Automatic Tank Battery Operation with Skid Mounted P. D. Meters and Components

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INTRODUCTION

Cities Service has three automatic tank batteries, all of which use positive displacement meters. All of these batteries are unattended and automatic in operation. Oil is produced, monitored, treated and run to the pipeline without manual intervention.

Although positive displacement meters are the heart of these units, there are other components just as necessary and important to automatic custody transfer (ACT) of oil to the pipeline.

This paper will discuss the ACT Units as developed by Cities Service with special emphasis on the components used to accomplish the necessary functions of automatic battery operation.

DIFFERENCES BETWEEN A REGULAR TANK BATTERY AND ACT

A regular tank battery (Fig. 1) may be composed of a gunbarrel or heater treater, enough stock tanks to hold 3 to 4 days production and a BS pond to contain tank bottoms.

A pumper must visit the battery at frequent intervals to

1. Fill and top out tanks.
2. Gage tanks for daily production.
3. Pump out tank bottoms.
4. Meet with the gager to witness tank runs.
5. Treat bad oil if gager refuses to run the oil.

A gager must visit the lease several times each month to

1. Gage full tanks.
2. Thief oil to determine BS&W oil gravity.
3. Put tanks on line.
4. Write several run tickets.
5. Seal tank stops.

An automatic custody transfer battery (ACT) as designed and operated by Cities Service consists of two heater treaters, one bad oil tank, one pipeline surge tank, a double monitor skid, a bad oil return skid, and a positive displacement meter skid.

ACT Batteries

ACT batteries are designed to automatically monitor produced oil for BS&W, treat bad oil, and meter the oil to the pipeline. None of these operations require the attendance of a pumper or gager. Using ACT the gager visits the lease once each month to obtain a printed run ticket showing the oil run during the month. At this time the gager checks a composite sample of the oil runs saved in a pressurized container for BS&W and oil gravity. The gager, during his one monthly visit, will also witness the proving of the sales meter and record the meter factor on the run ticket.

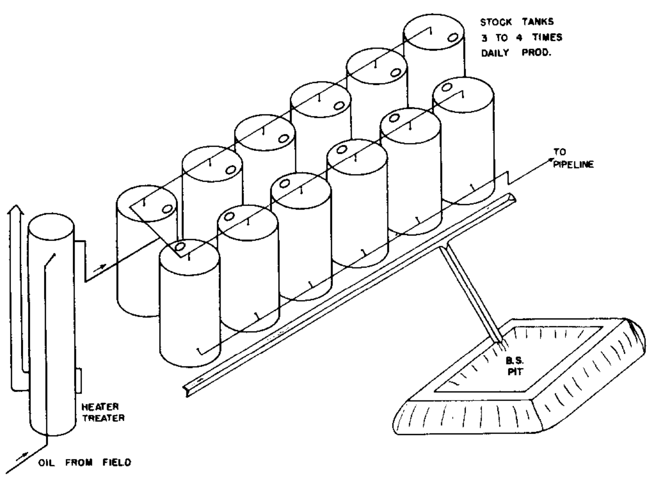

Fig. 1 COMMON TANK BATTERY

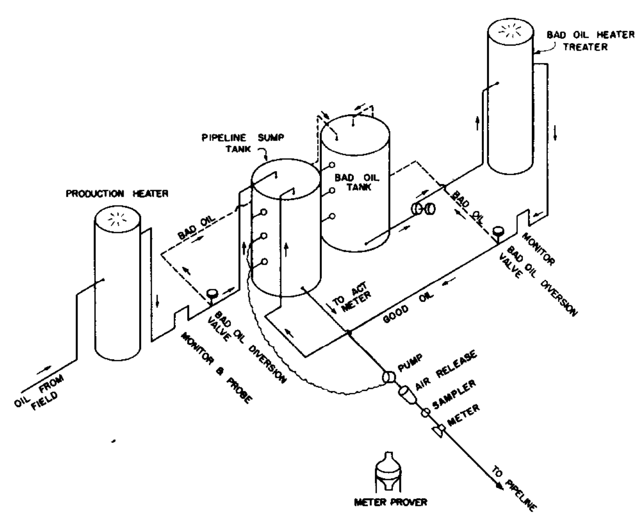

Fig. 2 AUTOMATIC TANK BATTERY USING P.D. METERS

The pumper can visit the ACT battery at his leisure to check daily production and the action of the battery. Bad oil is treated automatically so there are no tank bottoms or tanks full of bad oil to treat.

The advantages of ACT are summarized as follows:

1. Reduction of vapor losses
   1° API gravity increase corresponds to 2 1/2% increase in oil volume.
2. Reduction in trips to tank battery by gager and pumper.
3. Reduction in number of stock tanks needed.
4. Reduction or elimination of tank bottoms.
5. More accurate measurement of oil.

The flow diagram through a simplified version of an automatic tank battery is shown in Fig. 2 and described as follows:

Oil flows through a production heater treater then through the probe of a BS&W monitor. If the monitor indicates good oil (oil acceptable to the pipeline), the oil diversion valve routes the stream to the pipeline sump tank. The pipeline sump tank fills until the middle electric float switch starts the meter unit motor to pump oil through the meter and sampler to the pipeline.

Meter Unit Pump

The meter unit pump is stopped when the oil level in the sump tank reaches the bottom float. If the pipeline sump tank fills, the top electric float switch routes the oil stream to the bad oil tank and also sounds an alarm.

If the oil from the field contains an excess of BS&W, the oil diversion valve routes the oil to the bad oil tank and starts the chemical pump to inject treating chemical into the bad oil stream. When oil reaches the middle float, the bad oil pump is started and circulates the fluid through the second heater treater and then through a second BS&W monitor. If the oil is good, the diversion valve No. 2 routes the oil to the pipeline sump tank. If the oil is still bad, the oil is returned to the bad oil tank for recirculation through the bad oil heater treater.

COMPONENT PARTS OF ACT BATTERIES

Operation and maintenance of ACT batteries are simplified if the purpose and function of each component of the battery is understood. Following is a discussion of various parts or components used in ACT batteries.

