

Procedures For Welding Or Hot Tapping On Equipment Containing Flammables

API Publication 2201
Third Edition, October 1985

American Petroleum Institute
1220 L Street, Northwest
Washington, DC 20005



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*

ANSI¹

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

ASME²

Boiler and Pressure Vessel Code, Section IX

ACGIH³

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

OSHA⁴

- 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

¹American National Standards Institute, 1430 Broadway, New York, New York 10018.

²American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.

³American Conference of Governmental Industrial Hygienists, Building D-5, 6500 Glenway Avenue, Cincinnati, Ohio 45211.

⁴Occupational 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 $\frac{1}{8}$ -inch (2.4-millimeter) diameter welding electrode. Subsequent passes should be made with a $\frac{1}{4}$ -inch (3.2-millimeter) electrode diameter or less if the metal thickness does not exceed $\frac{1}{2}$ 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 $\frac{1}{2}$ 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. Gen-

erally, 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, 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 gage 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**

TABLE OF CONTENTS

Introduction.....	Page 1
-------------------	--------

General Division

Pressure Tapping.....	Page 2
Pressure Tapping Concrete Pipe.....	Page 12
Line Stopping.....	Page 16
Valve Inserting.....	Page 22

Technical Division

Under Pressure Welding.....	Page 24
Pressure Vessels.....	Page 24
Hot Tap Fittings.....	Page 28
Line Stop Fittings.....	Page 29
Access Fittings.....	Page 30
Pressure Engineering.....	Page 32
Tapping Saddle Design.....	Page 33
Branch Connection Design.....	Page 36
Pressure Installation Techniques.....	Page 46

INDEX OF FIGURES & DRAWINGS

Fig. 1 - Pressure Tap - Exploded View.....	Page 3
Fig. 2-6 Tapping Traps.....	Page 7-11
Fig. 7 - Typical Cross Sections of Concrete Pipe.....	Page 14
Fig. 8 - Concrete Tapping Saddle With Rigid Cland.....	Page 15
Fig. 9 - Cup Type Line Stop Machine.....	Page 17
Fig. 10 - Expanding Cylinder Type Line Stop Machine.....	Page 18
Fig. 11 - Pipeline Relocation w/o Shutdown.....	Page 19
Fig. 12 - Valve Installation or Pipe Repair w/o Shutdown.....	Page 20
Fig. 13 - Welding Hot Tap Fittings.....	Page 28
Fig. 14 - Welding Line Stop Fittings.....	Page 29
Fig. 15 - Tapping Nozzles.....	Page 34
Fig. 16 - Tapping Nozzles.....	Page 35
Fig. 17 - Branch Connection Reinforcement (Header Distortion).....	Page 38
Fig. 18 - Branch Connection Reinforcement (Two-Dimensional Analysis).....	Page 40

INDEX OF FIGURES & DRAWINGS
(cont)

Fig. 19 - Branch Connection Reinforcement (Two-Dimensional Analysis..	Page 41
Fig. 20 - Branch Connection Reinforcement (Header Distortion Due to Excess Reinforcing Material)...	Page 43
Fig. 21 - Branch Connection Reinforcement (Dimensional Summary).....	Page 45
Fig. 22 - 6" Gas Pipe Relocation (Gas Pipe Prior to Installation)....	Page 46
Fig. 23 - 6" Gas Pipe Relocation (New Piping Connected Into Lateral Linestop Tee).....	Page 47
Fig. 24 - 6" Gas Pipe Relocation (Pressure Taps Activate New Line)...	Page 48
Fig. 25 - 6" Gas Pipe Relocation (Line Stops Deactivate Old Line)....	Page 49
Fig. 26 - 6" Gas Pipe Relocation (Completed Installation).....	Page 50
Fig. 27 - Pipe Relocation Without Shutdown.....	Page 51
Fig. 28 - Pipe Relocation Without Shutdown.....	Page 52
Fig. 29 - Pipe Relocation Without Shutdown.....	Page 53
Fig. 30 - Pipe Relocation Without Shutdown.....	Page 54
Fig. 31 - Step 1 - Line Stop Tap.....	Page 55
Fig. 32 - Step 2 - Line Stop Tap.....	Page 56
Fig. 33 - Step 3 - Line Stop Tap.....	Page 57
Fig. 34 - Pressure Tap Without Valve.....	Page 58

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).

