PLAINTIFF'S EXHIBIT

TEX-132

TEXACO INC.
PUGET SOUND PLANT

TRAINING OUTLINE

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

A. BASIC TRAINING

TEXACO INC.
PUGET SOUND PLANT

TRAINING OUTLINE

DEPARTMENT: PIPE
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B. ON THE JOB TRAINING

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B. ON THE JOB TRAINING

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: July 1, 1970

ITEM NO. A-1 SUBJECT: DEPARTMENT ORGANIZATION

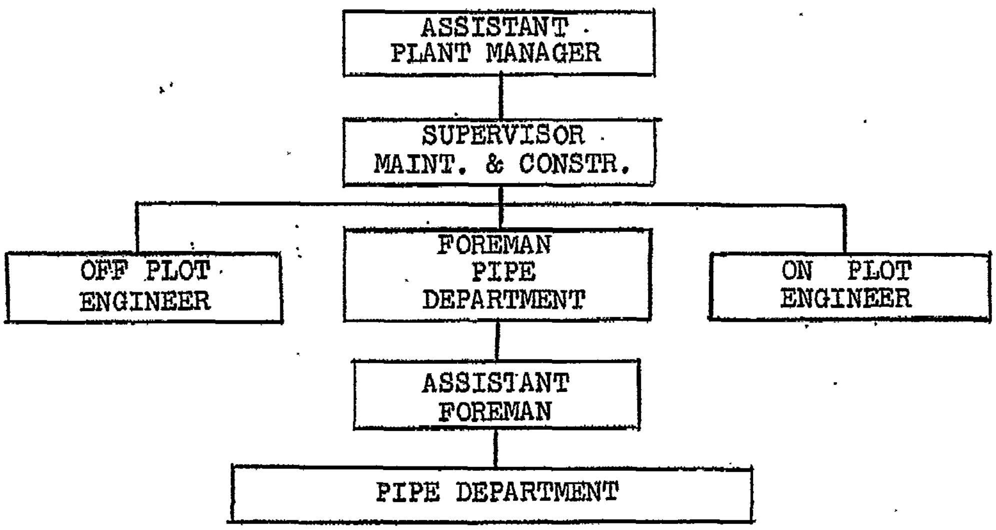
The Pipe Department is one of several departments of Puget Sound Plant which comes under the jurisdiction of the Assistant Plant Manager.

The Supervisor-Maintenance is in charge of the planning, scheduling and execution of work involving all the maintenance departments of the Plant including the Pipe Department.

The foreman of the Pipe Department is in direct charge of the personnel of the department and is responsible for the selection and assignment of craftsmen and trainees in accordance with the requirements of the daily work schedules. He is also responsible for the follow up of work performance to assure proper application of craft skills and quality workmanship.

The Pipe Foreman directly supervises the work of Pipefitters assigned to the respective units, coordinates the work and cooperates with the various operating departments in accomplishing scheduled work.

PIPE DEPARTMENT ORGANIZATION



TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER(TRAINEE)

DATE: July 1, 1970

ITEM NO. A-2 SUBJECT: RELATIONSHIP OF DEPARTMENT TO REFINERY OPERATIONS

The purpose of a refinery is to process crude oil and convert it into highly refined and saleable petroleum products, as economically and safely as possible, while maintaining high standards of quality which assure continued confidence of the buying public.

Each operating unit and department is designed, constructed and operated with the objective of providing a continuing supply of quality-controlled petroleum products for a highly competitive market. Maintaining each unit in a safe operable condition requires the knowledge and skills of many people and crafts. New techniques, materials, tools and methods are constantly being developed which require increasing knowledge, skill and training in order to take advantage of these developments and remain competitive.

The Pipe Department has an important role in maintaining continuity of refinery operations. The Pipefitter fabricates, installs, repairs, replaces, tests and maintains various types of pipe work, fittings, valves and operating equipment. The continued safe operation of a unit or related equipment may be dependent on how well the Pipefitter has performed such work as repacking a valve, installing the correct type and schedule numbered pipe or fitting, tightening up on a vessel head or pipe flange, cleaned and tested shell and tube equipment, and many other similar jobs requiring skilled craftsmanship and high standards of workmanship.

Since the Pipefitter's work may involve other crafts, or effect several operating departments, it is essential that he closely coordinate his work and cooperate with others in order to do a safe, workmanlike job. It can thus be seen that the Pipe Department plays an important part in relation to both the maintenance and operation of refinery equipment. As equipment or procedures are changed the Pipefitter may find it necessary to adapt himself to the use of new methods, new tools and undergo re-training. However, the Pipe Department still bears a continuing responsiblity and relationship to operations of the refinery which contribute substantially to the maintenance of the safety, economy and continuity of the refinery productive capacity.

TEXACO INC.
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DEPARTMENT: PIPE DATE: July 1, 1970
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ITEM NO. A-3 SUBJECT: DEPARTMENTAL STANDARDS AND WORKING RULES

1. When you cannot report for work as scheduled, and on time, give your Craft Supervisor or the Night Foreman on duty as much advance notice as possible. If you are unable to call, have someone call for you.

2. Requests for time off should be handled with your Craft Supervisor as far in advance as possible.

3. When you have been absent for any reason such as sickness, accident, vacation, etc., call your Craft Supervisor as far in advance as possible before returning to work so he can arrange schedules and advise you when to report for duty.

4. In case of change of address, notify your Craft Supervisor of new address and telephone number.

5. When you have finished a job, go at once to your next assignment, if known; otherwise, contact your supervisor. Do not loiter or loaf between jobs.

6. It is a Pipefitter's responsibility to see that his job progresses in a safe working manner, keep his helpers lined up and working, and to know where his helpers are at all times.

7. It is a Pipefitter's duty to make sure all necessary materials, equipment and tools are transported to his assigned job.

8. Instruct his helpers of proper tool handling and work procedures on the job.

9. Request work permits when required to do a job such as blinding lines or pumps, opening vessels or towers, entering and burning lights in vessels or towers, etc. (Read permits and follow special instruction written on permit.)

10. In an oil refinery, we must eliminate all possible causes of fire. Smoking is permitted, therefore, only in certain clearly marked areas and at specified times. People who cannot observe this very important safety rule just don't belong in an oil refinery. For the safety of everyone, this rule is rigidly enforced.

11. Pipefitters will be furnished tools necessary to perform their specific duties. It is the responsibility of each Fitter to make sure that the tools he uses, or returns for the use of others, are in safe working condition. Replacement of broken or damaged tools will be handled by the Main Tool Room.

12. The Plant telephone system is primarily for the transaction of Company business. Personal calls ordinarily should not be made during working hours. You are expected to use good judgment in this respect. Please use the phones for personal business only when absolutely necessary.

13. Do not leave the job unless reported to your Maintenance Supervisor.

14. It is a Pipefitter's responsibility to train and instruct a Craft Helper in the methods and procedures of his trade whenever so assigned by his supervisor.

TRAINING DETAILS

DEPARTMENT: PIPE DATE: July 1, 1970
CLASSIFICATION: PIPEFITTER (TRAINEE)

ITEM NO. A-4 SUBJECT: DEPARTMENT FIRE PROTECTION

Fire protection and fire fighting are the concern of each and every individual at Puget Sound Plant. All employes, exclusive of women, are subject to fire fighting duty as required, whether or not directly attached to the Fire and Emergency Organization. Accordingly, supervisors assigned a copy of this manual are responsible for keeping all personnel under their supervision informed in regard to their individual roles.

I. HOW TO REPORT A FIRE OR EMERGENCY

To report a fire or other emergency there are simple rules which should be followed:

1. REMAIN CALM - DO NOT PANIC

You have certain vital functions to perform - functions which must be carried out promptly and effectively - functions which call for clear thinking and sound judgment.

2. SIZE UP THE SITUATION QUICKLY

Is the fire small enough to handle alone- or will help be needed? Spot the nearest fire extinguishing equipment - weigh the possibilities of personal injury

3. TAKE ACTION

(a) Extinguish Fire
If you can handle it alone - SAFELY! or

(b) Give Alarm
If the fire is too large to handle without help - even if necessary to leave location to do so.

TAKE NO CHANCES OF LETTING FIRE GAIN SERIOUS HEADWAY BEFORE GIVING ALARM.

4. GIVING THE ALARM

Call the Boiler House immediately by telephone (22) giving:

1. Your name
2. Location of fire and department: have this information repeated back.
3. Nature of fire - seriousness.

Mobile radio equipment may be used if telephone is not convenient and would cause delay in sounding alarm. In this case, call the Gate or the Garage who in turn will relay the call to the Boiler House. However, it is preferable to call the Boiler House direct.

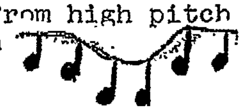
REMAIN CALM - HAVE PERSON RECEIVING CALL REPEAT INFORMATION BACK - BE SURE HE CLEARLY KNOWS LOCATION.

II. FIRE AND EMERGENCY SIGNALS

REGULAR FIRE ALARM: One wildcat cycle followed by number of short blasts to indicate zone number. Repeat wildcat cycle and zone signal one time, as follows:

ZONE NO.			ZONE SIGNAL	
1	1 Wildcat	(pause 10 sec.)	1 short blast Repeat wildcat and zone	(pause 10 sec.)
2	1 Wildcat	(pause 10 sec.)	2 short blasts Repeat wildcat and zone	(pause 10 sec.)
3	1 Wildcat	(pause 10 sec.)	3 short blasts Repeat wildcat and zone	(pause 10 sec.)
4	1 Wildcat	(pause 10 sec.)	4 short blasts Repeat wildcat and zone	(pause 10 sec.)
5	1 Wildcat	(pause 10 sec.)	5 short blasts Repeat wildcat and zone	(pause 10 sec.)

Responsibility: When Regular Fire Alarm sounds, all personnel assigned to the Fire and Emergency Organization who are on duty are required to report to their respective assignments as outlined herein. The only exceptions would be in the case of scheduled fire drills when individual members may be excused by authority of the Fire Chief (Plant Manager), or Assistant Fire Chief (Assistant Plant Manager) only. Persons temporarily on "limited duty" due to physical condition will be considered as temporarily relieved from fire fighting duties. Off duty employes are not required to report unless called out, except that Supervisors on Call Out Lists should not necessarily wait to be called.

The term "wildcat" or "wildcat cycle" refers to the variable pitch feature of the wildcat fire whistle, sounding the whistle through its range from high pitch down to low pitch and back to high pitch again  The high pitch is used for zone signals.

Fire Drill: Same as Regular Fire Alarm, including repeat.

Recall: One long blast of the high pitch. "Recall" to be sounded only when authorized by person acting as Fire Chief, Assistant Fire Chief, Fire Marshal or Acting Fire Marshal. Person calling the "recall" to the Boiler House should identify this authority.

GENERAL ALARM: 10 continuous wildcat cycles (approximately two minutes.)

"General Alarm" to be sounded only when authorized by person acting as Fire Chief, Assistant Fire Chief, Fire Marshal, or Acting Fire Marshal. Person calling a 'General Alarm" to the Boiler House should identify this authority.

Responsibility: When General Alarm is sounded, all available employes except women are required to report as outlined in Section XVII - General Alarm - of the Plant Fire Manual. Off duty employes should report on earing the alarm or on being called.

UNIT EMERGENCY ALARM: Series of short blasts (approximately 10), of air whistle on unit concerned.

Fire whistle will be tested each Friday noon immediately following the regular plant noon whistle. Test will consist of sounding one wildcat cycle.

If wildcat fire whistle is inoperative, the plant shift whistle will be used. Signals will be the same as above, substituting one long blast for each wildcat cycle.

Hourly employes reporting in response to General Alarm or Call Out should punch in as usual at the Main Gate.

TRAINING DETAILS

DEPARTMENT: PIPE DATE: July 1, 1970
CLASSIFICATION: PIPEFITTER (TRAINEE)

ITEM NO. A-5 SUBJECT: DEPARTMENT AND PLANT SAFETY PRACTICES

PURPOSE: The purpose of this section is to assemble in one place the more important and pertinent safety information applicable to the work of the Pipe Department. In general, all of the Regulations, Procedures, Practices and information contained herein should be studied carefully by every craftsman and trainee and practiced constantly.

REGULATIONS: The following regulations MUST be observed:

(1) No flange or head can be unbolted on any vessel or tank, or any line opened until a SAFETY WORK PERMIT, Form R-241-A (yellow form) has been issued by the operating department involved. The PERMIT must be posted conspicuously at the work site or point of entrance.

(2) No tank, vessel, tower, drum or other enclosed space is to be entered until a SAFETY WORK PERMIT has been issued authorizing entry.

(3) No burning, welding, grinding, chipping, sandblasting, pressure tapping, breaking concrete, use of internal combustion engines or other work can be performed which could be a source of ignition for any flammable materials, unless and until a HOT WORK PERMIT, Form R-241, (pink form) has been issued in proper form by the operating department involved and properly countersigned by an authorized operating supervisor.

(4) Standing instructions for issuing both Hot Work and Safety Work Permits must be reviewed by each Pipefitter and trainee.

(5) CAUTION - Always read the PERMIT - be sure you understand the precautions which must be observed - note the time period it covers - be sure it describes or identifies the line, vessel or equipment to be worked on - note the requirements for use of personal protective equipment - be sure the condition of the line, vessel or surrounding area is specified - and obey all the precautions written on the permit. WHEN IN DOUBT, CONSULT YOUR FOREMAN.

(6) Do not open or close valves on lines, vessels and operating equipment (except valves at utility stations - air, steam and water). Only Operators on the particular unit or area are permitted to operate valves.

(7) Hard hats must be worn on the job. Goggles must be used whenever a hazard to the eyes may be encountered. For example: chipping, breaking concrete, hammering on overhead lines and objects, breaking into lines, working where dust and rust is

blowing around, grinding, buffing, etc. Protective clothing (impervious suits) and other protective equipment must be worn when specified on HOT or SAFETY WORK PERMITS, when working on lines or equipment in acid or caustic service, or when instructed to do so by the Foreman in charge of the work.

(8) Pressure Tapping or Hot Tapping must never be performed until a HOT WORK PERMIT, Form R-241 (pink form) has been issued and then countersigned by the Assistant Plant Manager or the Plant Manager, and a fire watch is maintained. The Pipe and Operating Foremen shall provide close supervision during the entire tapping operation.

(9) Gloves should not be worn while using abrasive grinding wheels.

(10) When work is performed on pipe lines connected to equipment or lines in service and there is any danger of oil or other products escaping from a open end, or open-end valve, the valve flange or open end of the line should be blanked (blinded) off or plugged.

(11) When work is to be done on a line equipped with a cathodic protection system, the Instr-Elec Foreman must be consulted before the line is broken (disconnected) and SAFETY WORK PERMIT, Form R-241-A, must be issued.

(12) High pressure air shall not be used for testing pipework except as approved by the Engineering Department. In no case shall air be used to test lines last containing a volatile product, acid or caustic. Water or high flash oil is recommended for testing pipework in preference to air.

(13) When using buckets to raise or lower tools, equipment and material to top of towers or vessels, remove bail and replace with a heavy gauge wire or small cable.

(14) If working in a trench with straight up and down walls over 4 ft. deep, shoring should be installed to prevent cave-ins of dirt.

(15) Before operating on air tugger, cable and spool should be inspected for tangles in cable on spool and broken strands in cable.

PROCEDURES: The procedures outlined herein should be followed whenever performing the work described.

(1) Unheading, Breaking Into Lines, Blinding and Disconnecting Practices

Obtain Safety Work Permit. In addition, the following precautions should be observed:

(a) Use a drift pin, spud wrench or other suitable tool in lining up bolt holes in flanges. KEEP FINGERS OUT OF BOLT HOLES.

(b) Do not stand in line with faces of flanges when a wedge is being driven between them as a precaution against injury in event the wedge should jump out.

(c) When unbolting flanges be sure to loosen bottom bolts first on side opposite where you are standing so as to divert any possible pressure remaining in line away from the feet and body.

(d) When necessary to break into or unflange lines, pumps or vessels handling TEL (Tetraethyl Fluid) the current rules and regulations of the supplier (Dupont) shall be followed, therefore, consult your foreman and secure properly prepared SAFETY WORK PERMIT.

(2) Working on Scaffolds

Before using a scaffold the person using should check the following to assure safety:

(a) Supports should be solidly set on level surface or properly blocked.

(b) Cross braces should be firmly attached.

(c) Guard rails should be provided.

(d) Decking boards should be free of splits and checks. (Boards should be at least 2" X 10" lumber at least as good as #1 Common.)

(e) Decking boards shall have cleats at both ends to prevent boards slipping off bearing ledger.

(f) Decking boards should overhang the bearing ledger at each end at least 8" but not more than 12". Where overhang exceeds 12" the decking board should be wired down at both ends to prevent tilting.

(g) Decking boards must be free of oil and grease and kept free at all times.

(h) Ladders should be installed in best position for climbing and exit.

(i) Before beginning job worked from scaffold, check all exits possible, in case a quick descent has to be made.

PRACTICES: The following practices are considered as precautionary in nature a[illegible] it is recommended they be observed.

(1) Avoid walking on pipe lines whenever possible. Major jobs of work should not be done while standing on lines or fittings.

(2) Avoid walking on asbestos or transite roofs, on defective roofs, and on insulated lines.

(3) Keep clear of suspended loads wherever and whenever hoisting is being done.

(4) When lifting, make full use of the leg muscles, keep the back as nearly upright as possible and avoid twisting while lifting. Get help with heavy loads.

(5) When working with or around welding operations, secure and use safety glasses (goggles) with dark lenses. These may be obtained from the Tool Room. Never look directly at electric or acetylene welding rays. Reflection of electric arc off light colored (aluminum) surfaces can cause flash burns.

(6) All excavations of any kind in any area where employes are likely to walk must be either refilled, covered, fenced or roped off and warning flashers used at night.

(7) Leather gloves should be worn while fabricating pipe and fittings with welder.

(8) When using a come-a-long for lifting, arrange rigging so come-a-long is in a safe reach for operating. If rigging is too far above head, use a chain fall instead of a come-a-long.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: July 1, 1970

ITEM NO. A-6 SUBJECT: DEPARTMENTAL AND PLANT HOUSEKEEPING

DEFINITION: The term "housekeeping" is generally used throughout the petroleum industry and refers to the continuous maintenance of clean, neat and orderly conditions within a refinery. Lack of good housekeeping practices contributes to safety, fire and health hazards detrimental to all employes.

RESPONSIBILITY: It is the responsibility of each supervisor and employe in the Pipe Department to maintain the department and assigned work areas in conformance with Refinery Housekeeping Practices.

PIPE DEPARTMENT PRACTICES: In addition to the general practices applicable to every employe in the refinery, there is a number of "Housekeeping Practices" which are emphasized here and which must be observed by everyone in the Pipe Department.

(1) All roadways, passageways, aisles, stairways, platforms, etc., shall be kept free of unnecessary tools, materials and debris. Clean up after every job.

(2) Oil or chemically damaged scaffold decking boards should be promptly removed from service and tagged for destruction in order to prevent re-use.

(3) Any oil or chemical spilled on stairways, platforms, scaffold decking, walkways and similar areas where persons must work or walk should be cleaned up immediately or sand applied to prevent slips and falls.

(4) Waste material should not be allowed to accumulate but should be cleaned up and arrangements made to have it hauled away. Salvageable materials should be neatly piled until they can be hauled to the Plant salvage area.

(5) Never block access to fire fighting equipment with equipment or materials.

(6) If it is necessary to leave a job before clean up can be completed, advise the Pipe Foreman so arrangements can be made to reschedule clean up. It is the responsibility of every Pipefitter, after completing a job, to leave the work site in a clean, orderly and safe condition unless specifically directed otherwise.

(7) Area around pipe machine should be kept free of pieces of pipe, blocks, chips or shavings. Oil drippings should be kept cleaned up. Either Super-Dri or sand should be used to prevent slips and falls until clean-up can be effected.

(8) All tools and equipment should be cleaned and returned to their proper storage area. Broken tools should be tagged and sent to Main Tool Room for repair.

TEXACO INC.
PUGET SOUND PLANT

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DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: July 1, 1970

ITEM NO. A-7 SUBJECT: DEPARTMENTAL LUBRICATION

LOCATION AND STORAGE:

(1) Oils are delivered from the Storehouse in 5 and 55 gallon drums and dispensed through a spigot. Grease is delivered from the Storehouse in 5 pound and 35 pound metal containers. Climax or stick grease is stocked in the Storehouse and may be found in Lube rooms on operating units. Pipe Thread Dope, Graphite and thread cutting oil will be found at the Portable Tool Room or at the Storehouse. Teflon tape is provided by Craft Supervisors.

GRADES AND USES:

(1) When operating pneumatic (air) tools, such as Impact Motors, Knocker Motors, Portable Power Saw, Box Pressure Pumps, etc., use Regal C in the oiler.

(2) Graphite is used on bolts, flange faces where composition gaskets are used, valve stems, and pipe threads.

CAUTION: DO NOT USE THREAD DOPE ON DRINKING WATER OR INSTRUMENT AIR PIPING.

(3) Marfax 1 or 2 is used on the drilling bit of the pressure tap machine.

(4) Climax (any grade) is used to hold exchanger head gaskets in position while installing heads.

(5) Use a thick mixture of Universal Gear Lubricant HD 90 and Flake Graphite on heater bends, biscuits or where you may have extreme heat.

CAUTION: NEVER USE PIPE OR THREAD DOPE ON HEATER BENDS OR BISCUITS, OR WHERE YOU HAVE EXTREME HEAT.

(6) Cutting oil is used with the portable power hack saw, when cutting threads with stock and die, with the portable pipe machine, and pipe machines in the Pipe Shop.

METHODS OF APPLICATION:

(1) Tail hose with built-in oiler are provided when operating pneumatic tools. If none are available, install an oiler in the air supply which are available at the Portable and Main Tool Rooms.

CAUTION: CHECK THESE OILERS REGULARLY TO SEE THAT THEY ARE FULL AND OPERATING PROPERLY.

(2) Lubricators are installed on all air-operated pressure box pumps. Check lubricator before and during operation.

(3) Threads and gasket face should be wire brushed to remove all dirt and grit before applying thread dope.

(4) Marfax 1 or 2 should be applied to drill bit on pressure tap machine to serve as a lubricant during drilling operations.

(5) Before applying climax stick grease to exchanger heads, the gasket seat should be wire brushed and wiped clean with a rag. Any small particles of rust or scale left under a gasket may cause leaks.

(6) A mixture of graphite and Gear Lubricant should be applied with brush to threads of bolts used in all types of services. When heat comes in contact with this mixture, it burns the oil out leaving the graphite. When heat comes in contact with pipe or thread dope, it burns the liquid out leaving a hard finish, making it very difficult to remove nuts.

