

PRESSURE TESTING  
CONTINUOUS FLOW SYSTEMS FOR  
EXCHANGE CABLES

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1. GENERAL

- 1.01 This section provides information and instructions covering the design and construction of continuous flow pressure systems for exchange cables.
- 1.02 In general, cable sheaths containing both trunk and exchange compliments should be treated as exchange cable for continuous flow pressure operations.

2. DESIGN CONSIDERATIONS

- 2.01 In continuous flow pressure systems, the principle objective is the maintenance of adequate protective pressures over the entire length of each pressurized exchange cable. Minor gas leaks are expected in each cable system and are of very little consequence as long as adequate pressures are maintained over the system. The

daily amount of gas used by each individual system will vary, and although it is a factor to be considered, this variance in gas consumption is not as important as the maintenance of minimum pressures required over the system.

2.02 Each exchange cable leaving the central office should be designed as a separate gas system without restrictions to the free flow of gas from the pressure source to the extreme ends of the cable. Inter-connection between two exchange cables may, at times, be necessary or desirable, but in general, the individual system will be found most advantageous for maintenance and monitoring purposes.

### 3. APPLIED AND PROTECTIVE PRESSURES

3.01 For continuous flow systems, gas or dry air is applied to each cable at a constant pressure of 10 psi. This applied pressure is considered adequate to provide the desired protective pressures over the gas system for both underground and aerial plant. Applied constant pressures above 10 psi may damage aerial cable close to the source while applied pressures below 10 psi may not be sufficient to afford protection to the pressurized plant.

3.02 Each pressurized exchange cable should be designed and constructed so that the following minimum protective pressures may be maintained:

- (a) 3 psi pressure at the end, or ends, of the underground sections.
- (b) At least 1 psi pressure, 70° Temperature, at the ends of all aerial distribution cables.

3.03 When a sheath opening is to be made in an exchange cable under continuous flow pressure for construction or maintenance reasons, it will generally be necessary to maintain the protective pressures on both sides of the opening by placing auxiliary tanks of dry nitrogen at appropriate valve locations on either side of the opening. The requirement for maintenance of protective pressures at any given point on a pressurized cable will generally be determined by field forces based on the following factors:

- (a) Proximity of the sheath opening to the pressure source;
- (b) Amount of normal pressure at the point of sheath opening;
- (c) Weather conditions.

**3.04** In order to prevent overloading a Compressor-Dehydrator or depleting the gas supply from a multiple tank source, auxiliary tanks should be placed for construction or maintenance sheath openings as follows:

(a) When a sheath opening is to be made in underground cable, auxiliary tanks should generally be placed 1000 to 1500 feet on either side of the proposed opening. Place the tanks at convenient locations using permanent valve points if possible. If permanent valves are not available, temporary valves may be installed at splice locations in the lead sleeves or splice cases. Prior to opening the sheath, determine the normal pressure on the cable at the points selected for introduction of auxiliary pressure. Set the regulator pressure  $1/2$  pound above the normal pressures determined for each point. Maintain the auxiliary pressure sources for the duration of the sheath opening. When the sheath opening is less than 3000 feet from the permanent pressure source (Compressor-Dehydrator, Air Dryer, or Multiple Tanks) or when more than one sheath opening is made in the same pressurized cable, it may be advisable to maintain the auxiliary pressure sources after the sheath has been closed and until the cable pressure returns to normal or nearly so.

(b) When a sheath opening is to be made in large aerial feeder cables, distribution cables with a normal pressure above 2 pounds, or at points adjacent to the underground system, it will generally be advisable to place auxiliary tanks as described in Paragraph 3.04 (a). On aerial distribution cables with a normal pressure of 2 pounds or less, the auxiliary tank on the side of the sheath opening toward the permanent pressure source (Air Dryer, etc.) may be eliminated. Auxiliary pressure sources will generally be unnecessary for sheath openings at or near the ends of small aerial distribution cables.

(c) During inclement weather or under emergency conditions, it may be advisable to take additional precautions to ensure adequate auxiliary pressure in order to protect the service. Under most circumstances, pressurized underground cable and aerial feeder cable should generally not be completely deflated as this tends to introduce pressure leaks into the system when the cable is again inflated to its normal pressure.

