens that a distribution system is laid out in which certain of the mains are dead-ended, that is, are not connected so that gas may be fed from both ends thereof to the intermediate section. Such a system is illustrated in Figure 1, in which the main 100 is provided with the dead-end or closure cap 102. In such a main, in order to make an accurate test for gas leaks, it becomes necessary to provide a by-pass line 103, whereby gas posterior to the testing apparatus may be transmitted through the line 103 to a point anterior to the testing apparatus, so that the gas pressure upon the outer surfaces of the bags 34 and 35 can be maintained, whereby the bags will shut off flow of gas from both ends of the main toward the leak, and will thereby produce an indication of the leak at the point marked X. However, this is a specific type of test, and in the ordinary distribution main, which is fed from both directions, no such by-passing arrangement need be provided.

It is therefore believed that the present invention possesses distinct advantages in the reduction of time and labor necessary for locating and

repairing leaks in gas mains of distribution systems and the like. Further, the present apparatus allows for the location of such leaks without making a number of openings in the pavement or the soil structure above the main.

It is, of course, possible to use means other than inflatable gas main bags for interrupting the supply of gas to the section of main under test, such as mechanically actuated expandable members or the like.

I am aware that various other changes may be made in the details of construction in the illustrated embodiment of the invention, and therefore do not intend to be limited except as defined by the scope and spirit of the appended claims.

I claim:

1. The method of locating a leak in a gas distribution main having gas continuously flowing therethrough, which comprises establishing, from a point externally of said main, a static pressure condition within successive overlapping sections of said main, and indicating at said external point any variations in the static pressure caused by leakage from within the particular section at which said condition has been established.

2. The method of locating a leak in a fluid transmission main, which comprises successively internally blocking off sections of the main against fluid flow thereinto, and indicating externally of the main the fluid pressure conditions in the section of main so blocked off.

3. The method of locating a leak in a fluid transmission conduit, which comprises internally blocking off a predetermined length of said conduit against fluid flow thereinto, continuously indicating the fluid pressure in said length, and successively blocking off overlapped lengths of said conduit to determine the particular length in which the pressure decreases when so blocked off.

4. The method of locating a leak in a fluid transmission conduit, which comprises successively internally blocking off fluid flow into predetermined lengths of said conduit from a given reference point, continuously indicating the fluid pressure conditions in the lengths blocked off to determine the particular length in which the pressure decreases, and continuously indicating the distance from said reference point to the length under test.

5. The method of locating a leak in a fluid transmission conduit having fluid continuously flowing therethrough, which comprises testing successively predetermined lengths of said conduit by internally blocking off fluid flow to the length under test, and determining any leakage in the length under test by sensing the variation in pressure in the said length.

6. The method of locating a leak in a fluid transmission conduit having a substantially predetermined fluid pressure therein, which comprises testing from a given reference point successive predetermined lengths of said conduit, to determine the variation in static pressure in said length under test while preventing fluid flow to said length under test.

7. The method of locating a leak in a gas distribution main having gas flowing therethrough, which comprises opening said main at a given point, testing successive sections of said main in uniform steps from said point for variations in static pressure in the section under test, and simultaneously indicating the distance from said point to the section under test.

8. The method of testing a section of a gas

main for leakage, which comprises blocking said section at two spaced apart points to shut off gas flow through said section while trapping gas therein between said two spaced apart points, measuring variations in static pressure of the trapped gas, and measuring the distance from said section to an exterior remote point.

9. Apparatus for locating a leak in a gas distribution main comprising a pair of expansible members spaced apart a predetermined distance and movable as a unit axially through said main from a given reference point, means connected to said members and operable from adjacent said point for expanding said members to shut off gas flow into the section of the main therebetween, a gauge located adjacent said point and having a pressure connection opening into said main section intermediate said members for indicating variations in static pressure in said section, and means for measuring the distance from said reference point to said pair of expansible members.