(7) When cutting threads with a stock and die, use an oil can to apply cutting oil at regular intervals. This lubricates cutting edge of die helping to cut smooth threads.

(8) Portable and shop pipe machines have built-in cutting oil reservoirs and pumps to lubricate dies while cutting.

(9) One wrap of teflon tape is used on threads of drinking water lines rather than thread dope. If dope is used, it may get into lines a cause a bad taste in the water. Use one wrap of teflon tape on piping of instrument air. The use of thread dope may cause clogging and damage to instruments.

TRAINING DETAILS

DEPARTMENT: PIPE   DATE: July 1, 1970
CLASSIFICATION: PIPEFITTER (TRAINEE)

ITEM NO. A-8   SUBJECT: CARE, PURPOSE AND USE OF HAND AND PORTABLE POWER TOOLS

CARE OF HAND TOOLS:

(1) Each Pipefitter is assigned a tool box of hand tools, these tools should be kept clean and orderly at all times. If at any time a tool becomes broken or damaged, it should be returned to the Main Tool Room. A broken tool slip has to be signed by the Pipefitter before a tool is replaced.

(2) Tools checked out of the Tool Rooms should be cleaned and returned upon completion of job. If tool is broken or damaged notify toolkeeper so tool may be repaired or a replacement tool can be ordered.

PURPOSE AND USE OF HAND TOOLS:

(1) Knowledge of the proper tools to use and how to use them is necessary to good handling of pipe fittings. Wrenches are used on practically every pipe job, and if used improperly can cause serious damage to materials as well as tools and personnel. Be sure to select the right type and right size tool for each piping or maintenance job.

(2) Steam, air, water and pressure hose are also considered as tools for pipefitters. Hose should be coiled up when not in use and kept in their designated locations. In some cases, hose may be permanently left attached at some locations (steam and water). Hose for air and water are tested to withstand maximum plant air pressure, and may be used interchangeably. Hose for air and water are equipped with Chicago couplings and should never be used for steam or pressure testing service. Steam hose is a specially constructed, wire-wound hose designed to withstand both heat and pressure. Pressure hose is designed to withstand high pressures, and used with pressure pumps when testing lines or vessels for leaks.

CARE OF PORTABLE POWER TOOLS:

(1) Portable power tools are available for many different types of jobs. These tools must be lubricated at all times when in operation. Never drop or lay these tools in oil or where water can get on them. Impact guns are designed for only so much load, so use the proper size for the size of nut to be broken loose. Use an impact in short bursts from 10 to 15 seconds. Portable pipe machines should be kept covered at all times when not in use.

(2) All pneumatic portable power tools are equipped with a fine wire mesh filter screen, to filter out small particles of dirt and rust to keep them from entering the mechanism. Before operating, blow out hose with air to clean it.

PURPOSE AND USE OF PORTABLE POWER TOOLS:

(1) Portable power tools can save a Pipefitter a lot of hard manual labor if used properly. They are designed to only carry so much of a load, so select the proper size tool for the job.

CAUTION: NEVER TRY TO REPAIR A POWER TOOL IN THE FIELD. IF THEY ARE WORKING IMPROPERLY, SEND TO MAIN TOOL ROOM FOR REPAIR AND INFORM TOOLKEEPER.

SAFETY:

(1) Do not use defective tools.

(2) "S" wrenches or light wrenches of any kind shall not be struck with a hammer or maul. Only "striking" tools may be hammered.

(3) The use of two open end wrenches to secure extra leverage by one into the jaws of the other is a dangerous practice and is prohibited. The extra leverage may cause the wrench to break or spread and results in an injury. Where more leverage is needed, get the proper type and size of wrench.

(4) When using a wrench, be sure it fits properly and in applying force, push or pull evenly and steadily, otherwise, a sudden jerk or slip may cause injury.

(5) Before using any pneumatic (air) tool, inspect the hose couplings and hose connections to see that they are safely attached and in good condition. Chicago couplings should be wired.

(6) Chain hoists and chain blocks should never be used to hoist any load greater than its safe working capacity. Inspect carefully before each use to assure it is in good condition.

(7) Carry and handle tools in such a manner that they are not liable to cause injury to yourself or others. Be especially careful that sharp-edged tools are not carried in the pocket or in a manner where the arms or other parts of the body may strike the tool.

(8) Tools should not be carried in the hand or loosely in the clothing while climbing a ladder or climbing onto a scaffold. Heavy tools must be hoisted or lowered by a line.

(9) The proper tools in good repair shall be used only for the purposes intended.

(10) Small tools, when not in use on elevated locations, shall be kept in tool box, and large tools shall be placed in position where there is no danger of their being kicked off or causing a tripping hazard. Upon completion of a job, tools shall be removed from elevated locations. NEVER THROW TOOLS OR MATERIALS FROM ELEVATED LOCATIONS.

(11) Grinding wheels shall not be operated at speeds greater than their designed rating - check to make sure that proper wheel is attached to tool. Examine wheel for cracks - discard wheel if cracked.

(12) Air or electric driven wire brushes shall be examined before each use to be sure they are in safe operating condition. Wear goggles when using to protect eyes against small flying particles of wire. Face shields and rubber clothing may also be needed.

(13) Before using any pneumatic (air) tool that requires lubrication, check to make sure oiler is operating properly and filled. If no oiler is furnished with tool, install an oiler in air supply to the tool. Oilers should be checked and refilled often during working operations.

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PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE

DATE: July 1, 1970

ITEM NO. A-9 SUBJECT: PROCEDURES FOR OBTAINING AND TRANSPORTING TOOLS, MATERIALS AND EQUIPMENT

TOOLS AND EQUIPMENT:

(1) Tools will be in Pipe Shop Tool Storage Room. If additional tools are needed you get them from the Main Tool Room in the Machine Shop. You must sign a charge out slip, do the job and return the tool to the Tool Room.

(2) Equipment may be located in the following areas:

Warehouses 1-2 or 4
East of Warehouses in storage area
South of Warehouses in storage area
West of Machine Shop

STOREHOUSE:

(1) Each Pipefitter is authorized to order and receive material from the Storehouse. Before calling for or receiving material, compile a list giving the name, size, weight, type of material, and give estimate number, Bill of Material number or type of equipment and unit to be used in.

METHODS OF TRANSPORTING:

(1) Call Trucking Department giving type of material or equipment to be hauled, where equipment or material is located and where it is to be hauled. Also give type of trucking equipment needed.

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DEPARTMENT: PIPE
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ITEM NO. A-10 SUBJECT: LOCATION AND USE OF UTILITIES

USE:

(1) A utility is a form of energy used to get work done. At Puget Sound Plant, utilities include steam, electric power, service water and compressed air. These utilities amount to approximately 40% of the total cost to operate the Plant.

(2) A Pipefitter uses these utilities almost every working day. Compressed air is used for pneumatic tools, box pumps and cleaning tubular equipment. Steam is used to gas free lines, vessels, clean oil spills, unplug lines and in some cases to pressure for system tests on units. Service water is used for pressuring lines, vessels, system tests, drilling and cleaning tubular equipment. A Pipefitter uses electric power for light to work inside towers, vessels and for operating some types of portable power equipment.

CAUTION: ALWAYS USE A 32 VOLT LIGHT WITH VAPOR PROOF COVER WHEN WORKING IN TOWERS OR VESSELS.

(3) It is each Pipefitter's duty to see that utilities are not wasted.

LOCATION:

(1) In every operating unit and designated spots throughout the refinery, utility stations are mounted on stanchions. In most cases, service water, air and steam are mounted together. Steam lines are insulated to prevent personnel from burning their hands. Water lines are usually 1-1/2" pipe and are marked with a sign "Service Water Do Not Drink." Air and water lines will have a Chicago fitting attached. Electricity is mounted separately, 440 volt tie-ins are also provided for electric welding machines. Utilities are also mounted in all the working shops. The one used most by Pipefitters is on the North end of the welding shop, used for cleaning tubular equipment.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER TRAINEE

DATE: July 1, 1970

ITEM NO. A-11

SUBJECT: DEPARTMENTAL STANDARDS OF CRAFTSMANSHIP

A pipefitter as directed, performs on his own responsibility all types of pipe and plumbing work necessary to install, repair and maintain pipe and plumbing installations and similar equipment in the shop or in the field.

May direct the work of others assigned to the job. Cooperates with others in the performance of duties assigned.

Performs customary rigging incidental to the work of the department.

Observe safety instructions applicable to work performed and for adherence to general safety instructions applicable to all plant employes. Also, while actively directing others, is responsible for their adherence to such safety instructions.

May be assigned to plant fire fighting organization, attend fire drills and assist in or direct fighting of fire, as necessary.

May be required to instruct or train employes or others in the work of his craft.

Should have ability to understand verbal and written orders and issue instructions accurately and clearly for their proper execution.

Requires a general knowledge of company standards, requirements, specifications and common practices for pipefitting work in order to perform duties and jobs in a standard manner. This would include the proper use of valves, fittings, gaskets, bolts and pipe dope; maintaining proper elevations, knowledge of when to use screwed or welded pipe, flanges or unions and a multitude of common practices that are standard to Texaco and Puget Sound Plant. This refers to knowledge gained only through experience and might enable a pipefitter to perform a job without benefit of prints.

Requires a general knowledge of conditions under which equipment operates and plant locations of such equipment.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER TRAINEE

DATE: July 1, 1970

ITEM NO. A-12

SUBJECT: PROCEDURES FOR OBTAINING WORK PERMITS

a. PERMITS

(1) Before any type of equipment can be disassembled or blinded, a Safety or Hot Work Permit (whichever the job requires) must be obtained.

b. SCHEDULED DOWN PERIODS

(1) A permit list is turned in to operations each afternoon by a down period Supervisor for the work permits required the next day. (Note: This does not preclude the craftsman calling to his supervisor's attention that a permit may be required on a specific job.)

(2) If a work assignment arises during the shift that requires a permit, and the permit has not been issued, the Pipefitter should contact the Supervisor in charge and advise him accordingly.

(3) A permit is usually hung on equipment to be worked on during the unit down period and Operators will post the permits. All requirements noted on the permits should be carefully followed.

c. OPERATING UNITS

(1) The Stillman should be contacted for permits to work on units in operation. Explain the work to be performed and the equipment that is to be worked on. Conditions on permits must be followed.

d. TANK FARMS

(1) The Operating Supervisor in charge should be contacted and advised of work to be performed. If equipment or material is required, a Hot Work Permit should be requested for Transportation to enter firewalls around tank in order to make material delivery.

NOTE: All permits should be posted in open sight for inspection.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER TRAINEE

DATE: July 1, 1970

ITEM NO. A-13

SUBJECT: IDENTIFICATION, PURPOSE, CHARACTERISTICS AND USE OF MATERIALS

a. VALVE IDENTIFICATION

(1) Valves are listed by code numbers that identify the type, pressure rating, and variation in body, material and trim. A common type valve used in listed as V-100F1.

(a) In this example, the "V" represents valve and on blueprints will be prefixed by the nominal valve size. (2-V-100F1). 2 would be a 2" valve.

(b) The number 100 refers to the type of valve.

(c) The second letter, F, indicates the pressure rating.

(d) Listed below is a table showing the type classification given valves which identifies the large number in the code:

CODE CLASSIFICATION BY TYPE
100-299 - Gates
300-499 - Globes
500-599 - Angle
600-699 - Checks
700-849 - Cocks
850 - Miscellaneous

Note: 250-299; 450-499; 550-599; 650-699; 800-849; 900-944 covers TTCO. Ball Joint Facing.

(e) Listed below is a table showing the pressure rating of the valve, identifying the second letter in the code:

A - Iron and Brass below 125#
B - 125# Iron and Brass
C - 150#, 175#, 200#, 300# and 400# Iron, Brass and Semi-Steel
D - 250# Iron, Brass and Semi-Steel
E - 150# Steel
F - 300# Steel
G - 400# Steel
H - 600# Steel
J - 900# Steel
K - 1500# Steel
L - 2000# Steel
M - 2500# Steel
N - 3000# Steel
R - 300# to 1500# Ammonia Valves

(2) To identify V-100-F1

(a) The V always indicates a valve.

(b) The number 100 indicates a gate valve.

(c) The letter F shows the pressure rating to be 300# Steel.

Note: Sub-classifications under any one item number cover the variation in body material, trim facings, and other features. To identify this material in valves, reference must be made to the "Valve Specifications Manual" for details.

b. PURPOSE

(1) Valves are most important to the piping system since their use singly or in combination provides the means for controlling flow of fluids in the system. This unit of instruction covers valves most commonly used in refinery piping installations and the particular purposes for which they are best suited.

(2) The sole purpose of valves, of whatever type they may be, is to control the flow within the lines. Some of these valves are designed to stop the flow, that is, they should be used fully open or completely closed. Others are designed to check or to regulate, and some are designed to open automatically when the pressures reach a certain predetermined value, thus relieving the pressure in the vessel or line before it becomes dangerously high.

c. GLOBE VALVE

(1) Globe valves have a single body seat ring which is screwed into a web or seat that is cast into the body. Fluids change direction when flowing through a globe valve. This seating construction increases resistance to, and permits close regulation of, fluid flow.

Note: A simple rule to remember about globe valves - flow goes in the bottom and out the top.

(2) The main purpose of a globe valve is to regulate a desired flow of liquid.

(3) Globe valves are used as a bypass valve on regulator systems.

Example: If a regulator is not operating properly, the bypass can be used to manually control the flow while the regulator is being repaired.

(4) Globe valves should be placed in the lines in such position that the pressure will be against the bottom of the disc when the valve is closed. This relieves the bonnet and the packing of the working pressure when the valve is in a closed position.

(5) CAUTION: It is dangerous to repack a globe valve under pressure in hot or corrosive service for the following reasons:

(a) Foreign matter may become wedged between the flat faces of the disc or body seat. In either case, there will be a pressure against the bonnet, tending to blow the packing out of the stuffing box when the gland is removed.

d. GATE VALVE

(1) Fluids flow through gate valves in a straight line which offers minimum resistance to flow and reduction of pressure drop. A wedge-shaped disc operated by a hand wheel moves up and down at right angles to the flow and when in the down position fits snugly against two seat faces to shut off flow.

(2) Gate valves are best suited for services that require infrequent valve operation and where the valve is kept either fully open or fully closed. Ordinarily they are not suitable for throttling service since close regulation of flow is difficult and velocity of flow against a partly opened disc may cause damage to seating surfaces and severe wire-drawing errosive effects in the disc.

CAUTION: For reasons of safety, these valves should never be repacked under pressure, either wide open or completely closed.

e. NEEDLE VALVE

(1) Needle valves employ the same general construction as do globe valves with the exception of the discs and seats. Normally small, screwed needle valves are used.

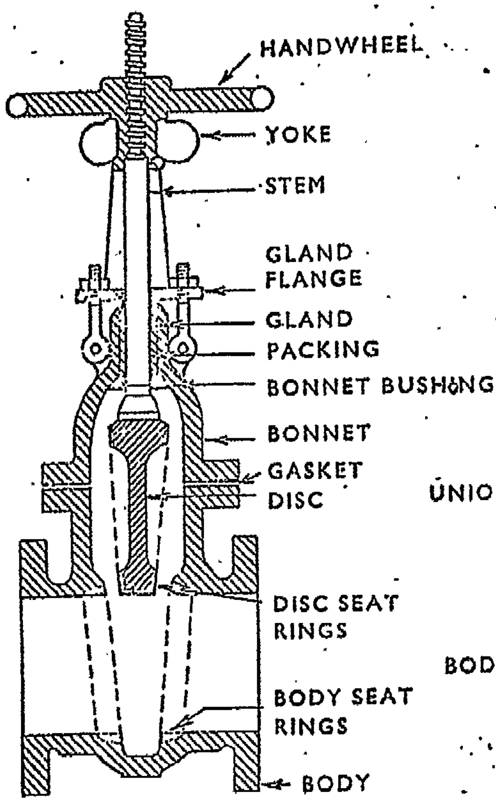
(2) The disc and seat of a needle valve have a long gradual taper which permits a very close control of the flow. They are recommended where close control is essential.

f. CHECK VALVES

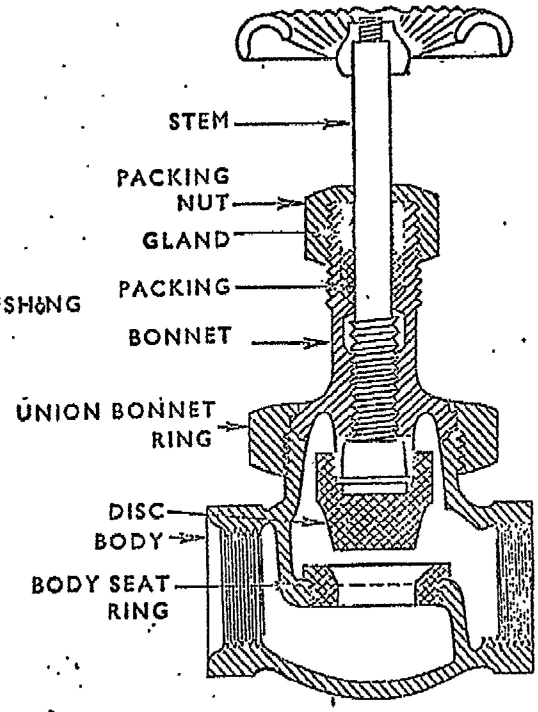
(1) Fluids can flow through check valves in one direction only, preventing back-flow when desired. There are only two basic types of check valves, the swing check and the lift or ball check.

(2) The swing check type has flow characteristics similar to that of gate valves and is generally used in conjunction with gate valves for this reason

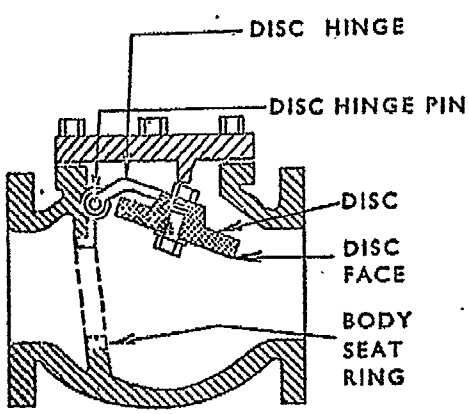
(3) The same applies to the flow characteristics and operating principles of the lift or ball check valve as compared to globe valves. In lift check valves. flow moves through the body in a changing course as in a globe valve.



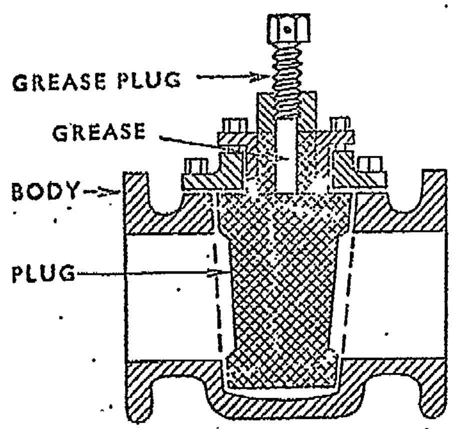
GATE VALVE



GLOBE VALVE

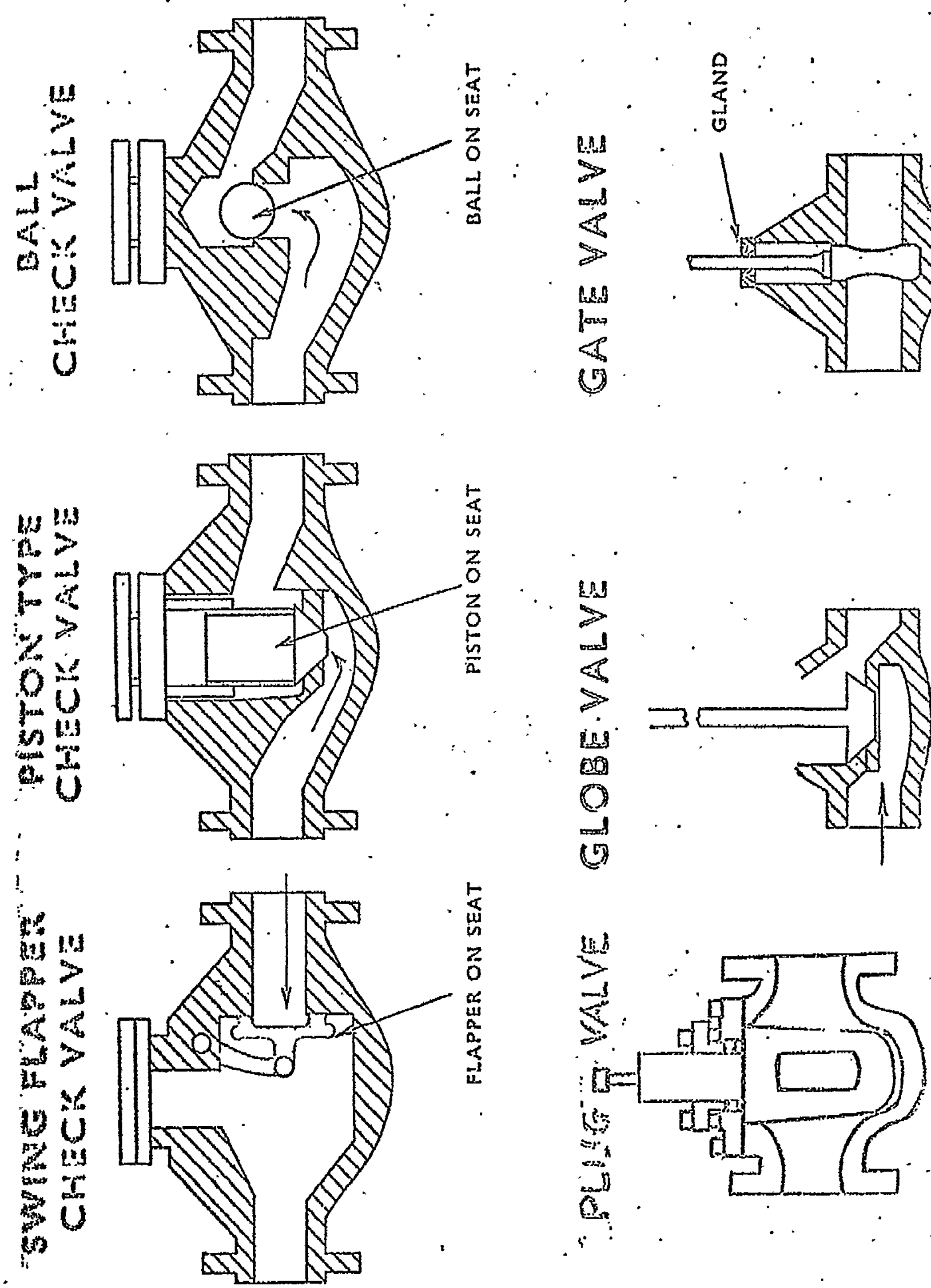


CHECK VALVE



COCK VALVE

TYPES OF VALVES


BALL CHECK VALVE
BALL ON SEAT
PISTON TYPE CHECK VALVE
PISTON ON SEAT
SWING FLAPPER CHECK VALVE
FLAPPER ON SEAT
GATE VALVE
GLAND
GLOBE VALVE
PLUG VALVE

(4) In both types, flow keeps the valve open and reversal of flow or gravity will close them automatically.

g. PLUG VALVES

(1) Lubricated cock type plug valves, using insoluble lubricants to insure ease of operation, tight sealing and resistance to wear and corrosion, are used for many services throughout the plant. They are the most satisfactory valves available for handling of gritty fluids and many other destructive, errosive, and corrosive industrial and chemical solutions.