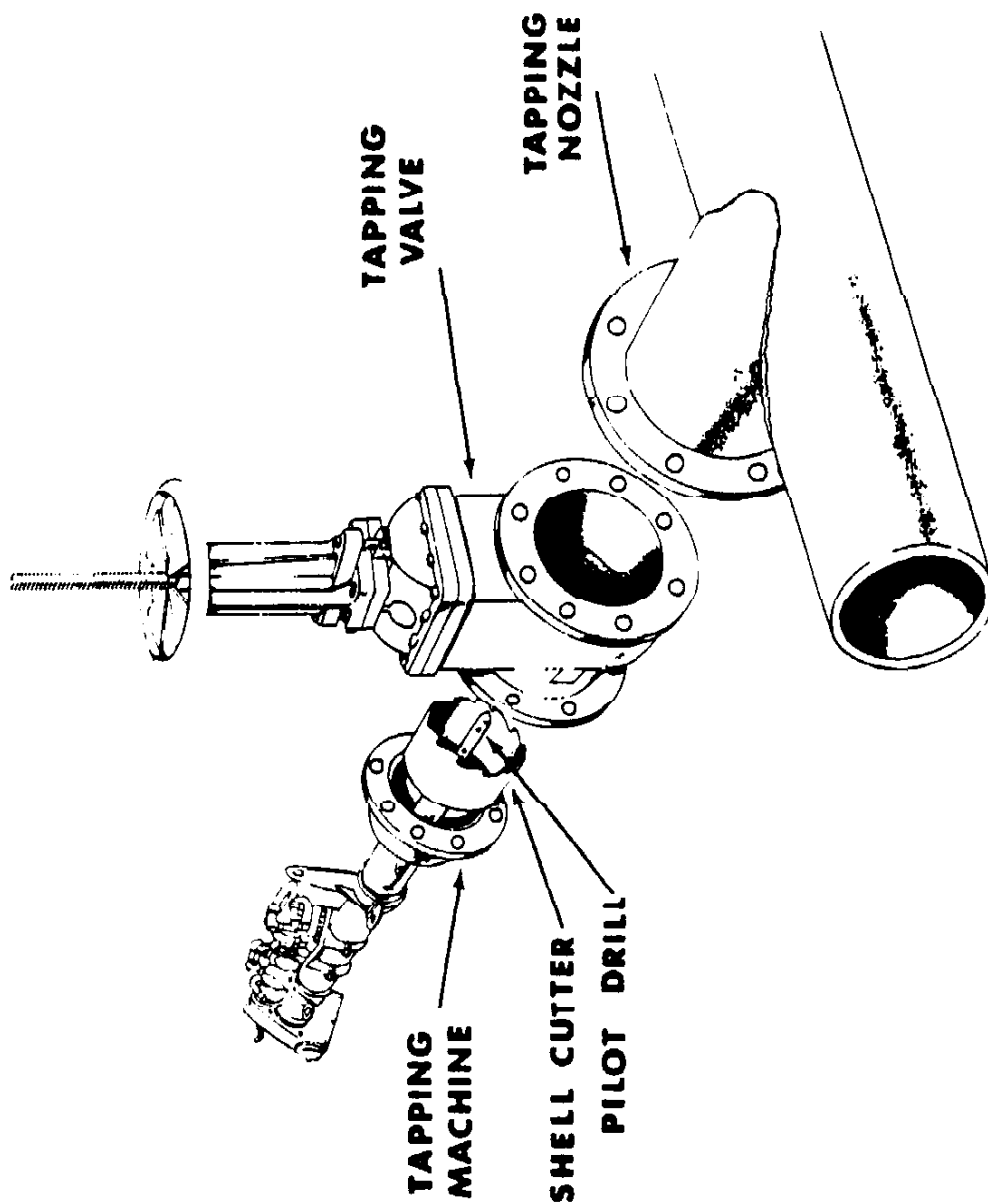
If we are dealing in the waterworks industry the word "tapping valve" has a definite and specific meaning. This is a double-disc parallel seat valve that carries a specially oversized bore. The seat ring lugs are removed, and in addition, special care is taken to insure that the bolt circle and outlet 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 of 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.

