Procedures For Welding Or Hot Tapping On Equipment Containing Flammables

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Procedures for Welding or Hot Tapping on Equipment Containing Flammables

SECTION 1—GENERAL

1.1 Scope

This publication covers some of the safety aspects to be considered when welding a hot tap connection onto a pipe or vessel installed in a refinery, chemical plant, or other similar facility. It is not a substitute for job planning. A detailed written procedure for hot tapping should be prepared or reviewed before starting each job to ensure that all proper steps are taken. Keeping in mind the safety of personnel and facilities, these procedures may need to be revised in response to unique problems that may arise.

This publication is not applicable to hot taps on gas or liquid petroleum transmission pipelines or service taps on gas distribution mains. The procedures described in this publication apply to piping and equipment fabricated from ferritic and austenitic steel. Other materials, such as aluminum, copper, and cast iron, may require special procedures.

Hot tapping is the technique of attaching connections to equipment in service by welding and drilling. Because air is excluded from inside the equipment, where hydrocarbons are present, the chance of fire or explosion while hot tapping is less than with methods where the equipment is opened. A hot tap connection can often be made without interfering with the process operation.

1.2 Referenced Publications

The latest editions of the following documents shall, to the extent specified, form a part of this publication.

API

Std 598	*Valve Inspection and Test*
Std 650	*Welded Steel Tanks for Oil Storage*
Publ 941	*Steels for Hydrogen Service at Elevated Temperatures and Pressures In Petroleum Refineries and Petrochemical Plants*
Tech. Bull. (OH-8)	*Medical Management of Chemical Exposures in the Petroleum Industry*

ANSI[1]

B31.3	*Chemical Plant and Petroleum Refinery Piping*
Z49.1	*Safety in Welding and Cutting*
Z88.2	*Practices for Respiratory Protection*

ASME[2]

Boiler and Pressure Vessel Code, Section IX

ACGIH[3]

Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment and Biological Exposure Indices, and companion documents referenced therein

OSHA[4]

29	*Code of Federal Regulations*, Part 1910

SECTION 2—HOT TAP MACHINES

Although commercial hot tapping machines are available, some companies prefer to build their own. These machines must be able to positively retain and remove the blank or coupon. All hot tapping machines have maximum working pressure and temperature ratings. These ratings should never be exceeded. They may be powered by hand, air, hydraulic fluids, or electricity.

A hot tap machine can be considered suitable if the pressure and temperature of the medium inside the line or vessel falls within the working limits of the hot tap machine. The seals and materials of the hot tap machine must be compatible with the fluids in the line or vessel and the material of the drill

[1]American National Standards Institute, 1430 Broadway, New York, New York 10018.
[2]American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.
[3]American Conference of Governmental Industrial Hygienists, Building D-5, 6500 Glenway Avenue, Cincinnati, Ohio 45211.
[4]Occupational Safety and Health Administration, U.S. Government Printing Office, Washington, D.C. 20402.

or cutter must be suitable for effective penetration of the metal of the pipe or vessel.

Before hot tapping is attempted, the machine, cutter, and pilot bit should be carefully inspected to ensure that they are in satisfactory condition and capable of being left in service, if necessary, in the event of mechanical problems or hot tap valve leakage.

SECTION 3—METALLURGY

3.1 General

Vessels or lines to be hot tapped must be properly inspected for adequate wall thickness and absence of imperfections to minimize the risk of burn-through. Also, controlled welding techniques should be followed by qualified welders to prevent overheating, and all appropriate safety procedures must be followed.

A thorough inspection of each connection area must verify that the metal thickness is adequate for the pressure and temperature involved. There must be no laminations or other imperfections. Hot taps should only be made in lamination-free areas with adequate metal thickness.

3.2 Burn-Through Prevention

To minimize the possibility of burn-through, the first weld pass to the equipment should be made with a $\frac{3}{32}$-inch (2.4-millimeter) diameter welding electrode. Subsequent passes should be made with a $\frac{1}{8}$-inch (3.2- millimeter) electrode diameter or less if the metal thickness does not exceed ½ inch (12.8 millimeters). In many situations, low hydrogen rods may be preferable to reduce the possibility of burn-through.

For wall thicknesses greater than ½ inch (12.8 millimeters), where burn-through is not a primary concern, larger diameter electrodes may be used.

3.3 Metal Thickness

Generally, a minimum base metal thickness of $\frac{3}{16}$ inch (4.8 millimeters) is recommended for hot tapping. Exceptions to the recommended thickness may be permitted when metallurgical requirements and pressure limitations specified by company authorities are met. Welding on thin material could result in overheating and burn-through. If practical, temporarily reduce the pressure and/or temperature within the equipment to provide an additional safety factor while welding takes place.

3.4 Metal Temperature

If the metal temperature is less than 50 F (10 C), heating the weld area before welding should be considered. Generally, welding should not be performed on lines or equipment when atmospheric temperature is less than −50 F (−45 C) unless special consideration is given to the base metal characteristics, electrodes, and a method of metal preheating. Hot tap machines should also be checked for suitability of use at low temperatures. Under all circumstances, hot tapping should be limited to the pressure/temperature rating of the machine.

3.5 Stress Relief

Some equipment is unsuitable for hot tapping because the metallurgy or thickness of metal requires stress relieving, which normally cannot be done while the equipment is pressurized. Special treatment is required for high tensile strength alloy steels and special welding electrodes must be used. Hot tap fitting and weld rod metallurgy must be compatible with the metallurgy of equipment to be tapped.

3.6 Chemistry of Line or Vessel Contents

The oxygen level within the equipment must be controlled to prevent the formation of a vapor/air mixture within flammable or explosive ranges. In addition, contents of the line or vessel being hot tapped must not contain:

1. Hydrogen, if the equipment has operated above the Nelson curve limits, because of the possibility of hydrogen attack of the metal (see API Publication 941).
2. Vapor/air or vapor/oxygen mixtures within flammable or explosive ranges.
3. Acids, chlorides, peroxides, or other chemicals likely to decompose or become hazardous from the heat of welding.
4. Caustic or amine, if the concentration and temperature are such that the fabrication specifications call for stress relieving.
5. Certain unsaturated hydrocarbons that may experience exothermic decomposition reaction (ethylene, for example) if the metal temperature resulting from hot tapping could initiate such a reaction at the maximum expected pressure. Such reactions could have the potential for causing localized hot spots on pipe walls that could lead to failure.

SECTION 4—PREPARATIONS

4.1 Written Plans

In advance of any hot tap work, the following items should be prepared:

1. A detailed written welding procedure.
2. A hot tap procedure.
3. A connection design.
4. Health, safety, fire protection, and other appropriate instructions, including owner or user requirements.

If the base metal temperature requires a preheat of the weld area, this should be covered in the plan.

Section IX of the *ASME Boiler and Pressure Vessel Code* relates to the qualification of welders, welding operators, and brazers and brazing operators, and the procedures they employ in welding or brazing according to the ASME Code.

To ensure that hot tapping will be performed under safe conditions, the supervisor in charge must be sure that proper investigation and preparatory steps have been taken. The checklist, included in the appendix, is attached for consideration. Other steps may be needed in addition to those provided in the checklist. The supervisor planning a hot tap job should review the particular job for all necessary preparations.

4.2 Personnel Qualifications

Welders must be qualified in accordance with the applicable code and specifications. They should be thoroughly familiar with welding equipment and procedures to be used. Only competent personnel should mount and assemble the tapping machine. This competence may be achieved by on-the-job training or by a training program provided by the manufacturer of the machine.

4.3 Toxicity Considerations

4.3.1 PETROLEUM SUBSTANCES

Tests have shown that prolonged or repeated exposure to some petroleum substances, in liquid or vapor form, may cause illness, including cancer, in laboratory animals. The significance of these results to human health is not fully understood because of the difficulty in translating to humans the data from animal tests. Nevertheless, everyone should minimize exposure to petroleum substances. The following health precautions are suggested:

1. Minimize skin contact and breathing of vapors.
2. Keep away from mouth; may be harmful or fatal if swallowed.
3. Keep work areas clean and well-ventilated.
4. Clean up any spills promptly.
5. Use soap and water or waterless hand cleaner to remove any petroleum product that contacts skin. Do not use gasoline or similar solvents to remove oil and grease from skin.
6. Promptly wash oil-soaked clothes and avoid using oil-soaked leather goods.

Information concerning health risks with respect to a particular material should be obtained from the employer, the supplier of that material, or the Material Safety Data Sheet. Government health, safety, and environmental agencies are additional sources of information.

4.3.2 WELDING FUMES

Toxicity depends on the composition and concentration of fumes. The composition and quantity of fumes depend on the materials being welded, the composition of the rods, any coatings or paints, the process used, and the circumstances of use. Toxic fumes are generated from welding on metals coated with or containing alloys of lead, zinc, cadmium, beryllium, and certain other metals. Some paints may also produce toxic fumes when heated. The potential health effects range in type and severity depending on these factors, and some can be extremely serious.

Further detailed information on welding toxicity and appropriate protective measures such as respirators can be obtained from the employer or by consulting *Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment* by the American Conference of Governmental Industrial Hygienists and Occupational Safety and Health Administration (OSHA) regulations. See 29 Code of Federal Regulations, Subpart Q (Welding, Cutting, and Brazing) 29 CFR 1910.251 and following, and Subpart Z (Toxic and Hazardous Substances), 29 CFR 1910/1000, API's technical bulletin *Medical Management of Chemical Exposures in the Petroleum Industry* (OH-8), and other references listed in 1.2.

4.4 Base Metal Suitability

The base metal thickness must provide support for the new connection and the hot tap machine or be properly reinforced to provide such support. The base metal must be free of laminations, hydrogen attack, or stress corrosion cracking (fissuring). There must be no other imperfections that would prevent a sound weld from being made. Stress relieving of the welded area must not be required.

4.5 Fittings

Care should be taken to select the proper fitting for the connection. Many types of connecting fittings are available such as weldolets, weld-ends, split tees, saddles, and nozzles. Connections should be designed to the applicable code, such as the ASME *Boiler and Pressure Vessel Code*, ANSI B31.3, or API Standard 650. The design should cover the specifications of gaskets, valves, and bolts.

Be sure the fitting is the proper size to accommodate the hot tap machine to allow for full depth of cutter penetration within the travel limits of the machine and to allow for uninterrupted tapping valve closure when the cutter is retracted.

Hot tapping closer than 18 inches (46 centimeters) to a flange or threaded connection or approximately 3 inches (7.5 centimeters) to a welded seam should be avoided.

4.6 Flow in Lines

Some flow is desirable in a line when hot tapping to minimize the potential for several undesirable conditions. Overheating liquids, blow-through caused by elevated metal temperatures, and fluid thermal expansion in closed systems are less likely when a relatively low to medium flow is maintained. Avoid high flow rates when welding.

In certain cases, such as a flare line, there may be insufficient or interrupted flow that may result in a flammable mixture during the welding operation. It may be necessary to continually purge or flood the line with steam, inert gas, or hydrocarbon gas to prevent the formation of flammable mixtures.

SECTION 5—SPECIAL CONDITIONS

5.1 Tanks in Service

Never pump into or out of a tank while hot work is in progress. All valves on liquid lines at the tank must be closed, tagged, locked, or otherwise rendered inoperative. Discontinue operation of all mechanical tank mixers. Avoid any procedures associated with operation of gas-blanketing valves or other valves that could cause venting.

Turn off all heating coils during the hot tap procedure.

Maintain at least 3 feet (1 meter) of liquid above the hot work area when welding or hot tapping is being done. A hand tape gage measurement of the tank contents should be made because automatic or remote reading gages may not be reliable enough for this measurement. No attempt should be made to hot tap above the liquid level in atmospheric pressure petroleum storage tanks because of the danger of an explosive atmosphere inside the tank.

5.2 Floating-Roof Tanks

Hot work should not be permitted on the deck of a floating-roof tank in service except under very carefully controlled conditions. Emergency exit plans should be made before starting work on such tanks.

Floating-roof tanks are subject to unique flammability hazards in the following locations:

1. Inside the pontoon.
2. Between the deck and liquid surface near the tank roof cage float compartment.
3. Near the roof seal vent.
4. Near the floating roof lift leg vent.
5. Between the primary and secondary seals.

Extreme caution is advised.

5.3 Work Above or Below Grade or in Congested Areas

For work above and below grade or in congested areas, an easily accessible personnel exit must be provided. To ensure that excavations are safe for entry and hot work, tests for oxygen deficiency and for the presence of flammable and toxic material should be made. If oxygen deficiency or either type of material is present, an air mover or some other positive means of ventilation should be provided. Air breathing equipment should be used to protect personnel from toxic atmospheres or from vapors emitted as a result of welding (see 1.2 and 4.3).

5.4 Compressed Air in Lines or Vessels

Welding should not be performed on compressed air lines or air receivers under pressure. Such equipment may contain a residue of lubricating oil or carbonaceous material, which may ignite. Even when depressured, welding should be done only after thorough cleaning or other steps are taken to ensure that either oxygen or combustible material is not present inside the line. Welding should not be performed on lines or vessels containing pure oxygen or oxygen-enriched atmospheres.

5.5 Lined Piping or Equipment

Hot tapping should not be done on lines or equipment with cladding or with glass, lead, refractory, plastic, or strip linings.

5.6 Cased Lines

If an underground line runs through a casing, care must be taken to ensure that the welding is done on the line, not on the casing, and that the annular space is gas-free.

5.7 Downstream Equipment

Avoid hot tapping upstream of rotating equipment or automatic control valves, unless such equipment is protected from the cuttings by filters or traps.

SECTION 6—PROCEDURES

6.1 Preliminary

Before proceeding to hot tap, the following conditions should be satisfied:

1. A competent company representative is present during the hot tap procedure.
2. The area to which a connection is to be made has been identified and physically marked.
3. The metal thickness has been measured and the absence of metal imperfections is verified.
4. A hot work permit has been secured if the area in which work is to be done requires such a permit.
5. All necessary gas and toxicity tests have been made to ensure a safe environment.
6. Personnel protective clothing and equipment are used where necessary.
7. A fire watch has been established and equipped with a suitable fire extinguisher, preferably dry chemical or pressurized fire hose.
8. Signs and barriers have been provided, where warranted, to isolate the job site from the public and from unauthorized personnel.

A procedure to isolate the work area in the event of a failure should be prepared. Personnel should be trained and familiar with both the procedure and the location of applicable equipment.

6.2 Welding

Upon completion of the steps outlined in 6.1, the following steps should be considered:

1. Exercise care to see that the fitting is properly positioned and supported before welding so that misalignment of the hot tap machine will not occur.
2. If the metal temperature is less than 50 F (10 C), preheating of the weld area prior to welding should be considered.
3. When metal temperatures are below the atmospheric dew point, preheating or other steps may be desirable to reduce the moisture content in the weld area. Moisture inclusion could result in weld porosity and underbead cracking.
4. If blowing dirt, snow, or rain is present, the weld area should be sheltered or protected during cleaning, preparation, and welding.

6.3 Inspecting the Weld

The welded attachment should be inspected during and after welding and before the hot tap machine is installed. Examination by radiograph, dye penetrant, ultrasonic, or magnetic particle is recommended, particularly on the first pass and final weld to check for underbead cracking. If these tests are used after the first pass, the weld area must be thoroughly cleaned of any foreign material or residues. These procedures should not be relied upon to replace hydrostatic or air testing.

6.4 Installing the Hot Tap Machine

Follow the machine installation instructions of the manufacturer and check the following items:

1. The hot tap valve to be used must be of adequate size, proper metallurgy, and be a full opening valve. It should be tested for seat leakage prior to installation (see API Standard 598).
2. During installation, the valve should be centered on the nozzle flange.
3. Run the boring bar through the valve opening to be sure the cutter does not jam or drag.
4. Carefully calculate the travel of the cutter to ensure that the tap can be completed within those dimensional limits, that the cut will be stopped before the cutter touches the opposite side of the tapped pipe, and that the cutter can be retracted far enough to allow unimpeded closure of the tapping valve.
5. Check that the bleed-off valve will hold pressure and is not plugged.
6. Ensure that precautions have been established for safe bleed-off and disposal of material collected in the machine above the hot tap valve.

6.5 Testing the Weld and Hot Tap Machine

The welded attachment and hot tap machine should be tested before cutting is started.

1. Check tightness of bolts, packing, packing nuts, and bypass line, if required, to avoid possible leakage.
2. If the current temperature of the line or vessel will permit, a hydrostatic test should be conducted in accordance with the applicable code. The new weld and the tapping machine should be pressure tested simultaneously. The test pressure should be at least equal to the operating pressure of the line or vessel to be tapped, but it should not exceed the present internal pressure by more than approximately 10 percent in order to avoid possible internal collapse of the pipe or vessel wall. The temperature of the metal should be considered to prevent brittle fracture.
3. Air or nitrogen with soap solution on the weld can be substituted for a hydrostatic test if the temperature precludes the hydrostatic test. At elevated temperatures, air should be used only after careful consideration to avoid the possibility of a combustible mixture.

6.6 Completion

It is often possible to tell when the cut is complete by the reduced resistance to the hand cranking or by the speedup of the drive motor. The manufacturer's instructions should be followed when retracting the bore and closing the valve.

If the blank or coupon is lost, no attempt should be made to search for it. In some cases it will be necessary to shut down the equipment and depressure the line to recover a lost blank.

APPENDIX

SUGGESTED HOT TAP CHECKLIST

This checklist may be used as a reminder to accomplish the steps in order. However, particular circumstances of the job may dictate additional preparatory steps. This checklist may be kept as a record of the job.

LOCATION: ____________ **DATE:** ____________

Before Starting Hot Tap

Each of the following considerations should be satisfied before starting a hot tap:

1. If required, has the properly approved work permit been obtained?
2. If required, has the hot work permit been obtained?
3. Does the tapping machine have suitable pressure and temperature ratings and adequate cutter travel for this job?
4. Has the exact location of the hot tap on the line or vessel been identified and marked?
5. Has the area to be welded been inspected for thickness and freedom from lamination, hydrogen attack, or other metallurgical imperfections?
6. Has the metallurgy of the line or vessel been established, and is it compatible with the connecting fitting?
7. Has it been determined that stress relieving of the welded area is not required?
8. Do the flanges, bolts, gasket, pipe, and valve to be installed meet the piping code for the line or vessel to be hot tapped?
9. Is there sufficient external clearance to accommodate the operation of the hot tap machine?
10. Is there sufficient internal clearance to retract the cutter through the valve?
11. Is the hot tap fitting of the proper length to accommodate operation of the hot tap machine?
12. Have combustible and toxic gas tests been conducted in the area of hot tapping?
13. Has the chemical composition of the line or vessel contents been considered to avoid welding on equipment containing flammable mixtures, hydrogen, or chemicals affecting metal strength?
14. Is the material in the line stable under heated conditions and free of oxygen?
15. Has fire-fighting equipment been provided?
16. Has suitable protective equipment been provided to all exposed personnel in the hot tapping area?
17. Is the area to be hot tapped located below the liquid level of a tank or on a line or piece of equipment in which fluid flow has been established?
18. Is there adequate hoisting and support equipment for the tapping machine and subsequent piping, satisfactory storage areas, and room for operational and emergency access?
19. Has a procedure to isolate the work area in the event of a failure been prepared, and are personnel trained to implement this procedure?

Before Welding

Each of the following considerations should be satisfied before welding:

1. Is a preheat of the weld area required?
2. Is the fitting properly positioned so misalignment of the hot tap machine will not occur?
3. Has the pressure and temperature of the contained material been reduced as much as the process operations will allow?
4. Is there liquid or flowing gas in contact with the area to be hot tapped?

Before Cutting

Each of the following considerations should be satisfied before cutting:

1. Has the weld been tested?
2. Have the hot tap valve, packing, gasket, and bolts been checked for possible leakage?
3. Has the packing or seals on hot tap machine been checked?
4. Has the bleed-off valve been checked to be sure it will hold, is operable, and is not obstructed?
5. Are all bolts on the cutter and pilot bit tight?
6. Is the coupon catcher on the pilot bit?
7. Is the valve centered on the flange?
8. Has the cutting depth been calculated to avoid cutting the opposite side of the pipe?
9. Has the boring bar been run through the valve to ensure free passage?

Before Removing Hot Tap Machine

Each of the following considerations should be satisfied before removing a hot tap machine:

1. Have the manufacturer's instructions been followed to be sure the boring bar is fully retracted before closing the hot tap valve?
2. Has the hot tap valve been closed?
3. Has the bleeder valve been opened?
4. Has all pressure been bled off the hot tap machine before removing bolts from the flange?

NOTES FOR A PRESSURE

INSTALLATION PRIMER

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PREFACE

The performance of any under pressure installation involves a great number of planning and procedural variables that contribute to the overall success of an operation. International Piping Services Co. has found over the years that if the job site engineer or superintendent knows the basic procedures and problems involved in a pressure installation, he will know what to expect and prepare for it prior to IPSCO's arrival. When a pressure installation operation is coordinated in this matter and everyone realizes that there is more to it than drilling a hole in a pipe, a safe and more economic job will surely result. For this reason, we have compiled this book. In it you will find general information describing basic pressure tapping, line stopping and valve inserting along with some technical data.

We intend this book as a pressure installation primer and urge anyone that actually becomes involved in an under pressure operation to contact us while still in the planning stages so that on the job site a smooth and successful operation takes place.

INTRODUCTION

I. GENERAL

A. Pressure installations are techniques which allow alterations, relocation, extension, addition, repair, replacement or abandonment of piping without shutdown or interruption of service to critical processes or customers.

B. What is wrong with shutdown or interruption of service? Nothing....

1. Until the possible consequences are considered of

   a. Contamination and loss of water, (either process or drinking)
   b. Loss of fire protection.
   c. Disposal of flammable or toxic fluids in product lines.

2. Until you can accurately evaluate the many "hidden" costs of shutdown.

   a. Planning and coordination - meetings, schedules, paperwork.
   b. Lost production and profits.
   c. Direct manpower - open and close valves, bleed, cool down, warm up.
   d. Overtime.
   e. Draining, purging.
   f. Refilling.

C. Like anything else, some pressure installations are quite routine - others are very complex, and could be dangerous. It is therefore extremely important that the design engineer be aware when a pressure installation is routine or when he should get assistance from a specialist.