#### 4. PRESSURE PLUGS

4.01 Pressure plugs for exchange cables should be constructed in accordance with other sections of the Practices covering Pressure Testing, Cold Resin Pressure Plug or Pressure Testing, Asphalt-Filled Plugs.

4.02 For continuous flow pressure systems on exchange cable, pressure plugs must be constructed at the following locations:

(a) At a convenient location in the central office vault. Avoid placing plugs in the textile insulated riser cables unless absolutely necessary. Do not place pressure plugs in the first two splicing bays from the cable entrances to these vaults, as this space may be required for future insulating joints.

(b) In the stubs of B, BB, BD, BE, 14, C, F, and NA type terminals. The B and BB terminals will require a plug in each stub with an associated by-pass.

(c) In polyethylene insulated conductor distribution cable at the junction with other types of cable.

(d) At the entrance to the building on block cable. In general, cable within the building should not be pressurized, except when it is necessary to place the plug at the building terminal due to inaccessibility of the entrance cable.

(e) In the stubs or tie cables between two exchange cables in order to isolate one system from the other. This will facilitate leak location and maintenance work and is desirable in most cases.

4.03 Any partial or complete restriction to the free flow of gas throughout the pressurized cable system must be by-passed. Therefore, pressure plugs unnecessary to the completed system should not be installed in the cables during initial leak location and construction phases of the continuous flow system.

#### 5. PERMANENT AND TEMPORARY PRESSURE VALVES

5.01 Permanent pressure valves should be placed on pressurized exchange cables at the following locations:

(a) On the pressure side of the plug in the central office vault. Valves may be placed at any convenient location on the cable which will not interfere with future cable racking or splicing with the following exceptions:

- (1) Do not place valves less than 36 inches from the pressure plug.
  - (2) Do not place valves in the first two splicing bays from the cable entrances to the vault.
- (b) At the ends of all aerial distribution cables.
- (c) On block cable not less than 36 inches from the plug on the pressure side.
- (d) At the end, or ends, of the underground sections. At these locations, it is preferable to place the valve on the nearest riser cable leaving the end of the underground section. The valve should be placed approximately one foot above the top of the riser pipe or cable guard and positioned to minimize possibility of future damage to the valve or cable sheath. Since the pressure at this point will approximate that of the end of the underground section, valve location at this point is more convenient for maintenance operations. If possible, avoid placing permanent valves in manholes on exchange pressure systems.
- (e) On lateral cables feeding more than 500 feet of aerial cable. Place the permanent valve on the riser pole as described in Paragraph 5.01 (d).

5.02 Permanent pressure valves should be installed in lead sleeves or splice cases nearest the specified location when possible, rather than in the cable sheath. Place permanent valves under various plant conditions in accordance with other Sections of the Practices covering installation of valves.

5.03 Temporary valves may be placed as required for initial leak location work and maintenance operations. These valves should be removed and the sheath opening properly sealed when such work is completed. In general, excess or temporary valves should not remain in plant longer than necessary because of potential gas leakage and possible deterioration of the valve core.

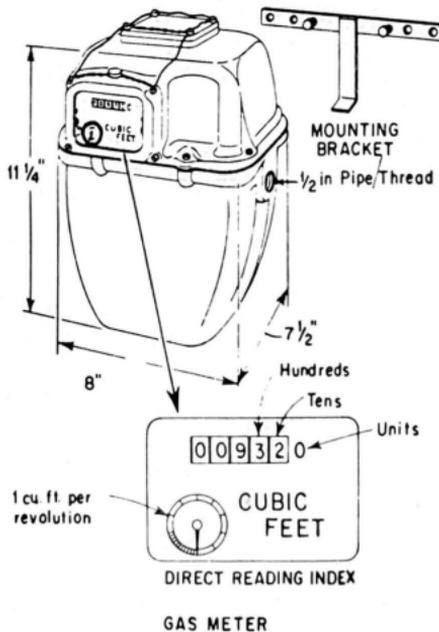
## 6. GAS BY-PASSES AND BY-PASS VALVES

6.01 Any partial or complete restriction to the free flow of gas throughout the pressurized exchange cable system should be eliminated or by-passed. Field forces can best determine the need for by-passes while making initial leak location tests and routine pressure tests.