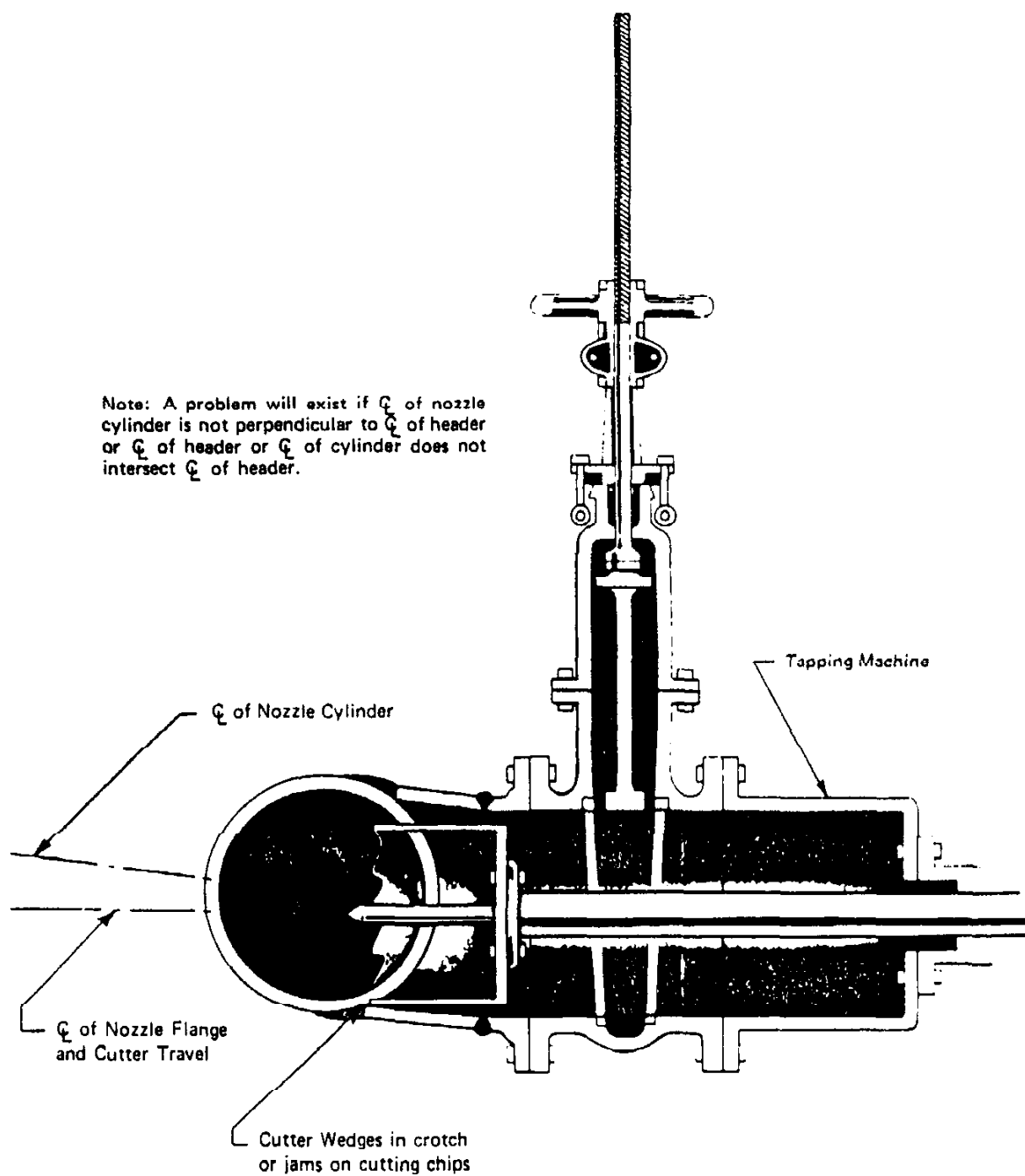


Fig. 2

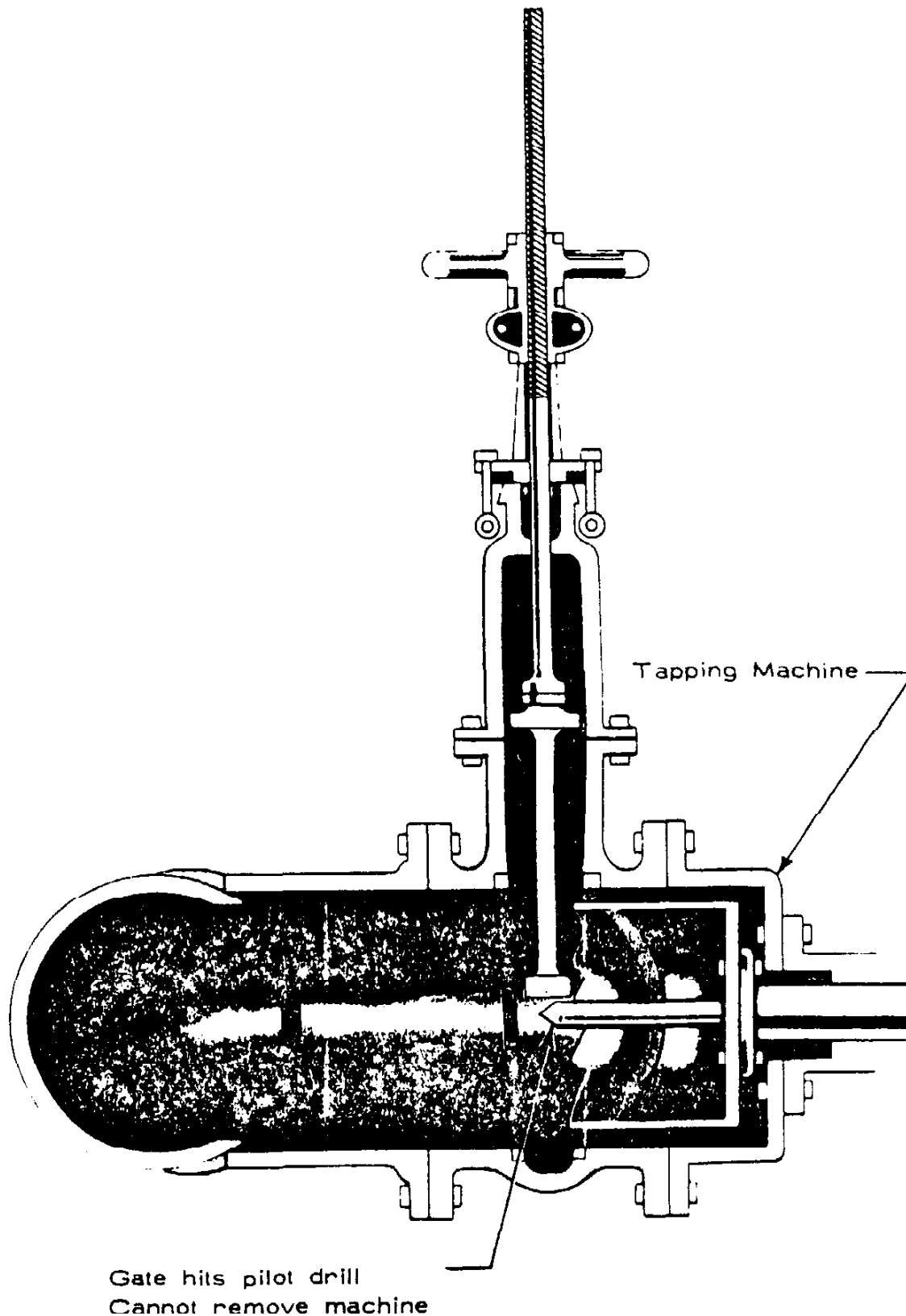