D. The specifications and detailed drawings for pressure installations must define the true scope of the work, otherwise:

1. The contractor will be overly protective in his bid.

2. Frequently the plant will later be hit for extras.

E. What are the specific pressure installation techniques?

1. Pressure tapping (hot tap, wet tap, pressure cut, side cut).

2. Pressure plugging. (line stop, stopper, "stopple", or pressure stop).

3. Valve inserting (insert, pressure cut-in).

PRESSURE TAPPING

INTRODUCTION:

The first of our three techniques is the pressure tap. It is also known variously as a hot tap, pressure cut, or side cut. Essentially three things are required to execute a pressure tap. First of all, a suitable tapping nozzle is attached to the existing pipe or header. The next thing needed is a tapping valve. The last requirement is the actual machinery, a tapping machine, which is used to execute the pressure cut. In the exploded view, you see all three of the essential components (Fig. 1).

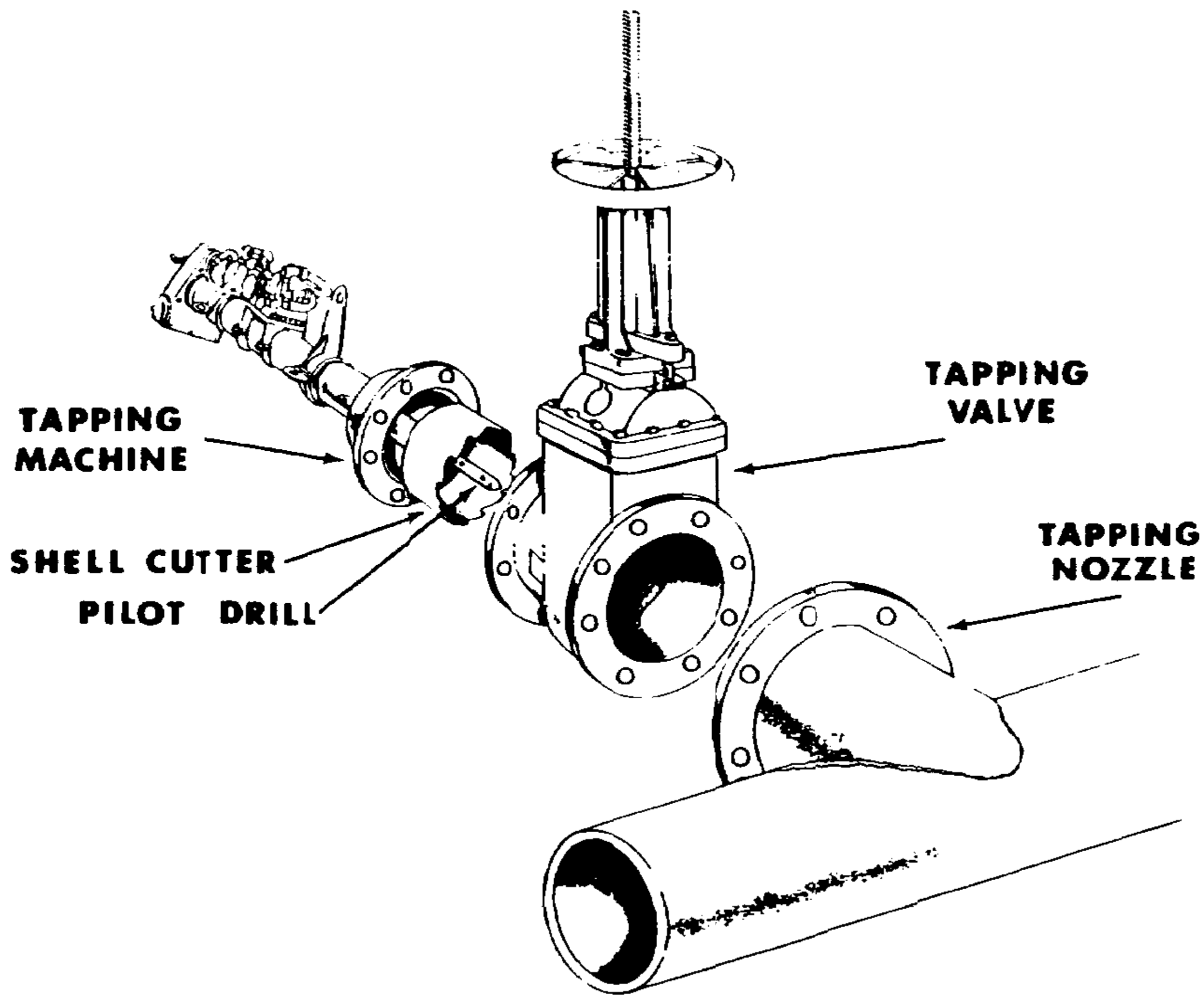
If we are dealing in the waterworks industry the word "tapping valve" has a definite and specific meaning. This is a double-disc parallel seat valve that carries a specially oversized bore. The seat ring lugs are removed, and in addition, special care is taken to insure that the bolt circle and outlet of the tapping valve are concentric with the bore thru the seat rings. In using a tapping valve - and remember this is a special valve - a full size cut can be made. Thus, a 36-inch diameter cut can be made thru a 36-inch tapping valve, the reason for this is the fact that the tapping valve is actually bored out from 36-1/4 to 36-1/2 inches in diameter.

However, in order to execute the pressure tap, we do not need this "special tapping valve". We can utilize any valve that has a clear round concentric bore and by concentric we mean that the bore must be relatively concentric with the two flange bolt circles, or if the valve happens to be a screwed valve, the pipe threads generated in each end of the valve must be relatively concentric with the bore thru the seat rings.

For that matter, we can use a ball valve, a pipeline gate valve, a waterworks line valve, or practically any other type of gate valve. Even though the valve was not intended by the manufacturer to be a "tapping valve". However, we must exercise extreme caution in the choice of the valve, as we will point out later in "tapping traps". (Fig. 2 thru 6)

Tapping machines come in all sizes. There are approximately four major manufacturers of tapping machines in the country today. Each manufacturer has built a machine to be used with his own product, which is, generally speaking, identified with a particular industry. Thus, the company that sells pipe pressure fittings for use on cross country pipelines, will tend to make a tapping machine that will withstand extremely high pressures. Conversely, a firm that sells low pressure water main fittings or fittings for use on low pressure gas distribution systems, will tend to make a machine that is somewhat lighter and will have a much lower pressure rating. Extreme care must be exercised in the selection of the tapping machine, since temperature-pressure ratings vary with each machine.

No one seems to know why the section of the main that is severed, is called a "coupon". At any rate, this term is generally speaking, universally used.



PRESSURE TAP

EXPLODED VIEW OF COMPONENTS

Fig. 1

When cutting into a flat plate, all of the teeth on a standard cutter are in contact at any given moment. Because each tooth is forming a chip, extremely high forces are generated and conventional tapping machines - no matter how large they are - cannot generate the torque necessary to complete the cut. Therefore, when making so-called plate or flat taps, special cutters with a reduced number of teeth have to be used.

Every nozzle - valve - tapping machine assembly is subject to certain possible "tapping traps". A general awareness of these various traps must be maintained because any one of them could stop the successful completion of a pressure tap. (See Figs. 2 thru 6)

GENERAL:

I. A. The process is old, dating back to the late 18th century when the wooden water mains were literally tapped like a wine keg.

B. Pressure tapping is relatively unlimited with respect to the type of pipe.

1. Steel
2. Cast Iron
3. Reinforced concrete, non cylinder
4. Reinforced concrete, cylinder
5. Asbestos cement
6. Non ferrous metal
7. Plastic

C. Pressure taps using plug, globe, butterfly, check and angle valves or others with restricted, obstructed, or non-concentric openings require special techniques developed by IPSCO.

D. Cutter size is limited to commercially available cutters, unless extra expense is warranted. IPSCO has available many special cutters and is capable of producing new:

1. Tapping valve cutters
2. Conventional valve cutters.
3. Line stop cutters
4. Drills for small size taps

E. The coupon is the severed section of pipe. It cannot be allowed to drop into the pipe. Therefore a pilot drill retains the coupon by one or more of the following mechanical retention devices. Note that the correct retention method must be matched with each pressure tap characteristic.

1. Latches. (May prevent cutter retraction if problems occur)
2. Spring detents. (No good at high temperature)
3. Wire clips. (Require layout for each tap)
4. Threaded pilot drill. (Must match automatic feed of machine)

Pipe condition can greatly effect the problems of coupon retraction.

F. Shell cutter design is in its infancy despite the fact that pressure tapping is 75 years old. IPSCO studies include:

1. Tooth geometry.
2. High speed inserted teeth.
3. Various carbon steel cutters.
4. Cemented-carbide inserted teeth.
5. Mechanical carbide inserted teeth.

G. Geometry must always be considered in designing a pressure tap.

1. Machine travel.
2. Gate clearance for the pilot drill.
3. Cutter depth for heavy wall pipe.
4. Pilot drill length for heavy wall pipe.
5. Concentricity.
6. Perpendicularity (Note see Figs. 1 thru 4)

H. Design must consider type of reinforcing and/or blocking for nozzle.

1. Code requirements.
2. Good practice .
3. Condition of pipe.
4. Beam strength.
5. Thrust blocking.
6. Cyclic loading.
7. Pressure surges (Water hammer)

I. RED FLAG!! Get advice if your taps involve any of the following considerations:

1. Temperature of 500°F. or higher.
2. Pressure of 350 PSIG or higher.
3. High pipe diameter to tap diameter ratio (i.e. tap approaches plate tap). When tap sizes are over 10 inches nominal diameter.
4. Low pipe diameter to tap diameter ratio (i.e. tap approaches size on size). When tap sizes are over 16 inch nominal diameter.
5. Ring joint flange, lap joint flange, butt weld, etc., outlets on valves.
6. Extra strong pipe.
7. All taps on the following pipe.

    a. Concrete (either cylinder or non cylinder)
    b. Asbestos cement pipe.
    c. Non ferrous metal.
    d. Cast iron above 12 inch.
    e. Plastic.

8. All taps in tight quarters, taps with long nozzles.
9. Any taps in which the designer would prefer a "non tappable" valve (i.e. butterfly, globe, check, plug, etc.)

PROCEDURE:

After the tapping nozzle has been joined to the existing pipe, the tapping valve is bolted to the outlet of the nozzle to make a pressure tight connection. The tapping machine, by means of a special adaptor, is bolted to the outlet of the tapping valve, which also makes a pressure tight connection. The tapping valve is opened and the cutter-pilot drill assembly is advanced through the valve to the nozzle until contact is made with the outside of the existing header. With the tapping machine's automatic feed set, power is supplied and rotation is then started. The pilot drill penetrates the side of the pipe. As soon as this penetration is accomplished, the nozzle, the valve, and the tapping machine adaptor are filled with whatever fluid happens to be inside the header. If this fluid is combustible, it is normal practice to open a bleed in the adaptor, thereby allowing the pressure in the header to purge out whatever air might be in the existing components. The bleed valve is closed as soon as the product begins to appear, and the cut continues.

The tap is completed when the shell cutter not only has severed the coupon, but has actually continued its travel into the existing header. In other words, the cut is not fully completed to its proper diameter until some period in time after the coupon has actually been severed.

By some suitable means, usually on the pilot drill, the coupon is prevented from dropping into the existing pipeline. Therefore, by retracting the boring bar on the tapping machine, the cutter, pilot drill, and coupon return back into the tapping machine adaptor. At this time the gate of the tapping valve can be closed. The tapping machine can now be removed having thus gained access to the interior of the pipeline without taking a line out of service.

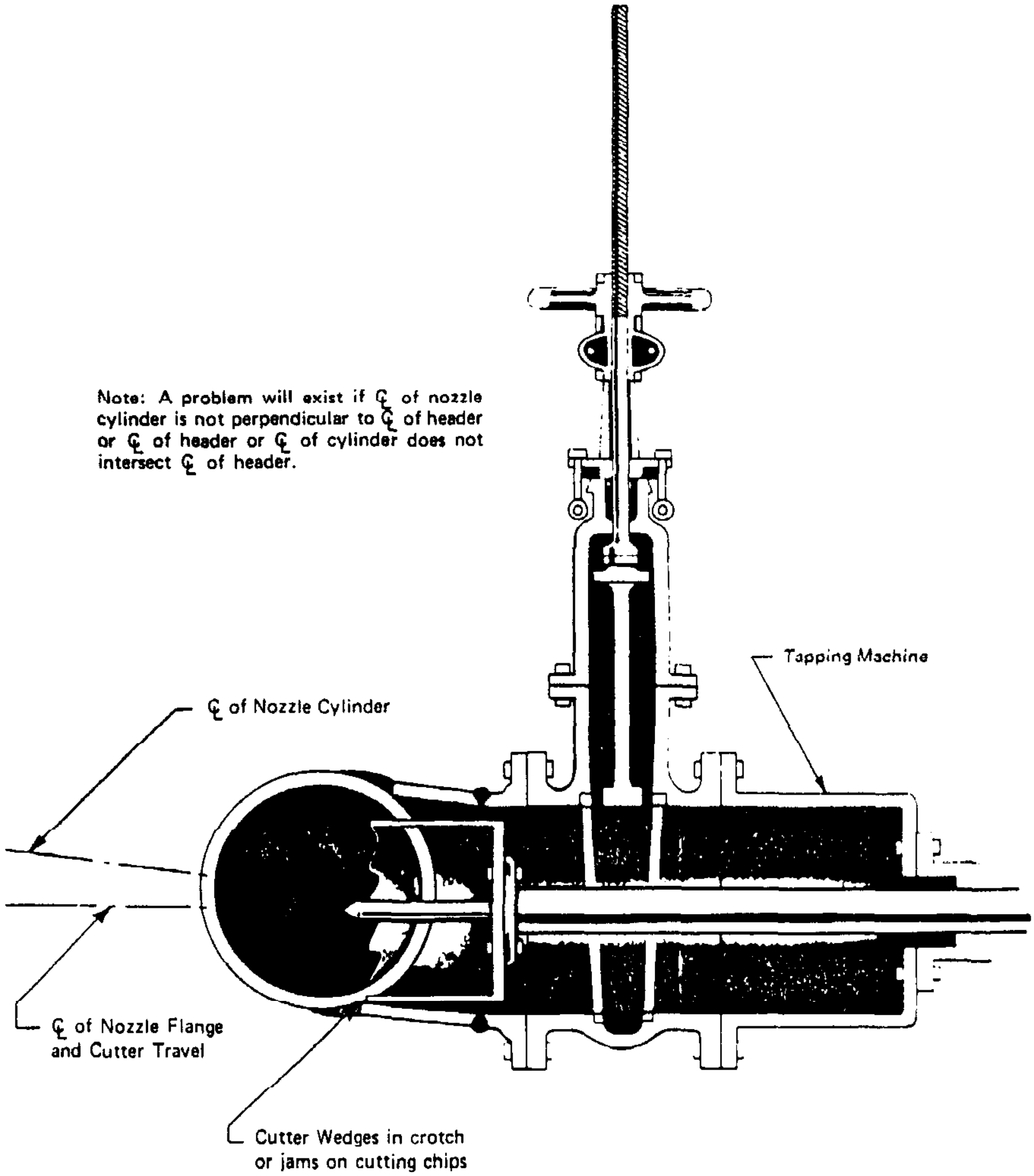

Note: A problem will exist if ℄ of nozzle cylinder is not perpendicular to ℄ of header or ℄ of header or ℄ of cylinder does not intersect ℄ of header.
Tapping Machine
℄ of Nozzle Cylinder
℄ of Nozzle Flange and Cutter Travel
Cutter Wedges in crotch or jams on cutting chips