Tankage

Even though one of the reasons for using ACT is reduction in the number of oil stock tanks, tanks cannot be entirely eliminated. ACT requires enough tank room for a sump tank for the pipeline pump and a tank for automatic treatment of bad oil. At the present time, it is desirable to have tank room to hold about 1 day's oil production to allow some storage when it is necessary to do repair work on the ACT unit. Cone bottom tanks are best adapted for ACT batteries because the cone bottoms facilitate automatic removal of oil from the tank bottoms for treatment.

POSITIVE DISPLACEMENT METERS FIGS. 3 & 4

A positive displacement meter is a constant flow device which measures a fluid by separating the flowing

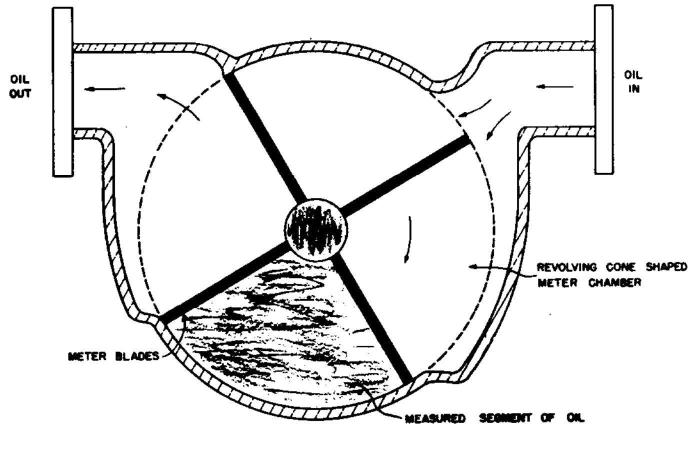

Fig. 3 PRINCIPLE OF POSITIVE DISPLACEMENT METER

fluid into segements and counting the number of segements passing through the meter chamber. The measuring element of a positive displacement meter may be a nutating disc, a rotary disc, or lobed impeller.

A positive displacement meter displaces a fixed quantity of fluid through the measuring chamber plus a certain amount of slippage. Slippage is that portion of the fluid which passes through a meter without causing registration and is dependent upon the clearance between the moving parts of the meter chamber. Slippage increases with meter wear.

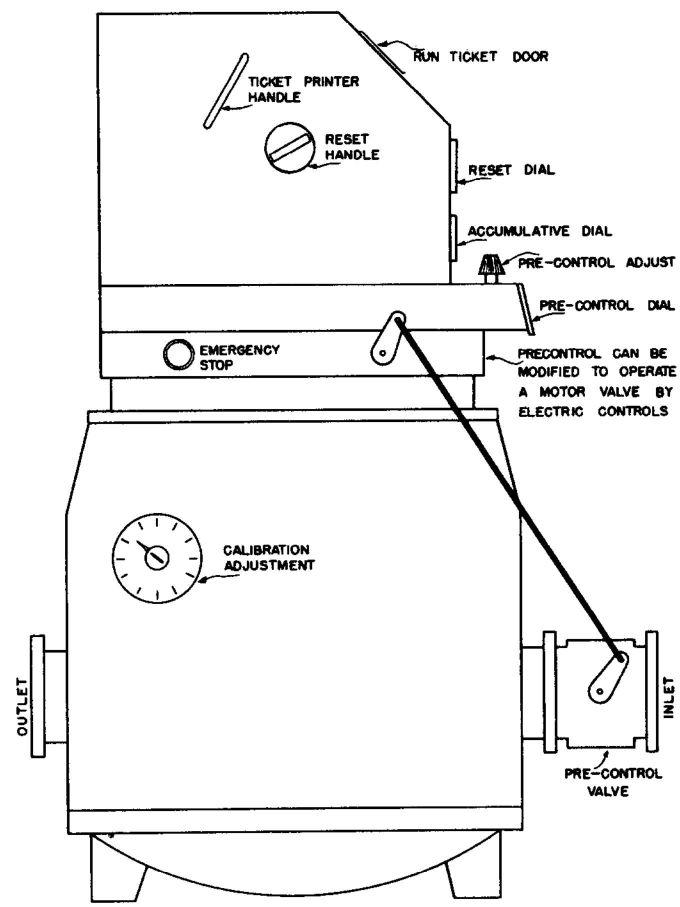

Fig. 4 POSITIVE DISPLACEMENT METER

A positive displacement meter as used for ACT is composed of the following parts:

1. The meter body or case.
2. The measuring chamber (Fig. 3)
3. The measuring element (Fig. 3)
4. The meter head (Fig. 4)
5. Intermediate Gears (Fig. 4)
6. Register (Fig. 4)
    a. Reset dial
    b. Accumulative dial
    c. Pre-control
    d. Ticket printer
7. Calibration adjustment (Fig. 4)
8. Temperature compensator

Temperature Compensation

Oil is bought and sold at a base temperature of 60°F. If oil transferred to pipeline is at a different temperature, the volume is corrected to the volume of the oil at 60°F.

Positive displacement meters can be equipped with a temperature compensating mechanism which mechanically changes the gearing of the meter so that the volume recorded on the counter is the volume of oil corrected to 60°F. (Fig. 5).

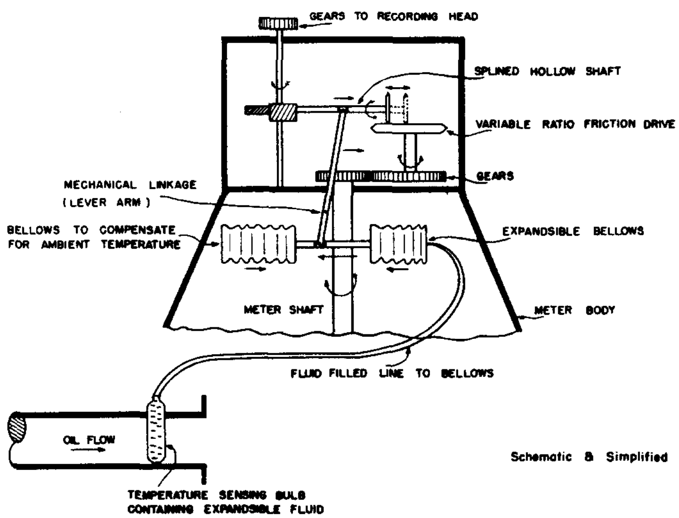

Fig. 5 PRINCIPAL OF TEMPERATURE COMPENSATION

A temperature compensator is a mechanism arranged to convert a thermal force into a mechanical adjustment of the meter through a bellows arrangement. A bulb containing an expansible fluid is located in the oil line leading to the meter. A tube runs from the temperature bulb to an expansible bellows arrangement located on the meter. The expansible bellows actuate a lever which changes a gear ratio in the meter gear chain. The change in gear ratio is reflected in the final dial reading on the meter.