6.02 By-Passes should be constructed in accordance with the Section of the Practices covering Pressure Testing, Arrangement of Gas By-Passes, with the exception that, in general, By-Pass Valves should not be installed. Where By-Pass Valves are considered necessary or desirable, they should be specified on the detail plans by the Plant Engineer.

## 7. METERING DEVICES

7.01 The Gas Meter is a recording device of the positive displacement type in which the gas is metered by the operation of two bellows. This meter has a direct reading cubic foot index and is rated at 10 psi maximum working pressure. The index panel on this meter records the air flow in increments of 10 cubic feet on the numerical index and 1 cubic foot per revolution on the dial index. For this reason, it will be necessary to take an average of several daily recordings to determine the approximate hourly or daily rate of flow through any particular meter. The Gas Meter is supplied with a mounting bracket, but connecting fittings for inlet and outlet tubing must be ordered separately. The Gas Meter and component parts are shown in the following illustration.



7.02 The Gas Meter may be utilized for any one or a combination of all the following purposes:

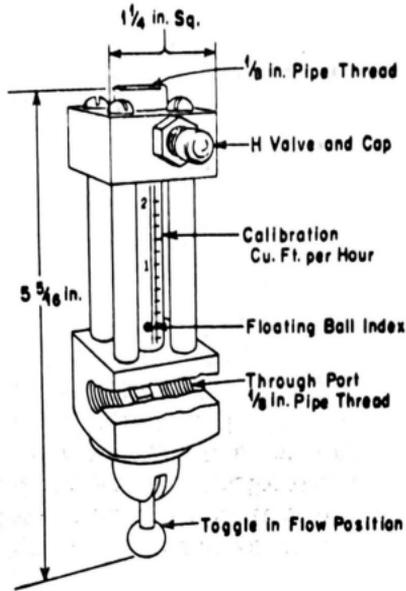
(a) To measure the total output of the Compressor-Dehydrator or Air Dryer. This is necessary to avoid over-loading the unit which could result in damage and excessive maintenance expense. The KS-14155 and KS-16321 Compressor-Dehydrators are factory equipped with a gas meter to record the full output of the unit. The KS-16432 Air Dryer (Refrigeration type) is not supplied with a master gas meter. Since the number of meters and cables that can be served by this unit will be limited by its comparatively small capacity, the total output of these units can be determined by totalling the average daily consumption of the monitoring meters for each cable pressure system.

(b) To measure the volume of gas delivered to groups of two or more cables served by one meter as an aid in determining when maintenance attention is necessary. This situation will be used occasionally for exchange cable pressurization but will be found more applicable for trunk systems as covered by other Sections of the Practices.

(c) To measure the volume of gas delivered to individual exchange cable systems as an aid in determining when maintenance attention is necessary.

7.03 The Air Rate Indicator is used for measuring the instantaneous rate of gas flow to an individual cable or system. It has a floating ball index and the scale is calibrated to show air flow in the range of 0.2 to 2.0 cubic feet per hour at a delivery pressure of 10 psi and 70°F. The lower block of the indicator has a through port which permits group assembly, if desired, and a toggle type shut-off valve. The upper block is equipped with a standard pressure

testing valve for measuring cable pressure. The Air Rate Indicator is shown in the following illustration:



7.04 The Air Rate Indicator provides a readily visible and immediate indication of the rate of gas flow to individual cables at the time of reading. The indicator will respond promptly to relatively large leaks near the office, and progressively less so as the distance of the leak from the office increases.