(2) Since the valve is opened and closed by rotation only, the movable valve member and the seating surfaces are self-protecting and self-cleaning.

h. HAMER VALVES

(1) Hamer valves have an attached figure-8 blind, which acts as the flow stopping element of this valve. When reversing the blind, open valve wheel in a counter-clockwise motion, reverse blind and tighten valve wheel.

(2) This type of valve is used where a quick removal of or installing of a blind is necessary.

CAUTION: BE SURE BLOCK VALVES ARE CLOSED ON BOTH SIDES OF A HAMER VALVE BEFORE REVERSING THE BLIND.

i. RELIEF VALVES

(1) To avoid damaging positive displacement pumps and to prevent the over pressuring of lines, towers, vessels and other equipment, relief valves are provided. These return the flow to a reservoir, to the pump's suction or to the flare line. When the operating pressure equals the valve pressure setting, the relief valve opens and discharges enough flow to hold the pressure at the predetermined level.

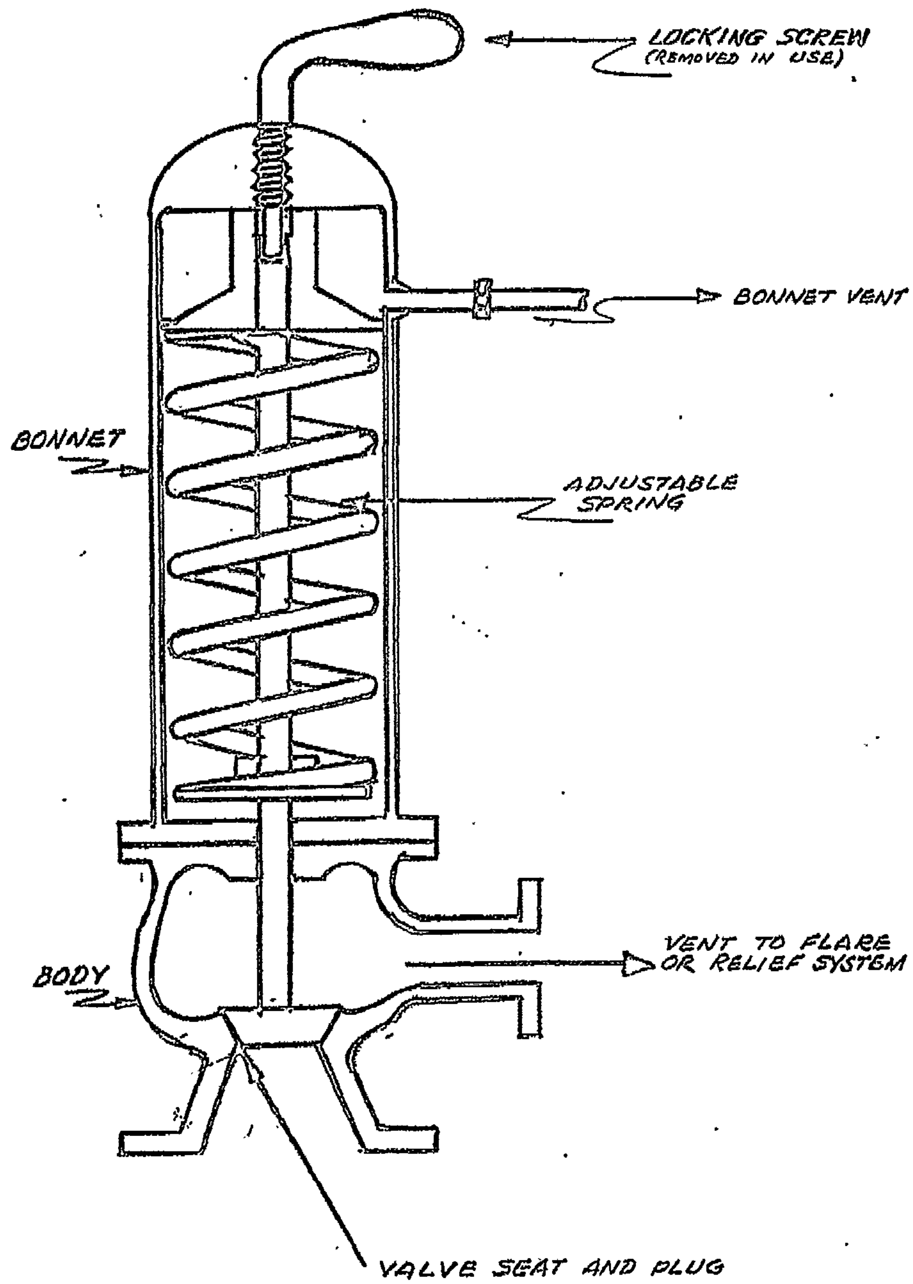
(2) Relief valves must be taken out of service at regular intervals and sent to valve shop to be reset and repaired if necessary. (Removal determined by Inspection Department).

(3) Another type of relief valve is a vacuum breaker. It is used on tanks or vessels where a vacuum could be pulled. In case a vacuum is pulled, these valves open to let in air from the outside.

j. SLIDE VALVES

(1) The mechanism of the slide valves at the FCCU is maintained by the machine department.

(2) These valves are hydraulically operated but can be manually operated in case of emergency.



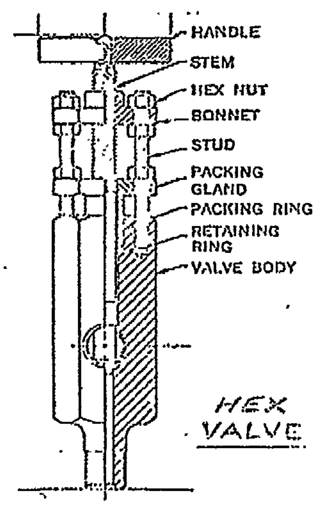
PRINCIPLE OF THE RELIEF VALVE

(3) A Pipefitters job on these valves is to disassemble, reassemble piping and flanges.

(4) The line side of most of these valves is connected with van-stone flanges and requires a corrugated iron gasket. It is necessary at times to crawl up into the larger lines to make sure the gasket is straight when reinstalling these valves.

k. HEX VALVES

(1) Hex valves are used mostly on instrument piping. They are very compact, taking very little space to install. Hex valves can be purchased with Pulsation Dampeners built in for use with pressure gauges.



HEX VALVE

1. IDENTIFICATION OF PIPE AND TUBING

(1) Piping classification is determined by three factors: size, weight (or schedule) and material.

(a) Size of piping has to do with the diameter.

(b) Weight is determined by wall thickness.

(c) Piping is made in a wide variety of materials for an equally wide variety of services. These materials range from clay soil pipe through various metals and alloys to plastics and fiberglass.

(2) Pipe sizes up to and including 12" are known by the inside diamter (I.D.) which is referred to as the "nominal pipe size." Above 12" the pipe size is determined by the outside diamter (O.D.).

(3) The outside diameter of all classes of pipe, regardless of wall thickness, always remains the same. The added wall thickness is always gained on the inside and therefore reduces the inside diameter of the pipe.

(4) Reference tables vary in classifying pipe. Some refer to wall thickness as being standard, extra heavy, or double extra heavy; while others use schedule numbers such as Sch. #40, Sch. #80, or Sch. #160. Standard pipe up to 10" inclusive, and Sch. #40 pipe have the same dimensions. This is also true of extra heavy and Sch. #80 pipe up to 8" inclusive.

(5) Double extra heavy pipe has no corresponding schedule number. In larger pipe sizes, the schedule number will vary from Sch. #10 to Sch. #160. By using schedule numbers, a more accurate classification can be given on wall thickness.

(6) In specifying pipe size, it is correct to refer to size as being the nominal pipe size. Wall thickness is referred to as the schedule number.

EXAMPLE: Three-inch pipe with a wall thickness of .216" would be classified as 3" Sch. #40 pipe.

NOTE: Welded fittings are also classified by schedule number and should always correspond with schedule number of pipe being used.

m. PURPOSE AND USE

(1) Piping used in a refinery is purchased in several types of material and various combinations and weights.

(a) Cast Iron - Soil pipe generally used for sewage and similar service. It is usually equipped with some variation of the bell and spigot end connection.

(b) Carbon Steel - Used primarily for field and unit installations where a low corrosion effect is anticipated.

(c) Alloy Steel (Chrome and Stainless Steel) - Used for piping installations with a high incidence of corrosion, high pressures and extreme heat.

(d) Galvanized - Used for drinking water and instrument air installation.

(e) Brass - Used for connections on wash basins and some types of instruments.

(f) Plastic - Used in chlorine and demineralizer service and some water service.

n. TUBING -

(1) Tubing is used frequently in pipe installations where high temperature and pressure are present,

(2) The classification of tubing differs from that of pipe sizes. Tubing size refers to the outside diameter and wall thickness.

EXAMPLE: Tubing measuring 3-1/2" outside diameter and having a wall thickness of 1/2" would be classified as 3-1/2" X 1/2" tubing. This wall thickness may also be referred to as "gauge."

(3) There are some common sizes of tubing used that correspond with the outside diameter of standard pipe sizes and can be used with pipe fittings.

(4) Listed in the following table is a comparison of tubing size and corresponding pipe size:

	SIZE	O.D.
Pipe	1-1/2"	1.900
Tubing	1-7/8"	1.875
Pipe	3"	3.500
Tubing	3-1/2"	3.500
Pipe	4"	4.500
Tubing	4-1/2"	4.500
Pipe	6"	6.625
Tubing	6-5/8"	6.625

o. FLANGES

(1) Many different types of flanges are used in refinery piping and several kinds of materials are used in flanges. Flanges are installed in lines for future construction, blinding when necessary to steam and repair, installing new block valves, running jumpovers from one line to anotner, and easy disassembling for maintenance purposes, etc.

(a) Flat Face - Has a gasket seat the entire surface of the flange, used mostly on pumps. May be either iron or steel.

(b) Raised Face - Has a raised gasket face approximately 1/16" above the surface of the flange. This is the type of flange most commonly used in the refinery.

(c) Ammonia - Ammonia flanges are a type of tongue and groove flange requiring a gasket for seating. These flanges come in three different shapes, oval, square and round. They must be purchased in pairs, one flange having the tongue face, the other having the groove. These flanges have a wide application in high pressure ammonia refrigeration service.

(d) Tongue and Groove - Similar to an ammonia flange. Gaskets must be used in the seating surface. Must be purchased in pairs, one flange having the tongue face and the other the groove face.

(e) Ring Joint - These are weld flanges and come in many different weights and combinations of materials. Metal rings are used for gaskets and come in two shapes, an oval ring and an octagonal ring. These Flanges are used in conjunction with high temperature, high pressure and gases. Each flange has an R number stamped on it. This designates the size and type of ring gasket required.

(f) Orifice - These flanges have holes drilled through from the outside to the inside opening, and tapped for pipe thread. Lines are run from these taps to instruments. Orifice plates are installed between flange to create a high and low pressure side.

(g) Reducing - These are flanges to reduce from a larger to a smaller size line. Used for reducing line size, end lines for clean out or pressure testing and taking samples.

(h) Screwed - Screwed flanges are drilled and tapped to pipe sizes. Used in low pressure service.

(i) Weld Hub - Weld hubs are constructed with a short nozzle reduced to pipe sizes and weights. They butt against the end of pipe for welding. Flanges are available in many weights and types of material.

(j) Slip-On - These flanges are constructed to slip over the end of pipe, then back-welded inside and out. These flanges are also available in many weights and types of material.

Note: It is advised that slip-on flanges be used when welding with pipe plugs.

(k) Van-Stone - Van-Stone flanges are a type of slip-on flange, but have no gasket face. The end of a line has a gasket face installed and the van-stone flange serves as a tightening agent to bring two gasket faces together.

p. GASKET PURPOSE

(1) The principal purpose of gaskets is to form a seal to prevent leaks into or out of vessels, pipeline, vacuum or pressure pumps, compressors, etc.

q. GASKET USE

(1) Gaskets are used between non-working parts such as the openings in vessels, between flanges on pipeline, or the head and block on an engine or pump. In general, gaskets are used between the fixed parts of any vessel or line that must hold either a pressure or a vacuum without leaking between the joints.

r. GASKET MATERIAL

(1) Gaskets are made from a great many kinds of materials. They are made from metals such as soft steel, copper, lead, monel, stainless steel and aluminum. They are made of natural or synthetic rubber, plastics, such as neoprene, asbestos, cotton, flax rayon, paper, leather, or a combination of these materials bonded together.

(2) Gaskets are made in a great many sizes and thicknesses. They are made to fit the openings where they are to be used or they may be cut to fit from sheet material. All types of soft gasket material are manufactured in sheet form.

(a) Composition - More commonly known as Garlock are used on lines or vessels with low temperature and pressure. 1/16" thick material is normally used, but 1/8" thick material is provided when required. Full face composition gaskets are also used when required.

(b) Ironclad Asbestos - These gaskets are used on joints and equipment with high temperature. This type of ironclad gasket is asbestos filled. These gaskets are used on some types of exchangers. (Flat heads, channel heads, floating heads and cover heads.)

(c) Oval Ring - These gaskets are made of metal and are used with ring flanges only. Each ring flange has an R number stamped on it designating the size and type required. They are oval in shape.

(d) Octagonal Ring - These gaskets are made of metal and are used with ring flanges only. They are octagonal in shape.

(e) Flexitallic - Has a solid metal ring on the outside with an inter-ring constructed of asbestos with metal rings separating the asbestos rings. These are used on lines or equipment with high temperature.

(f) Aluminum - These gaskets are made of soft aluminum and used on lines and equipment in refrigeration service.

(g) Ball Joint - These gaskets are made of metal, and used with ball joint flanges. Similar in shape to an oval ring. Not commonly used in newer constructed operating units.

(h) Corrugated Iron - Has a corrugated appearance on surface of gasket. Made of soft iron and used on lines and equipment with high temperature.

(i) Copper - Used on some types of pumps and compression heads.

(j) Soft Iron - Used on some types of exchanger heads with high temperature and pressure. Also used as bonnet gaskets on some types of valves.

(k) Rubber - Used on sight glasses for sealing, and also in some types of ammonia flanges.

(l) Teflon - Used as bonnet gaskets on valves in water condensate service.

s. PIPE FITTINGS, PURPOSE

(1) Pipe fittings are used to join lines from one given point to another in order to control flow of products.

t. TYPES AND USE OF FITTINGS

(1) Unions

(a) Most commonly used union in a refinery is the forged steel ground joint type.

(b) Socket weld unions are used when running steam tracing lines.

(c) Galvanized unions are used on drinking water and instrument air lines.

(d) Orifice unions are used to control or reduce flow.

(2) Orifice Fittings

(a) Orifice flanges are used in conjunction with instrument to control flow of products. Orifice flanges come in many different weights, sizes, and types of material.

Note: Orifice flanges should always be drilled and tapped to proper size before installing.

(b) The diameter of the center hole in orifice plates is determined by the Power Department.

(3) Screwed Fittings

(a) The Storehouse stocks screwed fittings up to and including 2". Most weights, sizes and types of material are provided. Larger sizes must be purchased by special order.

(4) Pipe Repair Clamps

(a) Repair clamps are only used as a temporary means of repair for small leaks in lines. Rubber gaskets are provided with pipe clamps; use asbestos gaskets for temperatures over 215°F.

(5) Compression Fittings for Small Tubing

(a) Tubing fittings are provided in three types of material, steel, stainless steel and brass for copper tubing. Most fittings used at Puget Sound Plant are provided with ferrules or sleeves.

(b) Most types of tubing fittings are provided in the Storehouse; such as elbows (tubing to tubing or tubing to pipe), adapters (tubing to pipe), unions (tubing to tubing), tees, plugs and crosses.

Note: When using valves with copper tubing, brass should be used. (EXPLAIN WHY.)

(6) Tube Turns or Bends

(a) Coil boxes and some heaters are equipped with welded 180° tube turns, these should be equal weight or more as the tube or pipe weight and of the same type of material as the tube or pipe.

(b) Removed 180° bends on heaters are stamped with a number corresponding with the tube number. These numbers should be installed looking up.

(7) Flanged Fittings

(a) Most of the flanged fittings (excluding valves) used in this refinery are cast iron (elbows and tees.)

(b) Cast iron fittings are easily broken when not tightened evenly. Always tighten evenly around flange. If one bolt is pulled up too tight, it may cause a gap on the opposite side and subsequent leak or break in the flange.

(8) Nipples

(a) Nipples from an all thread up to 6" long in pipe sizes up to and including 2" are available in the Storehouse.

(9) Dresser Couplings

(a) These couplings make tight connections on steel, cast iron and other lines. Parts consist of two resilient gaskets, a steel middle ring and two steel follower rings which fit over plain-end pipe and are bolted together. Resulting joints absorb expansion, contraction, vibration and deflection.

(10) Victaulic Coupling

(a) Serves the same purpose as a dresser coupling. The lines to be joined have groove cuts in them near the ends to match the gripper parts of the victaulic coupler.

(11) Collars

(a) Pipe couplings are commonly known as collars and are used to join two lengths of pipe together. Collars are constructed of steel and are provided in pipe sizes up to and including 2".

(12) Machine Bolts and Stud Bolts

(a) Machine bolts are more economical to buy. These should be used when there is no high temperature or high pressure present. Machine bolts are threaded on one end only, the other end being upset into the form of a head.

(b) Stud bolts are threaded the full length for nut assembly on each end. These should be used when high temperature or high pressure is present. Most Bills of Material will specify which type of bolt is to be used.

u. THREAD AND SEAT DOPE

(1) Graphite and Oil

(a) A thick mixture of graphite and oil should be used for a lubricant when installing heater bends or biscuits. It is recommended that this mixture be used for bolts where extreme high temperature is present.

(2) Thread-Tex

(a) Thread-Tex should be used on bolts and gasket seats with low temperature. Since Garlock gaskets are only lubricated on one side; Thread-Tex should be be applied to assure easy removal of gaskets.

(3) Copaltite

(a) Copaltite is used on gaskets on flange or exchanger heads when leaks are very difficult to stop.

(4) Permatex

(a) Permatex #1 is used for forming a hard gasket.

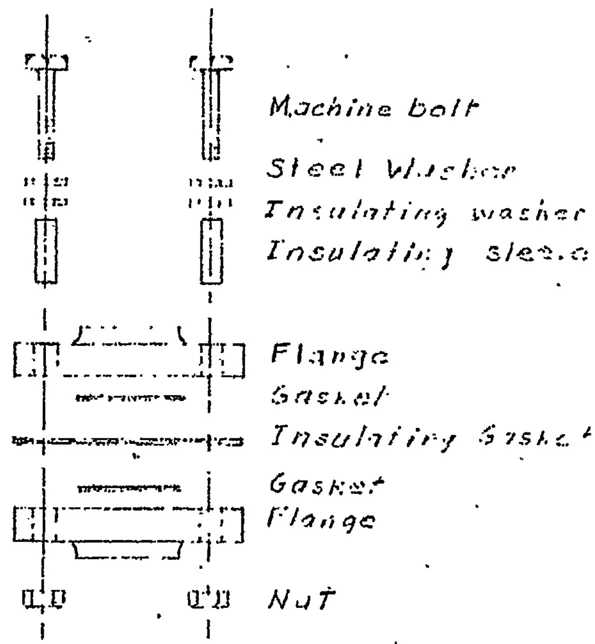
(b) Permatex #2 is pliable and will not completely harden. Used for sealing engineer's tape on tray sections in vessels and towers.

(5) Use of Proper Gaskets

The use of improper gaskets can be very costly if an operating unit has to come down for this reason. Remember that aluminum gaskets are used for refrigeration service, metal gaskets are used for high temperature and pressure. Garlock gaskets are used in low pressure and cool temperature service.

(6) Flange Insulation

Insulated gasket, sleeves, and washer sets are used to prevent galvanic corrosion caused by static electricity. They are installed as shown below.



TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: ALL
CLASSIFICATION: ALL

DATE: July 1, 1970

ITEM NO. A-14

SUBJECT: READ, INTERPRET AND WORK FROM BLUEPRINTS, SKETCHES AND BILLS OF MATERIAL AND REQUIRES A KNOWLEDGE OF SHOP MATHEMATICS

a. INTRODUCTION: The following material has been developed to give the craftsman a working knowledge of mechanical and construction drawings, elementary mathematics, Bills of Material and field sketching.

The craftsman in modern industry, regardless of his trade, must have the ability to study a blueprint or sketch and visualize the appearance of a finished job or object as well as the details of its construction. The necessity of taking precise field measurements and making accurate and legible field sketches is also an important part of the craftsman's work.

Practically everything that is constructed in a refinery today originates with a drawing or sketch along with a Bill of Material.

It is essential, then, that each person thoroughly understand every detail of a blueprint or sketch, and it's care and preparation, to easily read and interpret them.

b. FUNDAMENTALS OF READING AND INTERPRETING BLUEPRINTS AND SKETCHES:

(1) Blueprints - what they are: A blueprint is the reproduction to scale of a drawing which has been prepared by the engineer or draftsman to provide the workman with a description of the shape and size of an object, and other details essential to its construction, in such a form as to be easily recognizable by anyone familiar with a blueprint. Blueprint is actually a misnomer, as they may be black and white, brown and white, or blue and white. At Puget Sound Plant, the prints used are technically not blueprints. However, blueprint or print is a commonly accepted term for both types of reproductions.

Blueprints are actually the language of modern construction. They provide an excellent means whereby the engineer can transmit his ideas, and explain to the craftsman the details of what he wants accomplished.