Fig. 2

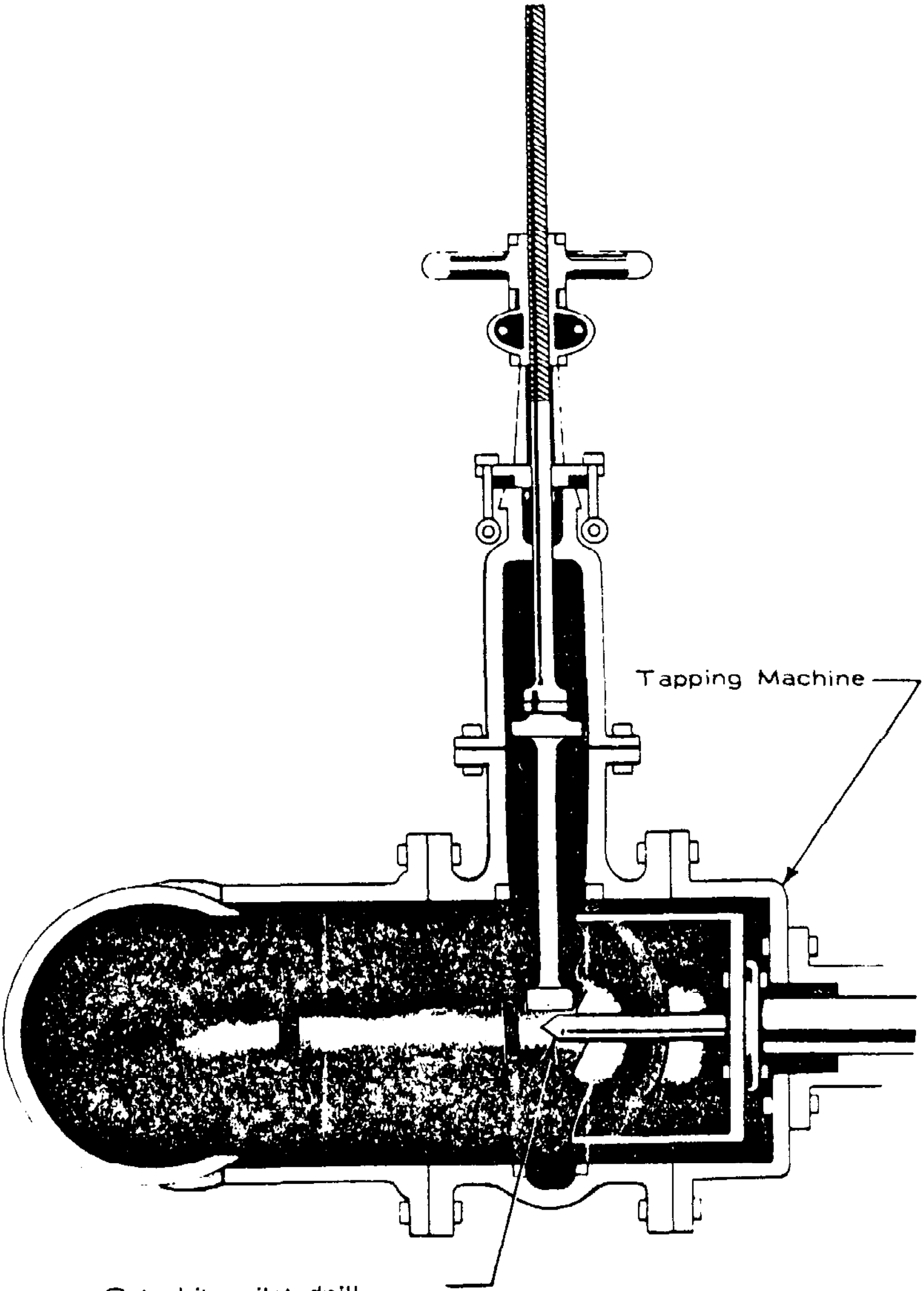


Fig. 3

TAPPING TRAPS NO.2

Valve Not Deep Enough for Cutting Equipment

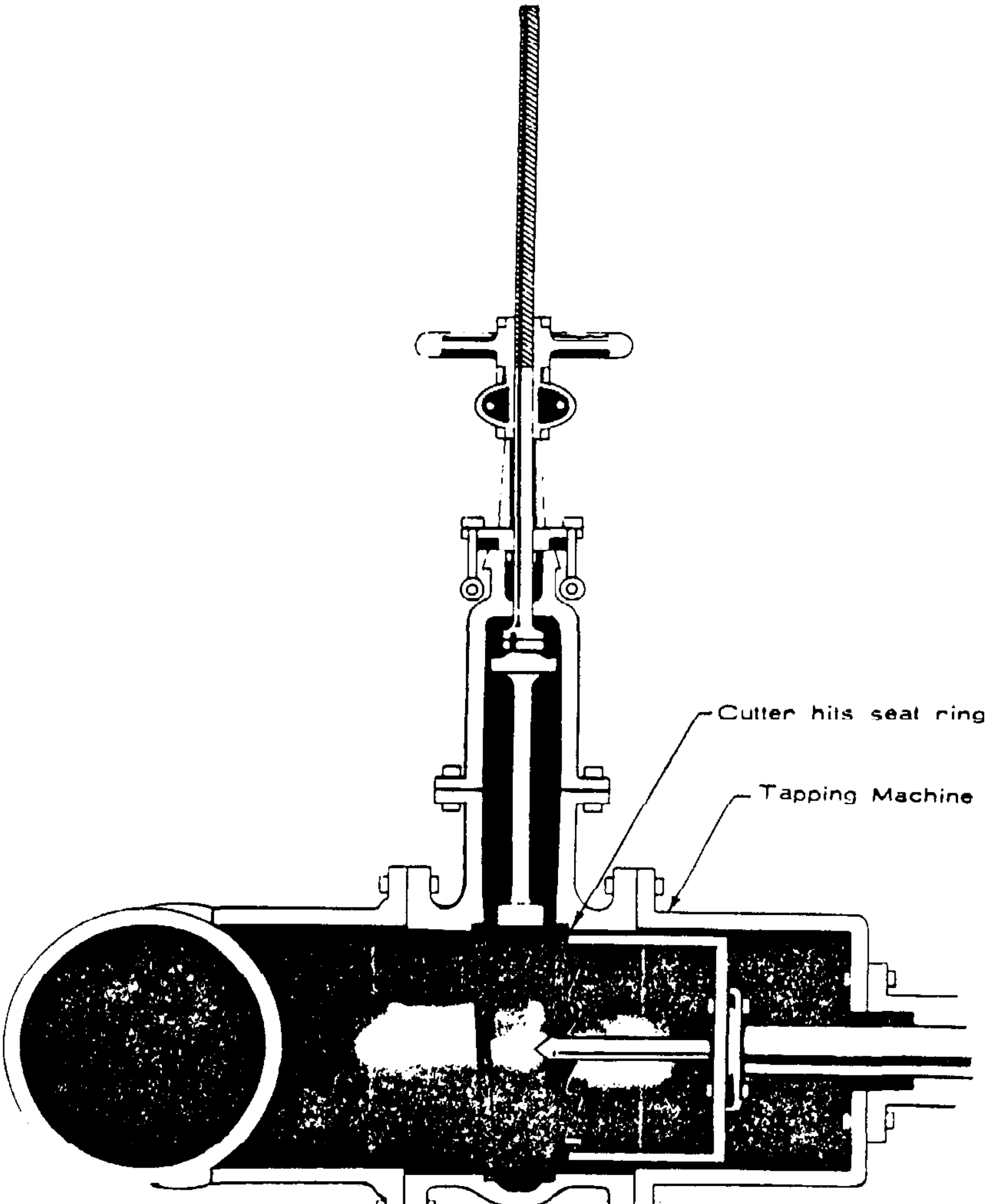


Fig. 4

TAPPING TRAPS NO. 3

Valve Seat Ring(s) not Concentric
with Valve Flange Bolt Circle

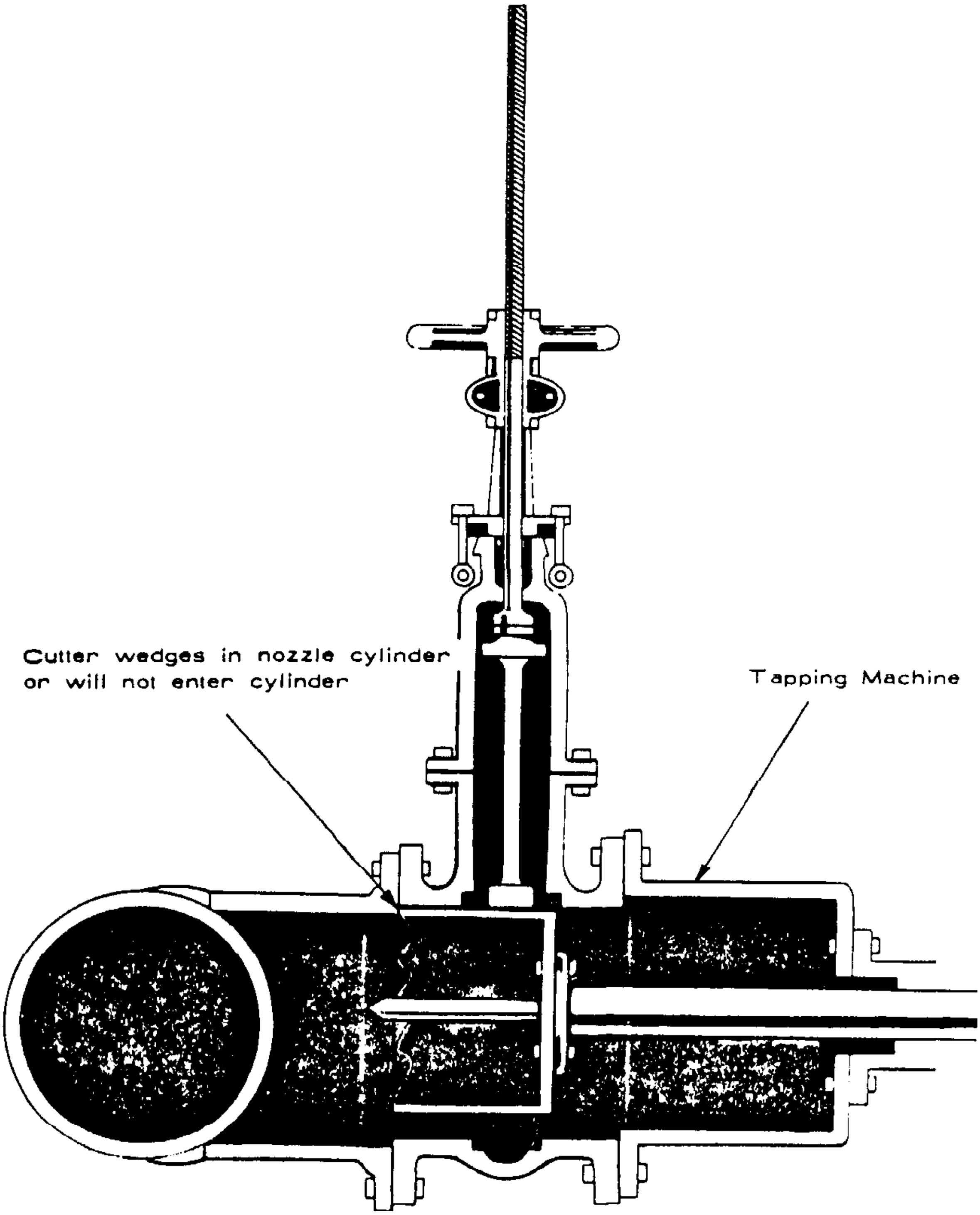


Fig. 5

TAPPING TRAPS NO. 4

Valve Flange Bolt Circles not Concentric

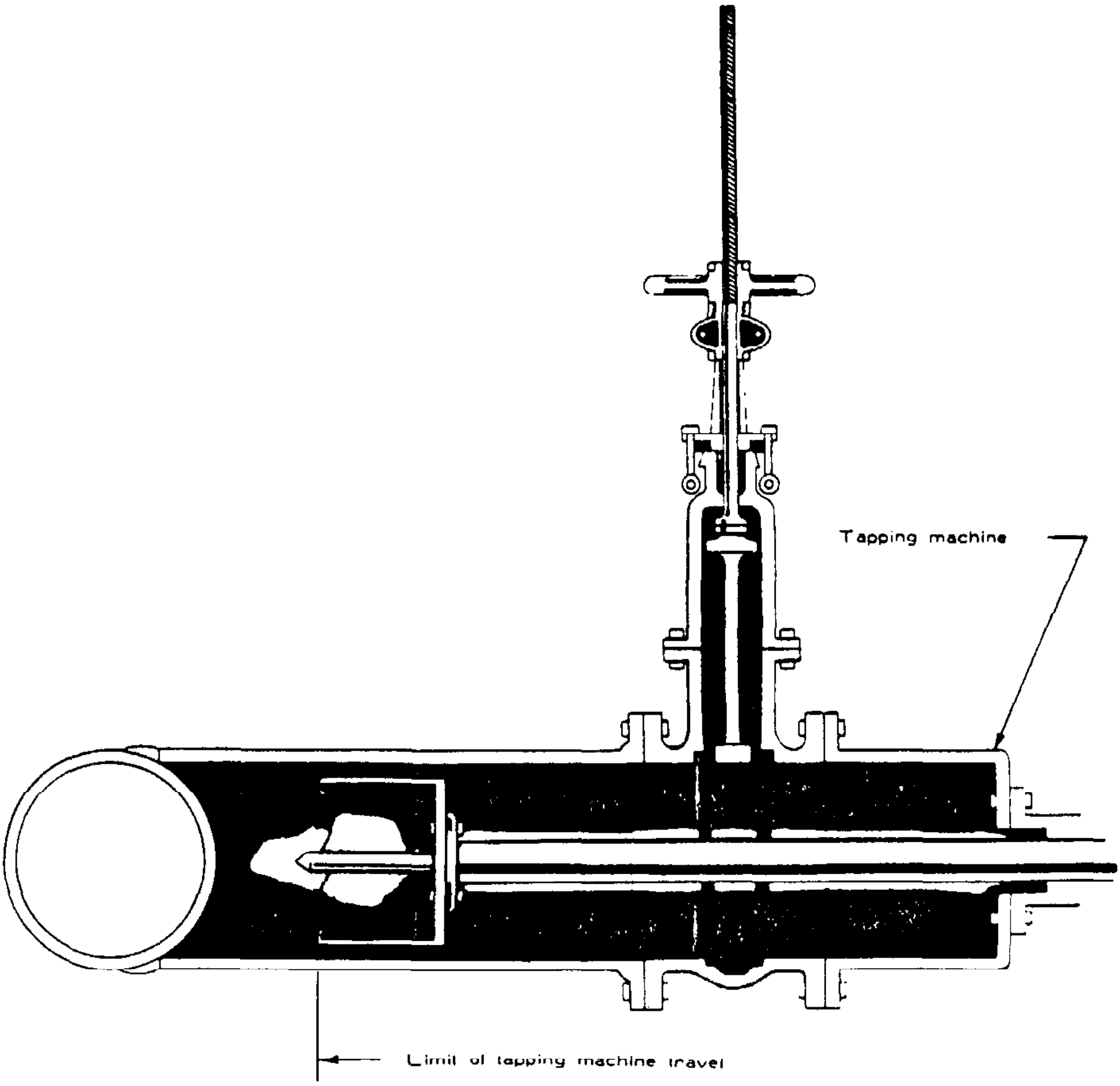


Fig. 6

TAPPING TRAPS NO. 5

Excessive Nozzle Length

PRESSURE TAPPING CONCRETE PIPE

GENERAL:

Dealing with concrete pipe, is a somewhat specialized area.

Although Fig. 7 shows several different designs, we like to think of concrete pipe as falling into two general categories - cylinder pipe and non-cylinder pipe. Non-cylinder pipe, consists of a concrete wall in which there is embedded longitudinal and circumferential reinforcing bars. Cylinder pipe starts with a relatively thin steel cylinder perhaps 16 or 14 gauge. Think of it as a piece of stove pipe. A concrete core is poured or spun inside this steel cylinder. The fluid that the pipe will carry flows inside this core. So far, the bursting strength is all in the thin cylinder, and strength must be added. One means of doing this is to reinforce the cylinder. A circumferential and longitudinal cage of reinforcing steel is laid outside of the steel cylinder. This cage is embedded in a concrete outer shell. Now the only purpose of the steel cylinder is to prevent gradual weepage thru the concrete which is a porous material.

Prestressed concrete cylinder pipe also starts with a lightweight steel cylinder, and an internal concrete core. The reinforcing is accomplished by taking prestressing wire, placing it in tension, and wrapping it around the O.D. of the steel cylinder. Incidentally, this is a high tensile strength wire with a yield strength of around 140,000 psi. A conventional reinforcing bar for normal concrete work has a yield strength of 40-75,000 psi. This prestressing squeezes the concrete core or liner placing it under compressive stress. A concrete cover is then poured to protect the prestressing wires.

Since the pipe wall is in compression, application of fluid pressure inside the pipe will tend to offset the initial compressive prestressing. Thus, in a perfect design, your concrete core is under no stress whatsoever.

PRESSURE TAPPING TECHNIQUE:

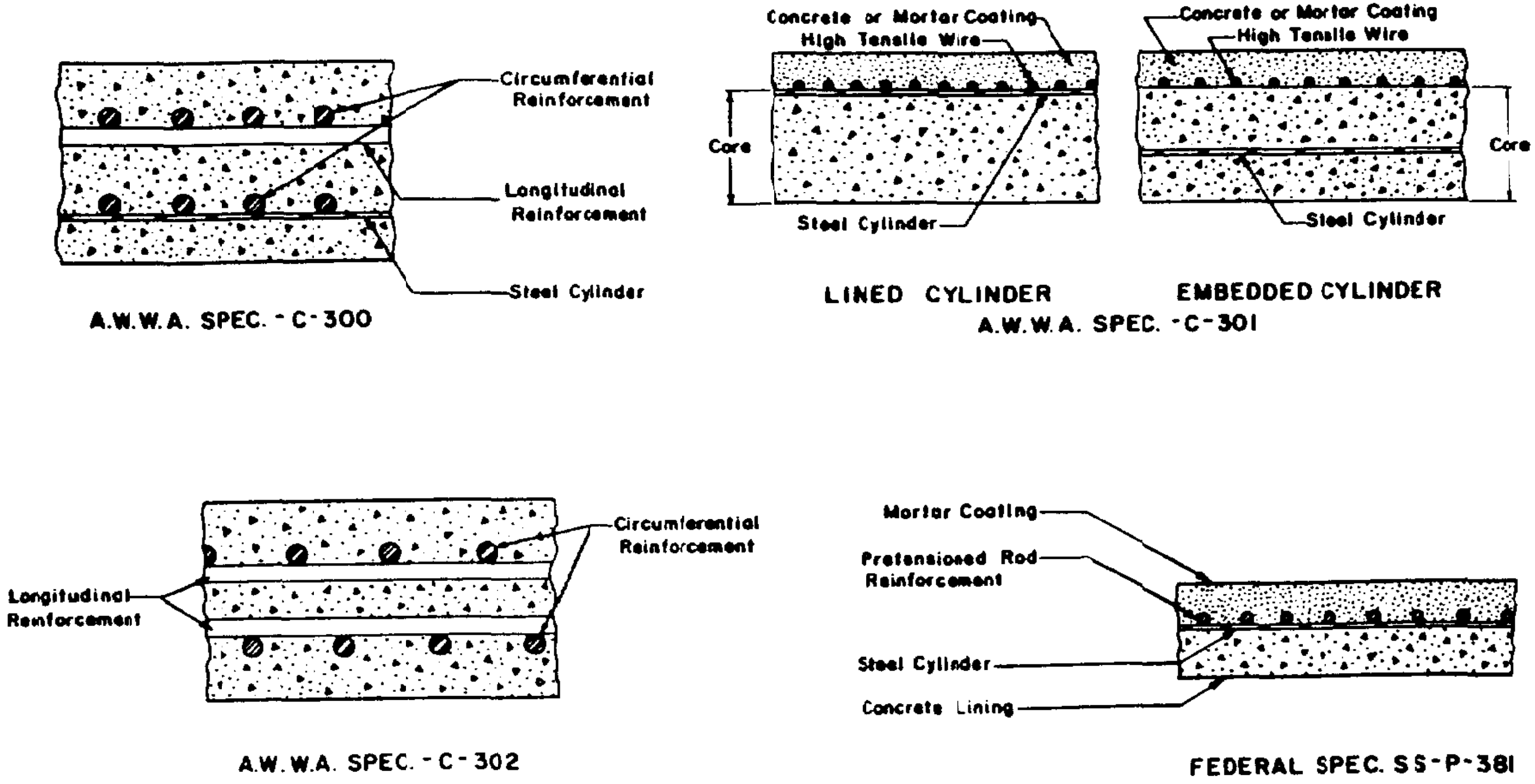
There are two basic types of saddles for tapping concrete cylinder pipe. Fig. 8 shows a so-called floating or adjustable gland that seals to the [illegible] cylinder with an "o" ring. The second design uses a more rigid gl[illegible] Note, [illegible] both designs seal to the contour of the steel [illegible] with an "o" ring.

You can see that in order to make this seal the outer concrete covering must be chipped away to expose the reinforcing cage or prestressing wires. The wires are then cut away with a cold chisel or a burning torch. A horizontal weld seam on the steel cylinder may have to be ground away to provide a smooth seat for the "o" ring.

A major problem exists in making larger diameter taps in concrete pipe. The inner concrete core tends to break or fracture away from the cylinder during the cutting process. To prevent this it is necessary to install some means of keeping the core intact, and we call this the "core retention means". The most common method is nothing more than butterfly bolts or toggle bolts if you please. They are installed under pressure with a small tapping machine and special adaptor. This operation is called "toggling".

After the nozzle with "o" ring is properly seated against the cylinder the assembly is checked by pressure testing. The saddle portion is filled with grout through the small nozzles at the top and allowed to cure.

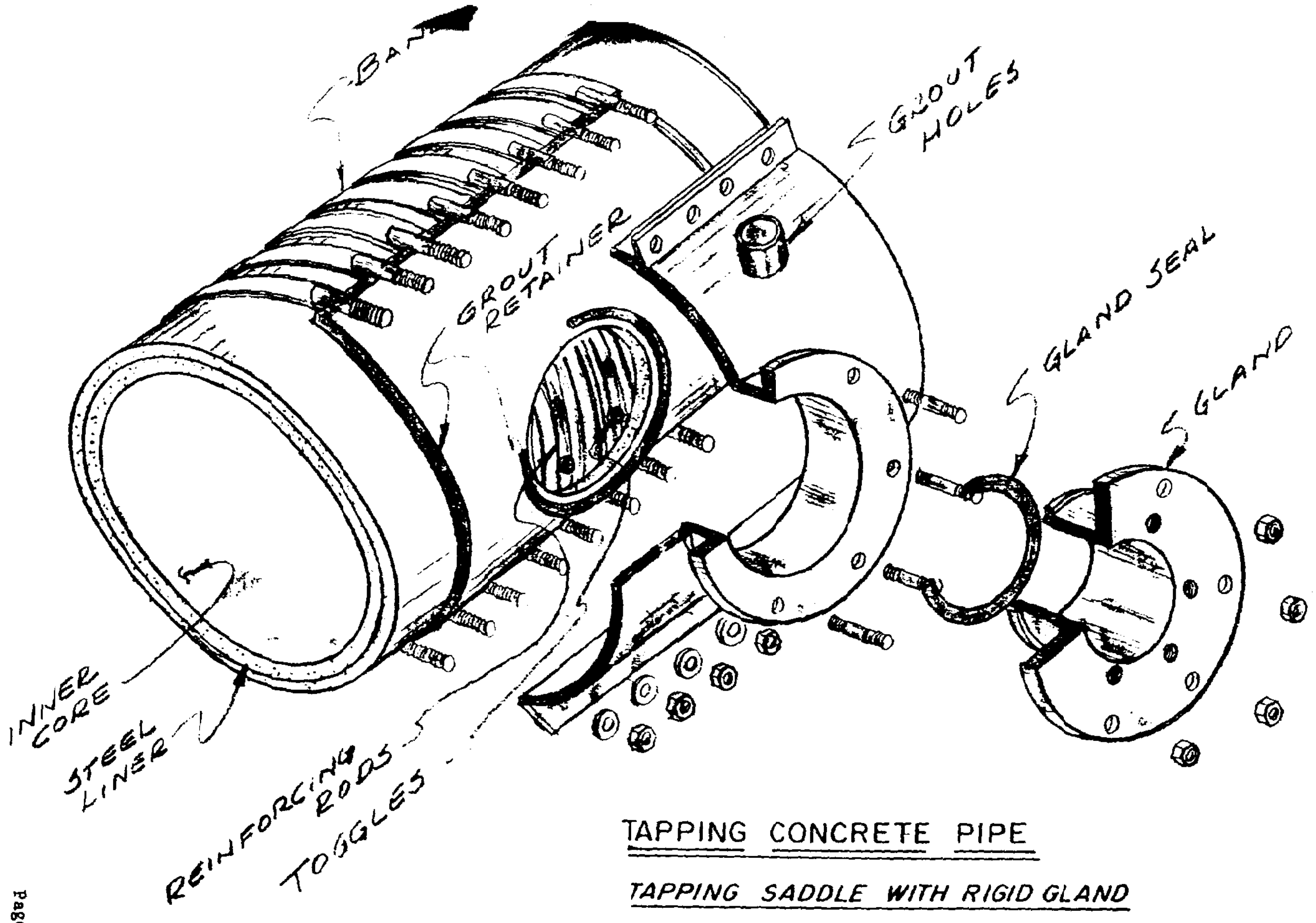
A valve is mounted and a conventional pressure tap is made using a carbide tipped shell cutter.



TAPPING CONCRETE PIPE

Typical Cross Sections of Pressure Pipe

Fig. 7



TAPPING CONCRETE PIPE

TAPPING SADDLE WITH RIGID GLAND

FIG. 8

LINE STOPPING (PRESSURE PLUGGING)

GENERAL:

Line stopping is essentially the installation of a temporary valve in a line where one presently does not exist. The existing pipe serves as part of the sealing surface for the temporary valves. There are four general types of line stops or pressure plugs. The first effects stoppage with a cylindrical plug sealing against machined surfaces of the pipe. These can either be the elastomer type stoppers or a steel wedge type stopper (Fig. 10). Probably the most popular is the second method where an elastomer cup seals against the pipe bore (Fig. 9). This seal is effected by line pressure and is available in the greatest range of pressures and sizes. In the third type of stopper, an expandable elastomer stopper seals against the bore of the pipe. This type is for low pressure application only. An inflatable gas bag or balloon sealing against the bore of a pipe is the fourth type of stopping device. This seal is generally independent of line pressure and must be restricted to very low pressures.

When line stopping, the choice of method is extremely important. There is no universal line plugging technique. The correct technique depends upon the following variables:

1. Temperature.
2. Pressure.
3. Size of main and wall thickness.
4. Interior condition of main deposits, corrosion, weld beads, etc.
5. Duration of the line stop.
6. Degree of leakage tolerated.
7. The flowing medium.