Pre-Control or Allowable Control (Fig. 3)

A pre-control or allowable control is a device which enables the operator to preset on the meter the number of barrels of oil he wishes to produce. When this volume passes through the meter a lever or electric operated valve connected to the meter closes, shutting off further delivery of oil.

The pre-control is simply a backward or subtractive counter. Each barrel of fluid passed through the meter subtracts one barrel from the preset volume. When the reading reaches zero, flow is shut off.

Ticket Printers (Fig. 3)

Ticket printers are available for use on positive displacement meters. The ticket printer has a visible reset dial and an accumulative dial. The accumulative figure is printed on the ticket. In using a ticket printer, a special run ticket is inserted in a slot at the top of the ticket printer. A handle is turned one revolution. This action prints the starting meter reading and inserts a pin through the ticket so it cannot be removed or tampered with until the handle is again turned printing the closing meter reading. The gager subtracts the two figures giving the gross barrels at 60° delivered through the meter. The gager records the gravity and BS&W content as determined by the sample saved during the run by the automatic sampler.

A meter factor is recorded on the run ticket. The gross volume is multiplied by the meter factor to give net volume delivered to the pipeline.

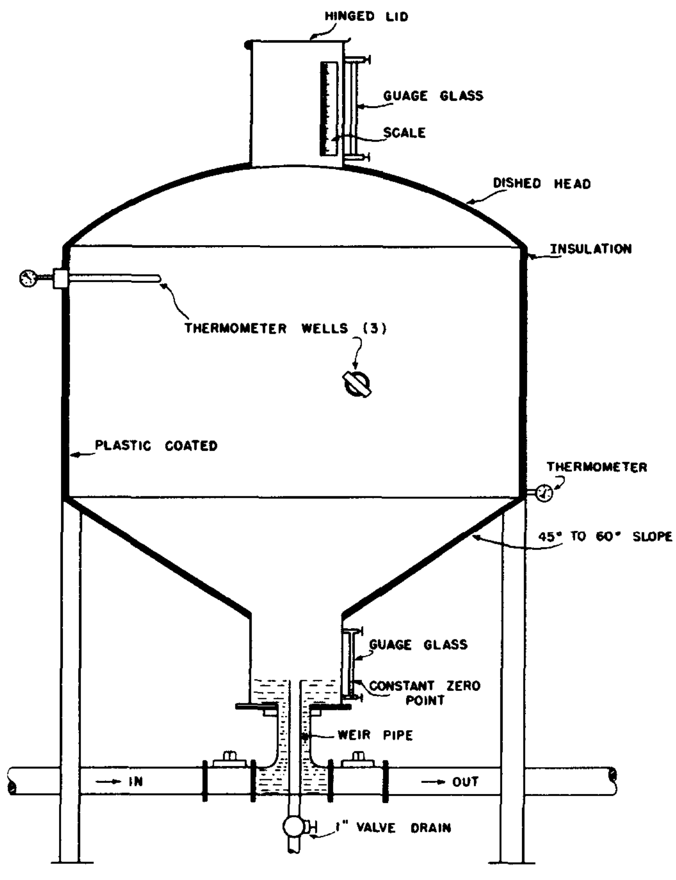

Fig. 6 **METER PROVER TANK**

Meter Factor

Meter factor is defined by API as a number representing performance of a meter by which the registration of the meter is multiplied, to obtain the actual volume passed through the meter. The meter factor is derived by checking delivery through the meter against a carefully calibrated tank or prover. The meter factor equals delivery into a meter prover - registration of meter. Actual delivery = Registration x meter factor.

Run Ticket

A typical printed run ticket then has the following information:

Closing meter reading	223241 Bbls.
Opening Meter reading	220001 Bbls.
Gross delivery at 60°F	3240 Bbls.
Meter factor	.99532
Percent BS&W	0.2%

The net volume delivered to the pipeline is calculated in the central office by multiplying the meter factor x gross delivery x % BS&W.

MOTOR OPERATED VALVES

Motor operated valves for this discussion will be confined to diaphram type air or gas operated valves as shown in Fig. 7.

Three types of diaphram valves are used for ACT installation:

1. Two way two position valves (on and off).
2. Three way two position valves (Flow in two directions. Bad oil diversion valve).
3. Three way three position valves (Flow in two directions and complete shut off).

Diaphram motor valves are actuated by a gas pressure of 20 - 30# on one or both sides of a diaphram, or on one side of a diaphram using a spring for the return stroke.

Entrance of gas into the diaphram chamber is controlled by an electric, solonoid operated pilot valve. The solonoid pilot valve can be activated by any electric control device such as an electric float switch, etc. The motor valves as used on Cities Service units are pilot operated by electric controls and operated by gas pressure.

A fail safe feature of these valves is that if electric current or gas pressure fail, the valve assumes the "closed" position.

METER PROVER

A meter prover is a device, usually a calibrated vessel, used to determine the relationship between the amount of liquid which actually passes through a meter and the amount indicated by the meter. (API Code)

The prover used by Cities Service to calibrate P.D. meters is shown in Fig. 6. The vessel holds 10 barrels, has a dished head and a conical 30° bottom. Both top and bottom are equipped with Seraphin necks to improve the accuracy of fluid measurement. The tank is plastic lined to prevent paraffin deposition and corrosion, and coated on the outside with insulation to reduce temperature fluctuations of fluid in the prover. Three thermometer wells are spaced around the tank; one at the top, one in the middle, and one near the bottom of the vertical portion of the tank.