The drawings made by an engineer in some other country, or in some other section of this country, or in some industry, other than the petroleum industry, could be followed by any one of you who is familiar with prints made by Texaco, Inc. engineers. The only difference might be in the unit of measurement used, such as the metric instead of feet and inches, and in the use of certain symbols.

(2) Use in Industry by Craftsmen: A print given a craftsman should be an accurate working drawing of an object and should show all the information necessary for the craftsman to perform the job in question. It is essential that the craftsman read every note and symbol on the blueprint.

The blueprint is an exact copy of a working drawing on file in the Engineering Department, and by following every note and detail exactly as shown on the print, he is protected in case of errors. However, if he checks each detail accurately he may find the error and call it to the attention of his supervisor and prevent possible improper work. In the case he has followed the blueprint accurately and an error has been made, the craftsman cannot be held responsible for a drafting room error.

(3) Drawing Paper and Sizes: To better understand prints and their origin, it is well for the craftsman to know more about them. The engineer or draftsman, in undertaking the preparation of plans for the construction of some object, makes what is known as a working drawing on thin white paper, or a high grade of cloth which has been starched and treated until it is transparent.

Paper is used only on temporary drawings or where permanent records are unnecessary. For example, simple sketches of some minor change in piping. Cloth is generally used where it is necessary to make permanent drawings to be retained for years.

Prints and drawings are usually made in certain standard sizes. At Texaco, these sizes are normally identified by a 'letter' preceeding the drawing number as well as by actual measurement. A 'D' size drawing is 22" x 38", a 'C' drawing is 17" x 22", a 'B' size is 11" x 17" and an 'A' drawing is 8-1/2" x 11". Sketches are drawn on 8-1/2" x 11" sheets. These sizes are not compulsory, however, the craftsman must work with whatever size drawing is best suited for a particular job.

(4) Making the Blueprint: In making a blueprint the working drawings, whether made on paper or cloth, are then used in much the same manner as a negative is used to make a finished photograph.

The blueprint paper regularly used is yellow-green on one side, white on the other. It must be kept in a dark room as bright light will cause it to change color.

The blueprint is made as follows:

(a) The working drawing is placed over blueprint paper.

(b) A strong electric arc light or sunlight is focused through the tracing paper.

(c) The inked or pencilled lines keep the light from parts of the blueprint paper, which changes color everywhere except where there are markings or lines on the original drawing.

(d) The blueprint paper is then immersed in water, which turns the paper blue except where there are lines, etc. These lines turn white thus completing the blueprint.

A blueline is made in a similar manner except that a different type of reproduction paper is used with an ammonia solution yielding blue lines, etc. on a white background.

As many copies as needed can be made from the original working drawing, which is then retained for future use as additional prints may be required.

(5) Care of Prints by Craftsmen: Although the craftsman's chief interest is in using the blueprint to guide him as to materials and dimensions, rather than paper, paper-sizes, and how the prints are made, knowledge of these things help him to understand the importance of taking proper care of the blueprints in his possession.

There are several things to remember

(a) If the print is rolled, re-roll it after use. Do not fold a rolled print.

(b) If the print is folded, fold it just as it was originally. Do not fold it opposite the original fold or crease.

(c) Do not leave exposed to sunlight when not in use, or for any great length of time - sunlight will cause fading.

(d) Do not get prints wet.

(e) Do not mark up prints with pencil, ink or crayon, unless given permission to do so.

From the foregoing it can be seen that blueprints are relatively expensive to produce, therefore, the least that can be expected of each craftsman is that he take considerable care when using these prints.

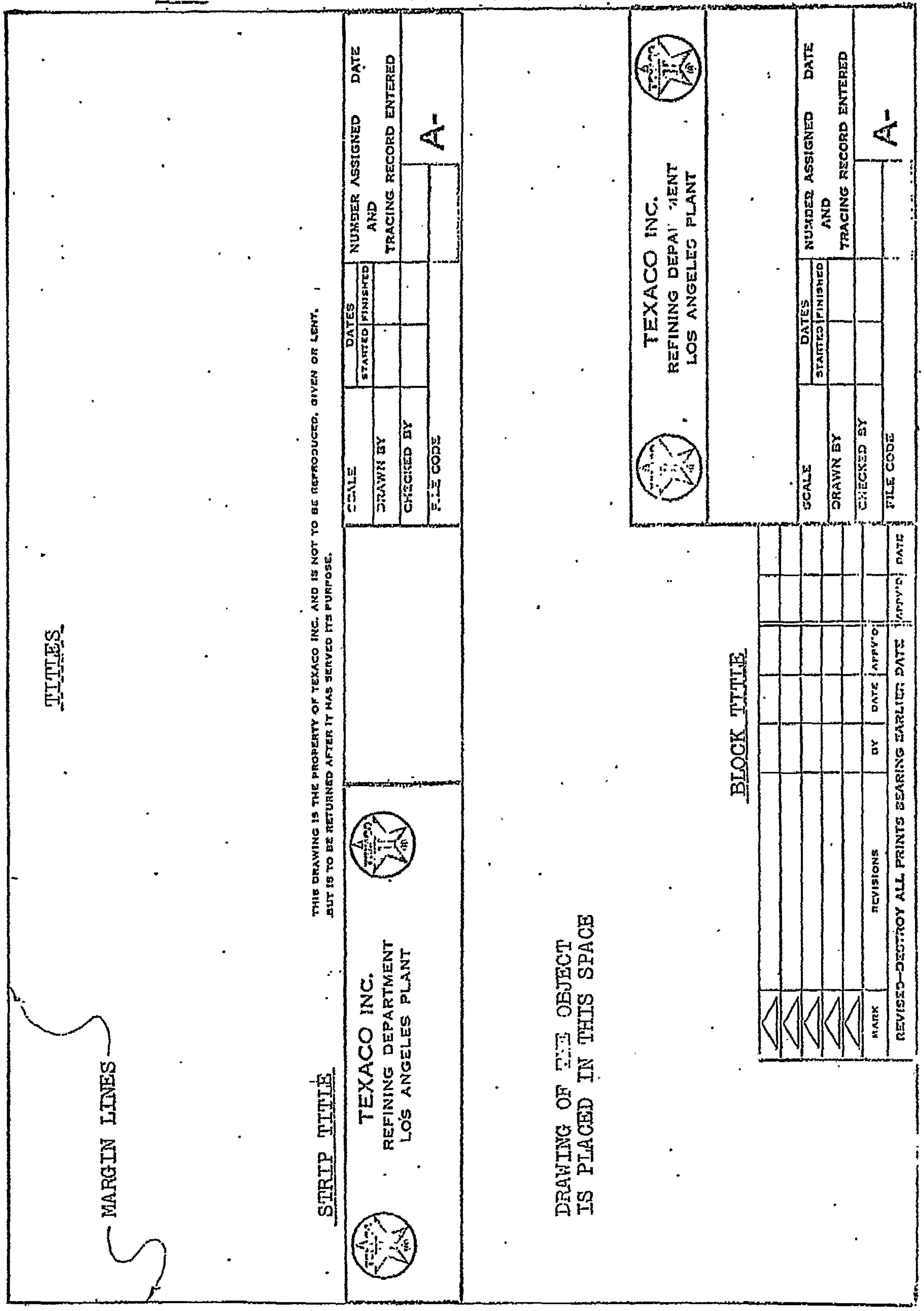

TITLES
MARGIN LINES
STRIP TITLE
TEXACO INC.
REFINING DEPARTMENT
LOS ANGELES PLANT
THIS DRAWING IS THE PROPERTY OF TEXACO INC. AND IS NOT TO BE REPRODUCED, GIVEN OR LENT, BUT IS TO BE RETURNED AFTER IT HAS SERVED ITS PURPOSE.
SCALE
DRAWN BY
CHECKED BY
FILE CODE
DATES
STARTED
FINISHED
NUMBER ASSIGNED AND TRACING RECORD ENTERED
DATE
A-
DRAWING OF THE OBJECT IS PLACED IN THIS SPACE
BLOCK TITLE
MARK
REVISIONS
BY
DATE
APPV'D
REVISED—DESTROY ALL PRINTS BEARING EARLIER DATE

FIGURE 1

(6) The Use of Titles and Margins on Drawings: Identification of a drawing makes it necessary to provide some means of showing what it represents, the Company name, initials or names of the persons making the drawing, checking and tracing the print, date of making, issuing or revising, name of object, materials required, a number for easy identification, etc.

Normally, there are two types of titles used - BLOCK and STRIP. Block titles are used at Texaco and are located inside the right and the bottom margin lines at the lower right-hand corner of the drawing. (See Figure 1) Strip titles or strips are located at the bottom of the drawing and are most often found on manufacturer's drawings.

MARGIN LINES are placed around the border of the drawing and act as a frame for the object or objects drawn, and provide means for proper spacing.

(7) Alterations or Revisions: Alterations or revisions of drawings must frequently be made due to some error in the original drawing, changes in design, dimensions, or for other reasons.

When this is necessary, a reissue of the print is made with the change or changes noted, or, in some instances, the original drawing may be VOIDED and a new blueprint issued under a new date. (See Figure 2)

(8) Use of Scales on Drawings: In most instances, small objects are drawn full size by an engineer or draftsman. However, some objects are so large that it presents a problem to the draftsman who must reduce the size to where it can be conveniently drawn on available sizes of drawing paper. Where the object is extremely small, the size may be increased in drawing. The reduction or increase of the drawing size in accurate proportion to the actual size is the device used by the draftsman to provide a readable print and is known as 'drawing to scale'. (See Figure 3)

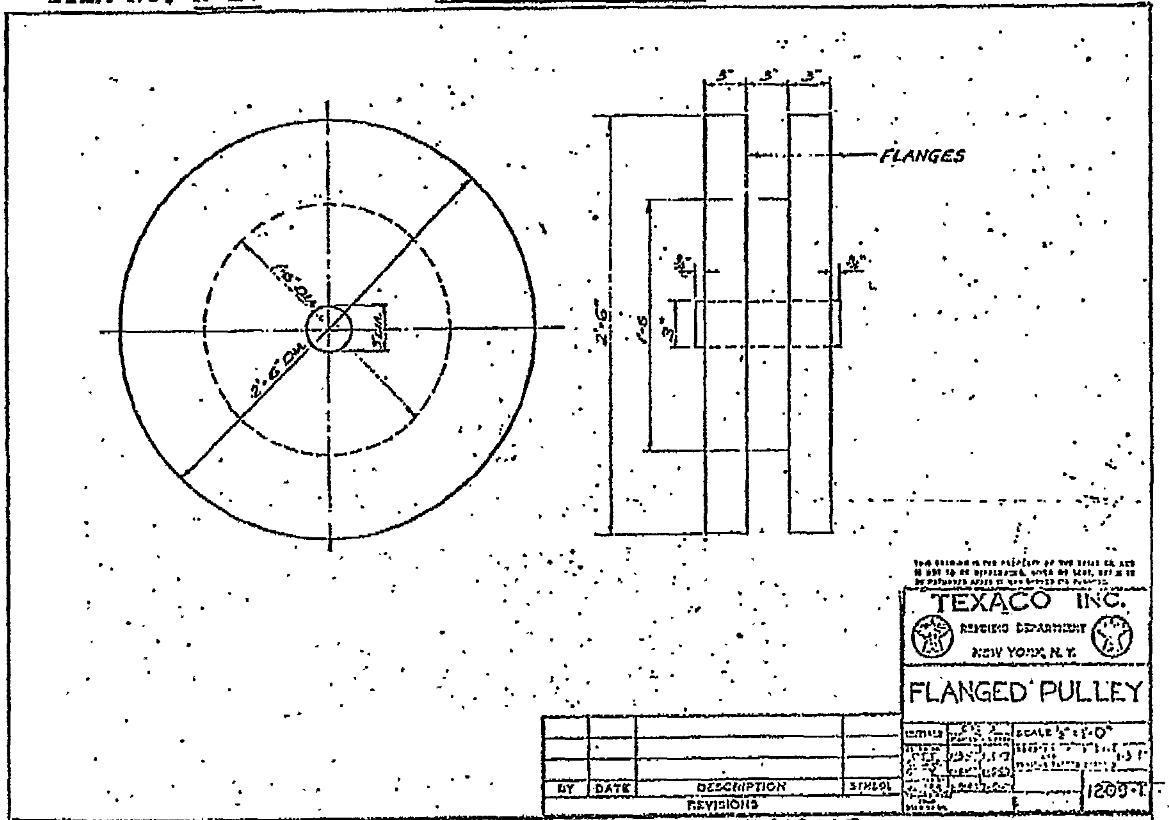
The foot is the most common means used as a basis for establishing the scale to be used in making a drawing.

FULL SIZE is shown as 12" = 1' - 0"

HALF SIZE is shown as 6" = 1' - 0"

QUARTER SIZE is shown as 3" = 1' - 0"

DOUBLE SIZE is indicated as such or may be shown as 2" = 1", etc.



ALTERATIONS OR REVISIONS

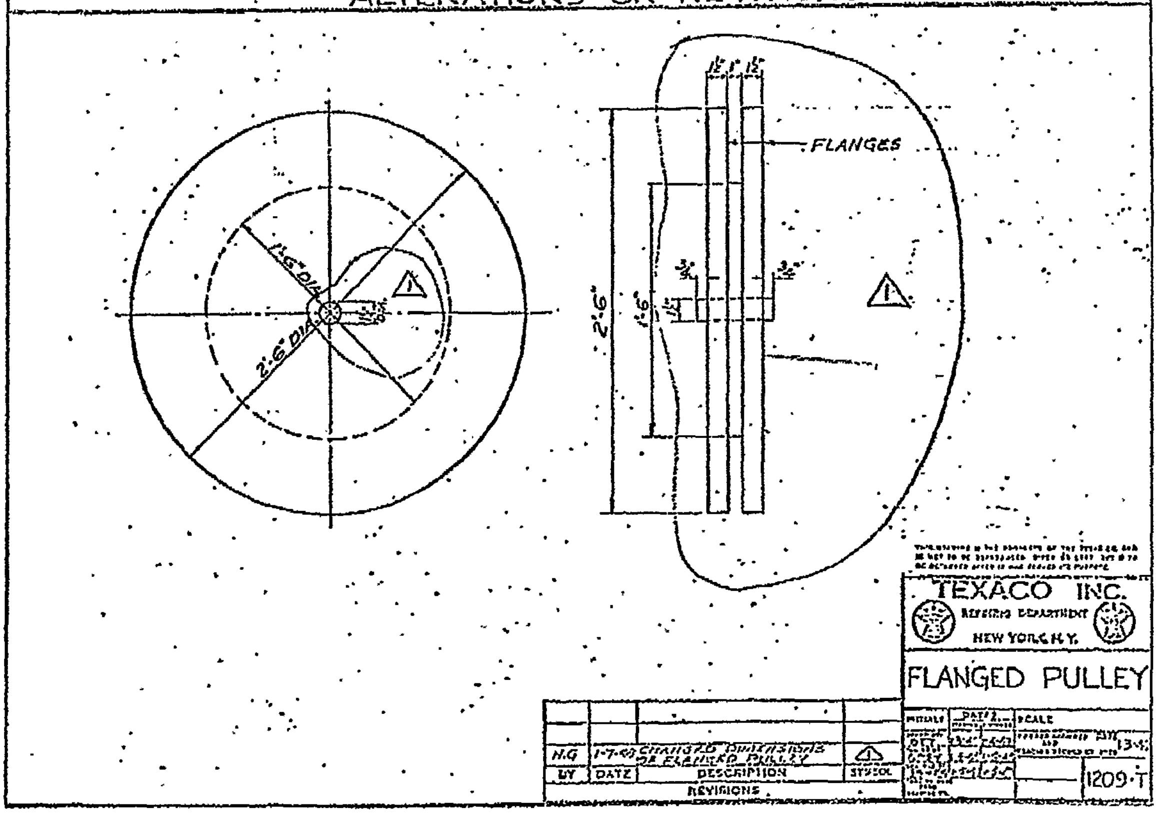
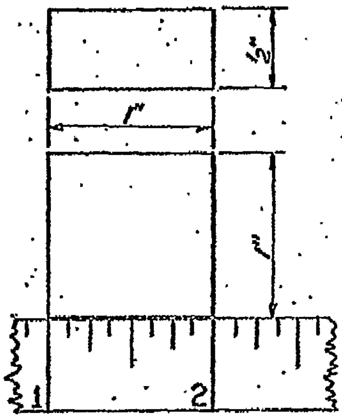


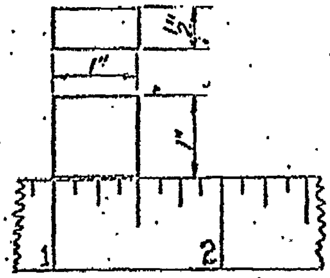
FIGURE 2

SCALE SIZES



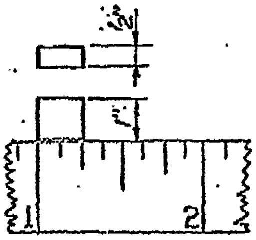
DRAWN FULL SIZE OR THE ACTUAL SIZE OF THE OBJECT. THE SCALE IN THE TITLE STRIP WOULD READ:
SCALE: 12"=1'-0"
EACH INCH IN THE DRAWING IS ONE INCH LONG AS SHOWN ON THE RULER

A



DRAWN HALF SIZE OR ONE HALF THE ACTUAL SIZE OF THE OBJECT THE SCALE: 6"=1'-0"
EACH INCH IN THE DRAWING MEASURES ONE-HALF INCH ON THE RULER.

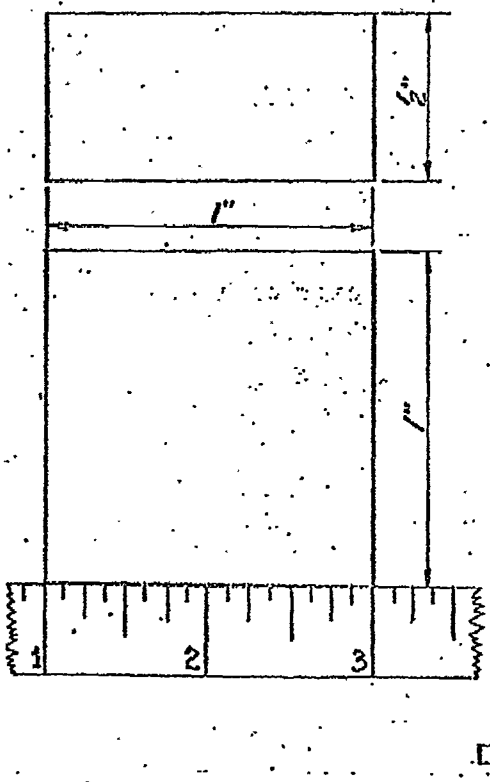
B



DRAWN QUARTER SIZE OR ONE-QUARTER THE ACTUAL SIZE OF THE OBJECT. THE SCALE: 3"=1'-0"
EACH INCH IN THE DRAWING MEASURES ONE QUARTER INCH ON THE RULER

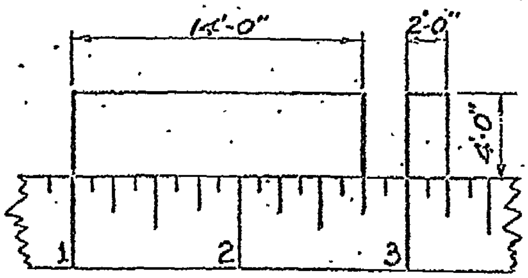
C

FIGURE D IS DRAWN DOUBLE SIZE OR TWICE SIZE OF THE OBJECT. EACH ONE-EIGHTH INCH ON THE DRAWING MEASURES ONE-QUARTER INCH ON THE RULER.
SCALE: DOUBLE SIZE



D

DRAWN 1/96 SIZE OR 1/96 THE ACTUAL SIZE OF THE OBJECT. EACH FOOT ON THE DRAWING MEASURES 1/8" ON THE RULER.
SCALE: 1/8"=1'-0"



E

FIGURE 3

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Scales of smaller sizes are most frequently used in Texaco drawings, as 1/2" = 1'-0", 1/4" = 1'-0" or 1/8" = 1'-0". Some drawings are drawn to no particular scale to speed the draftsman's work and so state in the title block.

CAUTION: THE BLUEPRINT SHOULD NEVER BE MEASURED TO OBTAIN A SIZE NOT SHOWN OR ONE THAT IS NOT IN APPARENT AGREEMENT WITH OTHER DETAILS.

CONSULT WITH YOUR FOREMAN OR THE PERSON RESPONSIBLE FOR THE JOB.

The reasons for this caution are:

(a) During the preparation of a print, shrinkage and distortion of the paper occurs, which may cause inaccuracies if measurements are taken directly from the finished blueprint.

(b) Changes in dimensions are sometimes made on the blueprint without changing the lines of the drawing.

(c) A correctly scaled drawing should show all dimensions, lines, and any special notations necessary to adequately describe the object, and it should not be necessary for the craftman to scale the drawing. (Unscaled drawings or simple sketches may require some measurements being taken in the field by the craftsman.)

The ordinary rule, scaled in sixteenths, is all that will be required normally by a craftsman for taking measurements, and the rule can be used for making simple drawings or sketches.

(9) Identification and Meaning of Lines on a Drawing: As is obvious, lines play an important part in the interpretation of prints and therefore each craftsman should know something about how drawings are made.