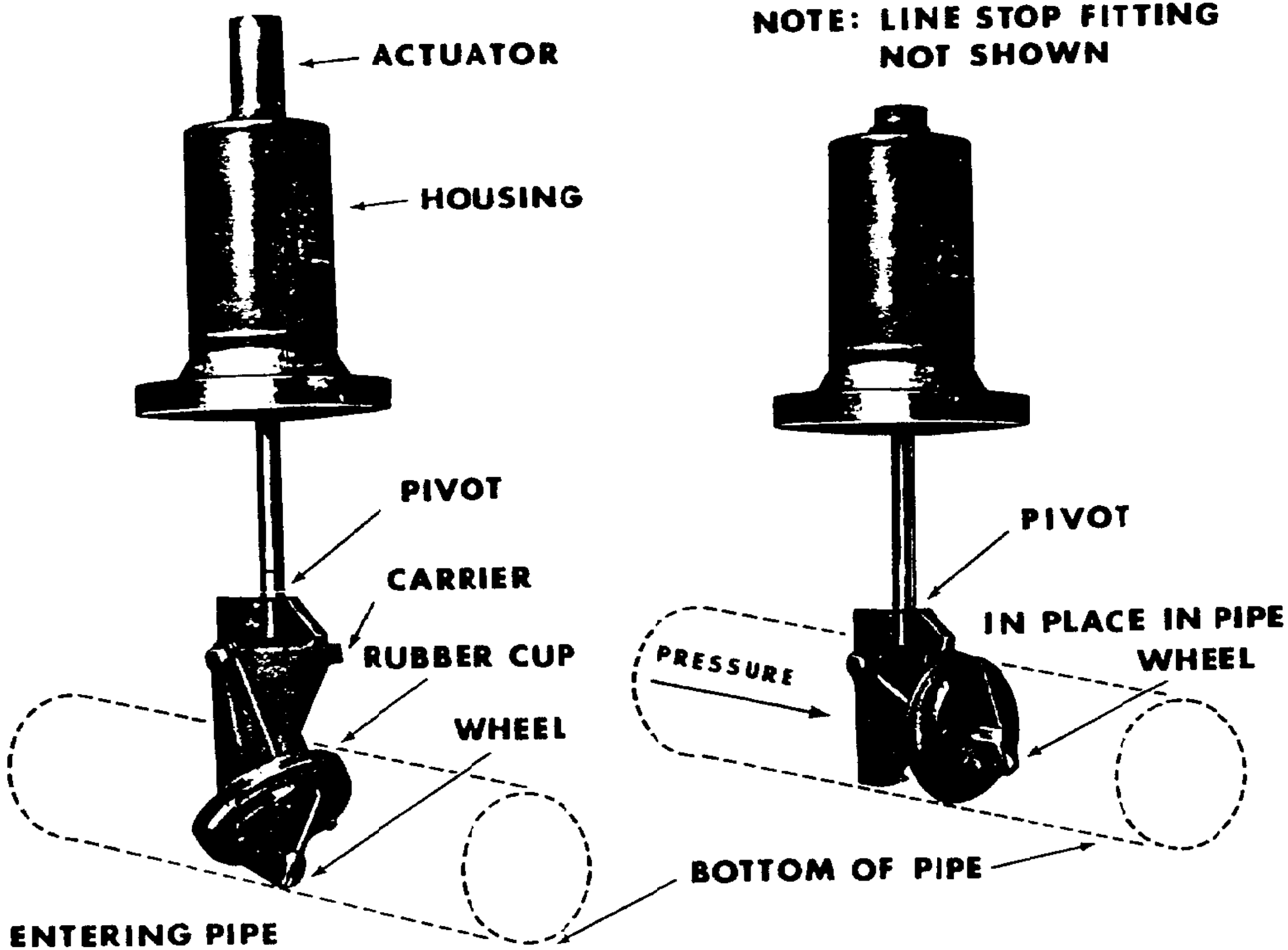
A point to remember is that a line stop operation can be repeated at a later date. Many pipeline and gas companies install line stop fittings instead of valves at points where a valving action will be needed infrequently.

Complete bottle tight shutoff is difficult to achieve. When it is achieved it is usually the result of good job site techniques. On hazardous jobs (steam, flammables, etc) use of special flanges, etc., can decrease the hazard. Pipe O.D. -(2xPipe Wall) = I.D. This simple formula can be the most important factor in reaching a bottle tight shutoff. The pipe I.D. must be verified exactly for every line stop. Sample inspection taps should always be specified unless the line stop is extremely low cost/non-critical.

Line stops can be used in an endless variety of ways. Some of them listed below are illustrated in Figs. 11 & 12 and 23 thru 34.

1. To isolate or dead end a pipeline.
2. To relocate a pipeline with two permanent valves.
3. To relocate a pipeline without permanent valves.
4. To install a valve into a pipeline without shutdown.
5. To install a piece of process equipment into a pipeline without shutdown.
6. As a means of laterally installing "non-tappable" valves.

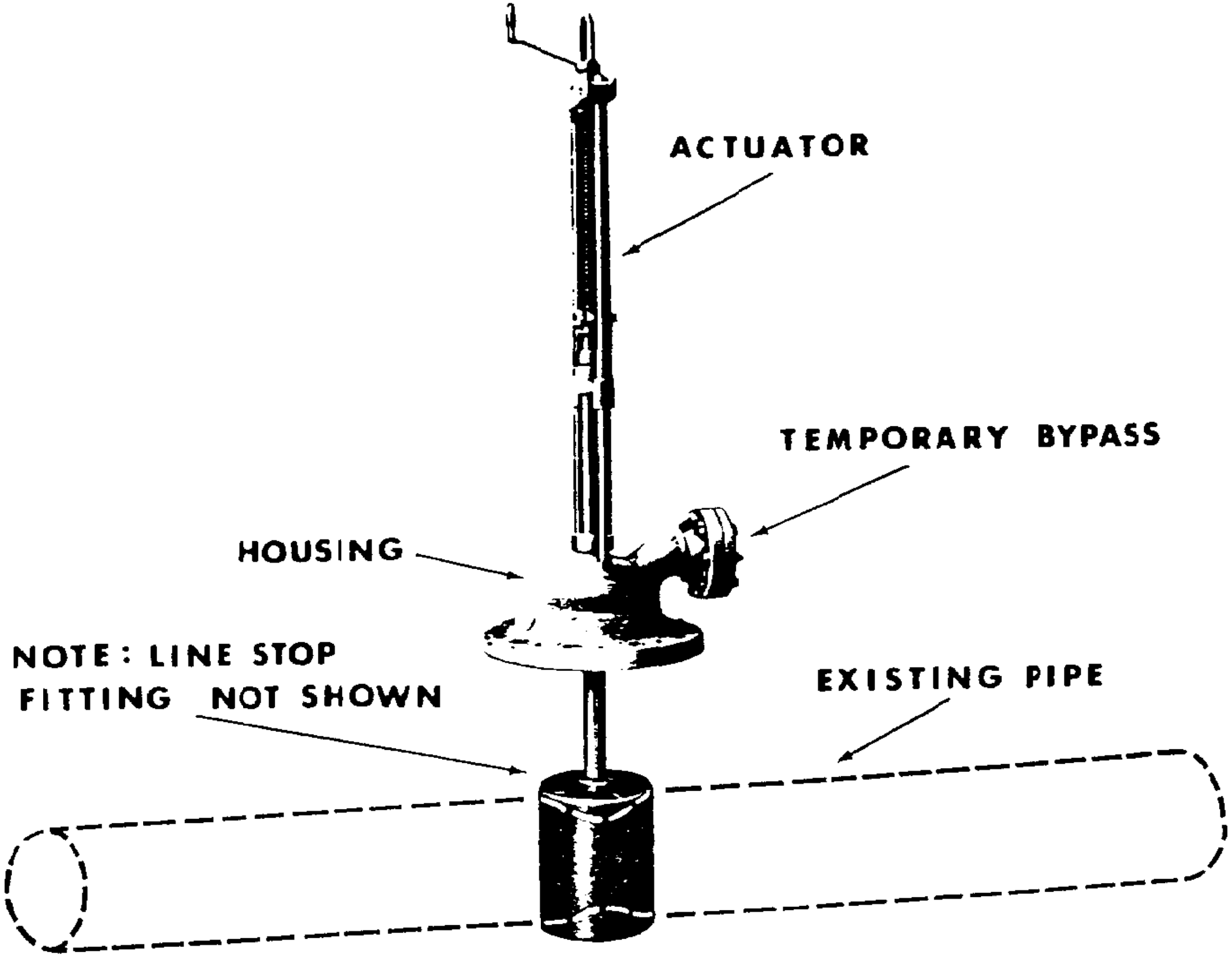
All line stops should receive early IPSCO attention.



LINE STOP

TYPICAL MACHINE WITH CUP-TYPE PLUGGING HEAD

Fig. 9

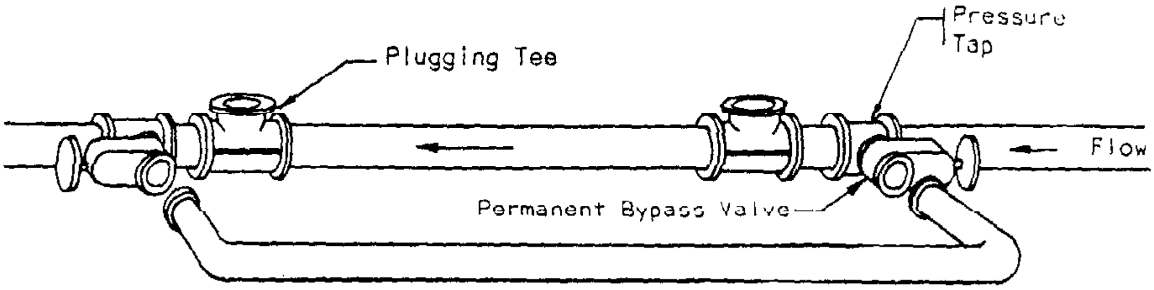


LINE STOP

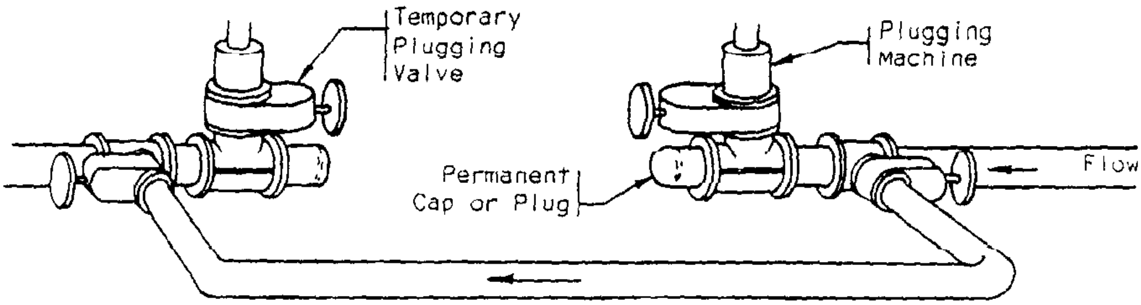
TYPICAL MACHINE WITH EXPANDING CYLINDRICAL PLUGGING HEAD

Fig. 10

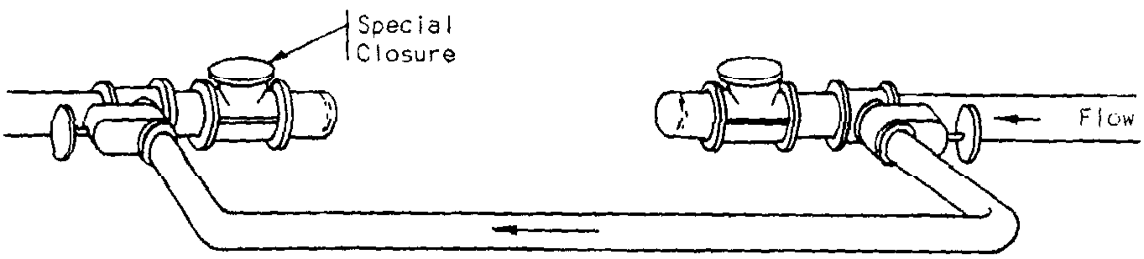
PIPE RELOCATION WITHOUT SHUTDOWN
(Pressure Plugging with Permanent Bypass)



A. BYPASS INSTALLED UNDER PRESSURE



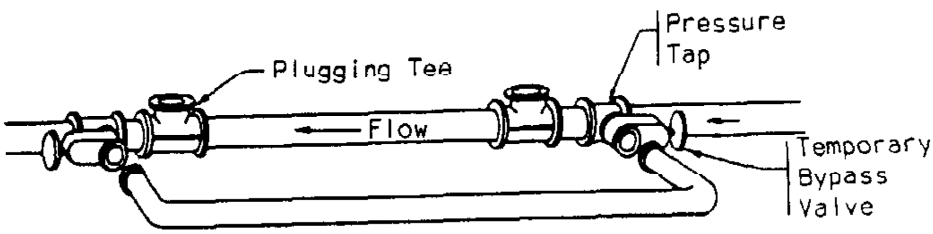
B. MAIN LINE TAPPED, PLUGGED, AND PERMANENTLY CAPPED



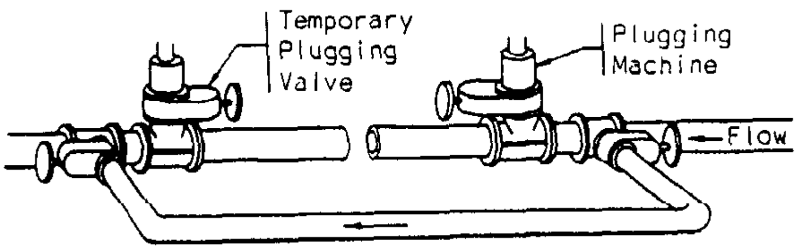
C. PLUGGING MACHINES AND TEMPORARY VALVES REMOVED

Fig. 11

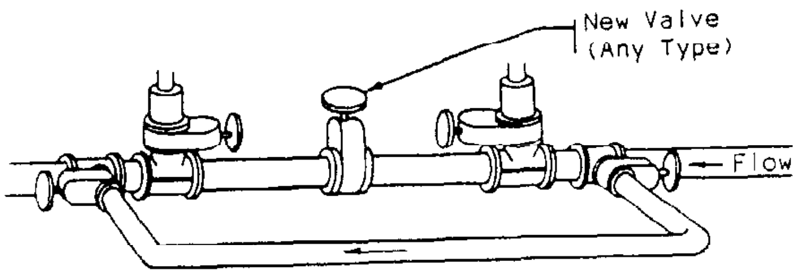
VALVE INSTALLATION OR PIPE REPAIR WITHOUT SHUTDOWN
(Pressure Plugging with Temporary Bypass)



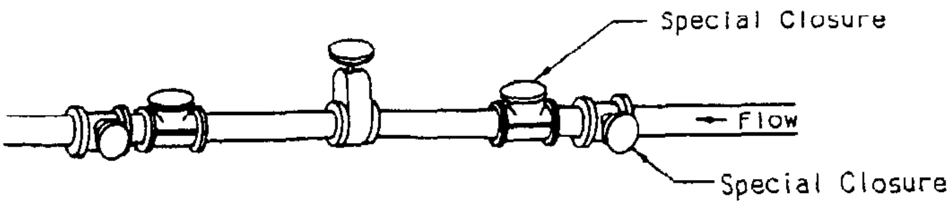
A. TEMPORARY BYPASS INSTALLED UNDER PRESSURE



B. MAIN LINE TAPPED, PLUGGED, AND CUT TO RECEIVE VALVE



C. NEW VALVE INSTALLED



D. PLUGGING MACHINE, TEMPORARY VALVES AND BYPASS REMOVED

FIG. 12

LINESTOP PROCEDURE:

A special linestop fitting is installed on the pipeline by either welding or mechanical seal. After pressure testing, a temporary valve is installed onto the fitting.

A pressure tap is made with a special cutter. When the tap is completed, the cutter and coupon is retracted into the tapping machine and the temporary valve is closed. If bypass taps are required they are also made.

The tapping machine is removed from the temporary valve and replaced by a linestop machine. The valve is opened and the linestop plugging head is lowered in place, cutting off flow in the pipeline.

To completely effect the plugging head seal and to test the seal efficiently, a bleed off point must be used. By opening the bleed off and reducing the pressure on the downstream side of the head, or in the case of the double line stop, in between the stops, the pipeline pressure will help seal the plugging head.

When the required work is completed and the linestop is to be removed, line pressure must be equilized on the "dead" side of the plugging head. This allows the head to be retracted and the line put back in service.

To complete the operation, the linestop machines are removed and completion machines are installed onto the temporary valves. A special closure plug is installed into the outlet flange of the linestop fitting. This allows the linestop machines and temporary valves to be removed. A blind flange is usually installed to finish the linestop operation.
(See Fig. 11-12 also 28 thru 31).

VALVE INSERTIONS

GENERAL:

Valve inserting is the installation of a cast iron, IBBM, double disc, NRS, lead caulk gate valve into a pipeline without interruption of service.

There are three basic techniques used to insert a valve into a pipeline under pressure. They are:

1. The Mueller method for 4 inch thru 8 inch valves.
2. The Smith method for 4 inch thru 20 inch valves.
3. The Smith method for 24 inch thru 54 inch valves.

All three of these methods are most competitive on cast iron water mains. However, special valves for insertion into steel and ductile iron mains are available on special order.

MATERIALS DESCRIPTION:

A. P. Smith Inserting Valves: The materials, internal design, construction, workmanship and test rating of these inserting valves are in general compliance with AWWA standard C-500, or the latest revision thereof, in so far as they apply, as modified by the following supplimentary requirements:

A. The inserting valves are of cast iron body, bronze-mounted non-rising stem, double non-revolving disc, parallel seat, side wedging construction.

B. All grey iron castings conform to the requirements of ASTM specifications: A126, Class B (31,000 psi minimum tensile strength).

C. Valve stems are cast manganese bronze, free from defects, and have a minimum tensile strength of 65,000 psi and a yield strength of 32,000 psi.

D. Valves have hollow bell (lead caulk) ends, one bell being larger than nominal to accept the inserting sleeve. Bells contain elastomer gaskets premanently attached in a plane perpendicular to the center line of the bore.

E. Valves are rated at 300 psig test, 150 psig working water pressure.

F. Valve stem seals consist of conventional stuffing boxes or the "o" ring seal. Gland bolts and nuts shall be of the same quality bronze as the valve stems.

Inserting Sleeves: Each inserting valve is provided with a split sleeve of the stuffing box type. Said sleeves have a bell (lead caulk) outlet outboard of the valve for sealing to the conduit. Wall thickness, materials of construction, and workmanship conform to AWWA standard C100-55 or the latest revision thereof, in so far as they apply.

Mueller Inserting Valves: The materials, internal design, construction, workmanship, test of inserting valves are in general compliance with AWWA standard, in so far as they apply.

A. Each inserting valve consists of a sleeve and a valve body. The sleeve is in two parts, which are installed around the main. After the main is drilled and a section removed, the valve body containing the gate valve mechanism is inserted in the sleeve.

B. The valve bodies and bonnets are high strength cast iron.

C. Body seat rings and disc rings are cast from high copper content bronze.

D. Stems fabricated from high tensile strength solid bronze rod. Steel bolts and nuts are heavily plated.

TECHNICAL

DIVISICN

SUGGESTED PROCEDURES FOR WELDING ON PRESSURIZED EQUIPMENT CONTAINING FLAMMABLES

SCOPE:

These procedures are for welding as well as making hot taps on pipelines, pressure vessels, or tanks containing flammable liquid or other materials. They represent a composite of industry safe practices for this type of work. They may be used as a guide or as a source of information; however, they cannot be expected to cover all contingencies which may be encountered. If a special need or a special problem exists, responsible supervision should revise these procedures, keeping in mind that safety of the operation is the primary consideration.

The methods described herein may be used by anyone desiring to do so. However, International Piping Services Co. shall not be held responsible or liable in any way either for loss or damage resulting therefrom, or for the violation of any federal, state, or municipal regulations with which they may conflict.

GENERAL:

Connections or other appurtenances may be installed on equipment by one of several methods. The method considered herein involves welding a piece of equipment which is under pressure. Because air is excluded from the contents, the possibility of fire or explosion from hydrocarbons is reduced as compared with methods requiring the equipment to be opened. The possibility of burning through the wall of the equipment during welding operations can be minimized by employment of capable welders and proper inspection of equipment prior to welding.

APPROVALS:

To maintain control of the conditions under which welding or hot tapping can be done, responsible supervision in charge will:

1. Determine that the contents of the system will permit welding. Hot work on lines or vessels containing corrosive or toxic materials should be given special consideration. Certain materials may cause metallurgical or chemical changes in the heat zone. Carbon steel, for example is changed metallurgically at elevated temperatures in the presence of caustic or elemental sulfur. Welding should never be performed on equipment which is operating above its rated working pressures and temperature, nor on equipment which is operating at less than atmospheric pressure (vacuum).

   Where air may occur in the presence of vapors in equipment, the oxygen content should be and should remain at a level which precludes formation of a flammable atmosphere. Heating compressed air lines or vessels may cause detonation if lubricating oil has been vaporized and distributed through the system by the compressor. These lines or vessels usually can be removed from service and cleaned prior to hot work.

2. Determine if the equipment is metallurgically suitable for welding. For example, hydrogen embrittlement or attack would make it impossible to complete the weld. Some steels and thicknesses require stress relieving. Special treatment is required for high-tensile alloy steels, and special welding rods must be used.

3. State conditions under which welding may be done and establish a safe procedure. The job should be inspected by the individual responsible for authorizing welding operations, and he should designate precautions to be followed before granting authorization to proceed. A gas test of the hot work area may be required. An inspection of the parent metal is necessary.

4. Observe the operation to make sure the foregoing conditions are followed during performance of the job.

CEDURE:

1 Obtain the above stated necessary approvals.

2. Provide either a suitable fire extinguisher (preferable dry chemical) and/or a pressurized fire hose.

3. Determine by inspection and by use of hammer testing ultrasonic thickness devices, radiography, or by the use of other approved thickness-measuring devices that the equipment to be welded is of sufficient strength and thickness to receive the connection. Previous inspection records and data on corrosion rates will be useful in making this determination.

4. Studies have indicated that most steels should be preheated prior to welding when the fluid or metal temperature is less than 50°F.

5. Select the proper fitting for use in making the connection. Many types of connecting fittings are available, such as Threadolets, Sockolets, Weld-Ends, split tees, saddles, nozzles, and plain miters. Design connection according to the proper code; i.e., ASME Boiler and Pressure Vessel Code; API Std. 650, Welded Steel Tanks for Oil Storage; or the applicable section of ASA B31, American Standard Code for Pressure Piping. When hot-tapping, be sure the fitting is of proper length to accomodate the hot tap tool. IPSCO designs and fabricates many specialized fittings for this purpose. These fittings are intended for pressure installation use only and not to be interpreted as commercially available Standard Fittings. See Figs. 13 & 14 for several design considerations required for proper selection.

IELD SAFETY:

In performing hot work jobs below grade level, excavations should permit quick access and exit by personnel. If necessary to remove fumes or flammable vapors, an air siphon or some other positive means of ventilation should be provided. If the job is above ground in a congested area, necessary precautions should be taken to prevent the trapping of personnel.

Flow in the line should be maintained at least until after welding operations have been completed. If the line is sufficiently long and the heat can be dissipated without flow, the flow may be discontinued. Generally, lines in overland transmission service would be considered long lines. Lines in refineries, plants, etc., would usually be considered short.

In certain cases, such as flare lines with insufficient flow or without flow, it may be necessary to flush the line with steam or inert gas. Such steam or gas should be kept flowing through the line during the welding operation.

If an underground line runs through a casing, be sure that welding is done on the line and not on the casing.

Never pump in or out of tanks, or agitate the contents of tanks, while hot work is in progress. The agitator switches should be tagged "Open". Close and tag all valves on product lines at the tanks. Avoid any procedures associated with operation of gas-blanketing valves or heater coil valves which would cause venting to occur.