The top Seraphin neck has a gage glass and a calibrated scale for accurate determination of the top fluid level. The bottom neck has a gage glass and a pipe overflow wire to insure a constant starting bottom fluid level.

Meter Proving

Positive meters are subject to wear on moving parts

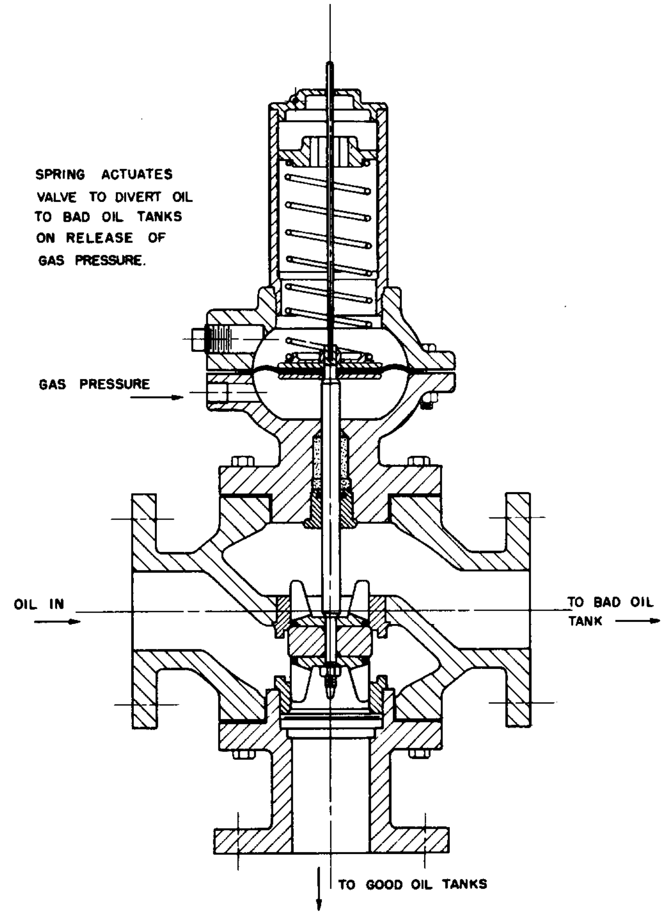

Fig. 7 BAD OIL DIVERSION VALVE

in the meter measuring chamber. The effect of wear is to increase slippage and thus effect the accuracy of the meter reading.

The meter is calibrated at regular intervals by running oil through the meter and into a calibrated prover tank under the same conditions of rate of flow and pressure

The meter is calibrated at regular intervals by running oil through the meter and into a calibrated prover tank under the same conditions of rate of flow and pressure as when the meter is in regular service. The gross volume of oil in the prover tank can be determined with accuracy and corrected to a temperature of 60°. The net volume in the prover should then correspond to the difference in opening and closing reading on the meter. If the volumes are different, a factor is determined by which to multiply the meter reading to obtain the volume of oil in the meter prover.

$$\text{Meter Factor} = \frac{\text{Volume in Prover Tank at } 60^\circ}{\text{Meter Registration Volume at } 60^\circ}$$

Fig. 6 A shows a meter proving report.

Meter factors should change gradually with time. A sudden increase or decrease in meter factor from one proving to the next indicates a serious malfunction of the meter or the temperature compensator.

Oil Samplers

An oil sampler is a device that periodically takes and saves a small proportional and representative sample from the oil stream flowing through the meter

POSTIVE DISPLACEMENT METER PROVING REPORT

Lease Type of Liquid Oil Date 12/3/57 Text No. 5

Make of Meter Model No. Size 1½ Temperature Compensated Yes

Serial No. 21544 Date of Last Calibration November 1 - 1957

Prover Rated Volume Bbls. 11.2594 Normal Pressure 29#

Prover Data	Run #1	Run #2	Run #3	Run #4
1. Time of Day	2:15	3:00	3:45	
2. Duration of Run Hrs.	0.225	0.221	0.223	
3. Gravity of oil @ 60°F	43°	43°	43°	
4. Prover Tank Temperature	86-86-86	88-88-88	88-88-88	
5. Average Prover Temperature	86	88	88	
6. Closing Reading - Bbls.	11.2634	11.2614	11.2614	
7. Opening Reading - Bbls.	0	0	0	
8. Gross Bbls. in Prover (6-7)	11.2634	11.2614	11.2614	
9. Temp. Correction for Tank Shell	1.000507	1.000546	1.000546	
10. Temp. Correction for Liquid	0.9873	0.9863	0.9863	
11. Net Bbls. in Prover (8x9x10)	11.12599	11.11318	11.11318	
Meter Data				
12. Closing Meter Reading in Bbls.	611.169	621.762	632.359	
13. Opening Meter Reading in Bbls.	600.570	611.175	621.774	
14. Net Bbls. Metered (12-13)	10.599	10.587	10.585	
15. Meter Factor (11 ÷ 14)	1.04972	1.04970	1.04990	
16. Rate of Flow (14 ÷ 2)	49.2	50.3	49.8	

Accumulative Reading 40272.5 Average Meter Factor 1.04971

Barrels Since Last Proving 19,324.6 Last Meter Factor 1.02867

Remarks: Difference 0.02104

Calibrator Adjusted-Div. No

Signed By: Witnessed By:

For: For:

Fig. 6A

line. From one to 42 samples can be taken per barrel. The size of each sample can vary from one drop to several cubic centimeters.

The sampler and container system used by Cities Service is illustrated in Figs. 8 and 9. A regular meter body drives the sampler, which insures a sample proportional to the volume of oil metered to the pipeline. A bypass line around the meter assures a representative sample. The sampler takes a sample for every barrel of oil passing through the meter body. The sample is passed into the vapor tight container where it remains until withdrawn by the pipeline gager.