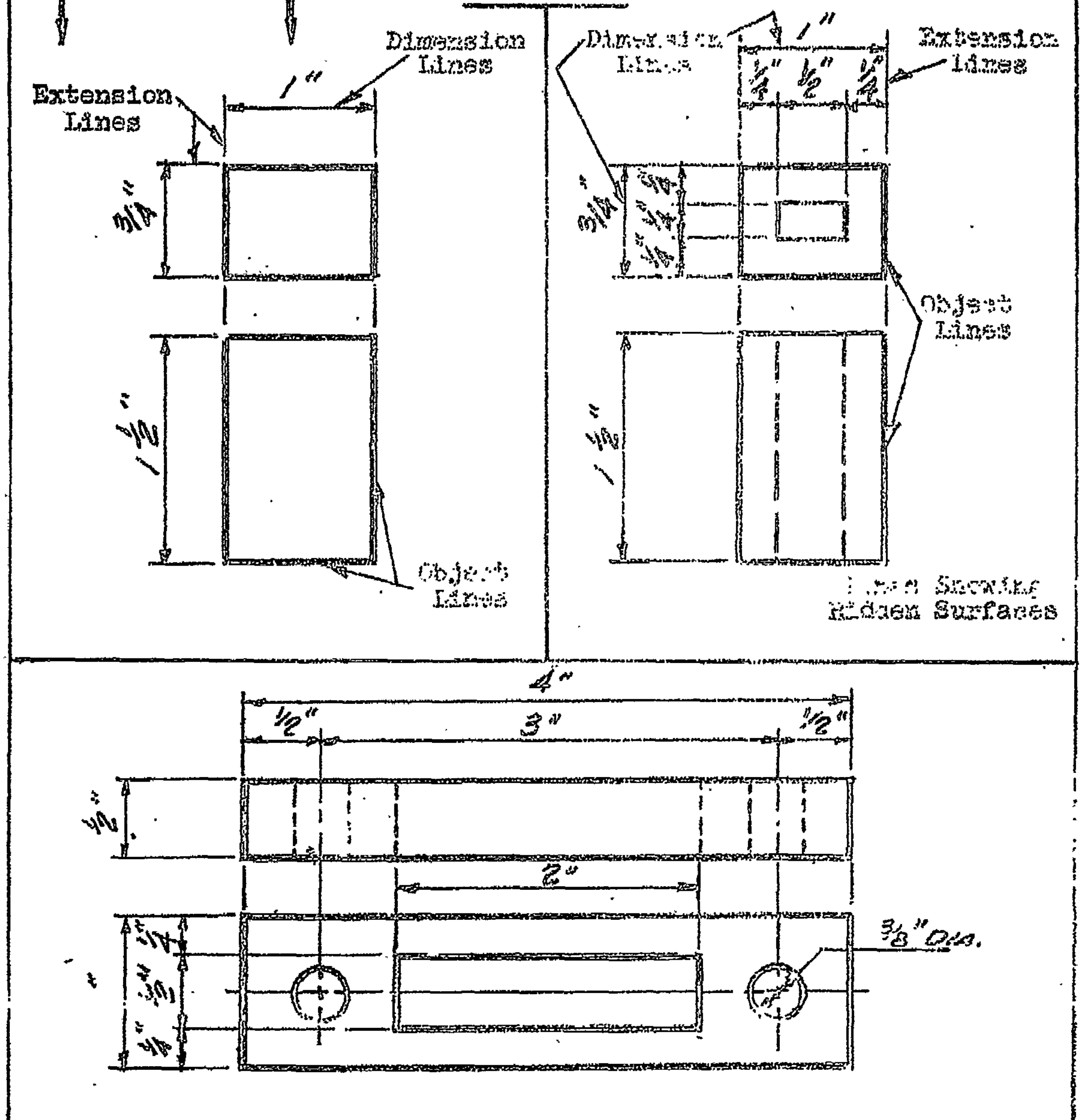
The craftsman must learn a new "language". He must first understand that a print is a set of instructions in a new language which he must learn to read. Since the alphabet of this language is in lines, then he must learn to read lines. (See Figure 4)

The types of lines commonly used can be shown as follows:

(a) HEAVY BOLD LINES - used to represent surfaces and edges which can be seen from the side that is being drawn - also known as visible lines, full lines, solid lines, object lines, visible boundary lines, etc.

TYPES OF LINES

1. Object Lines
2. Dashed Lines - Hidden
3. Extension Lines
4. 2" Dimension Lines With Dimensions
5. Center Lines
6. Break Lines
7. Section or Cutting Plane Lines



APPLICATION OF LINES

FIGURE 4

(b) EXTREMELY HEAVY LINES - used to differentiate between existing facilities and new installations. This is done by the draftsman so that the craftsman can readily pick out the work to be done in an existing system.

(c) DASHED LINES - or "dotted" lines as they are better known, are used to represent invisible surfaces or edges which cannot be seen.

(d) LIGHT SOLID LINES - known as "guide" lines or extension lines, are used to extend the object lines to points away from the object to give the draftsman more room to put in dimension lines.

(e) LIGHT SOLID LINES - with a break in the middle for the insertion of dimension figures and arrows at each end, are known as "dimension" lines and used to indicate distance between two points.

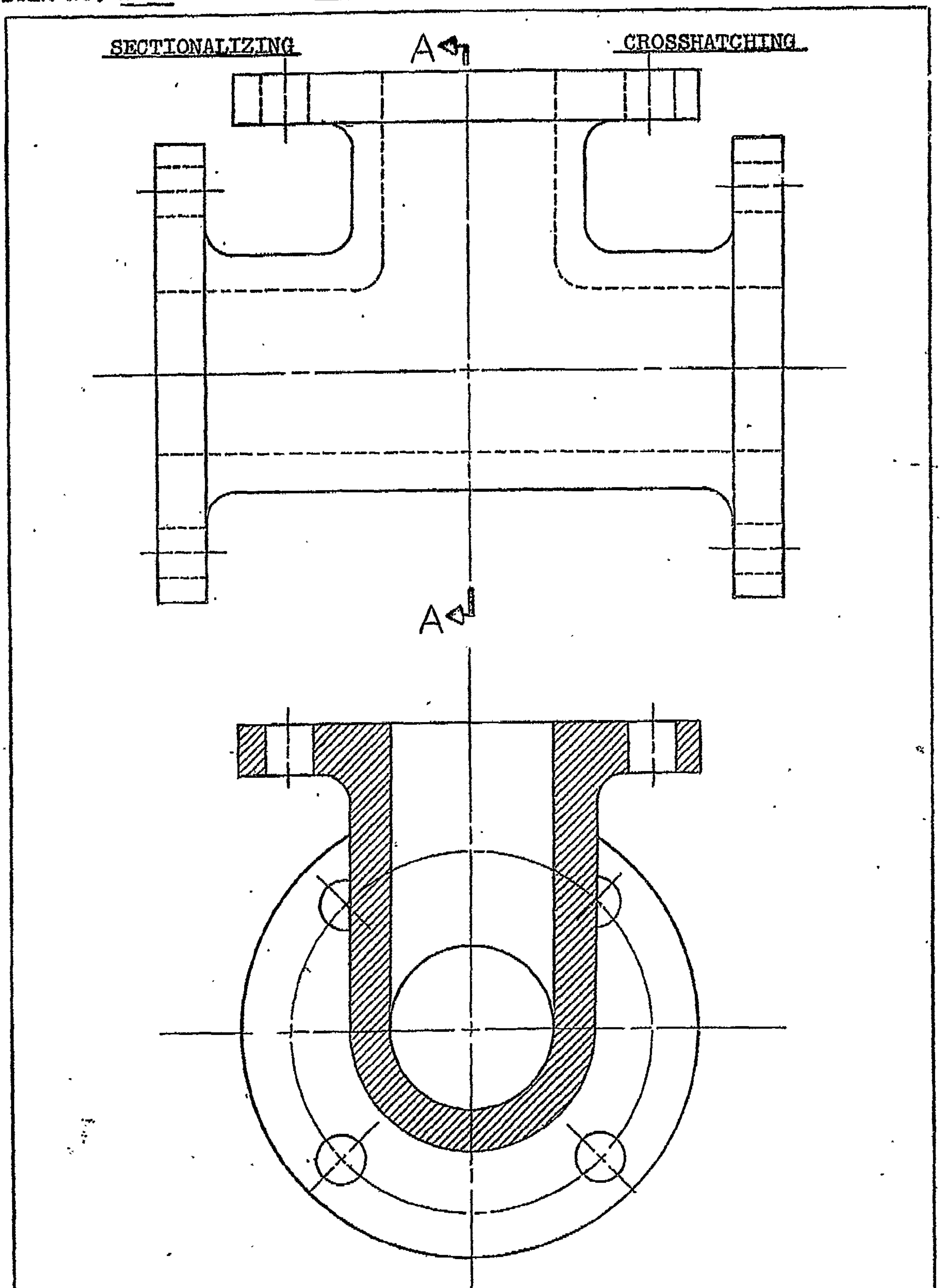
(f) LONG AND SHORT LINES - alternately spaced, are known as "center" lines and used to locate or denote the center of an object.

(g) BREAK LINES - are used to indicate that part of an object has been left out - usually because of space limitations of the paper on which the object is drawn.

(h) HEAVY LINES WITH TWO DOTS AND A LONG DASH - are known as "cutting plane lines" or "section lines," and are used to indicate where a certain section of the object is to be taken and drawn in greater detail elsewhere on the blueprint. Usually capital letters of the alphabet are used to identify the particular sections to be drawn in detail elsewhere on the blueprint and for cross-reference.

(10) Significant Markings on Drawings: In discussing the fundamentals of drawings, the many illustrations and markings, or symbols, used on drawings by the draftsman cannot be ignored. In order to read and interpret a print correctly, the workman must know the symbols most commonly used.

Limitation of space prevents the draftsman from writing out on the drawing all information necessary to show the kinds of material, thread, finish, measurements, and other detail. Therefore, symbols have been developed for this purpose.



SECTION A-A

FIGURE 5

(a) Sectional Drawings: Sometimes the construction of an object is so complicated or the size, shape, etc., are such that the regular size drawing will not adequately show the detail or give a complete understanding of the particular object. When this happens, a sectional drawing is made.

Sectional drawings generally show a part or section of the object in such a way as to reveal the shape or construction in more understandable detail.

Figure 5 illustrates a standard flanged tee such as most refinery workers are familiar with.

The top view shows the tee as normally viewed from the side. The exact part which is to be sectioned is indicated by the CUTTING PLANE LINE A-A.

The lower view shows a cross-section view which is indicated by slanted lines at 45 degrees. This part of the surface is "cross-hatched".

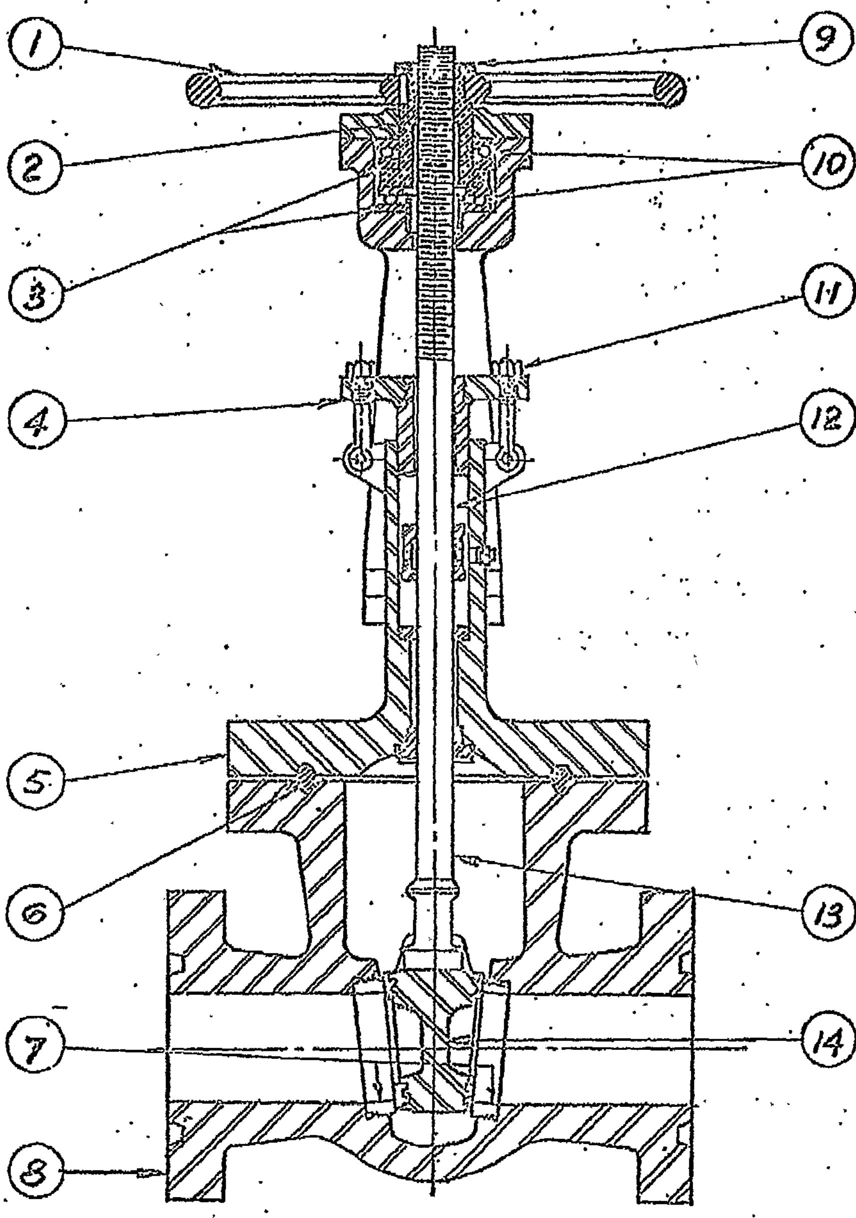
(b) Cross-Hatching Combinations: In many sectional views, it is necessary in order to clearly picture an object to slant the cross-hatching in opposite directions. This may be done regardless of whether the material depicted is the same or a different material. Where there is a single piece or object depicted, the cross-hatching is always in the same direction. (See Figure 6)

Some objects, such as bolts, nuts, screws, keys, rivets, oil cups, pipes, pulleys, etc., are seldom cross-hatched when shown in conjunction with a sectional view drawing.

(c) Conventional Breaks: Quite frequently, the need arises, due to the length of the object being drawn or paper size, to depict the object in less than its normal length.

When this is necessary, the draftsman uses a device known as "conventional breaks" which permits shortening the length of the object on the drawing, yet avoids a reduction in scale while aiding in illustrating the object so broken. (See Figure 7)

SECTIONED VALVE



CAST STEEL GATE VALVE

1-Handwheel
2-Yoke Nut
3-Bearing Rings
4-Packing Gland
5-Bonnet
6-Ring Gasket
7-Seat Rings
8-Body
9-Jamb Nut
10-Alemite Fittings
11-Bolt-Studs & Nuts
12-Packing
13-Stem
14-Solid Wedge

FIGURE 6

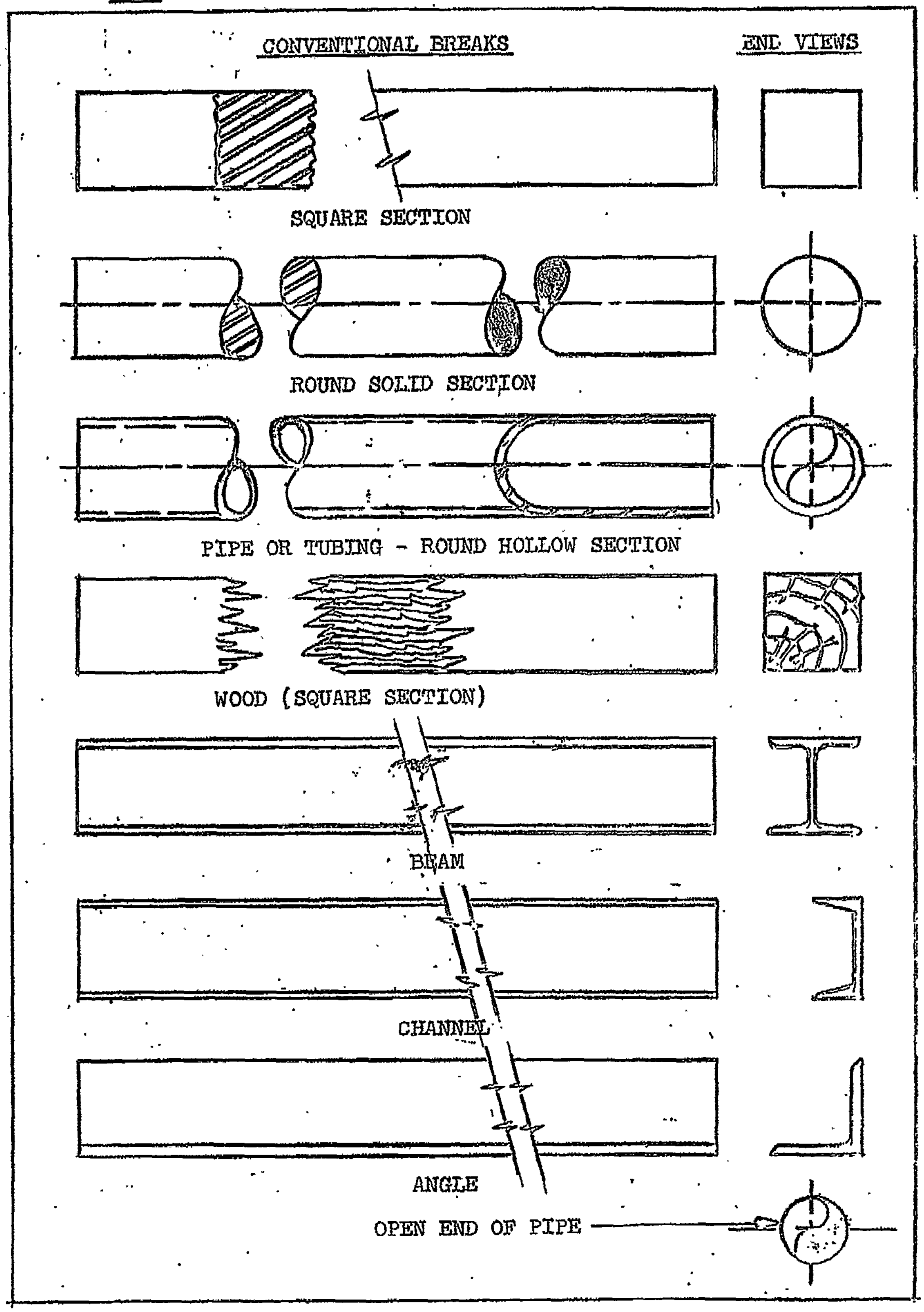

CONVENTIONAL BREAKS
END VIEWS
SQUARE SECTION
ROUND SOLID SECTION
PIPE OR TUBING - ROUND HOLLOW SECTION
WOOD (SQUARE SECTION)
BEAM
CHANNEL
ANGLE
OPEN END OF PIPE

FIGURE 7

CAUTION: REMEMBER, THE DIMENSIONS SHOWN ON THE PARTS OF AN OBJECT WHICH HAS BEEN "BROKEN" ARE THE ACTUAL LENGTHS - ALWAYS.

(d) Other Symbols and Markings: As has been stressed several times, the draftsman must use many symbols or abbreviations to express in the least possible space his ideas and the requirements of a particular job which he must illustrate.

Therefore, certain standard conventional symbols, markings, and abbreviations, other than those previously discussed, have been developed to further simplify illustration and conserve space. In order to clearly interpret a print, these commonly used standardized markings and abbreviations should be studied by the workman. (See pages 54 through 57).

Mentioned previously were universal symbols and markings. Later in this material, symbols pertinent to your specific craft will be illustrated.

In addition to symbols, "notes" concerning some facts may be shown on the drawing. Usually in using notes the draftsman prints the word "NOTE" somewhere near the bottom of the drawing, with the necessary information. To fully interpret a blueprint, the workman is cautioned to:

(1) ALWAYS STUDY THE DRAWING.

(2) TRY TO FORM A MENTAL PICTURE OF THE OBJECT.

(3) READ EVERY WRITTEN NOTATION ON THE DRAWING. (Sometimes the bit of information which is presumably missing will be found as a note in some conspicuous place.)

ABBREVIATIONS AND MARKINGS

American Petroleum Institute	API
American Pipe Threads	APT
American Society for Testing Materials	ASTM
American Standards Association	ASA
Angle	∠
Ball Joint	BJ
Bend Line	BL
Bevel End	BE
Bolt Circle Diameter	BCD
Bottom	bott
Brass	br
Bronze	brz
Building Line	BL
Cast Iron	CI
Center Line	℄
Center to Center	c-c
Centrigrade (degree)	C
Chamfer	chfr
Channel	⊏
Circular	cir
Column	col
Concentric	Conc
Copper	Cop
Counterbore	C'bore
Counter sink	Csk
Coupling	cplg
Cylinder	cyl

Degree	deg
Diagonal	diag
Diameter	D
Discharge	disch
Drawing	dwg
Eccentric	ecc
Elbow	ell
Elevation	elev
Extra Heavy	EH or XH
Faced and Drilled	F & D
Fabricate	fab
Fahrenheit (degree)	F
Feet	ft
Field Weld	FW
Figure 8 Blind	8
Flate Face Flange	FF Flg
Forged Steel	FS
Gallons	gal
Gallons per minute	gpm
Gauge	ga.
High Pressure	H P
I-beam	I
Inches	in.
Inside Diameter	I.D.
Insulate	insul.
Liquid Level	LL

Linear	lin
Long Radius	LR
Low Pressure	L-P
Mark	Mk.
Maximum	max
Number	# or No.
Outside Diameter	O.D.
Piece (s)	pc, pcs
Plain end	PE
Plate	PL
Pounds per square inch	psi
Pressure	press
Raised Face Flange	RF Flg.
Reducer	red.
Required	req'd
Revolutions per minute	RPM
Round or Round bar	Ø
Schedule	sch
Screwed	scrd
Short Radius	SR
Slip-on Flange	SO Flg.
Specifications	spec.
Square or Square Bar	□
Square Feet	□'
Square Inches	□"
Stainless Steel	SS
Standard	std

Steel	stl
Suction	suct
Swaged Nipple	sw nip
Tack Weld	TW
Tangent line	TL
Temperature	temp
Thread one end	TOE
Threads	thds
Volume	vol
Weld Cap or Welded Connection	WC
Wide Flange Beam	WF
Weld Neck Flange	WN Flg.
Working Point	WP

Equipment Designations

Furnaces or Heaters	F-
Exchangers or Coolers	E-
Towers, Drums and Vessels	V-
Pumps	P-
Compressors	C-
Turbines	T-
Tanks	Tk-

(11) Types of Drawings: The petroleum worker will come in contact with many varieties of drawings, all of which he should be capable of reading and interpreting. The most frequently encountered drawings are:

(a) Flow Diagrams: The primary purpose of flow diagrams is to convey pertinent information regarding material quantities and their destination with the process. They are also intended to act as guides for construction men and plant engineers in order that the problems which arise in the erection and operation of the plant may be intelligently solved. (See Figure 8)

(b) Plot Plans: This type of drawing gives an accurate picture of the plot or layout of a unit or system. It shows locations of equipment and buildings within the unit. Plot plans are used to denote the location of new installations relative to existing equipment or structures. (See Figure 9)

(c) Assembly Drawings: Assembly drawings show an object with its parts assembled and ready to operate. They are carefully drawn with sufficient views to show the location of each part that goes into the makeup of the machine. Each part is identified by a number giving reference to another drawing, sketch or note so that the workman can see where the parts go and place them in the proper position. The only dimensions given are those which are necessary to put the object together. Frequently, no assembly dimensions are necessary. (See Figure 10)

(d) Schematics: A schematic is a line drawing, using conventional symbols, that shows only the connections between parts. It has no scale and is not related to the actual positioning, in an assembly, of each part. Schematics are used primarily in electrical and instrument work. (See Figure 11)

(e) Conventional Working Drawings: The interpretation of prints depends primarily on the ability of the individual to translate a view or a series of views. The following are types of projection drawings:

1. Perspective Drawings: A picture of an object as it would normally appear to anyone looking at it is known as a perspective drawing.