On cone-roof tanks, maintain at least three feet of liquid head above the hot work area when welding or similar hot work is being done. A tape gauge of the tank contents should be made.

If oxyacetylene cutting and electric-arc welding are employed on pipelines filled with combustible gas, the gas must be free of air because of the possibility of an internal explosion. If air is introduced during any operation, the line must be purged with gas before cutting or welding is started.

During a cutting or welding operation, air is often prevented from entering the line at the joint by maintaining the gas pressure slightly above atmospheric and allowing the gas to escape through the joint (to burn on the outside). This procedure is referred to as "controlled-fire welding". Another method that is used to provide safe working conditions during cutting or welding operations is to replace the gas in the pipe with a non-combustible.

If a gas-filled pipeline is opened to the atmosphere, air will flow into the pipe very rapidly. During a tie-in operation, even momentary opening of the line will allow enough air to flow to be hazardous if welding is done. Therefore, the air should be removed with gas by purging before welding is undertaken.

The practice of "drifting gas" out of an open-end large-diameter pipeline to prevent air from entering is not effective. It requires a flow of gas of greater volume than would be safe to discharge.

Because air running into a gas-filled pipeline flows and stratifies along the bottom of the pipe, it can be most effectively purged with gas through a bottom opening. It is essential to be sure that air is absent after purging.

Cutting into a gas-filled pipe with an oxyacetylene torch does not inject unconsumed oxygen into the pipe from the torch.

In controlled fire cutting or welding on large pipe, the size of the flame burning from the joint required to keep out air is often too large for the welder to work near. The amount of air that enters the joint with a flame of tolerable height, if mixed with gas and exposed in the pipe, could cause serious burning of the welder.

In order to keep air out of a pipe, using the controlled-fire cutting or welding procedure, it is essential in the case of cutting to progressively "mud" behind the cut as it is made, and in the case of welding, tape the joint, thus burning off the tape as the weld is made.

During a tie-in, the amount of air entering the pipe can be minimized by the following procedures:

1. All new sections which are to be tied in should be previously purged of air, filled with gas and capped.

2. When a pipe is to be opened to the atmosphere, the open end should immediately be covered by some appropriate closure.

3. All cuts or open joints in the pipe should be "mudded" or taped as soon as they are made.

The air which still gets into the pipe by observing the above practices should be purged before any welding is done. This can be most effectively accomplished by purging to a final joint where both ends of the pipe are covered with a plate or canvas. By opening the covering at the bottom of the pipe, the air at the bottom can be displaced by "drifting in" gas, from either direction.

Confirmation of the completeness of purging should be determined by testing the exhausting gas from the bottom of the pipe with a reliable combustible gas indicator or suitable gravitometer. The instrument used should show essentially 100% gas.

Test the finished welding before cutting is started. Testing may be done hydrostatically below 200°F. If the temperature of the line or vessel is above 200°F., an air test, soaping the welds for leaks, may be used. Radiograph, dye penetrant, or magnetic particles also may be used for testing the integrity of the weld.

Do not weld on I.D. of fittings. Use reinforcing saddle instead.

INSTRUCTIONS
FOR INSTALLATION AND FIELD WELDING
FULL ENCIRCLEMENT HOT TAP FITTING

INSTALLATION:

A. Location Area

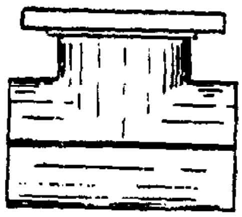
Pipeline must be stright, round and clean at the location area to be covered by the Hot Tap fitting.

B. Assembly

The matched ends of the Hot Tap fittings are identified by a painted yellow band and/or identical stamped numbers.

C. Welding

1. Weld sides completely.
2. Weld one end completely and let cool.
3. Weld other end completely.
4. End fillet welds should not exceed two times pipe thickness for best results.



Accurate use of all the preceeding instructions will assure:

1. Decrease the possibility of leakage.
2. Reduce possibility of warpage and residual stresses.
3. Insure alignment of nozzle outlet.

Fig. 13

INSTRUCTIONS
FOR INSTALLATION AND ALIGNMENT
FULL ENCIRCLEMENT LINE STOP

INSTALLATION:

A. Location Area

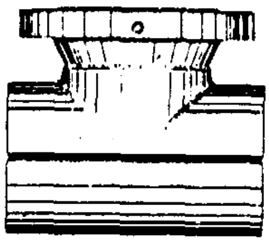
Pipeline must be straight, round and clean at the location area to be covered by the Line Stop fitting.

B. Assembly

The matched ends of the Line Stop fittings are identified by a painted yellow band and/or identical stamped numbers.

C. Welding

1. Weld sides completely.
2. Weld one end completely and let cool.
3. Weld other end completely.
4. End fillet welds should not exceed two times pipe thickness for best results.



Accurate use of all the preceeding instructions will assure:

1. Insertion of pressure plugging head without excess force.
2. Decrease the possibility of leakage.
3. Proper insertion of closure plug on completion of job.
4. Increase the capability of the Line Stop to hold pressure.

Fig. 14

INSTRUCTIONS FOR INSTALLING SMALL (3" or less) LINE STOP FITTINGS OR OTHER INTERNAL/EXTERNAL SCREWED HOT TAP NIPPLES

GENERAL:

The access or line stop fitting consists of a body and a plug. The body is to be butt welded directly to the line. The plug screws into the nipple body and seals the nipple completely. The plug is used to remove valves under full operating pressure.

PROCEDURE:

1. REMOVE THE PLUG.

   The plug must be removed from the nipple body before welding it to the line to prevent damage to the packing of the plug.

2. PROTECT THE NIPPLE BODY.

   The bore of the nipple and the external threads must be protected from weld spatter. A protective coating can be made by mixing powdered asbestos and water to a thick clay-like consistancy and spreading it over the external thread area. The bore can be protected by stuffing a retrievable wad of asbestos into the internal bore.

3. ESTABLISH WELD GAP.

   The welding type nipple body must be raised off the surface of the pipe to [illegible] This is done by placing spacers. or [illegible] welding rods, under the fitt[illegible] The spacers or welding rods [illegible]vide the necessary gap between the curv[illegible] of the pipe and the [illegible]ase of the fitting.

4. WELDING PROCEDURES.

   Arc welding on all grades and types of steel should be used, if at all possible. This will minimize warpage and distortion of the nipple body. The electric arc welding round clamp should be clamped to a small piece of (scrap) steel plate. This is the arc striking pad and should be placed relatively close to the nipple body. Avoid arcing the run or nipple as arc spots on the nipple can cause the nipple to warp while cooling.

   Tack weld - if possible preheat nipple body to 400°F. Center nipple on absolute top dead center of run on which it will be installed. The base joint is tack welded, preferably at four (4) points, using 1/8" rod. Use A.W.S.E. 7016 rod or equivalent. The spacers are then removed and all slag removed.

Stringer Bead - The stringer bead is applied completely around the base of the fitting. Use 1/8" diameter rod with a 1/8" maximum layer. The established weld gap assures full penetration and prevents a stress riser. The first pass is the most important one. Between passes all slag must be removed. The nipple body is to be kept cool during welding. Cold water or water-soaked rags should be used in conjunction with tempil sticks to insure that the temperature of the access fitting does not exceed 1000°F. If a liquid is used as a cooling agent, none should be allowed to come in contact with the hot weld metal.

ote, hot tap fittings should never be welded on the I.D. Certain materials ay cause metallurgical or chemical changes in the heat zone that temper the etal. Extreme difficulty or serious damage to the hot tap cutter may occur ue to the temper. If code requires welding on I.D. a considerably undersized utter must be used.

5. IF PREHEAT IS USED.

It is advisable to preheat to a temperature of 100°F. more than those shown. This is done to eliminate the possibility of the material cooling to a temperature below the minimum (400°F). Temperature crayons or electrical temperature controls are generally utilized to determine when the proper heat has been reached. Isolate all welding from chills and drafts.

6. COVER BEADS.

Use 5/32" diameter rod to complete job. Continuous cover beads should be added to fill the bevels and provide a smooth tapered weld.

The nipple body should be completely cool before the plug is screwed in. This is done to ascertain that the nipple body has not become warped.

7. TEST THE FINISHED WELDING.

Testing may be done hydrostatically below 200°F. If the temperature of the line is above 200°F., an air test, soaping the welds for leaks, may be used. Radiograph, dye penetrant, or magnetic particles also may be used for testing the integrity of the welds.

NOTES FOR PRESSURE ENGINEERING

GENERAL:

It is extremely important in the design stages of any project that involves pressure tapping - that the designer be aware of the size of the equipment that is required to make the tap.

For those who work with steel pipe, tapping nozzles generally consist of a welded branch connection. However, when tapping into pipe that is cast iron, asbestos cement, or concrete, we cannot, of course, weld the nozzle onto the existing header. In this tapping situation one of a great variety of alternate nozzle attachment techniques must be used.

It is important to understand the different types of nozzles that are available and which can be interchanged in the event of an emergency situation.

The grandaddy of all tapping sleeves is a split cast iron sleeve that is bolted around a cast iron main and made pressure tight to the existing header by means of a lead caulk joint in each end. These sleeves have been made since the late 1890's. Because the use of lead is a rapidly vanishing art and because of the high cost of labor, the mechanical joint tapping sleeve was developed for use on cast iron pipe. Generally speaking, on the smaller size pipes, this saddle - though it is more expensive than the lead caulk saddle - is less costly to install because of the labor savings on the job. As a general rule, a 12x12" saddle is the largest that you will encounter of this type of construction. There are manufacturers who make this type of saddle in sizes up thru a 48" main. However, the cost of this saddle is usually quite prohibitive.

This mechanical joint saddle is essentially the same type that is fabricated from steel. It uses a rubber compression joint to seal the saddle to the periphery of the existing main. Of course, this saddle can be used with any type of pipe. It can be used on a steel main, for instance, merely by manufacturing it to a different inner diameter.

SADDLE SELECTION:

In the event that the diameter of the tap is relatively small with respect to the diameter of the header, a saddle that seals between the branch connection, or hot tap, and the main may be used. It is accomplished by an "o" ring or a suitable molded rubber gasket around the periphery of the nozzle.

If the header is of fairly robust construction, a tapping nozzle which uses straps for drawing the saddle in tightly against the main can be used instead of a formed full section. When the pipe is somewhat corroded or has a thin wall section, the concentrated stresses that would result from using the straps are usually undesirable. In this case, the previous type of saddle is a good choice.

SADDLE DESIGN:

The simplest nozzle, is a piece of pipe shaped to the contour of the header, bevelled or scarfed, and welded to the header. This is the unreinforced shaped nipple. (Fig. 15-A) We will get into the question of branch connection reinforcing; however, at this time, I would like to briefly cover some of the reinforcing that can be utilized with the basic shaped nipple. Note in every case that the nozzle has started with an unreinforced nipple.

The simplest method of reinforcement is to flame cut an inner and outer elipse and then roll the resultant elliptical ring to the contour of the header. This is then slipped over the shaped nipple which has previously been welded to the header. This elliptical pad is then welded down to the header. This assembly is known as a pad reinforcement. (Fig.15B)

It is possible to purchase a forged or hot drawn saddle from suppliers such as Taylor Forge, Tube Turns, Ladish, Steel Forging, etc. This can be welded over the shaped nipple as a second type of reinforcement. (Fig. 15C)

The third type of reinforcement starts with two rectangular plates. An ellipital hole is burned in one and both pieces are rolled to fit the outside contour of the header. Installation procedure is much like the pad type reinforcement above. It is optional whether or not the girth welds are made. Of course, the horizontal weld must be made. (Fig.15D)

A forged full encirclement saddle is also available from commercial suppliers to go one step beyond the above reinforcement. (Fig.15E)

In the event that the forged full encirclement saddle is not commercially available, it is possible to field fabricate an extremely good encirclement reinforcement (Fig.15F) by combining the full encirclement sleeve above (Fig.15D) with the forged saddle (Fig.15C). The virtues of this marriage of the second and third type of reinforcement will be discussed later.

Three other types of suitable tapping nozzles should be discussed. These three would generally be classed as reinforced tapping nozzles.

The first is what is known as a forged pressure retention tee (Fig.16A). It looks a great deal like the forged full-encirclement saddle. The only difference is that the pressure retention tee is girth welded to the header and can be thought of as actually a pipe around a pipe. Previously the full-encirclement saddle was only optionally girth welded to the header. Thus all of the pressure was contained by the seal weld between the shaped nipple and the header. In the case of the pressure retention tee, all of the pressure is contained at the girth fillit weld. Of course, the longitudinal weld is mandatory.

The second nozzle type is the familiar "weld-o-let" (Fig.16B)., which is merely a forged nozzle that has extra beef in it to provide the required reinforcement.

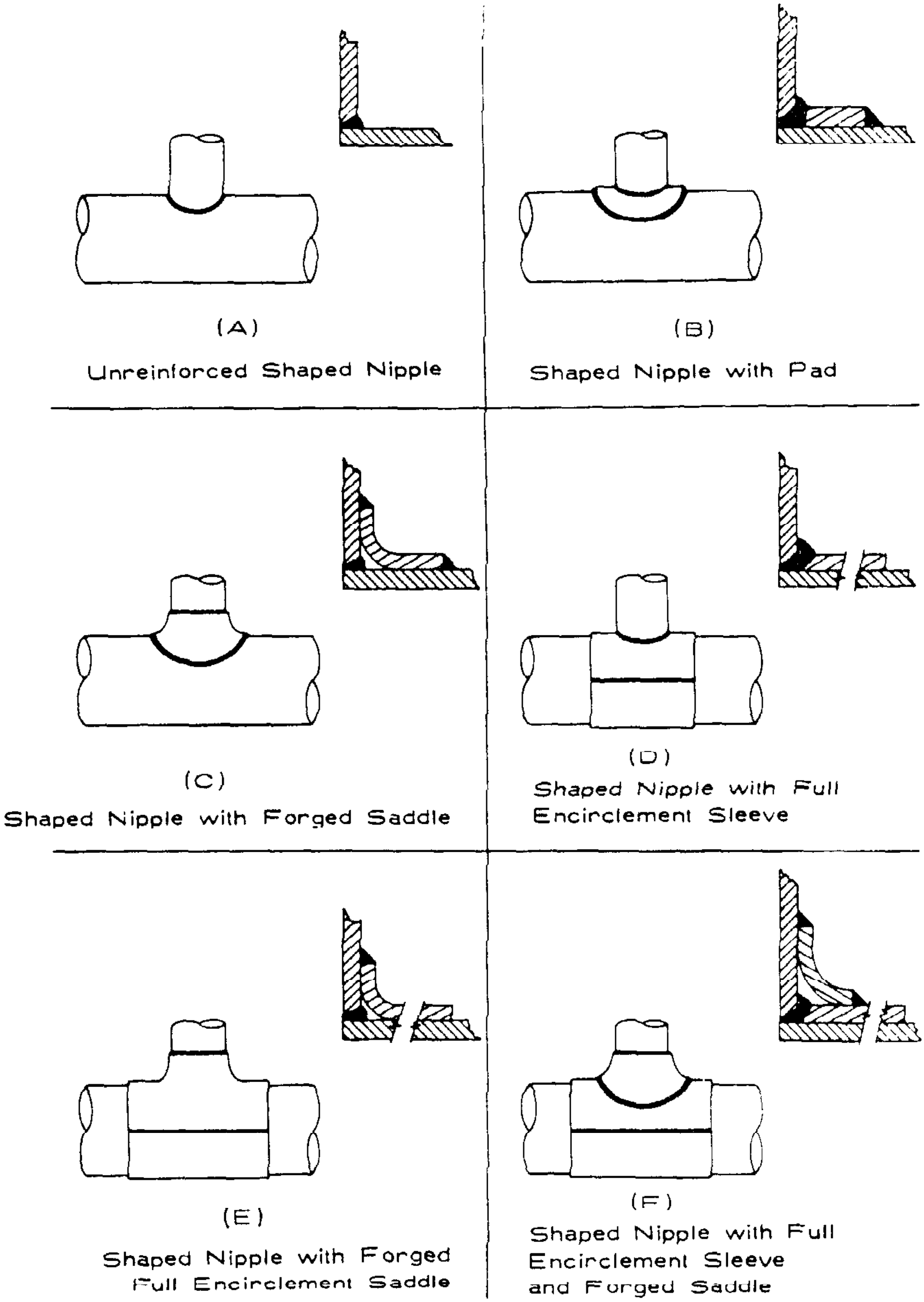
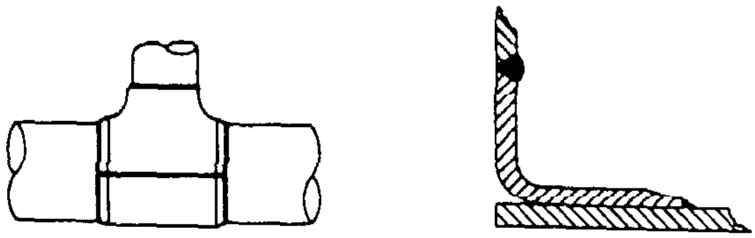


Fig. 15

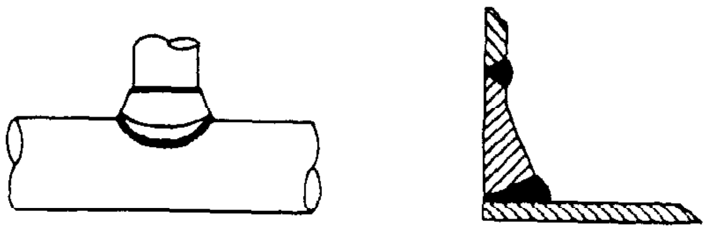
TAPPING NOZZLES

Welded to Header



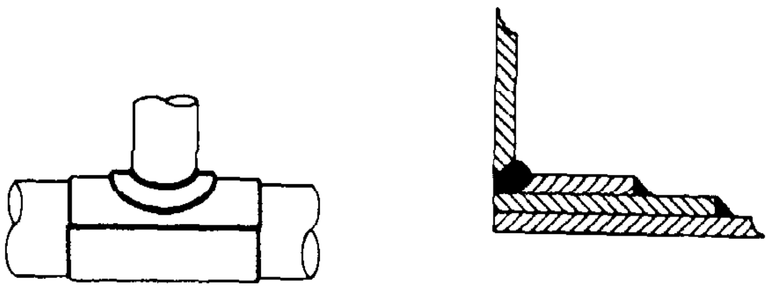
Forged Pressure Retention Tee

(A)



Forged Welding Nozzle (Weldolet)

(B)



Fabricated Pressure Retention Tee

(C)

Fig. 16

TAPPING NOZZLES

Welded to Header

Just as previously, a full encirclement sleeve could be additionally reinforced with either a pad or a forged saddle, we can field fabricate our own pressure retention tee merely by rolling two hoops to form the saddle, shaping a nozzle to fit the O.D. of the saddle and then reinforcing this junction with a simple pad. (Fig. 16C). Here as in the case of the forged pressure retention tee, the seal between the pipe and the header occurs only at the end girth welds.

There is a very special pressure retention tee, that is a combination of the compression joint tapping saddle discussed earlier and the pressure retention tee just examined. Inside each end of this particular tee is a specially designed rubber compression joint. When the tee is bolted up around the existing header, this rubber compression joint effectively seals the tapping tee to the header. At some time in the future, this tee can be permanently welded to the header. A longitudinal weld could also be made at the junction between the two halves. Thus a mechanical joint or compression type tapping tee becomes a pressure retention tee.

This installation is used in an environment where welding is prohibited. This sort of thing is useful in a refinery for instance, where welds could not be tolerated. Then, some time in the future, the welding could be completed, for instance, at a time two or three years hence when this section of the refinery was put thru a turn down for repair purposes.

Another possible use for this type of installation - and one that we have furnished several times - is on compressed air lines. If there is not good separation of oil at the outlet of the air compressor, it is possible to entrain an explosive mixture in your compressed air line. This is a rather bad problem in small shops and factories that may be equipped with extremely old compressors. In such a case the heat from welding a nozzle onto a line while it is in service could detonate the contents. Here a mechanical joint type of tee would be ideal allowing the pressure taps to be made today; then the final welding could be accomplished some time in the future. It should be noted that it is not really necessary to ever weld this type of tee to the line unless you wish to because of the additional strength and safety.

BRANCH CONNECTION DESIGN:

I would like to review the question of branch connection reinforcement. This is an area of discussion that has come into the gas and pipeline industries thanks to the good offices of one Ralph Nader. As you know Congress has passed PL90-481, "Natural Gas Pipeline Safety ACt of 1968" This has caused quite a furor with people like Drew Pearson and Ralph Nader saying the law is a lot of bunk. But the petroleum, pipeline and gas interests are saying that the law is going to put them into the poorhouse and as a result they are going to have to increase their tariffs. One conclusion can be reached and that is the fact that this rhubarb has caused a great deal of thinking - and this has been constructive thinking on the part of gas company and pipeline engineers as to what is and is not a safe branch connection.

A second comment can be made, and that is everyone now realizes that the classical ASME pressure vessel and pressure piping codes need a great deal of revision in terms of branch connection reinforcing.

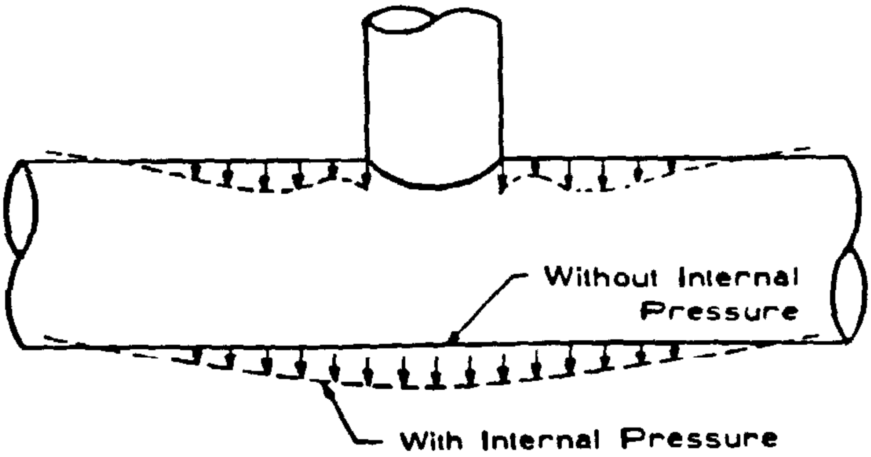
Certain authorities consider that the area replacement method (upon which our codes are based) is somewhat archaic and should be superseded by more sophisticated design criteria.