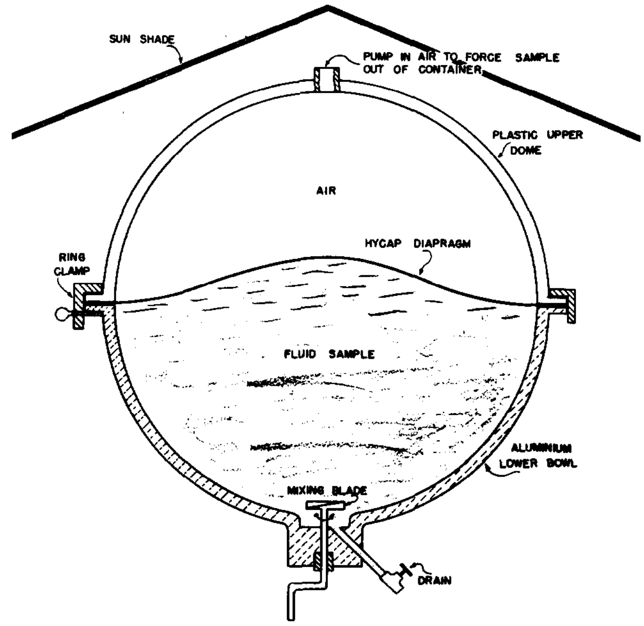

Fig. 9 VAPOR PROOF SAMPLE CONTANER

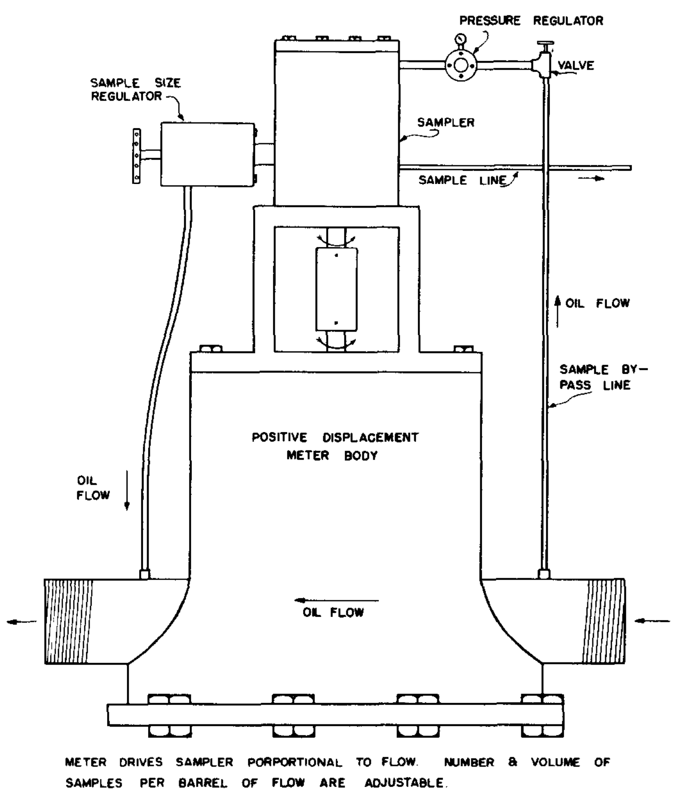

Fig. 8 METER DRIVEN OIL SAMPLER

Fluid Level Controls

A fluid level control is a device that is operated by changes of fluid level in a vessel. The function of a level control device is to activate other devices to change, maintain, or indicate the fluid level in a vessel. Fluid level controls may be mechanical, electrical, hydraulic or a combination of any of the above.

Cities Service is using a combination mechanical and electrical device, called a torque type float, for fluid level control. (Fig. 11.)

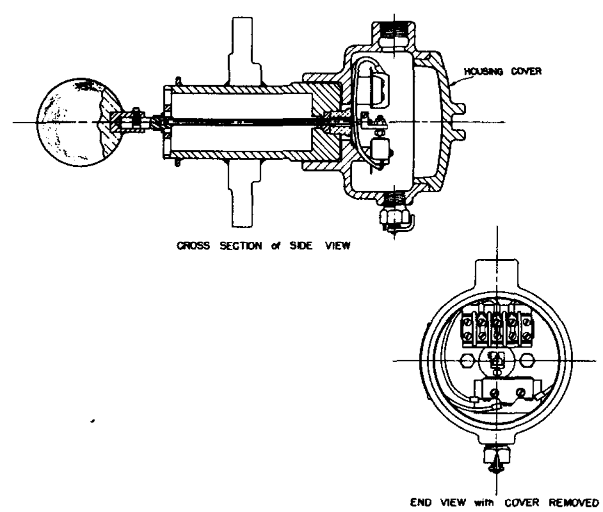

Fig. 11 END VIEW WITH COVER REMOVED

A torque tube electric float control consists of a rod with a float at the end extending into the tank and a microswitch at the end outside of the tank. The rod passes through a packing gland and allows enough motion so that a small pressure on the float will open or close a contact in the microswitch.

The microswitch is connected to and controls other devices such as pump motors, motor valves or alarm systems.

BW&S PROBE AND MONITOR

Control of the amount of BS&W in oil delivered to the pipeline is one of the most important functions of the ACT Unit. Pipelines have objected to ACT batteries in the past, due to their concern over receiving excess amounts of BS&W.

With the development of the BS&W monitor most of the pipelines' objection to ACT have diminished.

One Principal Function

The BS&W monitor has one principal function. That is to prevent oil containing an excess of BS&W from entering the pipeline. The monitor reading is not used yet for accounting purposes although it may in the future. BS&W content, as shown on run tickets, is obtained from grindout of the sample saved by the automatic sampler.

The BS&W monitor determines the amount of BS&W in an oil stream by the change in dielectric strength of the fluid stream as it passes between two charged plates of a capacitor. Water has a dielectric constant of about two. The ratio between oil and water is 40 to 1 which means that very small amounts of water can be detected in oil. Salt content of the water does not materially affect the accuracy of the reading.