PLATFORMER UNIT

FLOW DIAGRAM

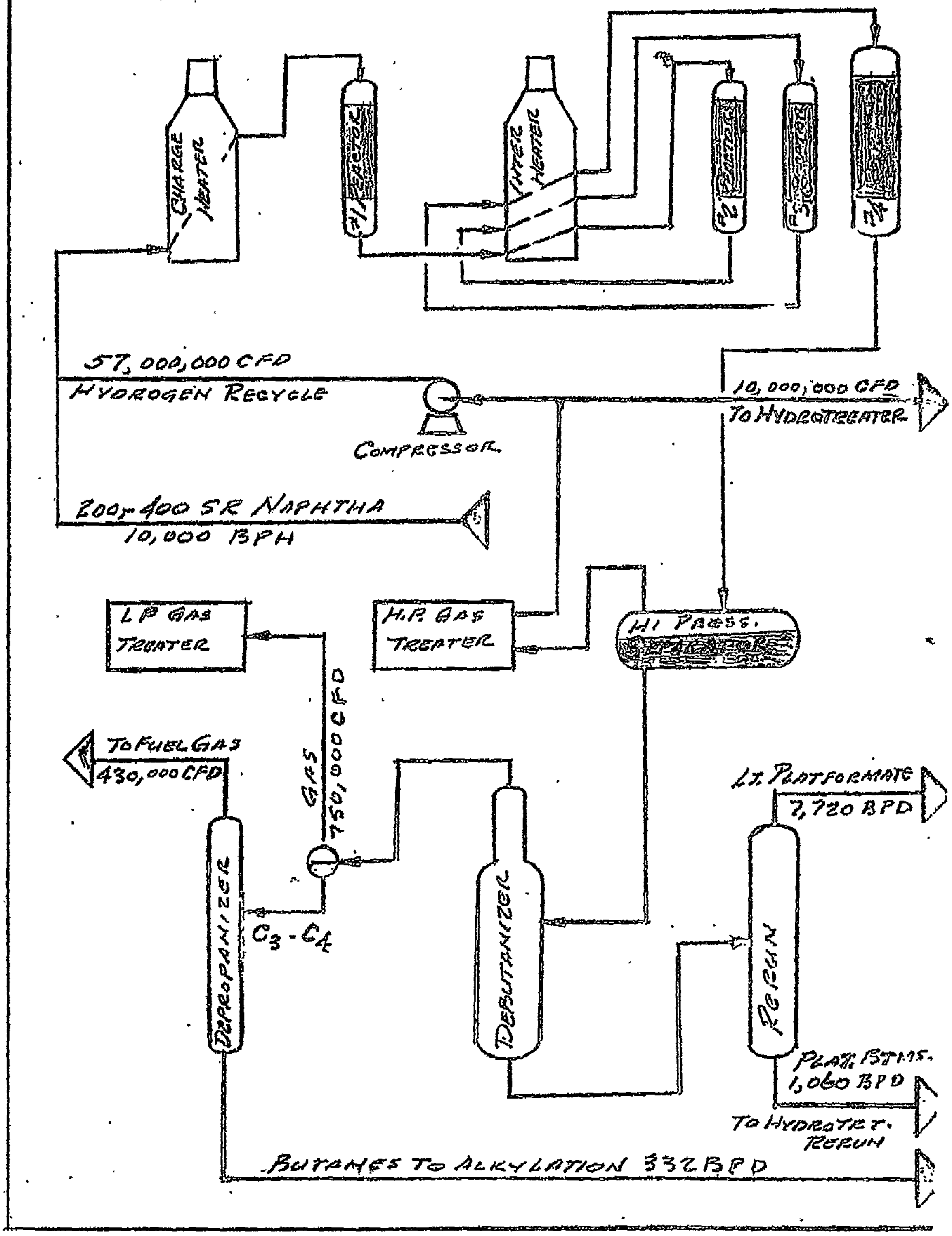


FIGURE 8

CHARGE	BY RJC	TITLE LAYOUT OF EQUIP	
REF DWG	DATE 11-10-67	NO 2 BOILER HOUSE	A-1411
APPD	CHKD	SOUTH AREA	DATE ISSUED

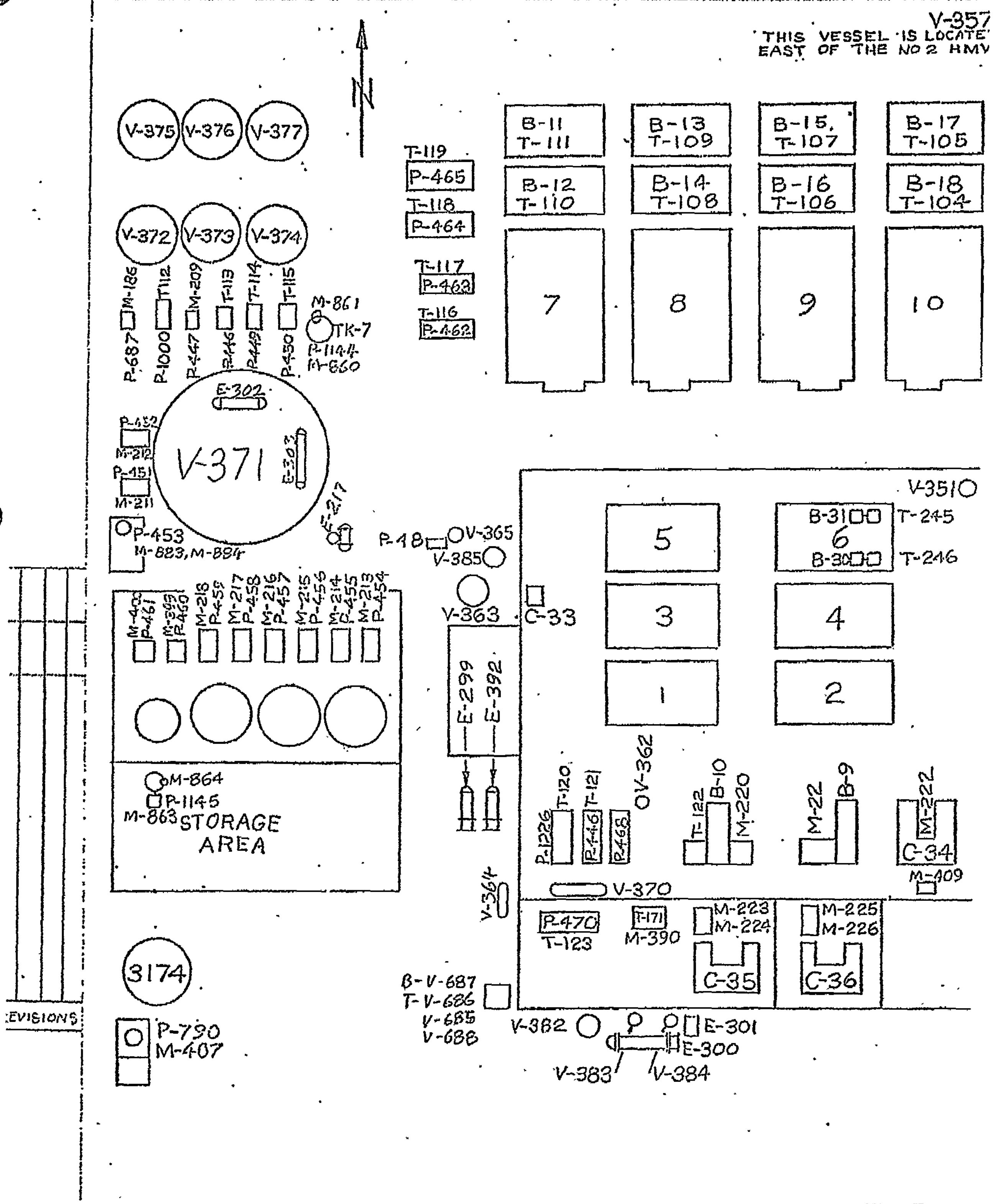


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FIGURE 9

ASSEMBLY OF DRILL JIG

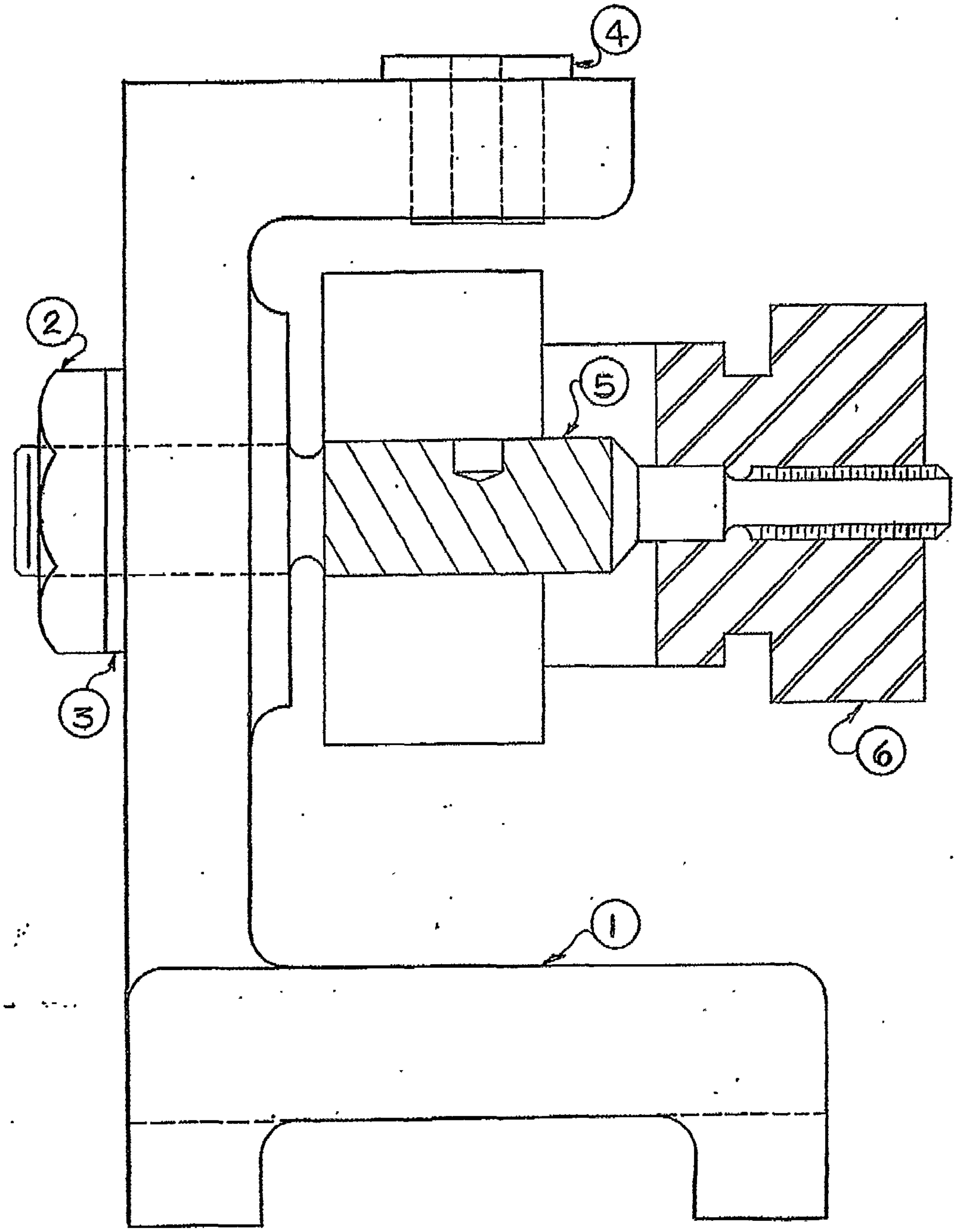


FIGURE 10

CONTROL CIRCUIT SCHEMATIC

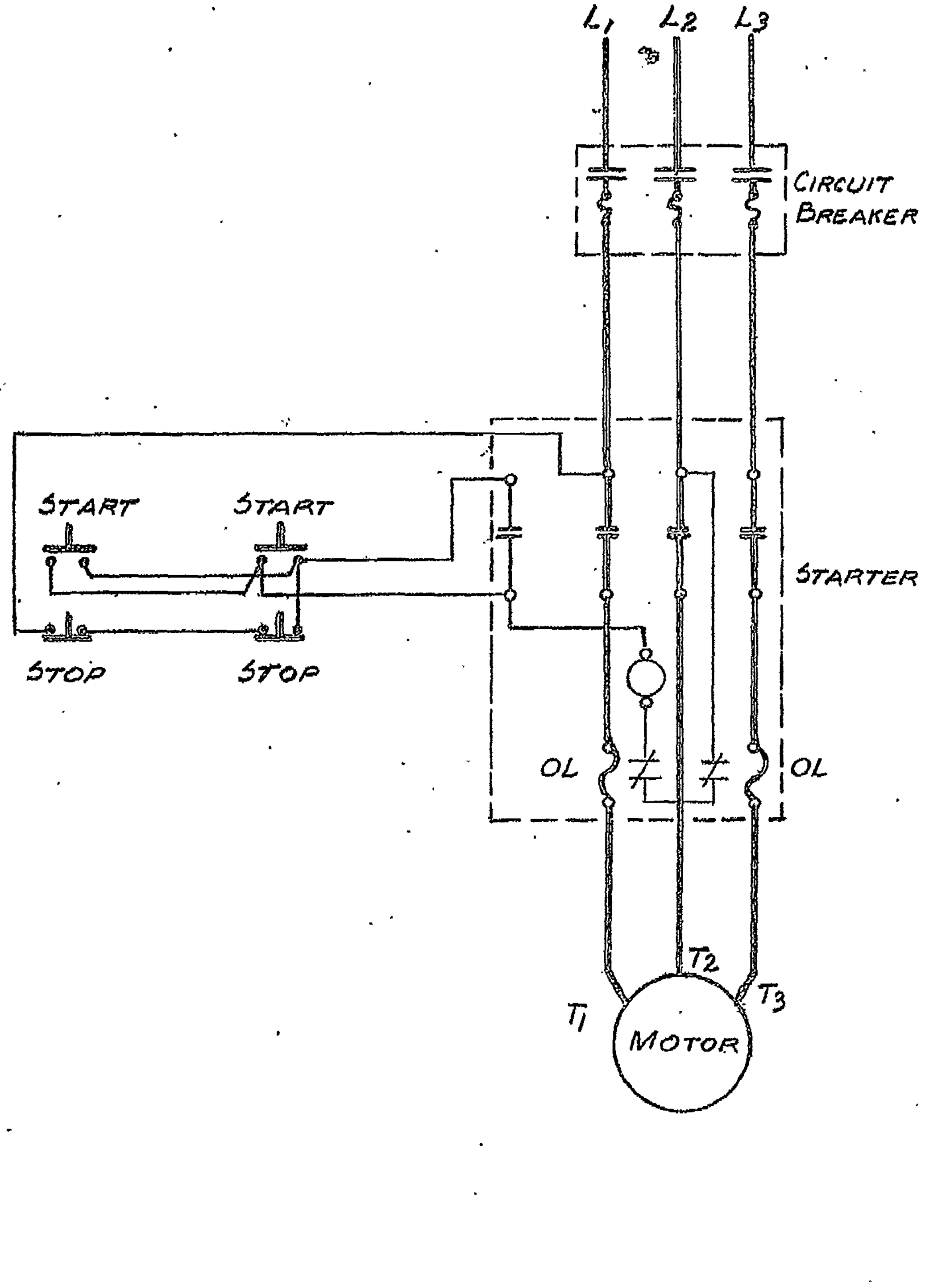


FIGURE 11

A picture, or perspective drawing, will give a clear mental picture of an object, but it will not give exact detailed information which would enable a workman to make that object.

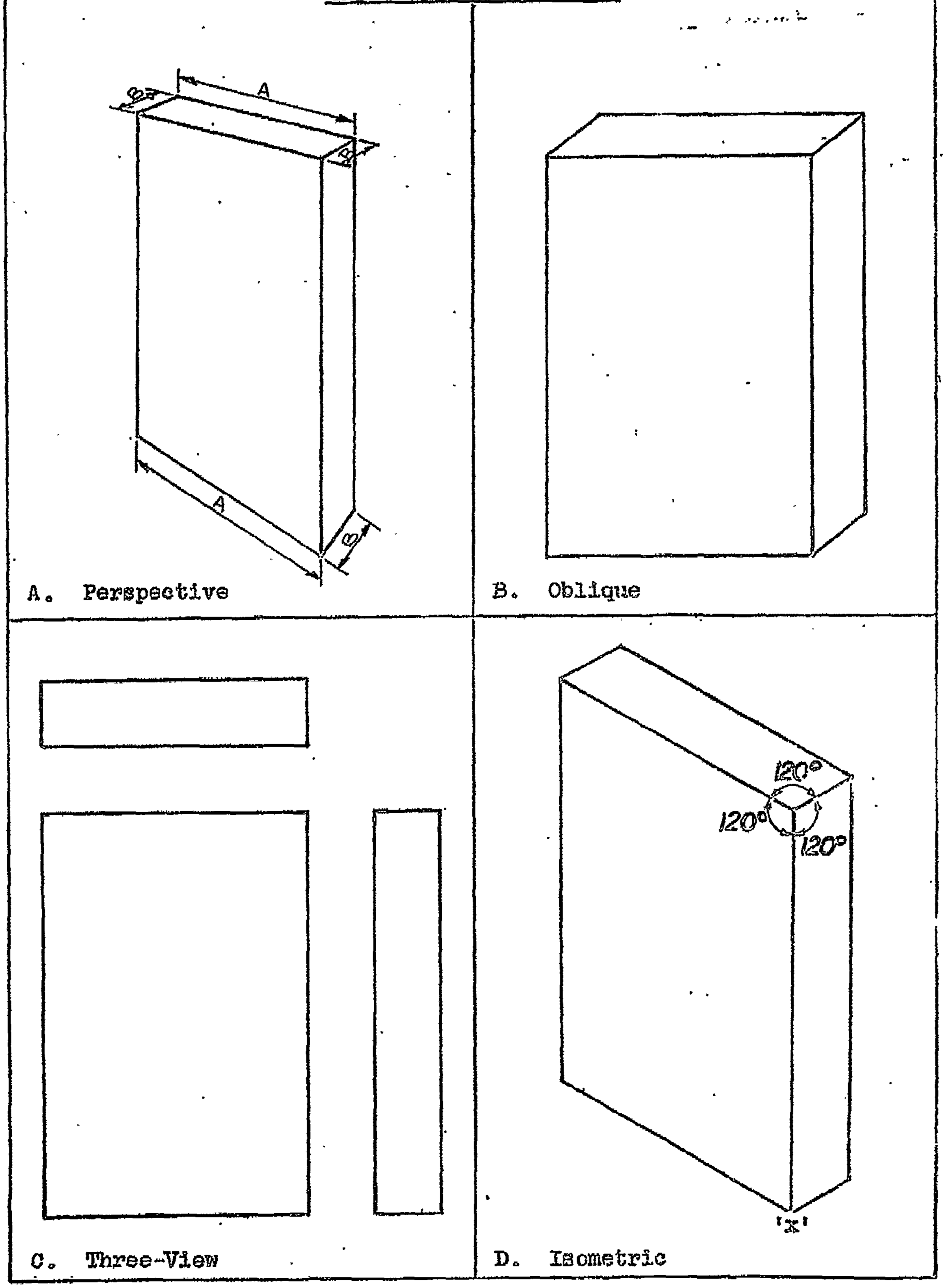
It will be noted from the perspective drawing in Figure 12 A that the three dimensions "B" are not equal, although they should be. Neither are the two dimensions "A" equal. Therefore, a good image of the object is seen but it would be difficult to reconstruct the object as sufficient information is not available.

2. Oblique Drawing: Oblique drawings are constructed on three axes, representing three mutually perpendicular edges, upon which measurements can be made. Two of the axes are always at right angles to each other and both lie in the picture or frontal plane. (See Figure 12B) The third axis makes an angle with the picture plane. Oblique drawings, like perspective drawings, are seldom used in the petroleum industry.

3. Three View Drawing: A common type of working drawing is the two or three view drawing. In this type of drawing, the views are either plan or elevation. A plan view represents what an object would look like when looking directly down on top of it. An elevation view is what is seen when the object is shown face on, either from the front or side. (See Figure 12 C) Quite often, one or two views is sufficient to show the necessary detail of an object. The arrangement of views is critical to the interpretation of a three view drawing. The plan view is always shown directly over the front elevation on a drawing. A side elevation is shown to the left or right of the front elevation, whichever is applicable.

4. Isometric Drawing: The most important type of drawing in the petroleum industry today is the isometric drawing. Three view drawings are sometimes rather complicated, thus this more pictorial type of drawing is used (See Figure 12 D). The isometric drawing originates with three axes, representing three mutually perpendicular edges,

METHODS OF PROJECTION



A. Perspective

B. Oblique

C. Three-View

D. Isometric

FIGURE 12

much the same as an oblique drawing. These three axes form equal angles of 120° and are called isometric axes. The axes may be arranged in different ways provided their relative positions are not changed. Any line of an object that parallels an isometric axis is an isometric line. Any other line on the drawing is a non-isometric line. Such lines will not show in their true length, as with non-isometric angles. Isometric drawings are seldom drawn to scale since the primary purpose of these drawings is to show the craftsman what the object looks like.

(12) Dimensions: The size of an object, whether length, width, height, thickness, depth, diameter, radius, etc., is indicated on a print by various means. These measures of the object may be shown in whole numbers, mixed numbers, fractions, and decimals, usually in terms of feet and inches. Metric measurements are very infrequently used. These measurements are called dimensions.

Angles of degree are also considered as a part of the dimensions.