## 8. METER PANEL AND AIR PIPE ARRANGEMENTS

8.01 The purposes of the metering panel and air pipe arrangements described in this Section are as follows:

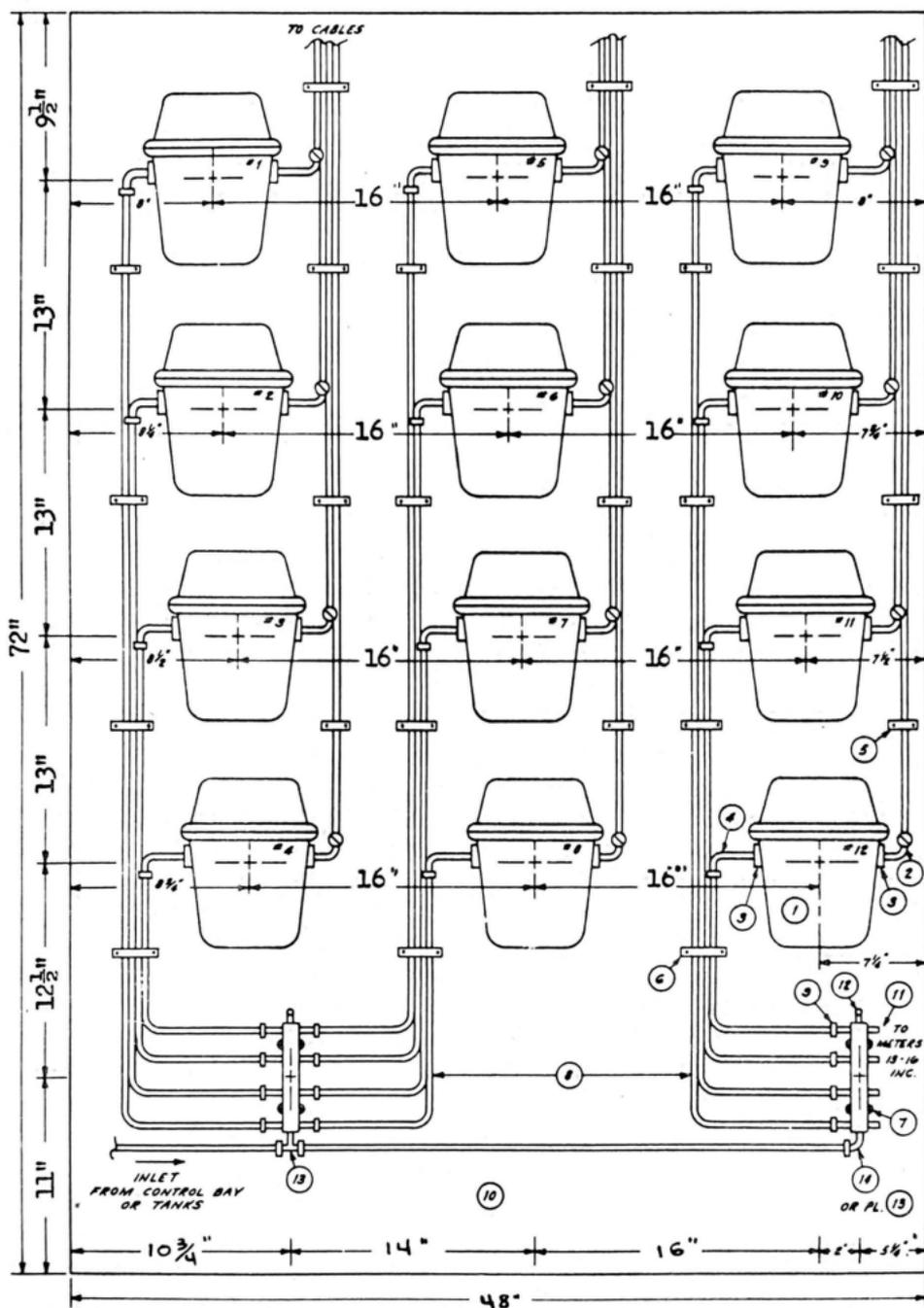
(a) To provide means of distributing the air flow from the Compressor-Dehydrator, Air Dryer or multiple nitrogen cylinders to the various cables.

(b) To establish facilities for measuring the air flow to the various cable systems being supplied by a particular pressure source.

(c) To provide convenient means of observing and recording the condition of that portion of the cable systems within the monitoring range of the metering equipment.

8.02 Metering equipment and associated air pipe will generally be mounted on a 3/4 inch painted plywood backboard. Each 6 foot by 4 foot section of the backboard will accommodate 12 Gas Meters and associated air pipe arrangements. The building space, location and number of backboard sections required will be specified and provided by the Engineer and should not be altered by other forces.

8.03 The backboard should be located outside the Central Office Vault in the most convenient available space which will afford the shortest air pipe route from the pressure source as well as to the various cables within the vault. The arrangement of the gas meters, air pipe and associated parts is shown in the following illustration.