Three Components

A BS&W monitor consists of three components: the probe or capacitor, the monitor or control unit, and the coaxial cable that connects the probe to the monitor. The monitor circuit impresses a charge on the condenser. One plate of the condenser is the pipe, the other is the probe. Leakage across the condenser is

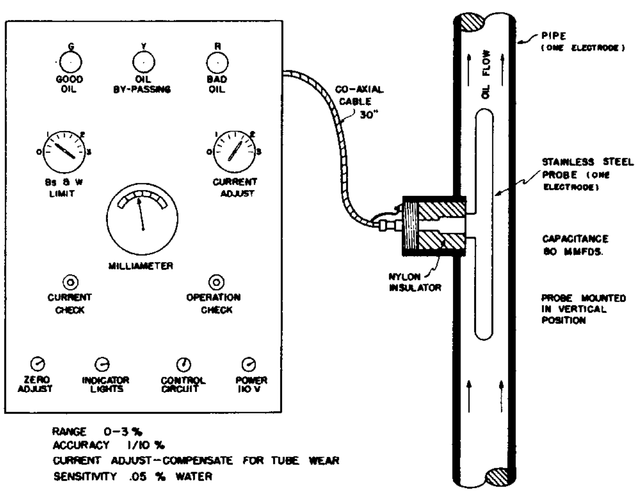

Fig. 10 Bs & W MONITOR & PROBE

proportioned to the dielectric between the plates, which in this case is oil or a mixture of oil and water. The balanced bridge circuit in the monitor can detect and indicate small amounts of water in oil.

The monitor is calibrated by setting the monitor to read the same BS&W as a grindout of a sample passing through the probe. The monitor can then be set at a predetermined maximum BS that will be passed. When BS&W passing through the probe exceeds the set amount, the monitor will indicate bad oil. The monitor, through control circuits, can then sound an alarm or activate a control valve to divert the oil stream through a treating system.

GRAPHIC PANELS

A graphic panel is a sheet of metal or plastic upon which is etched in color the flow diagram of an ACT unit. Graphic panels are available from a very simple "picture" of the flow process to an elaborate lighted model. The panel can be wired through relays to the process equipment in the battery with colored lights to represent the "off and on" functions of various pieces of equipment.

The function of a graphic panel is to furnish the operator with a clear picture of the fluid flow through the unit. Those panels, with lights connected to the various components through relays, can show various tank level, position of valves, etc. Malfunctions are quickly found.

Graphic panels may also incorporate various charts showing the number of hours a certain unit has run.

Graphic panels are helpful and desirable for the operation of an ACT unit, but are not absolutely necessary to its function.

Chemical Pumps

Chemical pumps are used to inject emulsion breaking chemical into a lead line to help break down oil-water emulsions.

The chemical pump is controlled by the BS&W monitor or the oil diversion valve.

Pumps, Motors And Controllers

Standard centrifugal or gear type pumps are used on ACT for oil transfer purposes. The motor and pump can be directly coupled together or the pump can be belt driven from the motor.

Cities Service has used direct coupled pump and motor. However, this arrangement does not have the flexibility of changing the pumping rate easily if production increases or declines. Consideration is now being given to a belt driven pump and motor about 25% larger than immediate conditions require. This would allow some flexibility for changing the volume of oil handled by the pumps.

Cities Service is using explosion proof motors and starters on all equipment located on skids or near stock tanks. There is some question as to whether explosion proof equipment is really necessary on ACT batteries, due to the small storage volume involved. However, until there is some industry wide agreement on this problem, explosion proof equipment will be used.

SKID MOUNTED ACT COMPONENTS

The components discussed in the first part of this report can be assembled in a variety of ways to build up an ACT battery. Each component can be individually installed in the appropriate place in the flow system or components can be assembled and mounted on skids.

Skid mounting is simply the assembly of ACT components on a steel platform. The platform or skid is so constructed that the entire assembly can be slid up onto a truck and transported as a unit.

ACT skid units are designed so that any valve fitting or component can be removed or repaired without disturbing other components on the skid.

The advantages of skid mounted ACT Units are:

1. Field installation of an ACT system is made easier, quicker and cheaper.
2. Skid units can be assembled in a plant where trained men, facilities, materials and components are readily available.
3. Skid units can be shop tested before field installation.
4. Skid units can be moved or reclaimed with a minimum of time and labor.

Bad Oil Return Skid (Fig. 12)

The function of the bad oil return pump skid is to automatically pump oil from the bad oil tank to the bad oil heater treater. A 12" boot on the bad oil skid is equipped with electric level controls which control the fluid level in the bad oil tank.

When fluid level in the bad oil tank reaches the level of the middle float, the bad oil pump is started and runs until the fluid level reaches the bottom float. When fluid falls below the bottom float the pump motor is stopped.

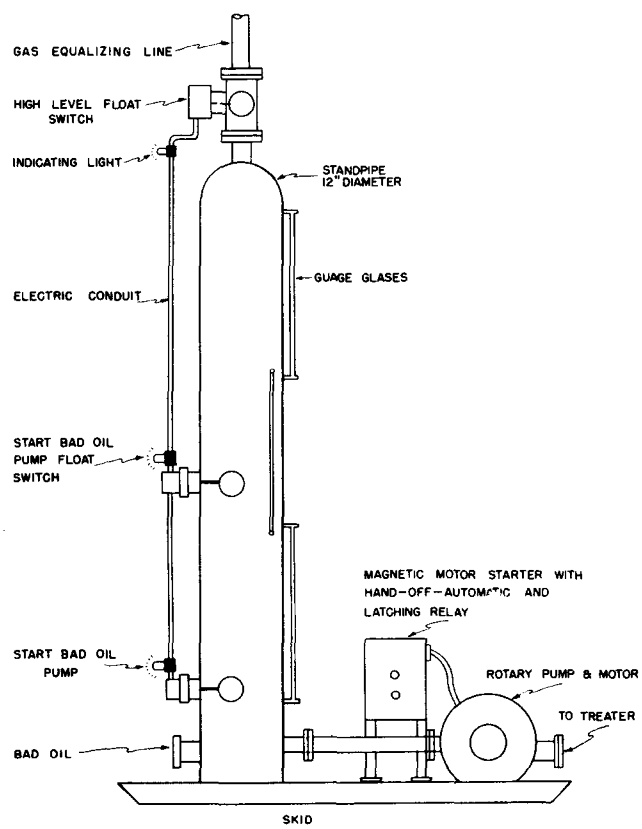

Fig. 12 BAD OIL RETURN PUMP SKID

The top float indicates that all tanks are full and an alarm is sounded to summon the pumper to the battery. Fluid level is indicated by colored lights mounted near each float. The operator can tell at a glance where the fluid level is by the color of the light. Fluid level is also visually apparent from the position of the fluid in the gage glasses. The pump motor is controlled by a motor starter in an explosion proof housing. The motor starter can be operated by the float controls or manually, if desired.