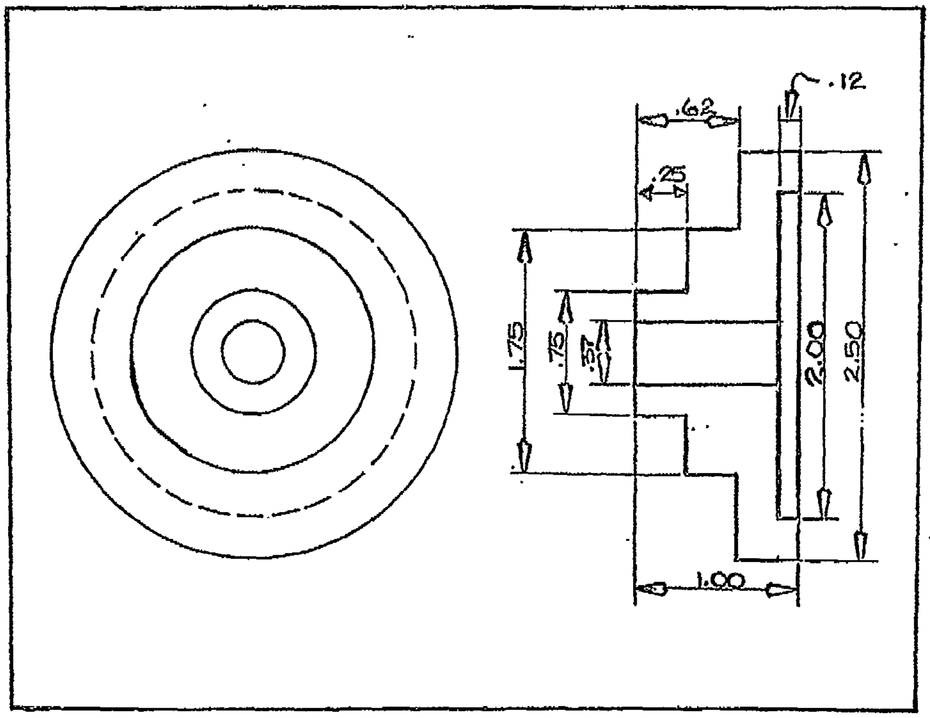


FIGURE 13

The dimensions of the object are usually shown in relation to the dimension lines. They may appear near the center of the dimension lines or elsewhere between the dimension lines, depending on the space available. The ends, or terminals, of the dimension lines are shown by arrowpoints.

Dimension values are either given as common fractions, 1/4", 3/8", etc. or as decimal fractions, 0.25, 0.375, etc. The common fraction is generally used in dimensioning drawings in the petroleum industry.

One of the views of an object will usually describe the shape of some detailed feature better than will the other view or views. Therefore, dimensions are usually shown in that view which is characteristic of what the object looks like. (See Figure 13).

(b) Bill of Material: Every craftsman, in order to fully understand a print or drawing, should be familiar with the use of Bills of Material. The Bill of Material may be and usually is issued on sheets separate from the print, or may appear on the print itself.

The Bill of Material is helpful to the craftsman in many ways. Its purpose is to give, as nearly as possible, necessary details about all the materials to be used on the job. The arrangement, method of preparation, language and symbols used all are intended to reduce confusion among those who must read, interpret and discuss the Bill of Material even if the discussion takes place at opposite ends of a telephone connection. (See Figure 14).

The Bill of Material shows:

(a) The title, who prepared the Bill of Material, the B of M number and the charge number. (The B of M number is especially important to the craftsman because in general, each piece of material is identifiable by this number).

(b) Scope of Work, which includes a brief description of the job, list of drawings or sketches necessary for planning the job, and the timing of completion in most cases.

(c) The initials of those receiving copies of the B of M (Always in the upper left-hand corner of the first page).

DLL/G(5) . CW-COBI FILE 10 BILL OF MATERIAL FORM R-415-CC

REFINING DEPARTMENT

DATE ISSUED: 6-24-64 B. M. NO. 4516

EST. TITLE PRODUCT PIPING to SALES TERMINAL

EST. NO. 50 725 MADE BY N.I.H. DATE 6-25-68

LOCATION NEAR TK 13501 / NEAR TK 13506 CHECKED BY E.H.H. 6/27/68 SHEET NO. 1 OF 1

LINE NO.	QUANTITY AND UNIT	DESCRIPTION	DWG. NO.	MARK	FURNISHED BY
1		SCOPE OF WORK			
2					
3		INSTALL (2) PIPE SUPPORTS			
4		PER DWG B-2524. ONE FOR			
5		PUMP P-171 & ONE FOR PUMP			
6		P-172. PUMP LOCATION PER			
7		DWG. D-4140 L1 & D-4140 L99			
8		RESPECTIVELY.			
9					
10					
11					
12					
13		MATERIAL REQUIRED			
14		TOTAL MATERIAL REQD. FOR			
15		2 LOCATIONS			
16					
17		REINFORCING BAR			
18	12	3/8 ϕ x 3'-3 1/4" STRAIGHT			E-343
19	16	1/2 ϕ x 2'-9" "			E-343
20	6	1/2 ϕ x 1'-0" x 3" RIGHT ANGLE BEND			E-343
21	7'-6 1/2"	12" STRUCTURAL CHANNEL (ANY WEIGHT)			SALVAGE YD
22	1 1/2 CU YARDS	CONCRETE ~ 2000 PSI (MIN)			AREA ENGR.
23		GRADE "C"			
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					

FIGURE 14

WA-TEX 001273

(d) Where the materials are to be used.

(e) Who furnishes the material, or the order number upon which material was ordered for delivery to the Storehouse or job.

(f) The number of pieces and a brief description of each kind of material to be used on the job and, in many cases, the dimensions.

(g) Whether materials are to be fabricated in the shop or to be purchased pre-fabricated.

c. MATHEMATICS REVIEW FOR THE CRAFTSMAN: In all crafts some type of math is used, whether it is the addition or subtraction of dimensions or the calculation of an angle. Thus, it is necessary that each craftsman be familiar with and have a working knowledge of simple mathematics.

(1) Fractions: A fraction is a numeral with two basic parts; the numerator and the denominator. In the fraction 3/4, the 3 is the numerator, the 4 is the denominator. Additional terms relating to fractions are:

(a) Equivalent fractions - fractions which represent the same number as 2/4=1/2, 8/8=1, or 6/8=3/4=12/16.

(b) Like fractions - fractions with similar denominators, such as 3/4 and 1/4.

(c) Unlike fractions - fractions with dissimilar denominators, like 2/3 and 3/8.

(d) Common denominator - a denominator which can be common to all fractions to be added or subtracted.

(e) Lowest term - the simplest form of a fraction. Addition of like fractions is simple. The numerators are just added together and placed over the common denominator, then the result is reduced to its lowest terms.

EXAMPLE: In Figure A the overall dimension is required. To obtain this dimension, the two fractions must be added.

3/4"+3/4"=6/4"

Since 4/4=1, then 6/4" = 1-2/4"

2/4=1/2, thus 6/4"=1/2"

The overall dimension is 1-1/2"

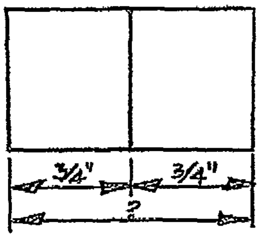


FIGURE A

Addition of unlike fractions is more difficult, for a common denominator must be found. For example, to add 2/3 and 3/4 the common denominator is found by multiplying the denominators together. Thus, 2/3 + 3/4=? can be solved by finding the number of 1/12's in 2/3 and in 3/4 and adding them together. There are 8/12 in 2/3, or 2/3=8/12 and 3/4=9/12. So, 9/12 + 8/12=17/12=1-5/12.

Very often it is not necessary to multiply the denominators together to find the common denominator.

If two or more fractions are to be added together, such as 3/4+1/8+1/2=?, a common denominator may already exist as the denominator of one of the fractions. In the example, 8 is a common denominator all the fractions to be added as it is divisible evenly by all of the denominators. Thus, 3/4=6/8, 1/8=1/8, and 1/2=4/8. Now that a common denominator has been found, the fractions can be added. Then the sum of the fractions is 6/8+1/8+4/8=11/8. Reduced to lowest terms the solution becomes 1-3/8.

Subtraction of fractions is done in much the same manner, as a common denominator must be found before subtracting.

EXAMPLE: In Figure B, a missing dimension is needed. To find the dimension, one fraction must be subtracted from the other.

7/8"-9/16"=?

Since 16 is divisible evenly by both denominators, it is the common denominator.

7/8=14/16, 9/16=9/16

Then 14/16"-9/16=5/16", already in its lowest terms.

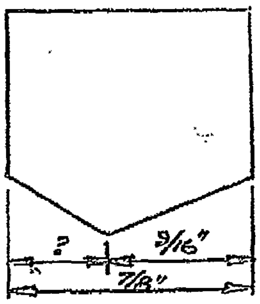


Figure B

(2) <u>Decimals</u>: Another type of numeral denoting a part of a number that is less than one is called a decimal. Examples of decimals are:

.2 = two tenths
.13 = thirteen hundredths
.469 = four hundred sixty-nine thousandths

A fraction may be converted to a decimal by dividing the numerator by the denominator, as 1/2=.5. Then .5 is the same as 1/2.

Decimals are added and subtracted the same as whole numbers. The only precaution to be taken is to keep the decimal points aligned.

(3) Solving Right Triangles with Square Root: The following formulas are given to find the length of any side of a right triangle when the other two sides are known. A right triangle, by definition, is any triangle that contains a 90° angle. (See Figure C)

$B = \sqrt{A^2 + C^2}$

$A = \sqrt{B^2 - C^2}$

$C = \sqrt{B^2 - A^2}$

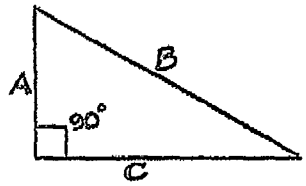


FIGURE C

The symbol $\sqrt{\quad}$ indicates that the square root of the quantity within the symbol must be found. The small 2 at the upper right of the letters in the formulas means that the lengths represented by the letters must be multiplied by themselves. This process of multiplying a number by itself is called 'squaring' the number.

EXAMPLE: Find the length 'B' when A=15" and C=20".

$$B = \sqrt{A^2 + C^2}$$
$$= \sqrt{(15x15) + (20x20)}$$
$$= \sqrt{225 + 400}$$
$$= \sqrt{625}$$
$$B = 25"$$

Squares and square roots of whole numbers from 1 to 100 are found in a table on pages 167-169 of The Pipefitter's and Pipe Welder's Handbook, by T. W. Frankland.

All piping offsets are based on right triangles. With only two dimensions, the third may be found. (See Figure D).

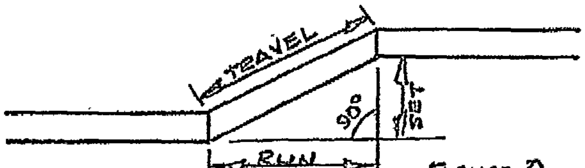


FIGURE D

(4) Calculating an Angle: In computing piping offsets, the pipefitter will use the six trigonometric functions of the angle of fitting. This calculation also makes use of the right triangle. (See Figure E)

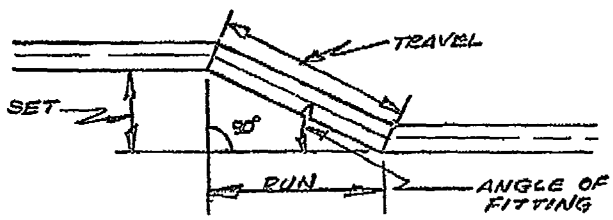


FIGURE E

These functions are:

Sine = set/travel*
Cosine = run/travel
Tangent = set/run
Cotangent = run/set
Cosecant = travel/set
Secant = travel/run

The angles equivalent to the sines, cosines, etc., are found in the Trigonomety Tables on Pages 171-175 of The Pipefitter's and Pipe Welder's Handbook, by T. W. Frankland.

EXAMPLE: Find the angle of fitting if the travel of an offset is 8" and the set is 4" (Refer to Figure E)

Sine = set/travel
Sine = 4/8 = 1/2 = .5
Refering to the trigonometry Tables, the angle whose sine is .5 is 30°. Therefore, the angle of fitting is 30°.

*This equation means that the sine of the anglo of fitting equals the set divided by the travel.

d. Additional Print Information for the Pipefitter: The pipefitter will come in contact with various types of pipe drawings. Pipe is used in many places and for many purposes in construction work. It is used primarily for the transportation of liquids and gases in the petroleum industry.

(1) Two View Piping Drawings: One or two views is all that is necessary to show most piping drawings, however, three views are sometimes used. This type of piping drawing is used very seldom used because it can be complicated. (See Figure 15)

(2) Isometric Piping Drawings: So that a piping drawing may be better traced and understood, the isometric type of projection is preferred.

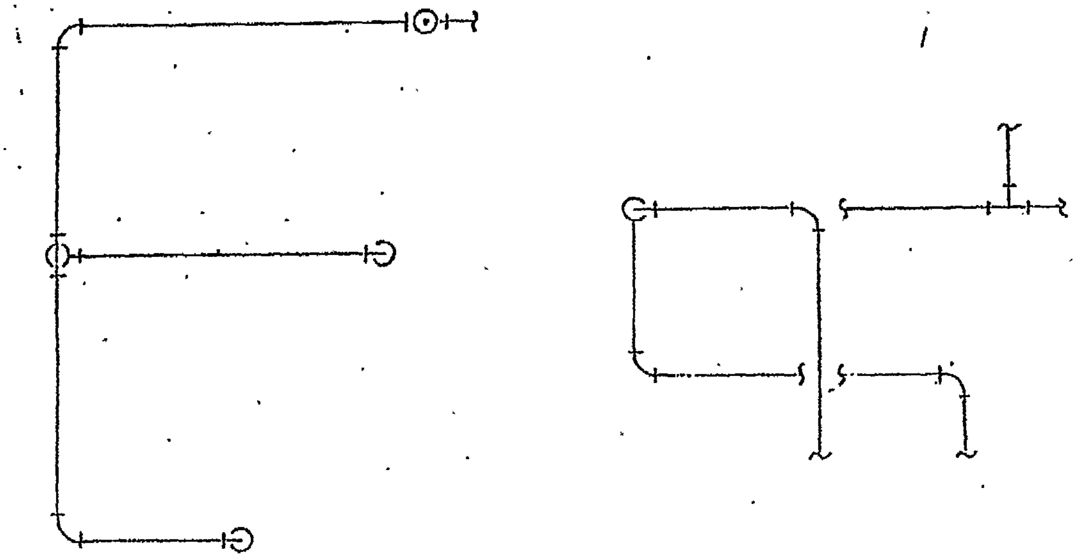
In a refinery, the greater part of piping work is the addition to or changing of lines already in service. In this case, isometric drawings are made of the existing piping systems with additions or changes shown in very heavy lines and noted on the drawing. As mentioned before, this type drawing is seldom drawn to scale, their purpose being to enable the pipefitter to form a mental picture of the completed system. (See Figure 16) NOTE: Figure 15 and Figure 16 are of the same assembly.

(3) One Line and Two Line Drawings: Piping drawings using the two line system resemble the actual pipe job more closely than the one line drawings. (See Figure 17A). One line drawings are the easiest and fastest to prepare, and for these reasons are used most often by Texaco, Inc. (See Figure 17B)

(4) Symbols and Conventions: Anyone who has installed pipefittings and valves knows that they are complicated pieces of mechanism. It will be readily seen that it is a waste of time for a draftsman to make complicated a working drawing of every gate valve to be installed in the field. The draftsman knows that a gate valve is and so does a fitter, so a note on a print is all that is necessary to convey the information. This applies to other types of valves and pipe fittings used in the field. In order to simplify the kraftsman's work, symbols for fitting and valves have been agreed upon and accepted by engineers and draftsmen.

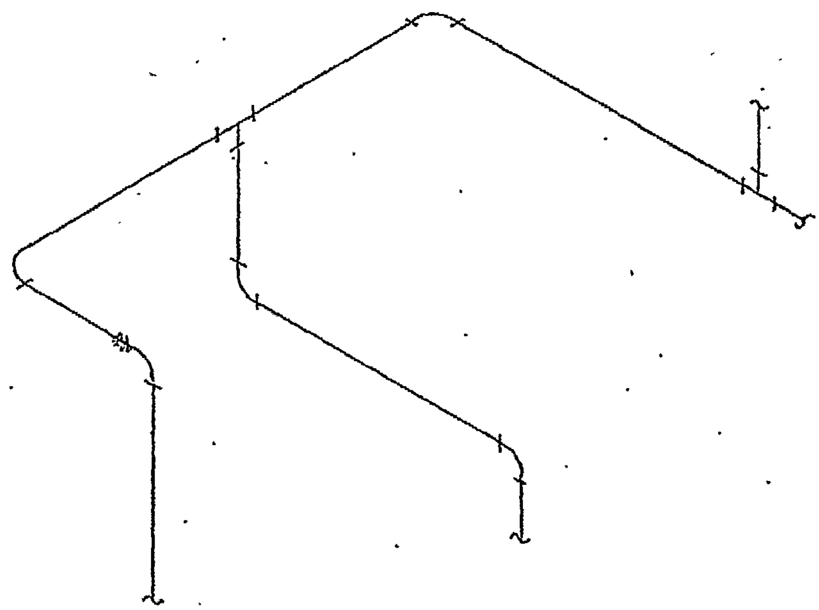
BY SRS DATE 10-15-68 SUBJECT Two View vs. Isometric Piping SHEET NO. ...... OF ......

CHKD. BY .... DATE .... JOB NO. ....



PLAN ELEVATION

FIGURE 1

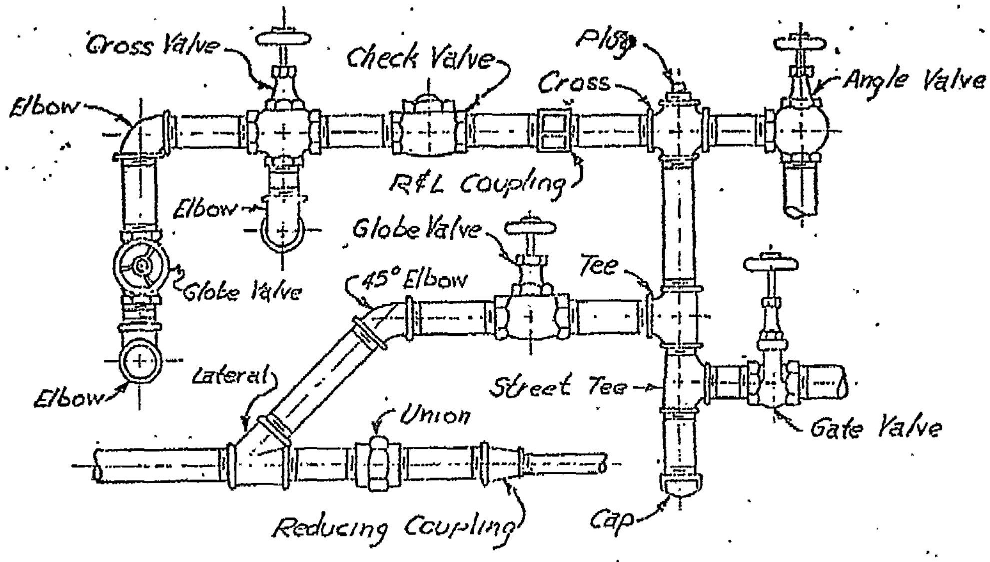


ISOMETRIC

FIGURE 1

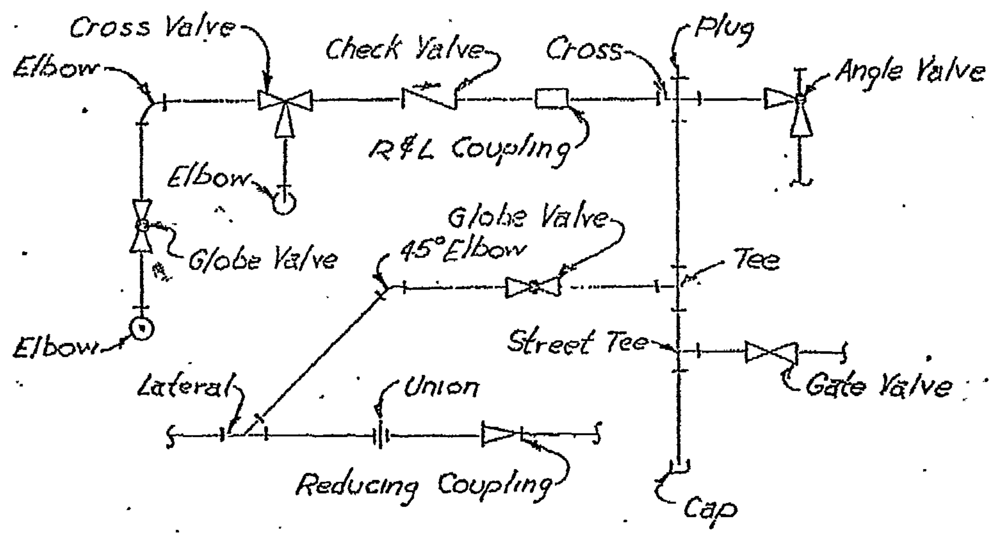
BY SRS DATE 11-16-68 SUBJECT Double Line vs. Single Line Drawings SHEET NO. ...... OF ......

CHKD. BY ...... DATE ...... JOB NO. ......



DOUBLE LINE PIPING DRAWING

A



SINGLE LINE PIPING DRAWING

B

FIGURE 17

The symbols of common pipe fittings are shown in Figure 18. Each symbol is drawn as simply as possible and to resemble the fitting being described. Symbols are given for screwed, flanged and welded fittings.

(5) Piping Details: Used primarily in the pipe and weld shops, piping detail drawings show how sections of piping should be fabricated. Often the detail drawings or spools are issued along with an assembly drawing (See Figure 19-24). The notations on the assembly drawing refer to the individual spool drawings.

(6) Dimensioning: The dimensions on a piping drawing are principally location dimensions most of which are made to center lines, both in double and single line representations. Flanged connections are dimensioned to the face of the Flange. Common dimensioning is then from center to center, face to face, center to face, end to end, center to end or face to end (See Figures 19-24 for examples of types of dimensioning.)