Fig. 3

TAPPING TRAPS NO.2

Valve Not Deep Enough for Cutting Equipment

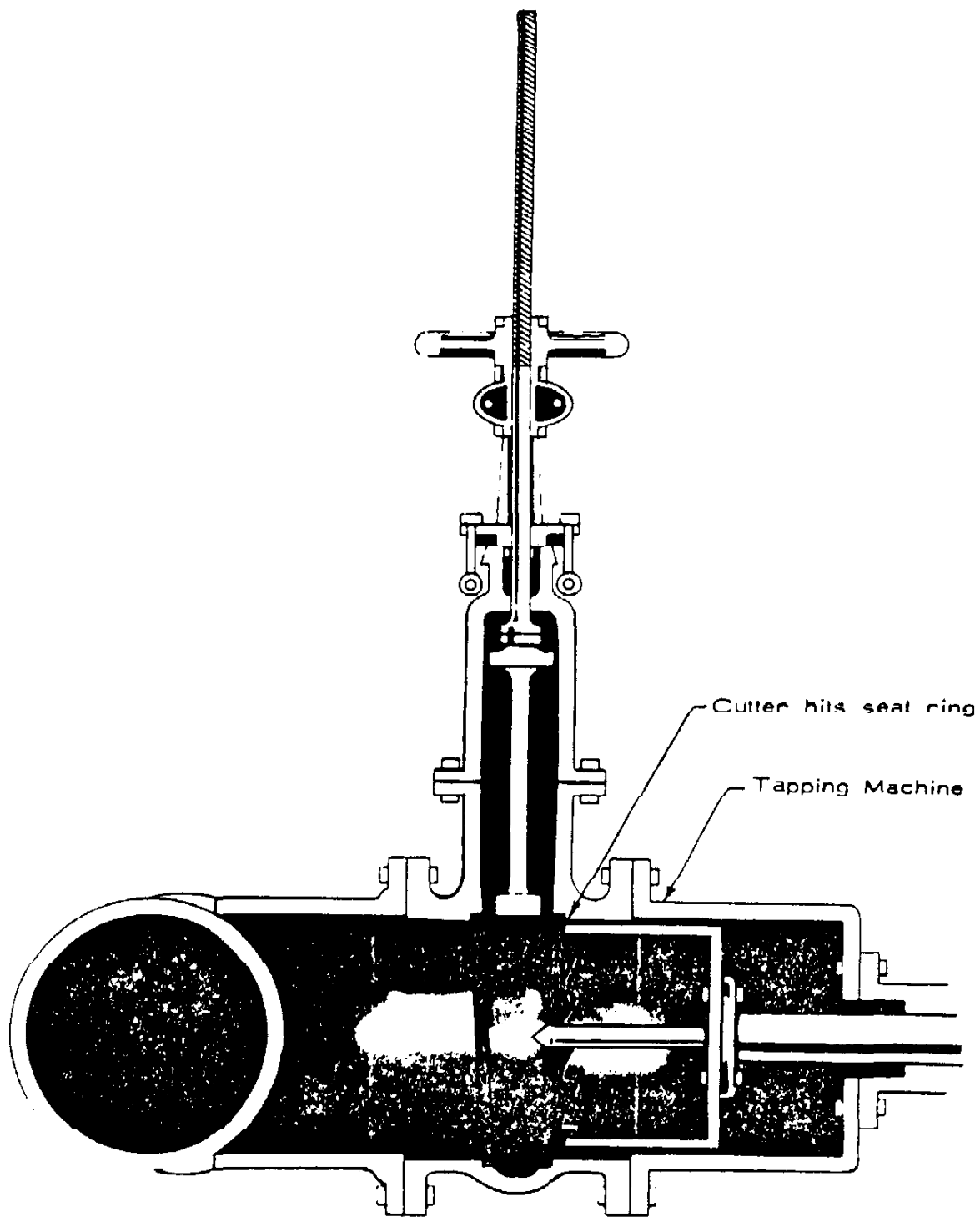


Fig. 4
TAPPING TRAPS NO. 3

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