10. Apparatus for locating a leak in a gas distribution main comprising a pair of expansible members spaced apart a predetermined distance and movable as a unit axially through said main from a given reference point, means connected to said members and operable from adjacent said point for expanding said members to shut off gas flow into the section of the main therebetween, a gauge located adjacent said point and having a pressure connection opening into said main section intermediate said members for indicating variations in static pressure in said section, and means operable from said point for moving said members axially through said main.

11. Apparatus for locating a leak in a gas distribution main comprising a pair of expansible members spaced apart a predetermined distance and movable as a unit axially through said main from a given reference point, means connected to said members and operable from adjacent said point for expanding said members to shut off gas flow into the section of the main therebetween, a gauge located adjacent said point and having a pressure connection opening into said main section intermediate said members for indicating variations in static pressure in said section, and means operable from said point for moving said members axially through said main, said means having indicia thereon for indicating the position of said members relative to said point.

12. Means for locating a gas leak in a distribution main, comprising a pair of expansible members interconnected in predetermined spacing and movable as a unit axially of said main, means for expanding said members to prevent gas flow therebetween, including flexible means for transmitting the expanding force to said members from a remote point, a pressure connection carried by said last named means and open intermediate said members, means at said point responsive to pressure in said connection for indicating the pressure in the main intermediate said members, and means for moving said members axially of said main and simultaneously indicating the position of said members with respect to said point.

13. Apparatus for locating a leak in a gas distribution main, comprising a control panel, a pair of inflatable members adapted to be inserted in deflated condition through a relatively small opening in the main and having a relatively stiff pressure-transmitting connection therebe-

tween of predetermined length, a flexible pressure-transmitting conduit between said members and said panel having two passageways therein, means at said panel for supplying fluid under pressure through one of said passageways to inflate both said members for stopping off gas flow in said main between said members, said other passageway being open to the interior of said main between said members, gauge means at said panel connected to said other passageway and responsive to the pressure in said main between said members, and means for moving said members axially along said main from said opening and including means indicating the position of said members relative to said opening.

14. In apparatus for locating a leak in a gas distribution main, a unit for stopping off flow of gas to a section of main under test, comprising a pair of inflatable members adapted to be inserted into the main in deflated condition, a resilient inextensible spacing means between said members and extending at one end through the rear member, a flexible pressure-transmitting conduit connected to the rear member, a second flexible pressure-transmitting conduit enclosing said spacing means and communicating with the interior of both said members for equalizing the pressure therebetween, inextensible propelling means secured to the extended end of said resilient inextensible spacing means, whereby said unit can be moved axially within said main and said members can be inflated and deflated from a point externally of said main, and a pressure connection extending into the space between said inflatable members.

15. In apparatus for locating a leak in a gas distribution main, a unit for stopping off flow of gas to a section of main under test, comprising a pair of inflatable members adapted to be inserted into the main in deflated condition, a resilient spacing means between said members, a flexible pressure-transmitting conduit connected to the rear member, a second flexible pressure-transmitting conduit enclosing said spacing means and communicating with the interior of both said members for equalizing the pressure therebetween, and a fluid pressure connection extending through said first flexible conduit and through said rear member and opening into the main intermediate said members whereby variations in static pressure in said section of said main can be indicated externally of said main.

16. In apparatus for locating a leak in a gas distribution main, means for successively testing predetermined sections of said main, comprising a pair of expansible members spaced apart a predetermined distance and having means extending outwardly of said main at a given reference point for moving said members axially within said main and for expanding said members to shut off flow of gas to the section of the main between said members, and means for indicating the distance from the section under test to said reference point.

17. In apparatus for locating a leak in a gas distribution main, means for successively testing predetermined sections of said main, comprising a pair of expansible members spaced apart a predetermined distance and having means extending outwardly of said main at a given reference point for moving said members axially within said main and for expanding said members to shut off flow of gas to the section of the main between said members, and means opening into said main intermediate said members and ex-

tending through said expanding means for indicating externally of said main at said reference point variations in static pressure in said main section between said members.