Note: The various parts of the meter panel listed below are numbered in accordance with the circled numerals in the preceding illustration.

1. Gas Meter.
2. H-101 Angle Type Valve.
3. No. 2110 Bushing.
4. No. 912 Elbow, 1/4 In. O. D. Tube x 1/8 In. Male Pipe Thread.
5. Special Pipe Strap - Fabricate as needed from standard tinned copper Bonding Ribbon.
6. Special Pipe Strap - Fabricate as needed from standard tinned copper Bonding Ribbon.
7. 17-507 Type Manifold.
8. 1/4 In. O. D. Seamless Copper Tubing.
9. No. 812 Union, 1/4 In. O. D. Tube x 1/8 In. Male Pipe Thread.
10. 3/4 In. Painted Plywood Backboard.
11. C Pressure Flange Plug.
12. L Pressure Flange Plug.
13. No. 1014 Tee, 1/4 In. O. D. Tube x 1/4 In. Male Pipe Thread.
14. No. 912 Elbow, 1/4 In. O. D. Tube x 1/4 In. Male Pipe Thread.

8.04 In general, each exchange cable will be designed as a separate pressure system served through an individual gas meter. Each gas meter should be marked with a number indicating its sequence on the metering panel as well as the number of the cable, or cables, that it serves. These arrangements will facilitate meter reading, recording and maintenance operations.

8.05 In some instances where two or more short exchange cables provide service to the same general area or where an exchange cable provides service to widely separated sections of the area, it may be found advantageous to combine all or part of such cables with another cable to form one pressure system served through a single gas meter. Where such design is to be employed, it should be specified on the detail plans.

8.06 Where multiple exchange cable systems are designed as described in Paragraph 8.05, it may be desirable to place Air Rate Indicators at convenient locations between the gas meter and the air inlet to each individual cable. This will provide means of determining the rate of flow to each cable as well as an aid in maintenance operations. Air Rate Indicators should not be placed except when specified on the detail plans.

8.07 Seamless 1/4 inch O. D. Copper Tubing is used on the meter panel as well as to pipe air from the meters to the various cable systems. The associated brass fittings are of the compression type which permits assembly without flaring the ends of the tubing. The soft copper tubing is supplied in coils of 50 and 100 foot lengths and can be easily cut and formed in the required lengths. In forming the tubing, avoid flattening it in the bends in order to prevent restriction to the free flow of gas. The tubing should be cut with a #600 Toledo Tube Cutter and slightly reamed to eliminate burrs. This tool eliminates the copper grit and burrs usually associated with the use of a saw and which could damage or restrict gas meters, valves or other equipment.

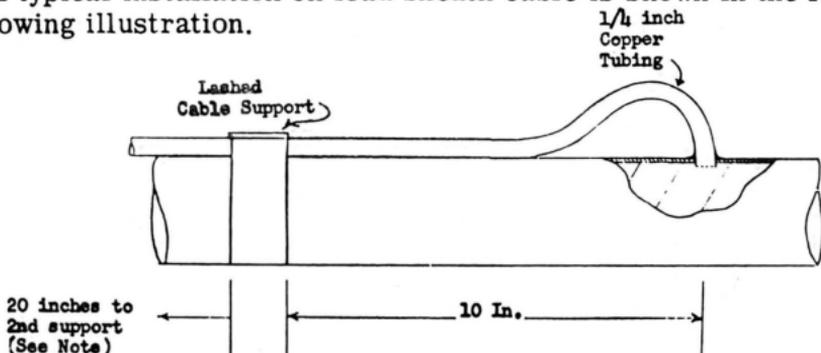
8.08 In placing copper tubing from the meter panel to the various cable systems, the following factors should be considered:

- (a) Select the shortest practical route from the meter panel to the cable.
- (b) The point of entrance of the tubing into the cable sheath can be located at any convenient available space on the cable in the vault except that the air inlet should not be less than 36 inches from the pressure plug.
- (c) When possible, avoid placing the tubing entrance into the cable sheath in the first two splicing bays from the duct entrances to the vault.