One of the biggest objections to the area replacement method is that the techniques does not give a consistant margin of safety with respect to failure, distortion, or fatigue from one design to another. In other words, one designer might fulfill the requirements of the code and actually come up with a design that is far less safe than one prepared by a fellow engineer whose design also meets the area replacement criteria, but goes about it in a different manner.

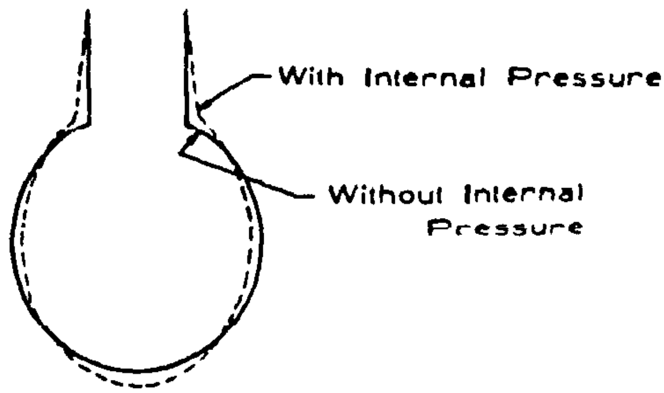
Let me stress one thought, however, before we get into some of the "nuts and bolts". Stick with that code which is defensible to your superior and is defensible to the plant in the event of a failure. In other words, no matter how good a new German or British, or Belgian pressure vessel or pipeline code might be from an engineering standpoint, do not design according to it unless you can prove that by following that design you also conform to the ASME or USAS codes. The old pressure piping code for water and steam has not been revised since 1955. Thus, it represents the best thinking that evolved before the war and during the early postwar period. Technology moved awfully slow in those days.

The most recent code is USAS B31.8 which is the gas transmission and distribution piping code. These people have been under the gun because of Congressional action and their code probably represents the best practice that we have today still within the framework of the old area replacement methods.

Why do we have branch connection reinforcement? The following drawings represent actual measured and observed deflection due to the presence of a branch connection (Fig. 17). Why does the pipe bulge and deflect like this? Well, obviously a portion of it has been removed due to the hole being cut into it. The metal that was removed used to be, theoretically, in pure tension. The old barlow hoop stress if you please. Now with that hole cut in it, the tensile load must be transferred to portions of the piping adjacent to the opening. This means that sections of the metal in this area are carrying a higher stress than the hoop stresses farther away on the header. Good designers size the wall thickness of the pipe to provide a given factor of safety based upon the hoop stress calculations. Now you come along and punch a hole in the pipe, which means that certain sections of metal will be stressed beyond the design stress. Thus, you have shot down part of the factor of safety. Let me reiterate that this deflection pattern is exactly what has been observed.



Longitudinal Deflection Under Internal Pressure



Cross Sectional Deflection Under Internal Pressure

Fig. 17

BRANCH CONNECTION REINFORCEMENT

Observed Header Distortion Due to Unreinforced Branch Connection

Many theoreticians have tried to explain this behavior in two-dimensional analysis. To date, there has been practically nothing done in three-dimensional analysis of the forces arising from branch connection openings. Since we now have computers as a design tool, it is very possible that some good sound, solid, three-dimensional stress analysis may come soon. Actually, when you think about it, you can take a straight piece of pipe with no external loading, but with internal pressure, and examine the forces that exist at, let's say section A and section B. You will find that they are colinear and that the centerline of this two-dimensional section, of course, lies along the centerline of the pipe. Hence, the resultant of the pressure at each section, falls at the center of gravity.

Now in Fig. 18, a section of the metal at B is cut away. This has a net effect of lowering the center of gravity to a new point. However, we still have the same cross sectional area, looking down the pipe, and the same pressure, therefore the same result force. The only problem is that it is now concentrated at a different center of gravity. What do we have, in effect, then? The moment arm set up because of the change in the center of gravity. This moment arm causes a longitudinal deflection that you saw in the previous picture.

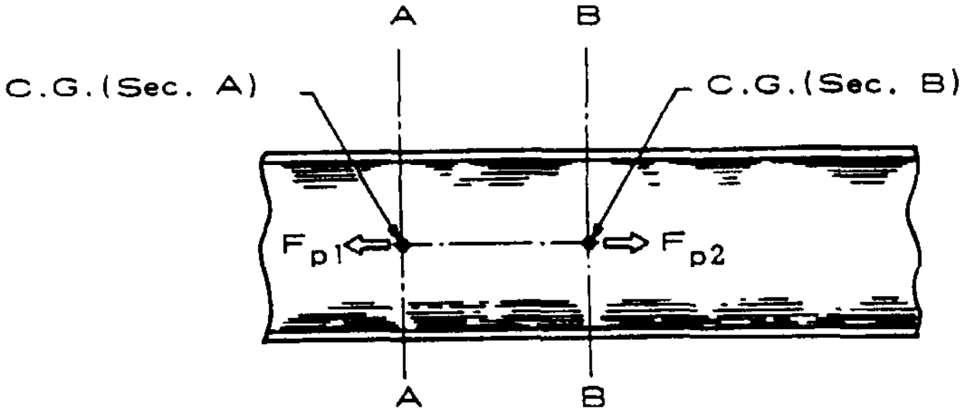
Working with a two-dimensional analysis we are indebted to a gentleman by the name of Hohn for this work which was performed in Germany and reported in 1939.

Obviously, that center of gravity at Section B must get back amidstream. This can be accomplished by putting a mass of metal in Section B more or less floating in the centerline of the nozzle. This would be "M" as shown by the shaded square in Fig. 19. This amount of metal or (remember now this is two-dimensional so we are talking area rather than a three-dimensional mass) would shift the center of gravity back to the horizontal centerline of the pipe.

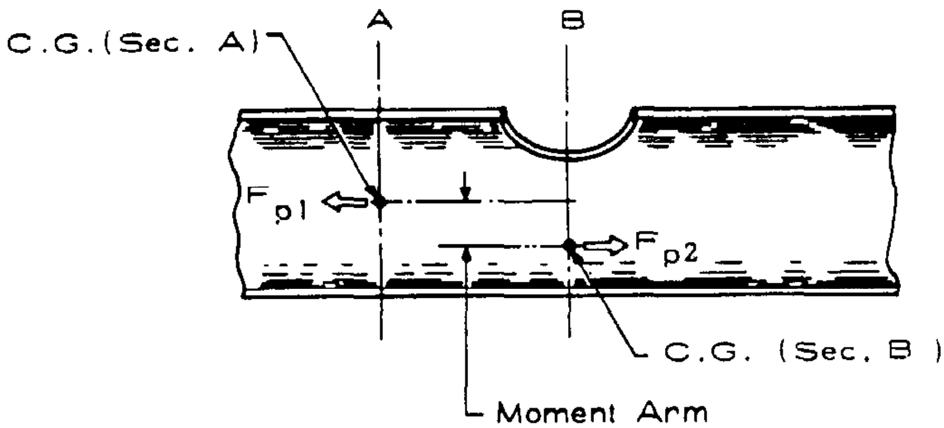
The problem though is that we cannot replace the metal, or area, in the center of the outlet. It must be placed adjacent to the centerline of the outlet around the periphery of the nozzle. Thus, I think you can see Mr. Hohn's theory will never get the center of gravity exactly back on the horizontal centerline of the pipe. If a section in between A and B is examined a new center of gravity somewhat offset will be found. Thus, we are again forced to live with the moment arm.

Even worse, using Mr. Hohn's theory, too much reinforcing can be put around the outlet nozzle, and if this happens then a moment arm in the opposite direction will result and longitudinal distortion will be different from that which you originally saw.

This brings us to one extremely important point. No matter what is done with nozzle reinforcement, there is going to be a stress intensification, or a stress riser, of a minimum of 140% to 160% at the crotch. This means that there will be some point or points that will be subjected to a stress approximately 50% greater than the barlow hoop stresses.



Centers of Gravity (force) Are Colinear

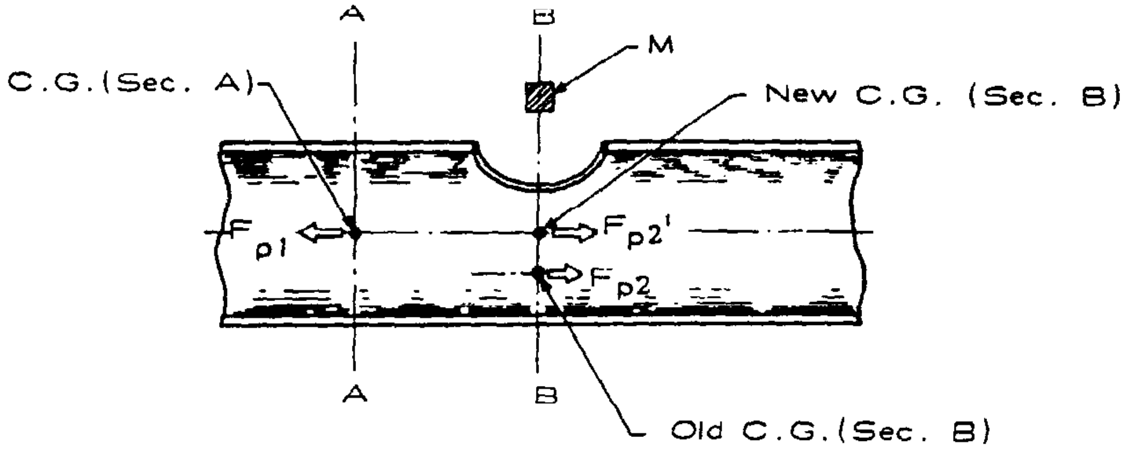


Centers of Gravity Become Offset

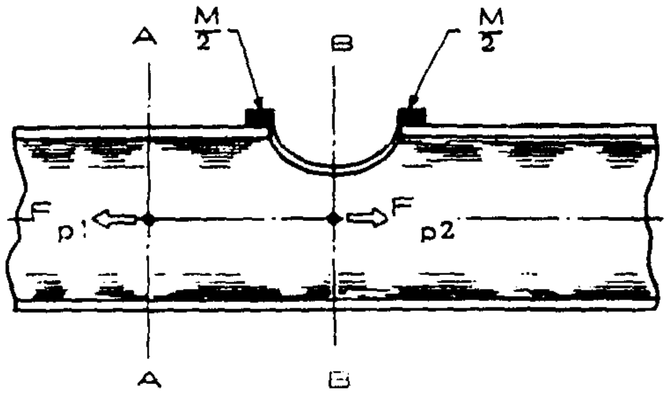
Fig. 18

BRANCH CONNECTION REINFORCEMENT

Two-Dimensional Analysis



Theoretical Placement of Material (M) to Correct Offset in Centers of Gravity



Actual Placement of Reinforcing Material ($\frac{M}{2}$) Adjacent to Branch Cutlet

Addition of proper amount of reinforcing material, at proper location, eliminates longitudinal bending moment

BRANCH CONNECTION REINFORCEMENT

Two-Dimensional Analysis

Fig. 19

Whenever we have a size outlet we just have to live with, there is nothing that can be done about it except try to prevent those increased stresses from running away to 200, 300, 400, or 500% of the design stresses.

If you are a theoretician and do not subscribe to Hohn's theory here, or if you do not understand Hohn's theory, I think by looking at Fig. 20 you can see why there would be certain sections of metal adjacent to the branch connection that would operate at a high stress level. Think of it this way, given an internal pressure in a pipe, the pipe will tend to expand according to its modulus of elasticity with an increase in internal pressure. Because the section through the reinforcing pad is greater, the girth expansion will not be as great or in other words, the pad will be flatter - it will not "give" as much. Thus, there is a bending moment. This bending moment placed on top of the barlow hoop stresses gives a net stress that by definition, has to be higher than the hoop stress itself.

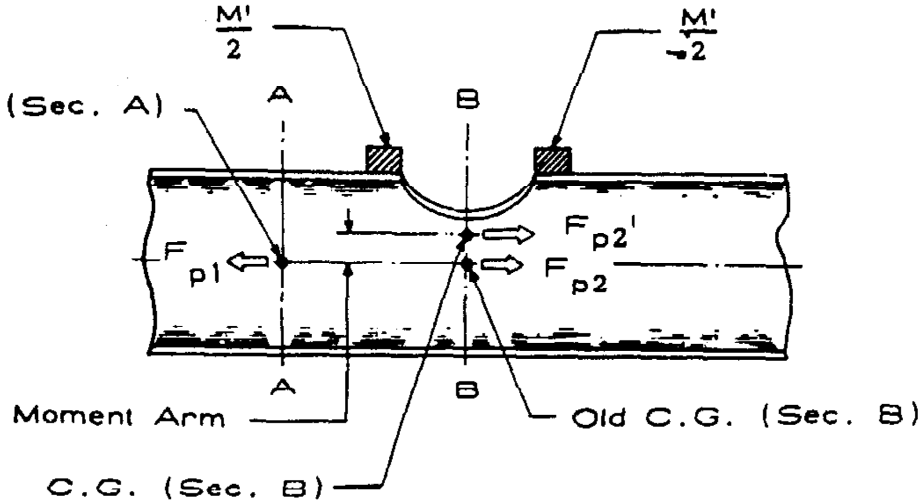
At the risk of overemphasizing, there is no way to prevent stress intensification less than 140% adjacent to a branch connection.

Let's take a look at the header itself. When a pipeline is designed, three factors must be taken into account. First, there must be a certain amount of material in the pipe wall thickness to withstand the internal environment. This thickness is determined by applying the applicable code rules concerning the nature of the material flowing in the pipe, its temperature, the location of the pipe itself, the material from which the pipe wall is made, the method in which it is joined together, etc. Secondly, an allowance must be provided for corrosion and erosion, again according to prescribed code rules. Third, an additional allowance must be provided for mechanical strength; for instance, an allowance might have to be provided if the pipe is to be threaded or if it is grooved for Victolic couplings, or other special end preparations. The sum of these three calculations and/or allowances, gives a total thickness. This is the minimum thickness with which this particular pipe can be constructed.

Now bear in mind, that the resultant number will not always come out even. That is, a stock wall thickness.

When buying pipe, it must be purchased according to the capabilities of suppliers or manufacturers. In addition to the fact that he has certain so-called stock or standard wall thicknesses, he cannot hold exactly to that given wall thickness. He must allow a certain mill tolerance. This tolerance will vary according to the type of pipe, the manufacturing process, etc. For example, if the manufacturer has a 10,000 mill tolerance on pipe of 3/8" wall thickness, count on only having 0.365 inch wall, so in performing our various design calculations, .365 must be used.

Thus, on one hand so much thickness is required in the pipe for strength, corrosion, erosion, and for mechanical consideration. On the other hand, a pipe supplier or manufacturer replies "I don't make that thickness, you will have to go to the next size up". Find out how much variation is allowed and deduct that amount, giving the net thickness that we can play with. Any difference in thickness represents an excess. This is a very important point.



Excess Reinforcing Material Shifts Center of Gravity (Force), Causing Moment Arm

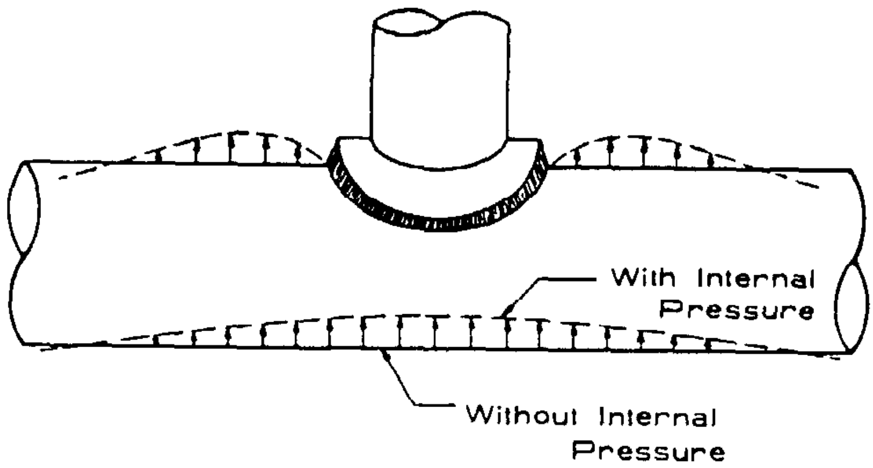


Fig. 20

BRANCH CONNECTION REINFORCEMENT

Theoretical Header Distortion Due to Excess Reinforcing Material

This excess wall thickness can be used for branch connection reinforcement. Likewise, the same analysis can be applied to a nozzle or branch. It is possible to make the branch thicker than actually needed in order to obtain additional beef for reinforcing purposes. This brings us to the heart of the area replacement concept used in pressure vessel and pipeline design in this country. Fig. 21 was taken out of the most recent copy of USAS B31.8 which is the gas transmission and piping code. This represents a cross section of a branch connection. Remember, whenever I use the term branch connection, I am speaking in terms of tapping nozzles. We have a header that is H thick, we only require T thickness. We have a nozzle of B thickness, however, we only require Tb. In each case, we have more material in the header and the branch than we require to satisfy the code. How does this affect us?

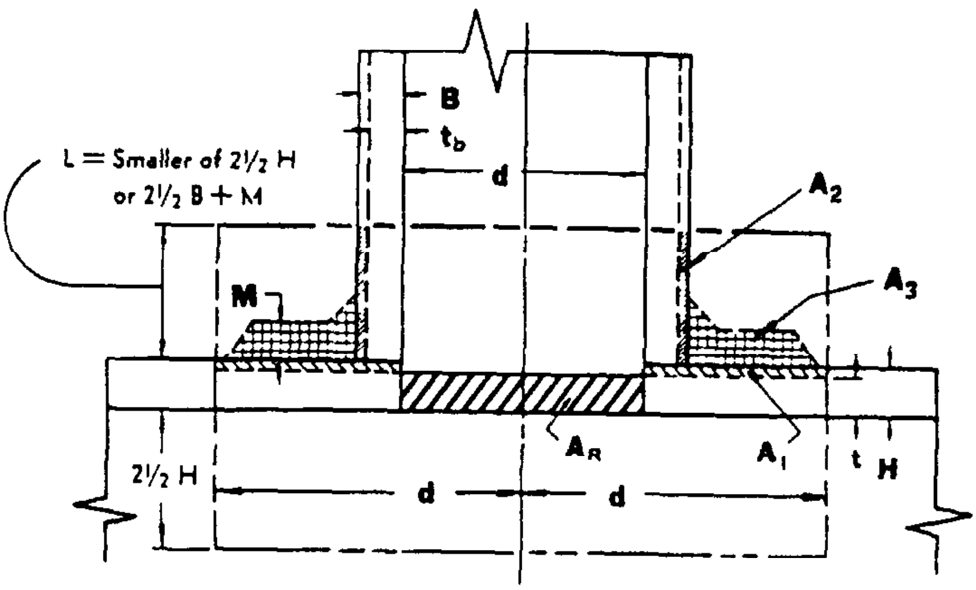
The code says, any material removed from the header pipe, must be replaced, adjacent to the nozzle. Now what is meant by material removed? Well, obviously that is the diameter, remember this is area rather than volume replacement. Multiply the diameter of the opening in the header, (in this case the pressure tap) times the thickness of material required to satisfy the code. Remember now that this thickness consists of three elements - that which is required to satisfy pressure, that for corrosion and erosion, and third, that for mechanical contingencies.

This area of metal removed must be replaced. You can see that with a very thick header, no reinforcing needs to be added. All the excess thickness is already cleaned off.

One important point is that the metal must be replaced fairly close to the nozzle. Remembering the early two-dimensional analysis it follows that if the metal is placed too far away from the opening, it will have virtually no effect on shifting the center of gravity. Thus, all codes define a so-called reinforcement zone in which the metal must be placed in order to count, any metal outside the zone does not count. This zone in this particular code lies longitudinally at a distance equal to the diameter of the tap and each direction of the centerline of the tap.

Parallel to the direction of the nozzle or perpendicular to the header, the zone extends approximately 2-1/2 times the thickness of the header. This figure should always be calculated for each individual case.

It is wise to bear in mind that a great majority of the pressure taps made are on low pressure water, steam, waste water, and gas. A second point is that existing piping is, generally speaking, very heavy for the job that has to be done. At any rate, given a thick header at a low pressure, quite frequently reinforcing is not required.



REINFORCEMENT OF BRANCH CONNECTIONS

"Area of Reinforcement" Enclosed by ——— — — ——— Lines.

Reinforcement Area Required $A_R = (d)(t)$

Area Available as Reinforcement $= A_1 + A_2 + A_3$

$A_1 = (H - t)(d)$

$A_2 = 2(B - t_b)L$

A_3 = Summation of Area of All Added Reinforcement, Including Weld Areas which Lie within the "Area of Reinforcement."