18. A method of locating leaks in a fluid transmission main, which comprises making an opening in the main at a point adjacent the leak, inserting interconnected spaced fluid blocking means into the main through the opening, continuously registering the fluid pressure in the section of main between said blocking means, and moving said means into successive overlapping positions along the main until the pressure registration indicates a continuous decrease in pressure in the section of main between said blocking means.

19. The method of locating a leak in a gas distribution conduit, which comprises interrupting the supply of gas to the section of main under test, measuring the pressure drop in the section to which the supply has been interrupted, and measuring the distance from a reference point to the section in which a pressure drop has been ascertained.

20. The method of locating a leak in a gas distribution conduit, which comprises interrupting the supply of gas to successive overlapping sections of main, and successively measuring the rate of pressure drop in each section after the gas supply thereto has been interrupted.

21. The combination, with apparatus of the class described for locating a leak in a gas distribution main, of means for interrupting the flow of gas into a selected section of said main, comprising a pair of inflatable bags, each of said bags having a nipple at opposite ends thereof, a flexible conduit connecting adjacent nipples of each bag, resilient spacing means within said conduit, a closure for the opposite nipple of one of said bags, and a pair of pressure connections, one extending to the opposite nipple of the other of said bags and the other extending through said other bag and into communication with the space between said bags.

22. The method of determining the condition of successive sections of a gas distribution main having gas flowing therethrough, which comprises successively interrupting the supply of gas to said sections, and measuring the pressure conditions in the section under test.

23. The method of determining the condition of successive sections of a gas distribution main having gas flowing therethrough, which comprises successively interrupting the supply of gas to said sections, slightly decreasing the volume in the section under test, and indicating any variations in static pressure in said section.

24. Apparatus for locating a leak in a gas distribution means comprising a pair of inflatable

bags, a tubular member connecting said bags, whereby the interior of one bag is in communication with the interior of the other, a conduit connected at one end to one of said bags and having two generally longitudinally extending bores formed therein, a tubular connection leading from one of said bores into communication with the interior of said bags, a second tubular connection leading from the other bore to said one bag and into the space between said bags, and pressure measuring means connected to said conduit in communication with said second bore.

25. Apparatus for locating a leak in a gas distribution main, comprising a pair of inflatable bags, each having a resilient inextensible member connecting the ends thereof, a tubular member connecting said bags and providing for communication from the interior of one bag to the interior of the other, a resilient inextensible member disposed within said tubular connection and connected at its opposite ends to the inextensible members in said bags, a conduit having generally parallel longitudinally disposed bores therein and connected at one end to the outer end of one of said bags and the outer end of the inextensible member associated therewith, a tubular connection from one of said bores to the interior of said bags, a second tubular connection from the other of said bores to the space between said bags, said second connection including a flexible section and extending generally along the inextensible member in said one bag, and pressure measuring means associated with said other bore.

26. Apparatus for locating a leak in a gas distribution main, comprising a pair of inflatable bags, a tubular bushing secured at each end of each of said bags, a resilient inextensible member disposed in each of said bags and connected at each end to the associated bushing, a tubular member connecting adjacent ends of said bags and including bushings at the end thereof connected to the bushings at the adjacent ends of said bags, a resilient inextensible member disposed within said tubular member and connected to the bushings at the outer ends of the latter, a conduit having generally parallel longitudinally disposed bores therein, a tubular connection from one of said bores leading through the adjacent bushing into the interior of said one bag, a second tubular connection leading from the other bore through said one bag and outwardly through the bushing at the other end thereof into communication with the space between said bags, and pressure supplying and measuring means adapted to be connected, respectively, with the outer ends of said bores.

ELMER F. SCHULTZ.

CERTIFICATE OF CORRECTION.

Patent No. 2,192,155.

February 27, 1940.

ELMER F. SCHULDT.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 7, second column, line 6, claim 24, for the word "horses" read bores; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 2nd day of April, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.