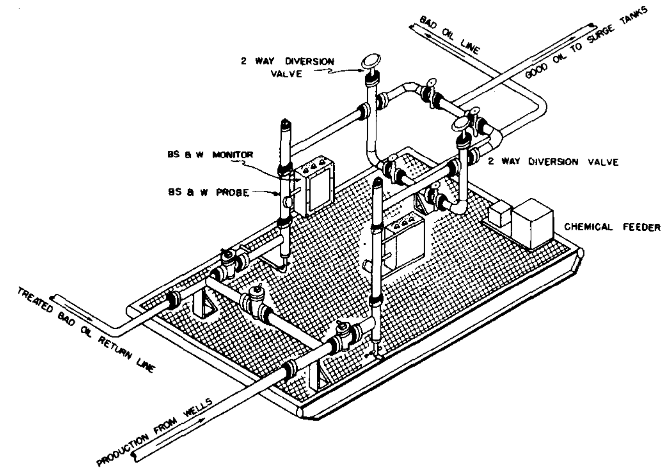

Fig. 13 DOUBLE MONITOR SKID

Double Monitor Skid (Fig. 13)

The double monitor skid contains two BS&W probes, two mintors, two oil diversion valves and a chemical pump. Each monitor operates independently of the other. One monitor checks the production stream, the other the bad oil return stream.

The function of the monitor unit is to detect oil with an excess of BS&W. Normal flow is from the field through the production heater and then through the production monitor. If the oil is good, the stream is diverted to the pipeline sump tank. If oil contains an excess of BS&W, the stream is diverted to the bad oil tank. When bad oil is detected, the chemical pump is started by the monitor to inject oil treating chemical into the bad oil stream.

Bad oil is circulated back through a second heater treater and then through the bad oil monitor. If the oil has been treated out, the diversion valve routes the oil to the pipeline sump tank. If the oil is still bad, the diversion valve routes the oil to the bad oil tank for further treatment.

Meter Unit Skid (Fig. 14)

The function of the ACT meter skid is to pump oil from the pipeline sump tank where the oil reaches a predetermined level, meter the oil and record the volume delivered to the pipeline corrected to 60°F. A sample of the oil delivered to the pipeline is saved in a pressurized container for the gager. Two positive displacement meters are used, one for a sales meter, the other for a check meter. The function of each component on the meter skid is described as follows:

1. Standpipe - The standpipe contains the float

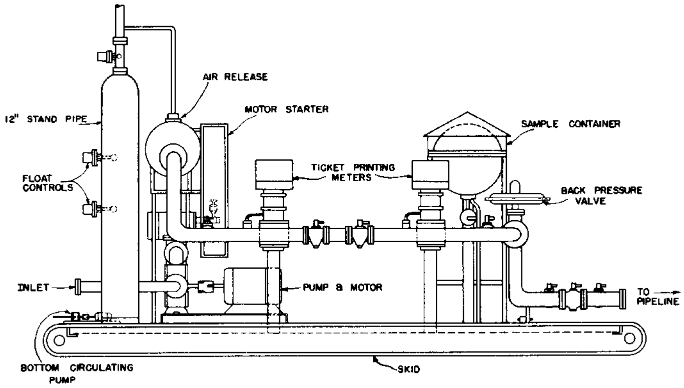

Fig. 14 OIL HILL DUAL METER SKID FOR ACT

controls to control the level of the fluid in the pipeline sump tank. The middle float starts the meter skid pump, the bottom float stops the pump. The top float diverts oil flow from the monitor unit to the bad oil tank for storage.

2. Pump and motor - The pump is a positive displacement pump that pumps oil through the meter skid at a constant rate of 2000 barrels per day. Positive displacement meters are most accurate with a constant flow through the meter.
3. Oil sampler - Oil sampler is driven by a meter body and takes one sample per barrel. Sample is saved in a vapor proof container.
4. Air eliminator - Positive displacement meters will record air or gas as well as fluid. It is therefore necessary to remove all air or gas from the metered stream to prevent erroneous meter readings.
5. Strainer - The function of the strainer is to prevent entry of large particles into the oil meters.
6. Sales meter - Sales meter is a positive displacement temperature compensated meter with a ticket printer. Check meter is the same as the sales meter. Either meter can be used for the sales meter.
7. Back pressure regulator - The function of the back pressure regulator is to maintain a constant pressure on the meter system. Positive displacement oil meters are most accurate under constant conditions of flow and pressure.
8. Bottom circulating Pump - This is a small rotary pump rated at 4 bbls./hr. This pump takes suction from the cone bottom of the pipeline sump tank and discharge to the bad oil heater treater. The use of this pump prevents buildup of BS&W in the bottom of the pipeline sump tank.
9. Pressure switch - When the meter pump is started, the back pressure valve allows skid pressure to build up to 20#. At this pressure a pressure switch starts the pipeline pump.

ACT BATTERIES

After the appropriate components have been mounted on skids it is a simple matter to arrange the different skid units into an ACT battery.

Fig. 14 shows the first Cities Service Pampa ACT battery. In this battery the use of skid mounted units were not employed to such an extent as in later batteries. The monitor probe, the bad oil pump and the bottom circulating pumps were separately installed in the flow system. Float controls were installed in the bad oil tank and the pipeline sump tank.

Graphic Control Panel

A graphic control panel was used in this battery. This battery required considerable field labor to install the several ACT components in the flow system.

Fig. 15 shows the improved version of skid mounting ACT components. Three skids are used which require a minimum of field installation. Float controls are installed and wired on the skids, eliminating the necessity of installing float controls in the tanks themselves. Each skid is completely wired and piped and requires only electric supply to each skid and connection into the flow system.

The necessity for a graphic panel is eliminated by installing signal lights on each skid component. Colored lights show which float controls are working. Colored lights also indicate when the monitors are diverting or treating bad oil.