$A_1 + A_2 + A_3$ must be equal to or greater than A_R

Where:

H = Nominal Wall Thickness of Header

B = Nominal Wall Thickness of Branch

t_b = Required Nominal Wall Thickness of the Branch (Under the appropriate section of the Code)

t = Required Nominal Wall Thickness of the Header (Under the appropriate section of the Code)

d = The Length of the Finished Opening in the Header Wall (Measured parallel to the Axis of the Header)

M = Actual (by measurement) or Nominal Thickness of Added Reinforcement

Fig. 21

BRANCH CONNECTION REINFORCEMENT

Dimensional Summary

PRESSURE INSTALLATION

TECHNIQUES

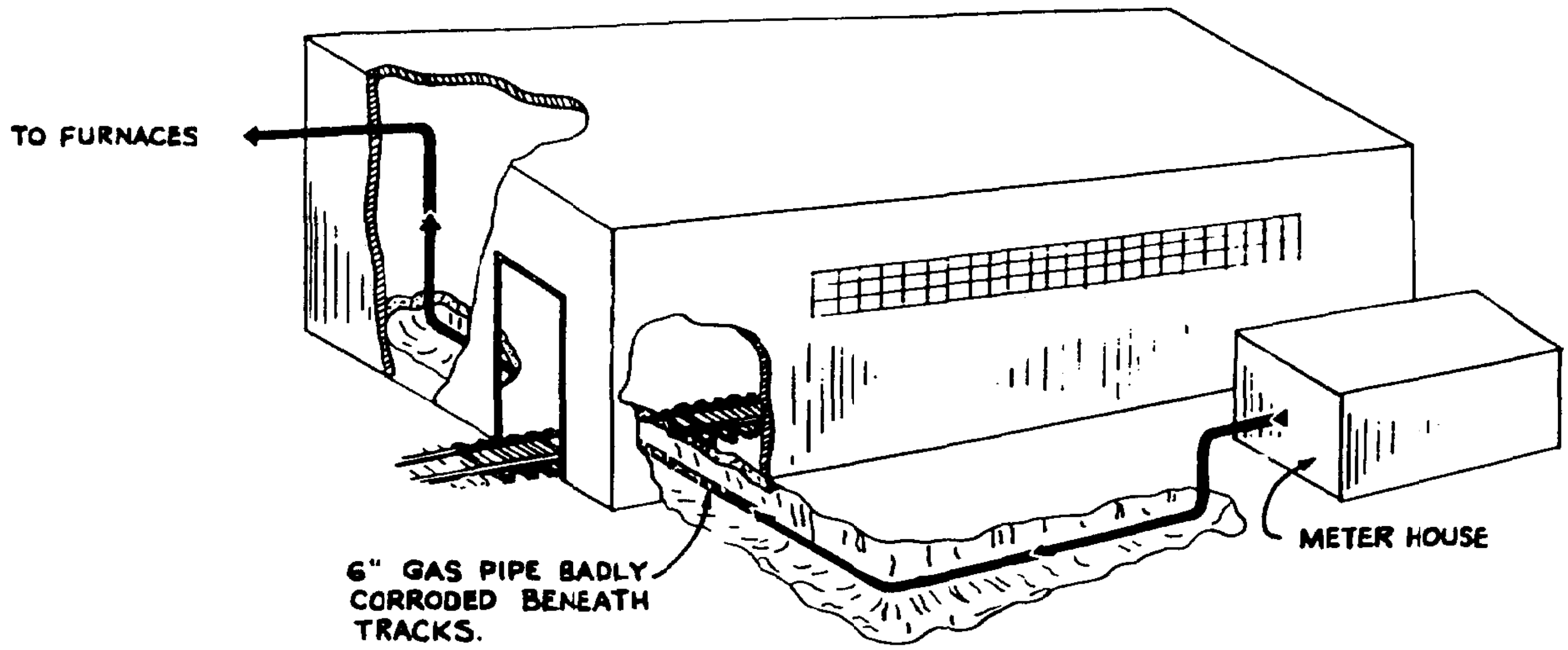


Fig. 22

6" GAS PIPE RELOCATION

Gas Piping Prior to Installation

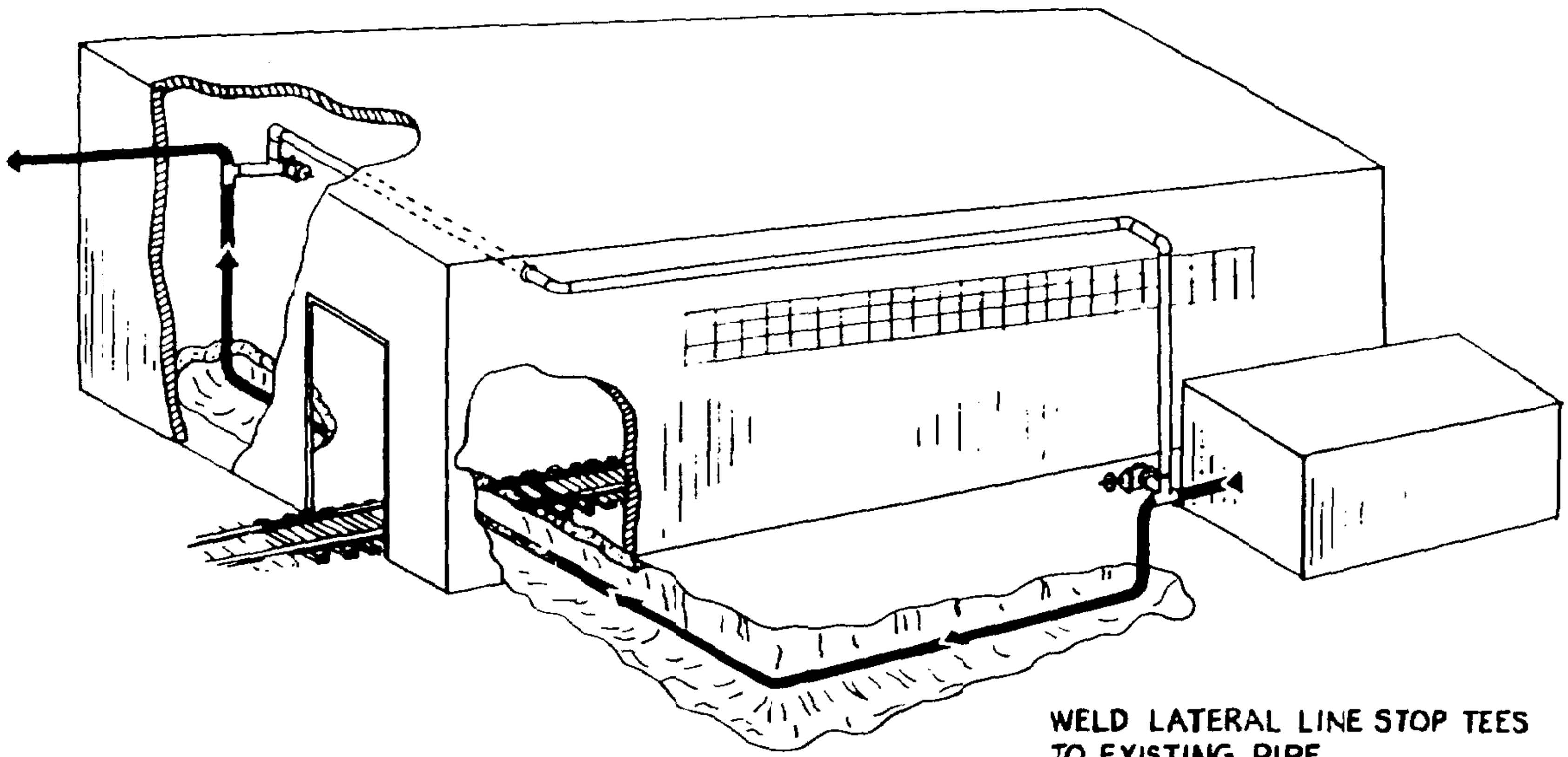


Fig. 23

6" GAS PIPE RELOCATICN

New Piping Connected into Lateral Line Stop Tees

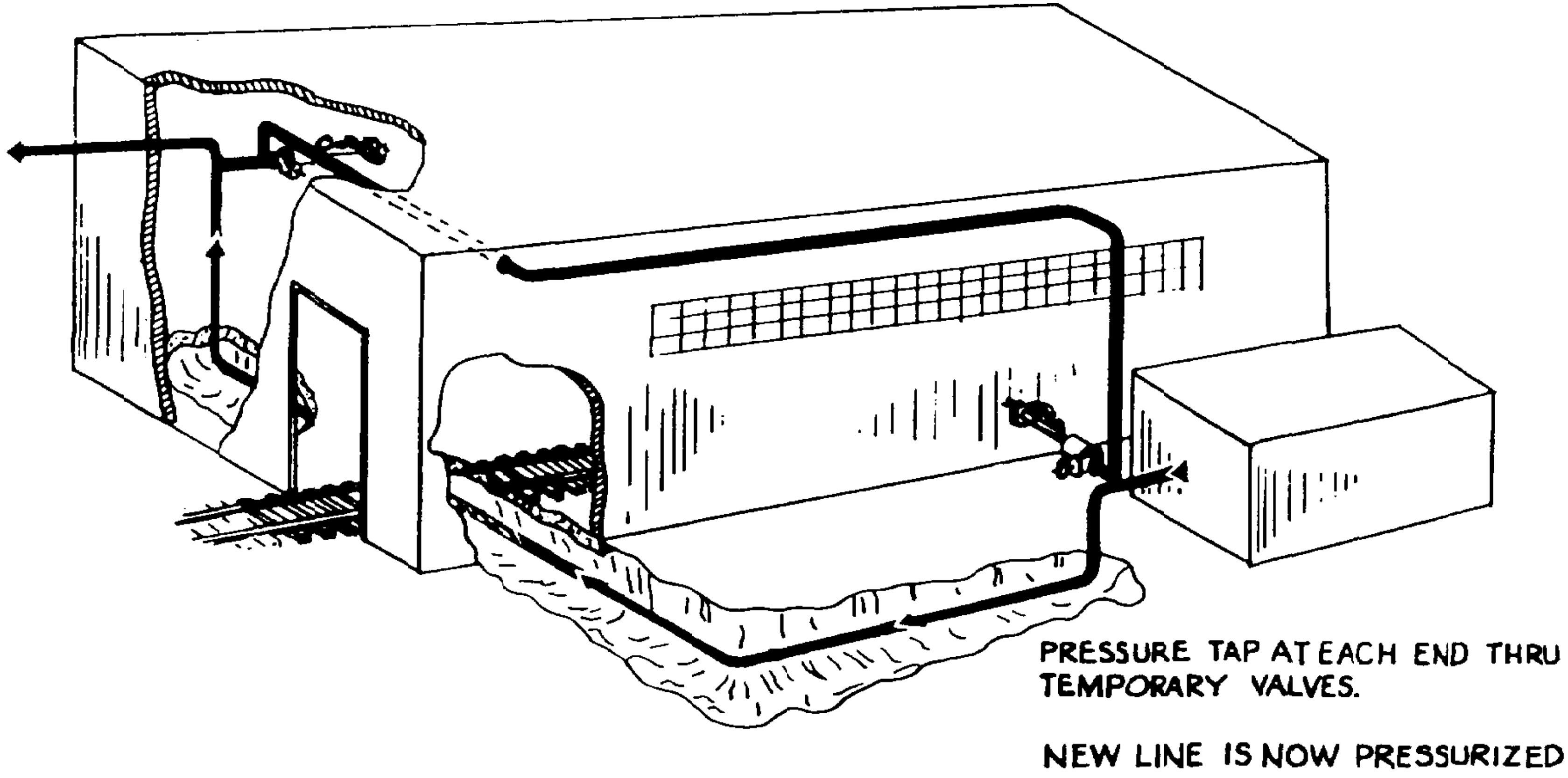


Fig. 24

6" GAS PIPE RELOCATION

Pressure Taps Activate New Line

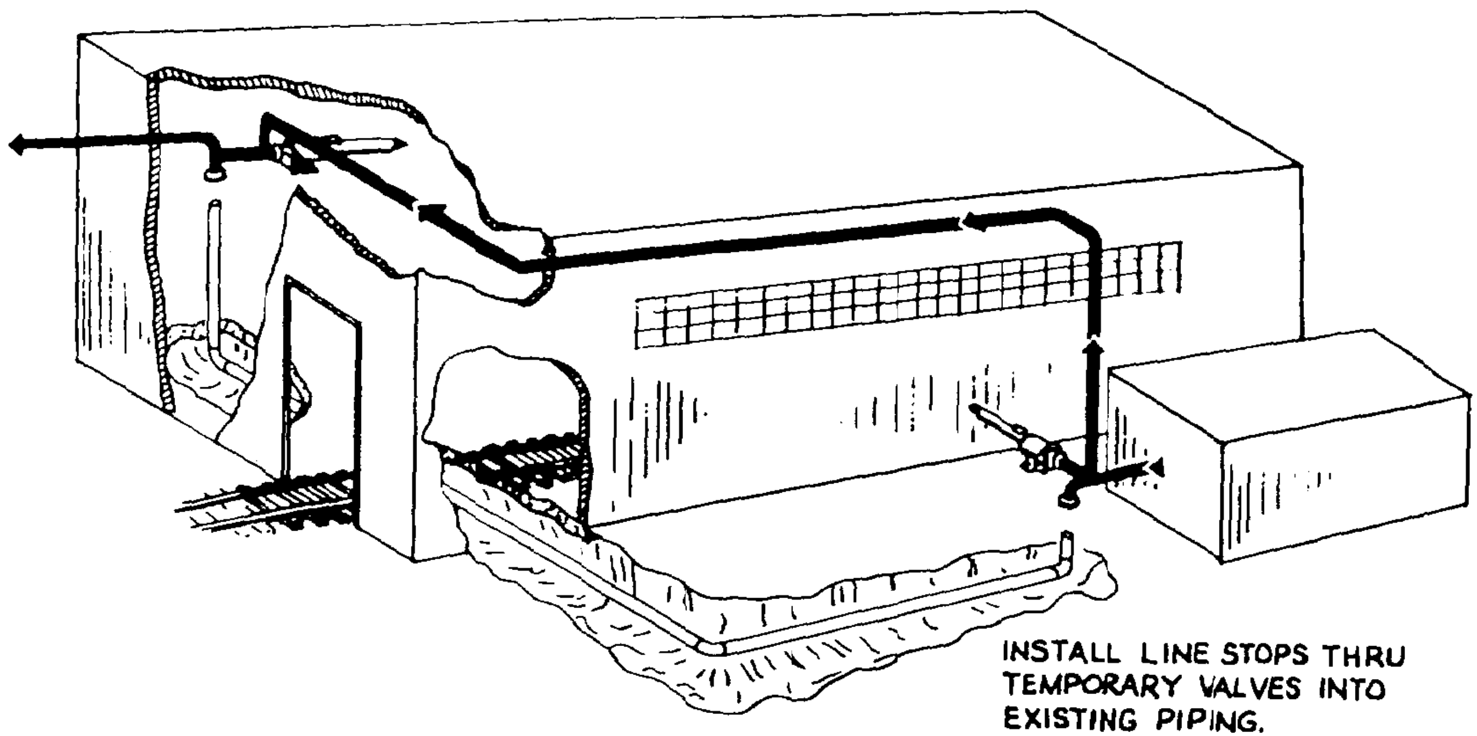
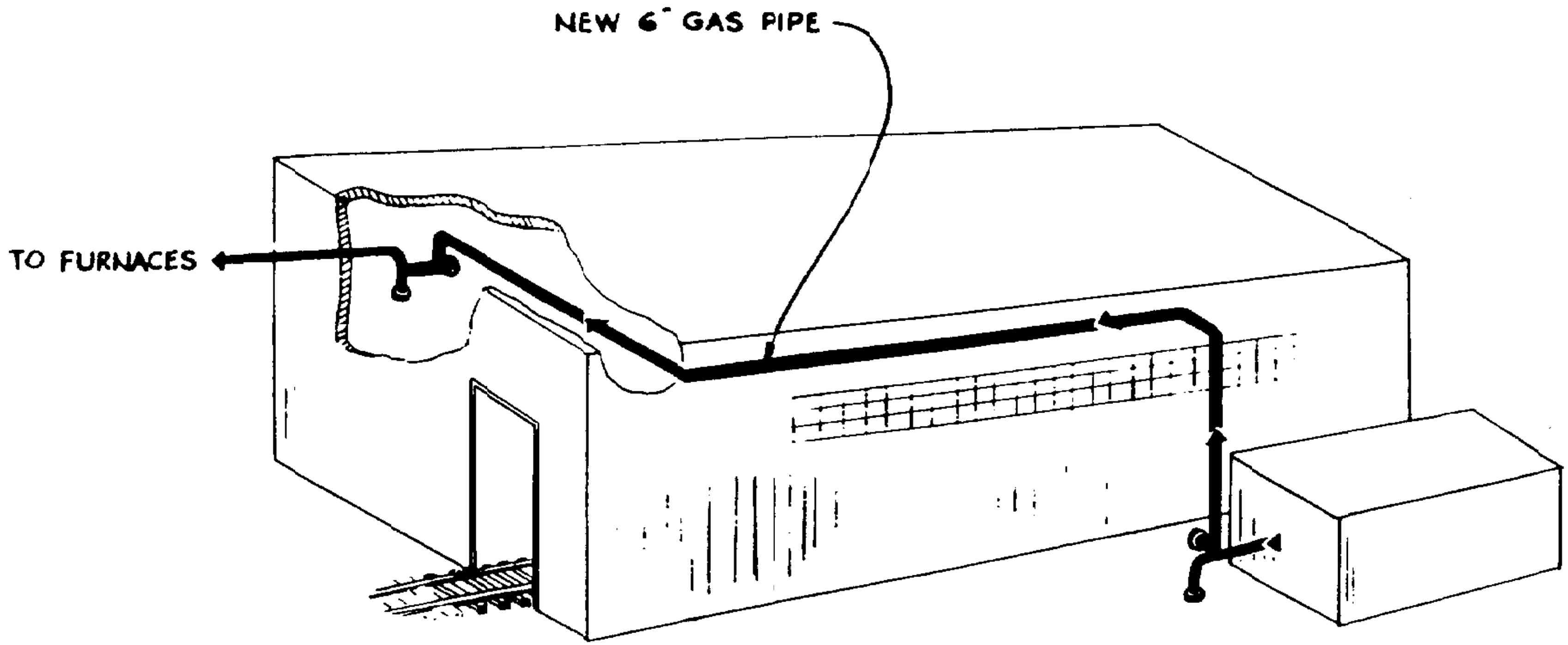


Fig. 25

6" GAS PIPE RELOCATION

Line Stops Deactivate Old Line



INSTALL COMPLETION PLUGS THRU TEMPORARY VALVES.

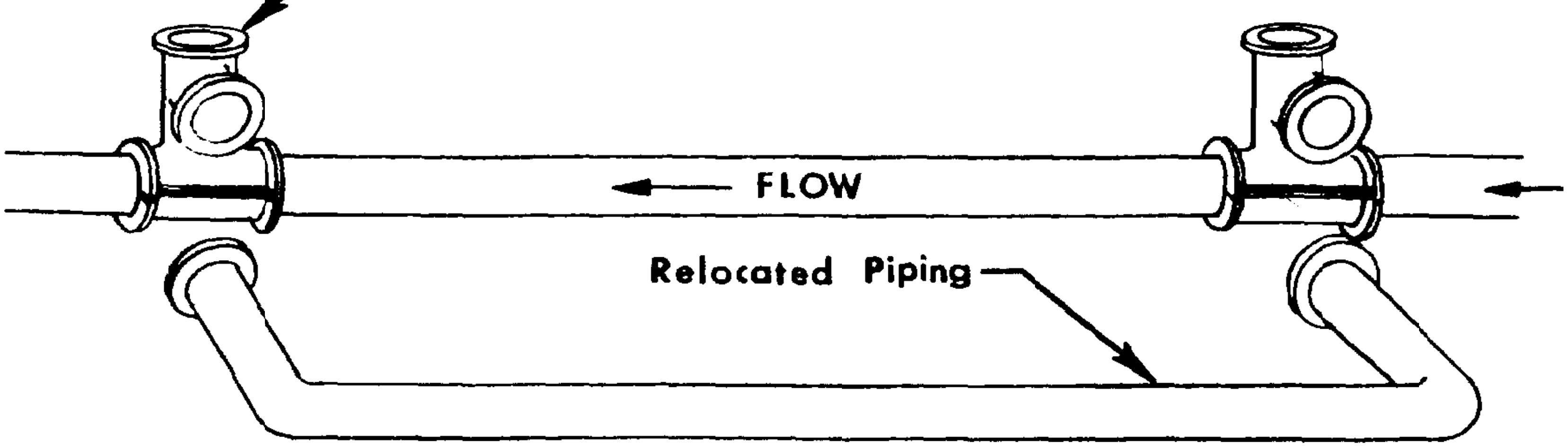
RECOVER TEMPORARY VALVES.

REMOVE OLD PIPING.