8.09 The copper air pipe feeding the cable systems from the meter panel can be introduced into the cable sheath by either of the following methods:

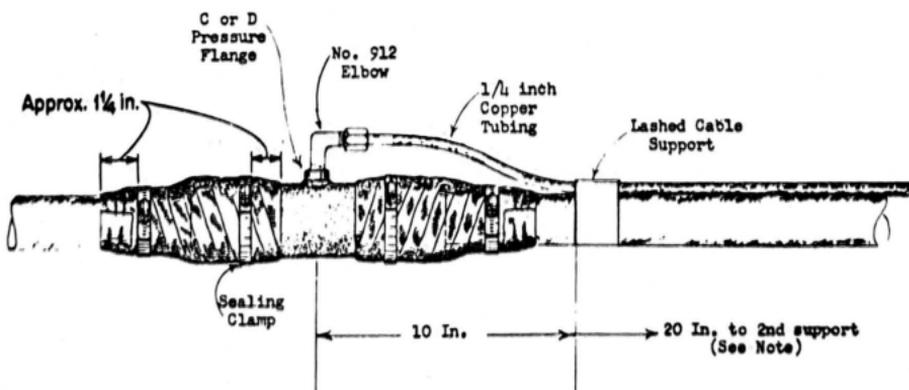
- (a) Direct connection to lead sheath or lead sleeve. Drill a hole in the cable sheath with the Cable Drill at the selected inlet location and carefully remove or puncture the exposed core wrap paper. Form the end of the copper tubing into a half-loop having a radius of 1 to 1 1/2 inches. Clean the end of the copper tube, insert it into the hole in the sheath and solder directly to the

sheath or lead sleeve. Polyethylene sheath cable should be prepared with a lead sleeve as covered in the Section on Pressure Testing, Valves, Flanges and Ells, Alpeth or Stalpeth Cable. A typical installation on lead sheath cable is shown in the following illustration.



Note: Where tubing parallels cable for more than 30 inches, supports shall be spaced 20 inches apart.

(b) Indirect connection of tubing using an elbow fitting and C Flange. For lead sheath cable or lead sleeve, install a C Pressure Flange at the selected inlet location in accordance with the Section covering Pressure Testing, Flanges and Screw Plugs, Lead Cable and Sleeves. Install a No. 912 Elbow, 1/4 In. O. D. Tube by 1/4 In. Male Pipe Thread in the C Pressure Flange and connect the copper tube to the compression fitting. This method may be used on polethylene sheath cables by installing a lead sleeve as covered in the Section on Pressure Testing, Valves, Flanges and Ells, Alpeth or Stalpeth Cable. A typical installation on polyethylene sheath cable is shown in the following illustration.



Note: Where tubing parallels cable for more than 30 inches, supports shall be spaced 20 inches apart.

## 9. MONITORING

9.01 To facilitate maintenance operations and ensure adequate protective pressures over the entire continuous flow system, each individual pressure system should be monitored by one or more of the following methods:

- (a) Periodic reading and recording of gas meters at the pressure source.
- (b) Periodic readings of B End Point Contactors when installed on exchange cables.
- (c) Periodic pressure readings at permanent key valve locations as required for maintenance purposes.

9.02 Gas meters should be read and recorded at approximately the same time each working day. Any large deviation from the normal daily gas consumption for any particular system should be reported to responsible maintenance forces for determination of cause. The normal consumption of gas for a new cable system can generally be determined by the average daily consumption of the first thirty days readings after the protective pressures over the particular system are considered adequate.