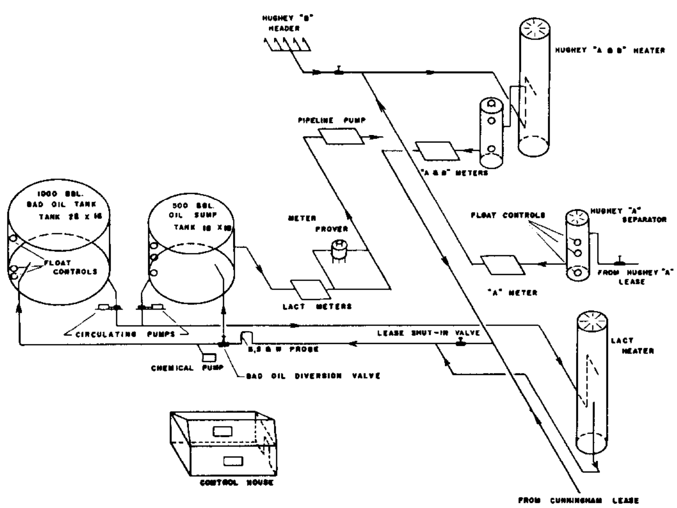

Fig. 15 PAMPA LACT and LEASE METERS

Oil Hill ACT Battery

In the Oil Hill ACT battery, the operation is as follows:

1. Production from the field passes through the production heater and through the production BS&W monitor probe. If the oil is good, the oil is diverted to the pipeline sump tank. If the oil contains an excess of BS&W, the oil is diverted to the bad oil tank. At the same time a red light flashes on and treating chemical is injected into the bad oil stream.
2. The bad oil tank fills until the middle float is reached. The middle float starts the bad oil pump which pumps oil through the bad oil heater treater until the oil level reaches the bottom float. The bottom float stops the bad

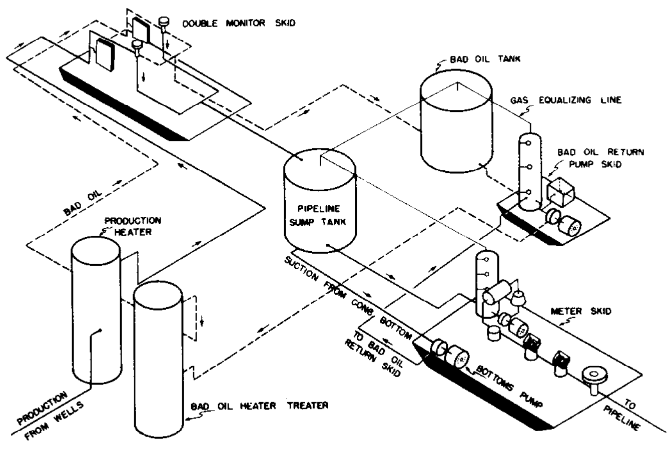

Fig. 16 OIL HILL ACT UNIT

oil pump. The top float on the bad oil skid indicates an emergency situation. At this point, a red light is turned on to summon the pumper. Oil from the bad oil heater treater flows through the second probe on the monitor skid. If the oil is good, the diversion valve routes the oil to the pipeline sump tank. If the oil is still bad, the diversion valve routes the oil back to the bad oil tank for further treatment.

3. The pipeline sump tank fills until the oil level reaches the second float in the meter skid standpipe when the meter skid pump is started. Pressure is built up to 20# at which time a pressure switch starts the pipeline pump. A uniform pressure is maintained on the meter skid by the back pressure valve.

Oil is metered to the pipeline until the oil level reaches the bottom float. The bottom float control turns off the meter skid pump. If the oil level reaches the top float control, the oil diversion valves are positioned to divert the oil stream to the bad oil tank.

The meter skid also contains a bottoms pump. The purpose of this pump is to remove a small volume of oil from the core bottom of the pipeline sump tank at any time the meter skid unit is operating. The oil pumped from the core bottom is routed to the bad oil heater treater. The reason for this operation is to prevent buildup of tank bottoms in the pipeline sump tank.

COST OF ACT UNITS & COMPONENTS

UNITS

1. Double Monitor Skid	$3400
2. Meter Skid for ACT	$6900
3. Bad Oil Return Skid	$1760
	$12,060

COMPONENTS

Monitor Skid	Unit Cost	Total
2-BS&W Monitors	$415	$830
2-4" Probe	225	450
2-Plexiglass Window in Monitor	20	40
2-Failsafe Relay on Monitor	40	80
2-Coaxial Cable	25	50
2-3 Way 2 Position Automatic Valves with Solenoid Pilot	362	724
1-Chemical Injector Pump	225	225
7-Valves	35	245
1-Skid & Misc.	760	760

METER SKID

3-Torque Type Float Switches/Lights	105	315
1-Rotary Pump/5HP Motor 180 BPH	520	520
1-Rotary Pump/1/4HP Motor 4 BPH	160	160
1-Strainer	70	70
1-Meter Driven Sampler Complete	500	500
1-Air Eliminator	230	230
2-P.D. Meters/Ticket Printers	520	1040
1-3" Back Pressure Valve	250	250
1-5 Gallon Vapor Proof Sample Container	190	190
9-3" Valves	40	360
1-Exp. Proof Motor Starter/Breaker	270	270
1-Latching Relay	40	40
1-Pressure Switch to Start Pipeline Pump	160	160
1-Pressure Gage	10	10
1-Thermometer Well	30	30
1-Standpipe for Float Controls	200	200
1-440/110 Volt Transformer	125	125
1-Skid Assembly Complete	2200	2200
1-Misc. Wire Fittings, etc.	230	230

BAD OIL RETURN SKID

1-12" Standpipe & Connections for Float Controls	200	200
1-3'x6' Skid/Valves & Fittings	250	250
3-Torque Float Switches	105	315
1-Rotary Pump/Motor 100 Bbls./hr.	480	480
1-Motor Starter & Controls Exp. Proof	270	270
1-Latching Relay/box	30	30
2-Gage Glasses	10	20
1-Misc. Wire Fittings & Labor	200	200