Fig. 26

6" GAS PIPE RELOCATION

Completed Installation



PIPE RELOCATION WITHOUT SHUTDOWN - II

Fig. 27

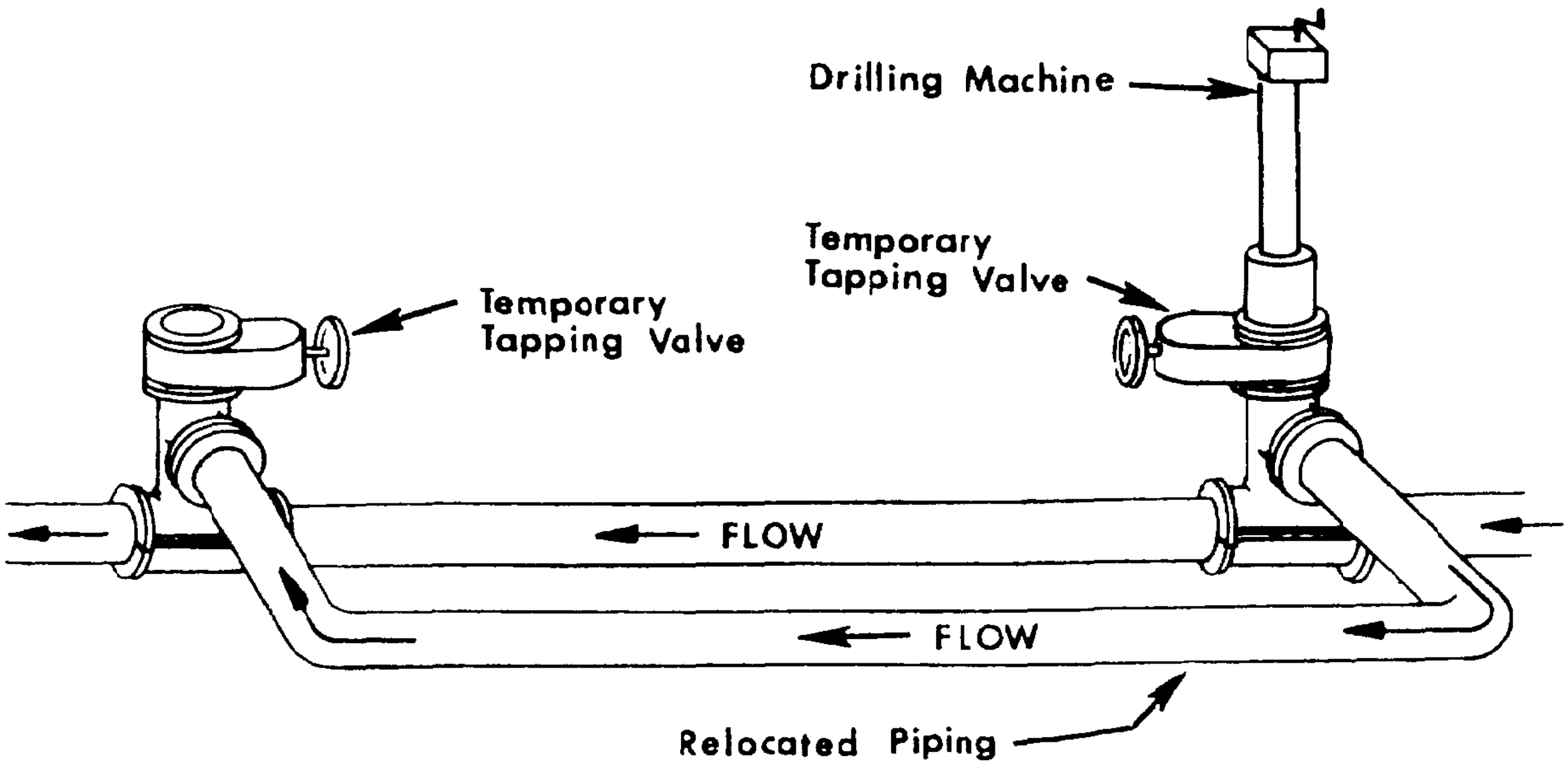


Fig. 28

PIPE RELOCATION WITHOUT SHUTDOWN - II

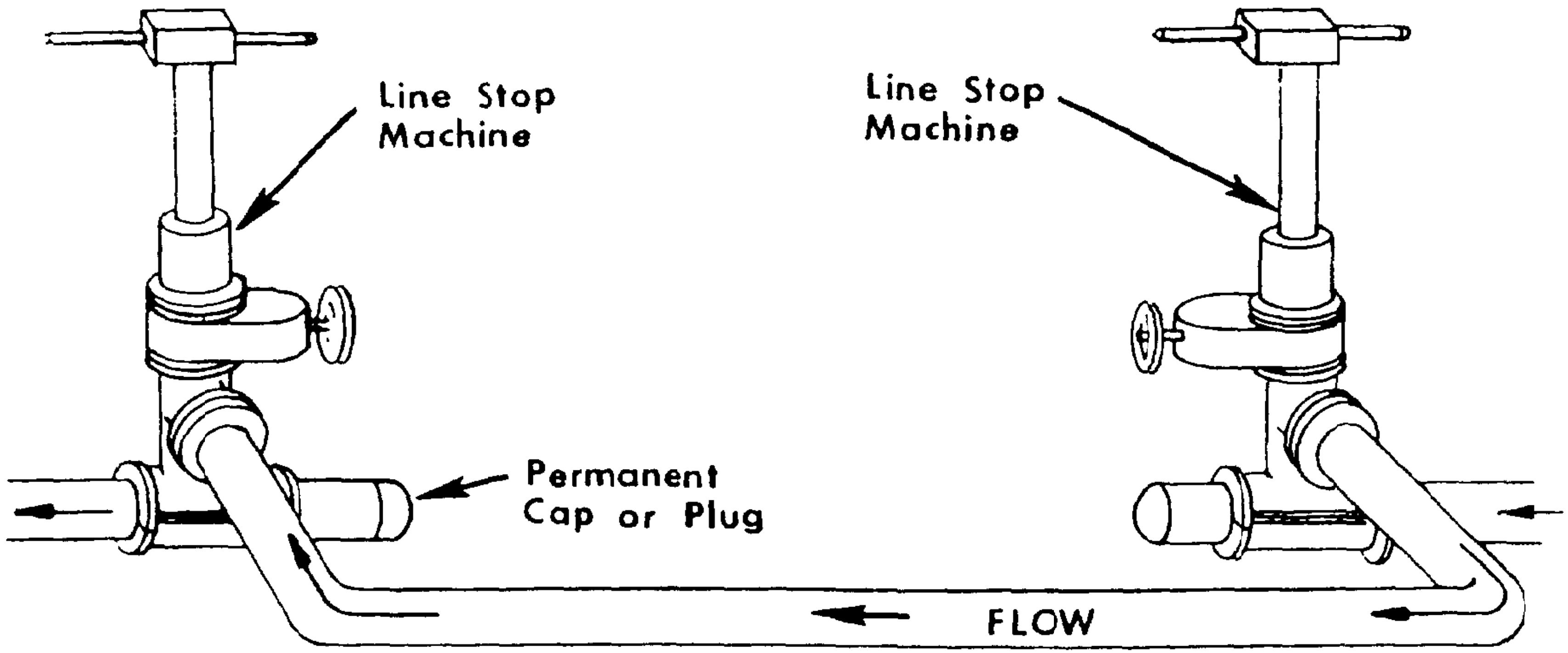


Fig. 29

PIPE RELOCATION WITHOUT SHUTDOWN - II

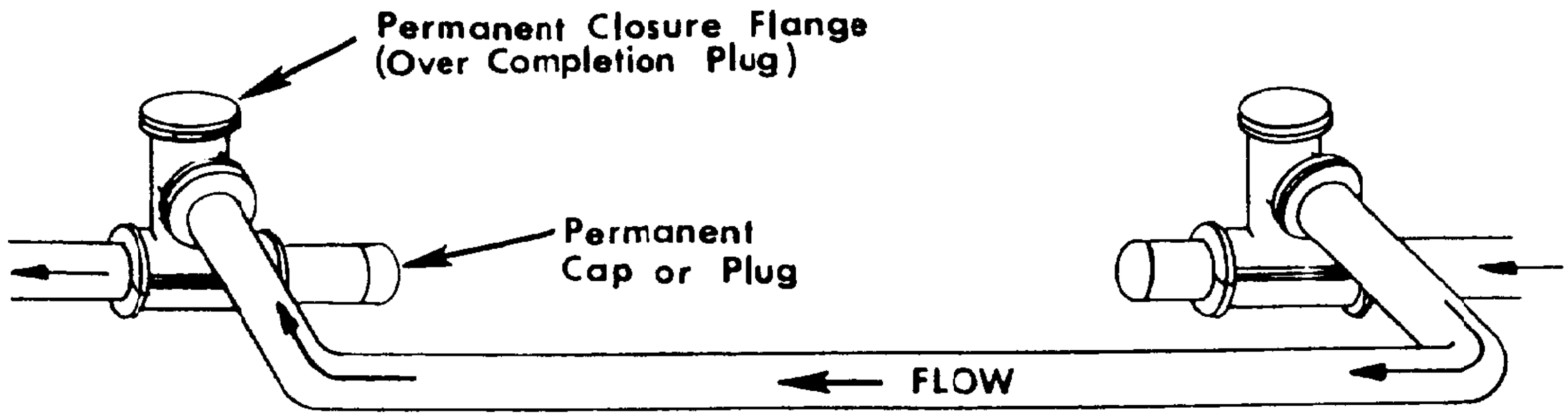
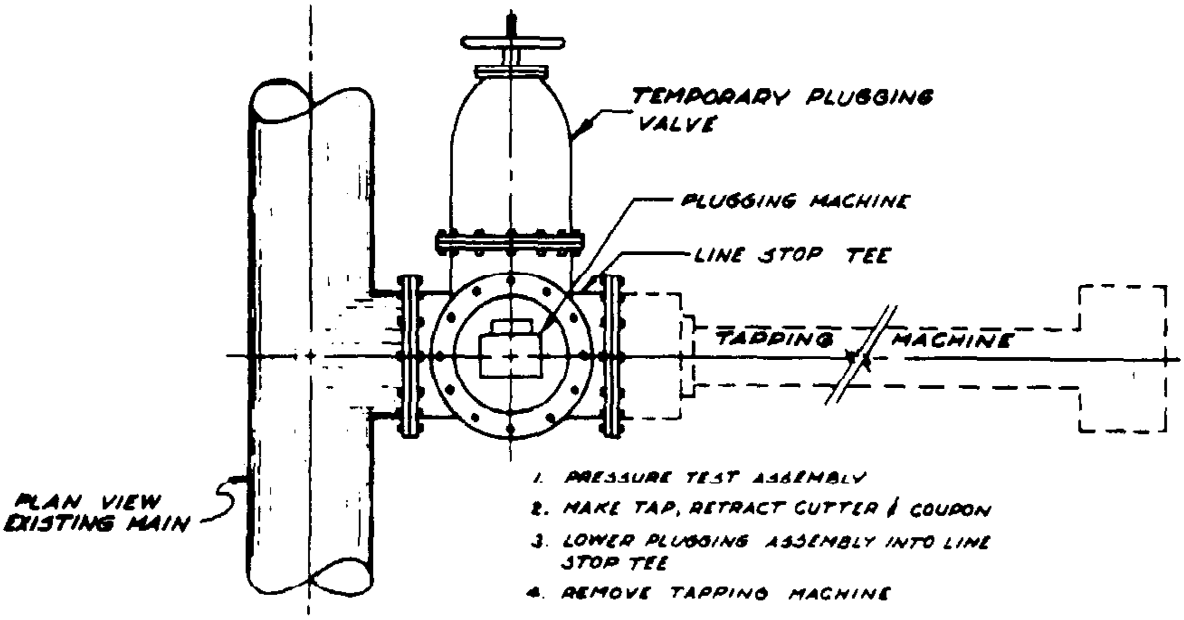
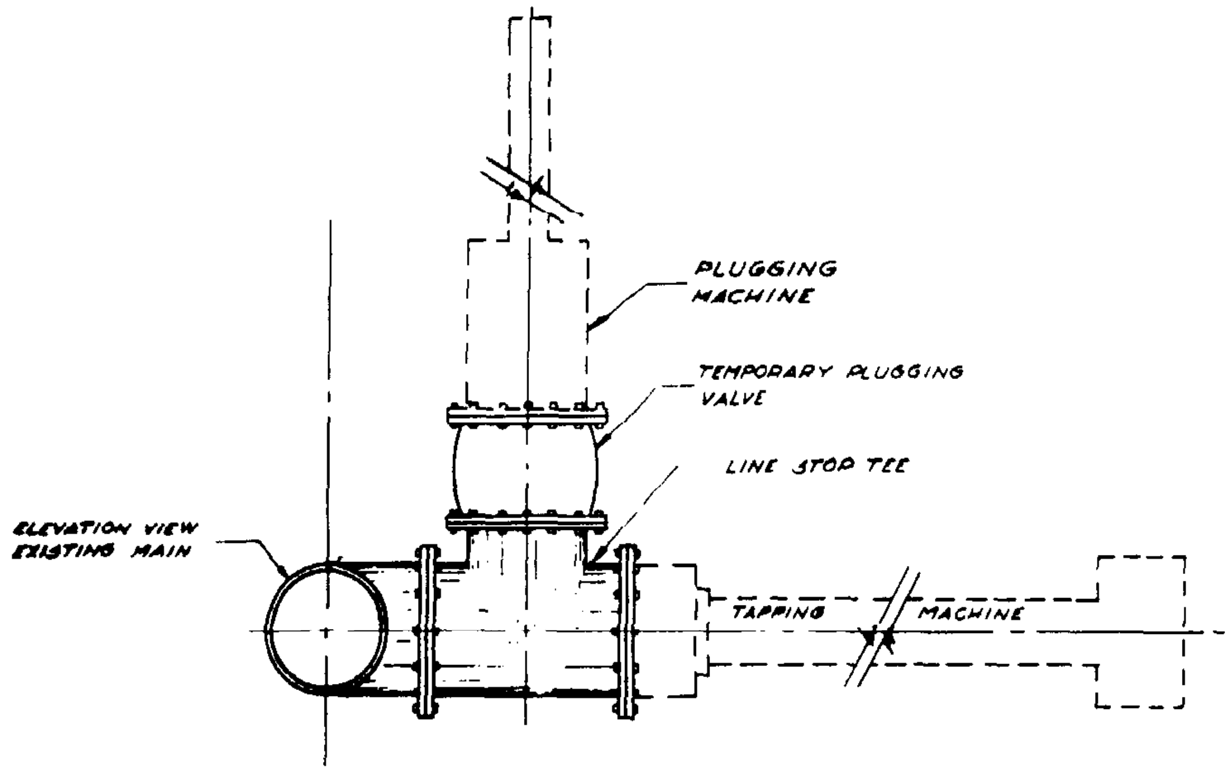


Fig. 30

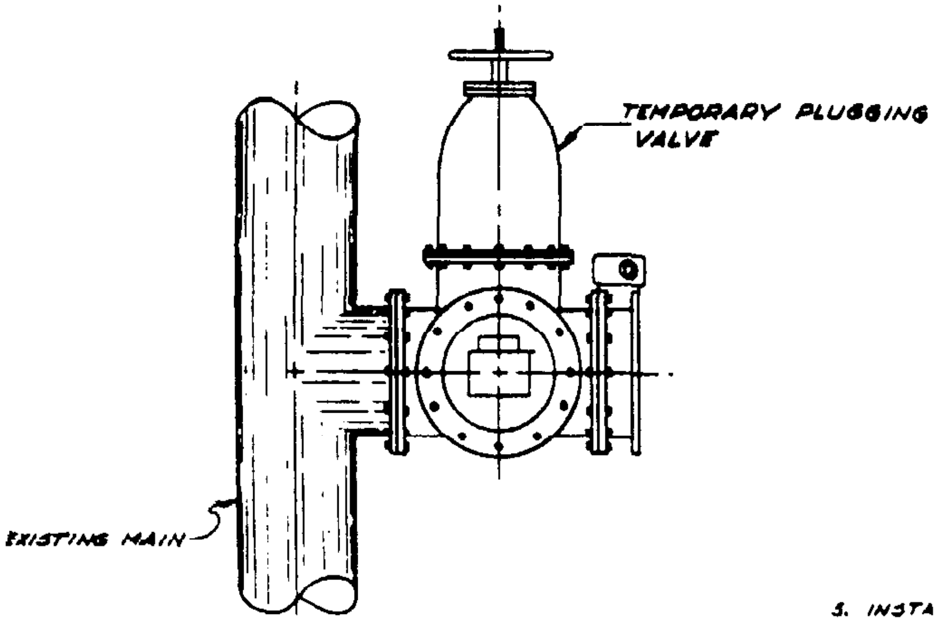
PIPE RELOCATION WITHOUT SHUTDOWN - II



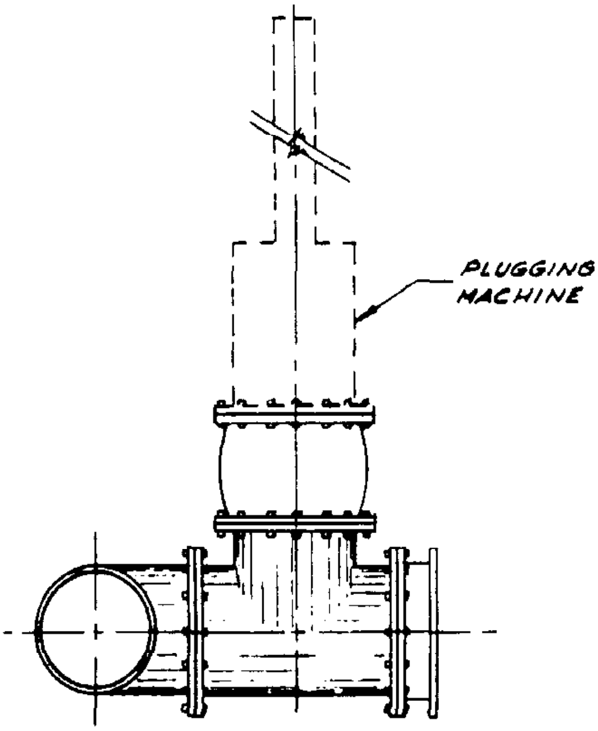


Step 1 - Line Stop Tap

Fig. 31

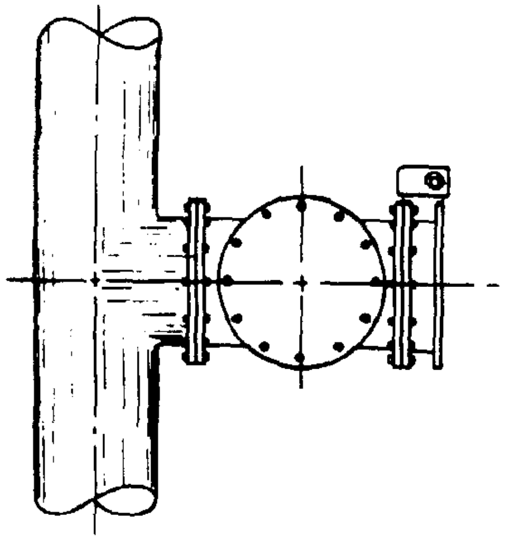


5. INSTALL BUTTERFLY VALVE
6. CLOSE BUTTERFLY VALVE
7. RETRACT PLUGGING ASSEMBLY INTO PLUGGING MACHINE
8. CLOSE PLUGGING VALVE
9. REMOVE PLUGGING MACHINE

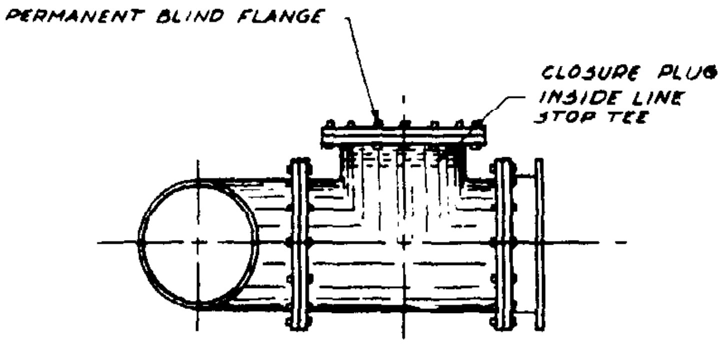


Step 2 - Line Stop Tap

Fig. 32

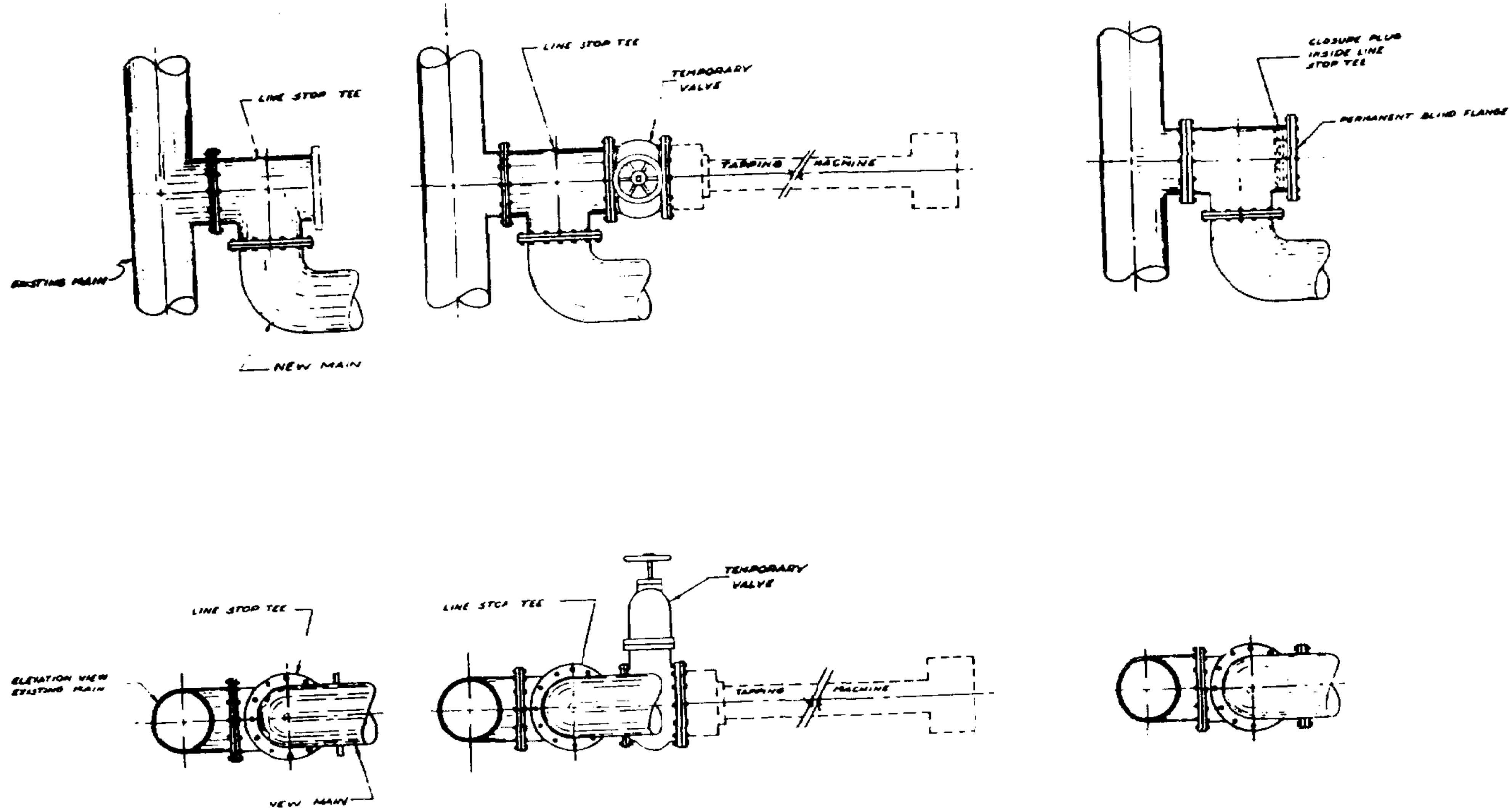


10. INSTALL CLOSURE MACHINE ONTO PLUGGING VALVE
11. INSERT CLOSURE PLUG INTO LINE STOP TEE
12. REMOVE CLOSURE MACHINE AND TEMPORARY PLUGGING VALVE
13. INSTALL PERMANENT BLIND FLANGE



Step 3 - Line Stop Tap

Fig. 33



Pressure Tap Without Valve

Fig 34