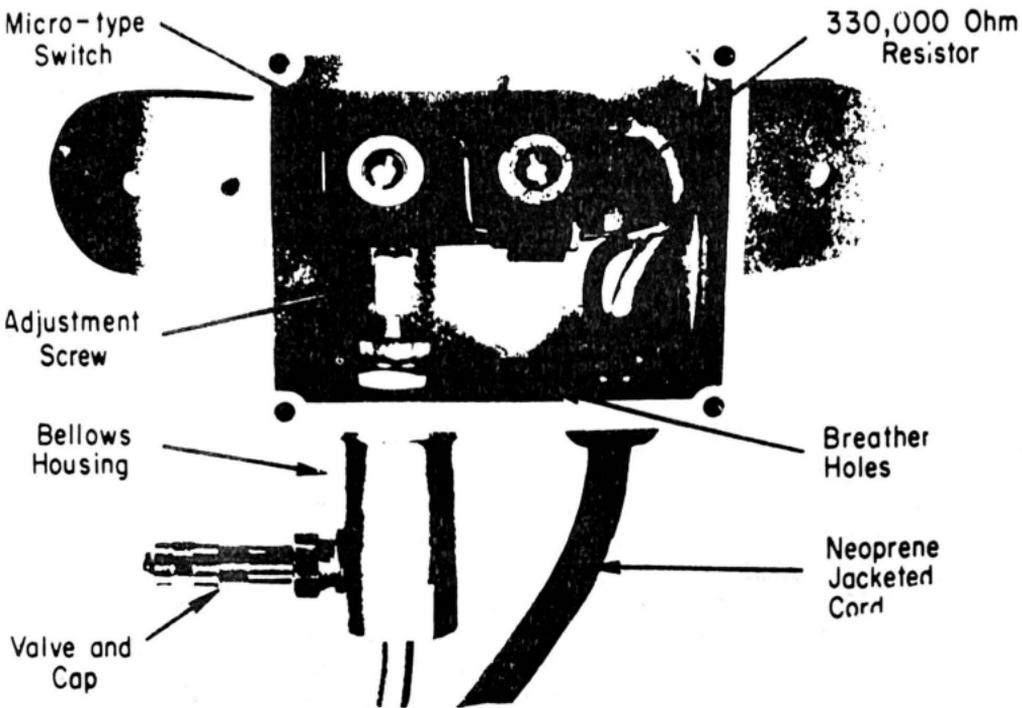
9.03 The monitoring limits of each gas meter will vary in accordance with such factors as age and size of the cable, type of sheath, overall length of the system and condition of the system. Major leaks, such as large sheath breaks or sheath openings, will usually register within a twenty four hour period if within the effective monitoring range of the gas meter. For minor leaks within the meter range or major leaks at the outer ends of the system, a period of several days may be required before a change in rate of flow, if any, will be indicated by the gas meter.

9.04 Due to the many variable factors which may effect the average rate of flow for each system, responsible maintenance forces will be required to carefully analyze each reported deviation in daily consumption in order to determine the need for possible maintenance attention. For example, if there is a sheath opening in close proximity to the pressure source or a radical change of atmospheric temperature has occurred, a rather large deviation from normal flow will not indicate the need for immediate attention or maintenance work. If, however, these factors are not present, further investigation would be advisable.

9.05 When specified on the detail plans, B End Point Contactors may be installed on exchange pressure systems to provide a convenient method of monitoring the protective pressures from the central office test room. These contactors will augment the limited range of the gas meters, thereby reducing the amount of field work necessary to determine the condition of the cable sheath. In general, five or six contactors will be sufficient to provide coverage for each exchange system. The contactors should be placed on strategic distribution or aerial feeder cables which will afford the best indication of the overall condition of the entire system. It will be necessary to establish the pressure characteristics of each pressure system in order to best determine the exact location of each B End Point Contactor as well as the total required for adequate coverage. Even under these conditions, it may be necessary to move one or more of the contactors after operating conditions have been determined in order to improve the monitoring coverage.

9.06 The B End Point Contactor is equipped with a 330,000 ohm resistor which is connected to a selected working pair of a distribution terminal by means of a six-foot length of neoprene covered, 18-gauge, 2 conductor cord. The contactor is preferably connected to a single party line for convenience in testing when the line is not in use. A five-foot length of 1/4 O. D. tinned copper tubing is also furnished with the unit for connection to the pressurized cable. The unit is pre-set at the factory to operate at 2 psi on decreasing pressure. However, it is adjustable in the field by means of the adjustment screw to operate at any desired pressure between 0 to 10 psi. For installation and adjustment procedures for the contactor, refer to other sections of the Practice covering Pressure

Testing, B End Point Contactor. The Contactor, without cover and neoprene cover gasket, is shown in the following illustration.



9.07 When increased flow readings of the gas meters or operation of B End Point Contactors indicate that maintenance attention is necessary, it will be necessary to take pressure readings at key valve locations in order to determine the cause and approximate location of the loss of pressure. After the trouble has been isolated to a reasonable working area, leak location work may proceed in the normal manner as covered in other Sections of the Practices.