STANDARD PIPING SYMBOLS

SINGLE-LINE

SCREWED FLANGED WELDED

UNION
ELBOW
STREET ELBOW
TEE
CONCENTRIC
REDUCING ELBOW
ECCENTRIC REDUCER
LATERAL
RISE OR DROP IN LINE
CONN. TO MAIN - FROM TOP
" " " - FROM SIDE
" " " - FROM BOTTOM
ANCHOR
EXPANSION JOINT
PLUG COCK VALVE
GATE VALVE
GLOBE VALVE
CHECK VALVE
ANGLE VALVE
DIAPHRAGM OR CONTROL VALVE
MOTOR OPERATED VALVE
QUICK OPENING VALVE
RELIEF VALVE
MULTI-PORT VALVE

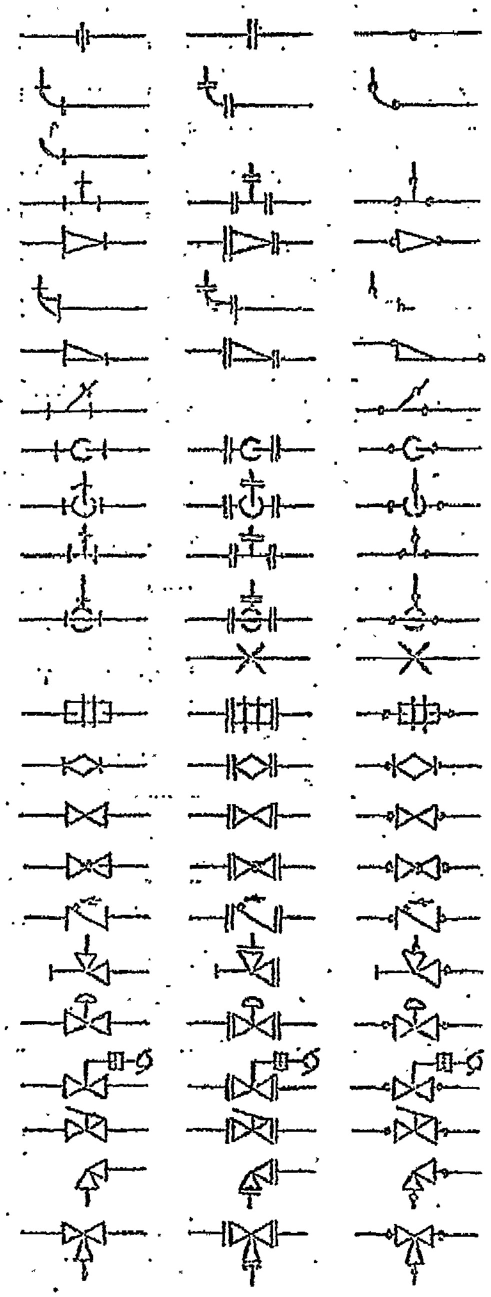


FIGURE 18

CHARGE EST 9593	BY CAM	TITLE @ FCCU V-406	PAGE 77
REF DWG PS. 1016-1 thru-5	DATE 8-18-67	RELIEF VALVE SYSTEMS	AS-1016
APPD	CHKD	PLNG (5)	DATE ISSUED 8-21-67

ASSEMBLY SKETCH

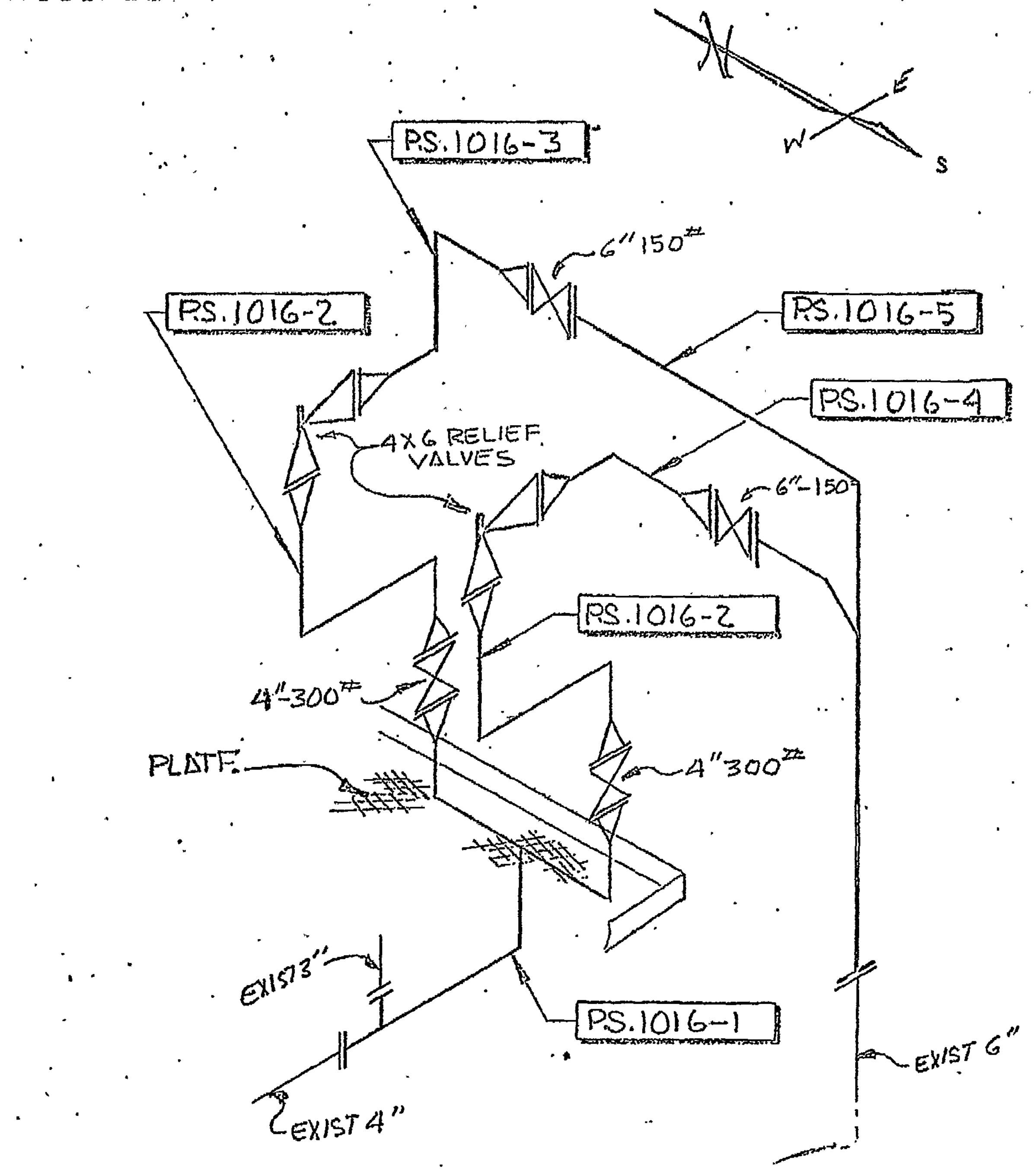
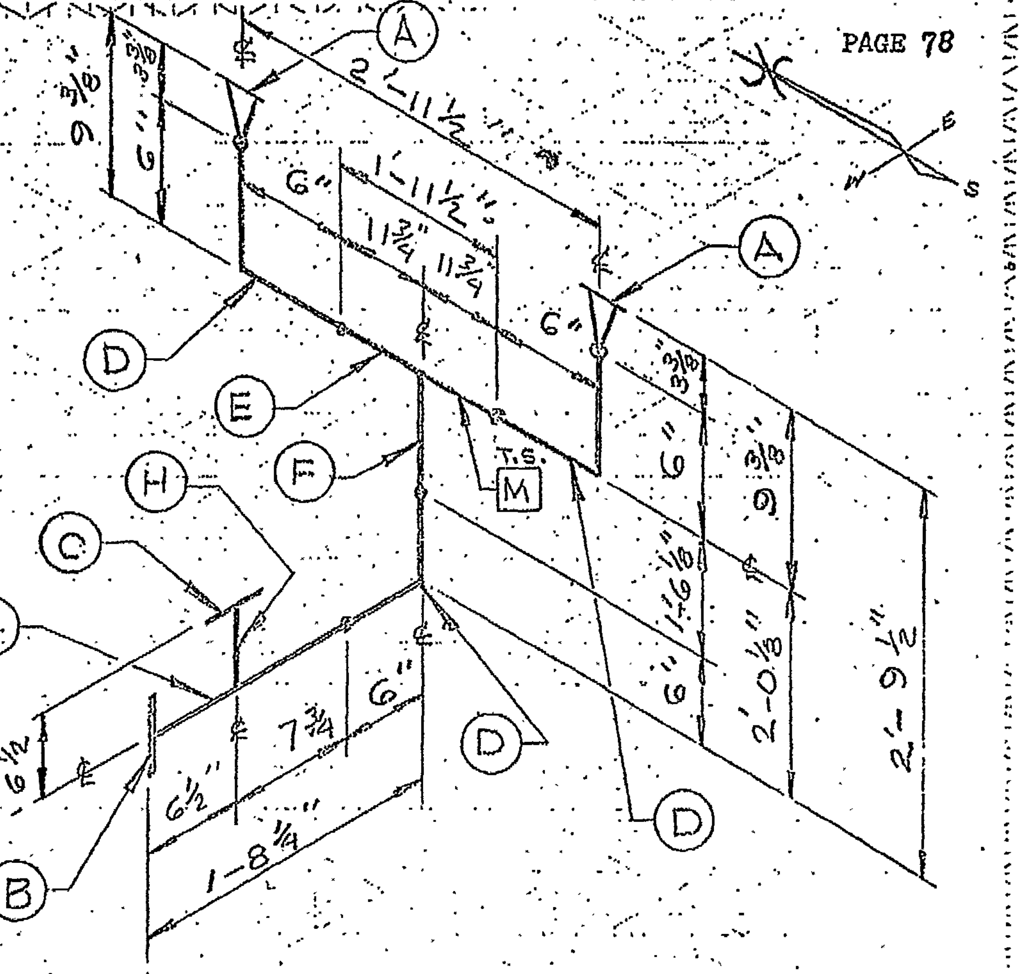


FIGURE 19

WA-TEX 001283

CHARGE EST 9593	BY LAM.	TITLE @ FCCU · V-406	
REF DWG	DATE 8-18-67	RELIEF VALVE SYSTEM	PS-1016-1
APPD	CHKD RW	B/M 4255	DATE ISSUED

ITEM A-14
TRAINING DETAILS



DIM'S BY
McKNIGHT

REQ'D 1 MARK PS.1016-1 SPEC J-15 STRESS RELIEVE NO

ITEM NO	REQ'D FOR ONE	SIZE	SCH OR BORE	WT OR CLASS	GRADE	TYPE	DESCRIPTION	FURN BY
A	2	4"		300#		RF WN	FLANGE	B/M 4255
B	1	4"		300#		RF SO	FLANGE	
C	1	3"		300#		RF SO	FLANGE	
D	3	4"		STD		LR 90°	WELD ELL	
E	1	4"	40			SMLS	PIPE (BBE) 1'-11 1/2"	
F	1	4"	40			SMLS	PIPE (SIE-BE) 1-5 5/8"	
G	1	4"	40			SMLS	PIPE (PIE-BIE) 1'-1 3/4"	
H	1	3"	40			SMLS	PIPE (PIE-SIE) 4 7/8"	B/M 4255
							FIGURE 20	

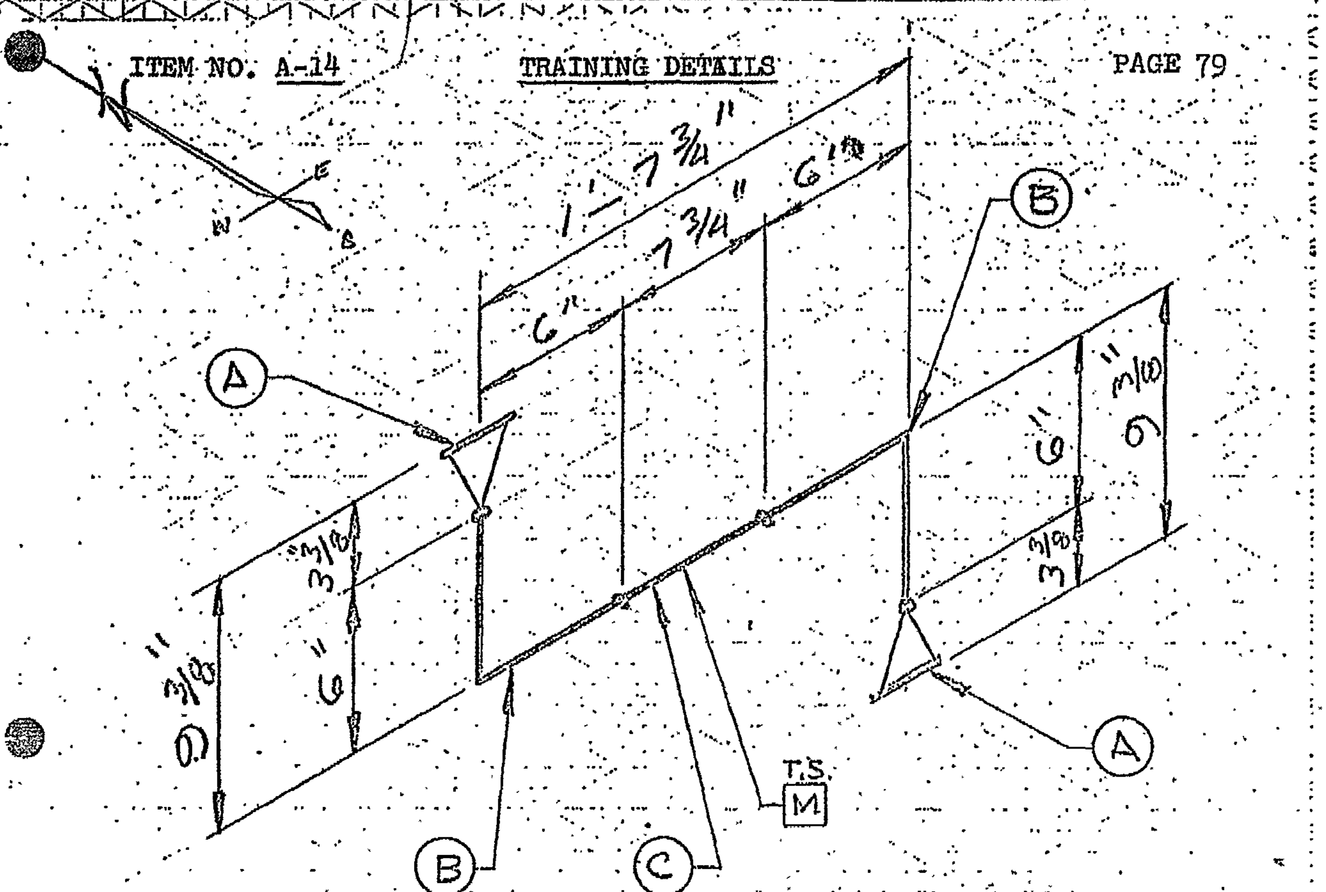
MASTER #510

5-66

WA-TEX 001284

CHARGE 51-9593	BY LAM	TITLE @ FCCU V-406		PLAN.. L..
REF DWG	DATE 8-18-67	RELIEF VALVE SYSTEM		PS-1016-2
APPD	CHKD JCW	B/M 4255		DATE ISSUED

ITEM NO. A-14 TRAINING DETAILS PAGE 79



DIM'S BY McKNIGHT

REQ'D 2 MARK PS. 1016-2 SPEC U-15 STRESS RELIEVE NO

ITEM NO	REQ'D FOR ONE	SIZE	SCH OR BORE	WT OR CLASS	GRADE	TYPE	DESCRIPTION	FURN BY
A	2	4"		300#		RFWN	FLANGE	B/M 4255
B	2	4"		STD		LR 90°	WELD ELL	B/M 4255
C	1	4"	40			SMLS	PIPE (BBE) 7 3/4"	B/M 4255
D								
E								
F								
G								
H								

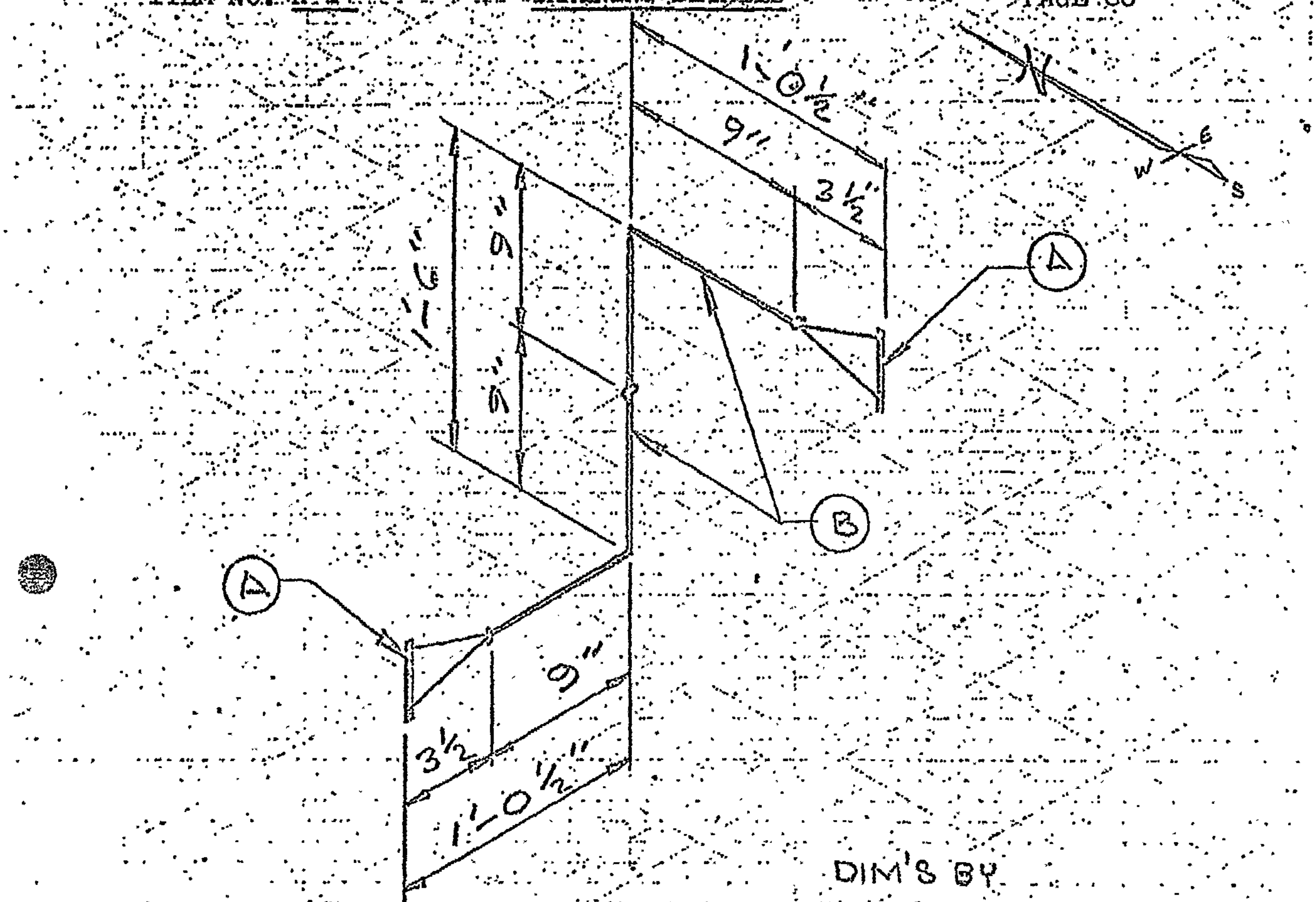
M... TER #510

5-66

WA-TEX 001285

CHARGE EST9593	BY LAM.	TITLE @ FCCU V-406	TEXACO LA
REF DWG	DATE 8-18-60	RELIEF VALVE SYSTEMS	PS-1016-3
APPD	CHKD	B/M 4255	DATE ISSUED

ITEM NO. A-14 TRAINING DETAILS PAGE 80



DIM'S BY McKNIGHT

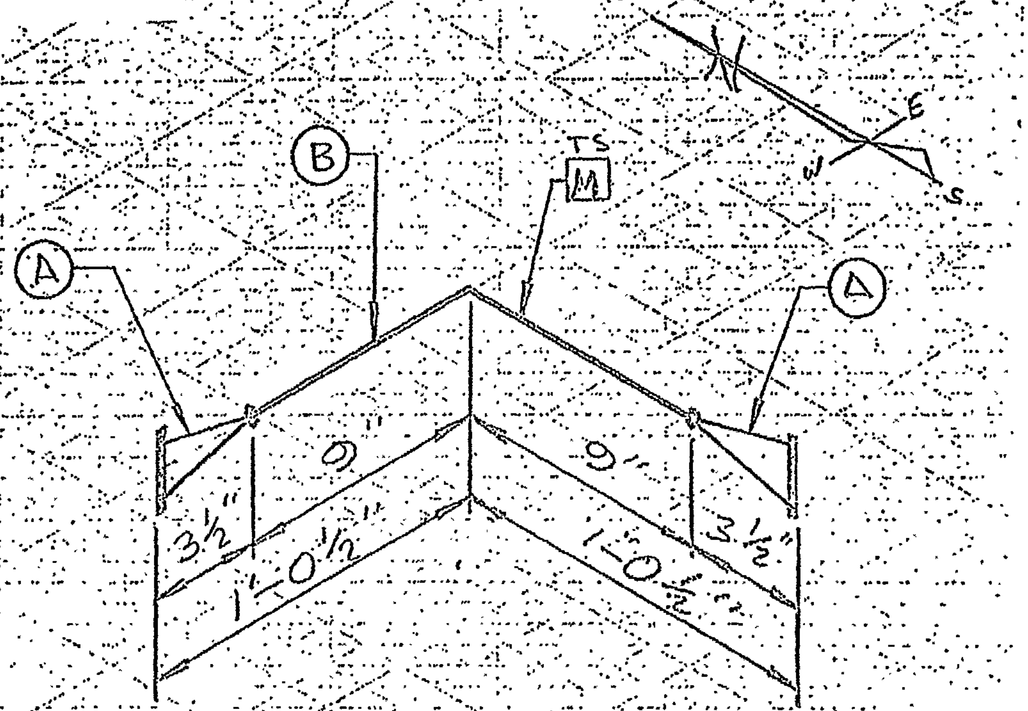
REQ'D 1 MARK PS.1063-3 SPEC U-15 STRESS RELIEVE NO

ITEM NO	REQ'D FOR ONE	SIZE	SCH OR BORE	WT OR CLASS	GRADE	TYPE	DESCRIPTION	FUR BY
A	2	6"		150#		RF WN	FLANGE	BM 425
B	2	6"		STD		LR 90°	WELD ELL	BM 425
C								
D								
E								
F								
G								
H								

FIGURE 22

CHARGE EST9593	BY LAM	TITLE @ FCCU V-406	TEXACO · LA
REF DWG	DATE 8-18-67	RELIEF VALVE SYSTEM	PS-1016-4
APPD	CHKD	B/M 4255	DATE ISSUED

ITEM NO. A-14 TRAINING DETAILS PAGE 81



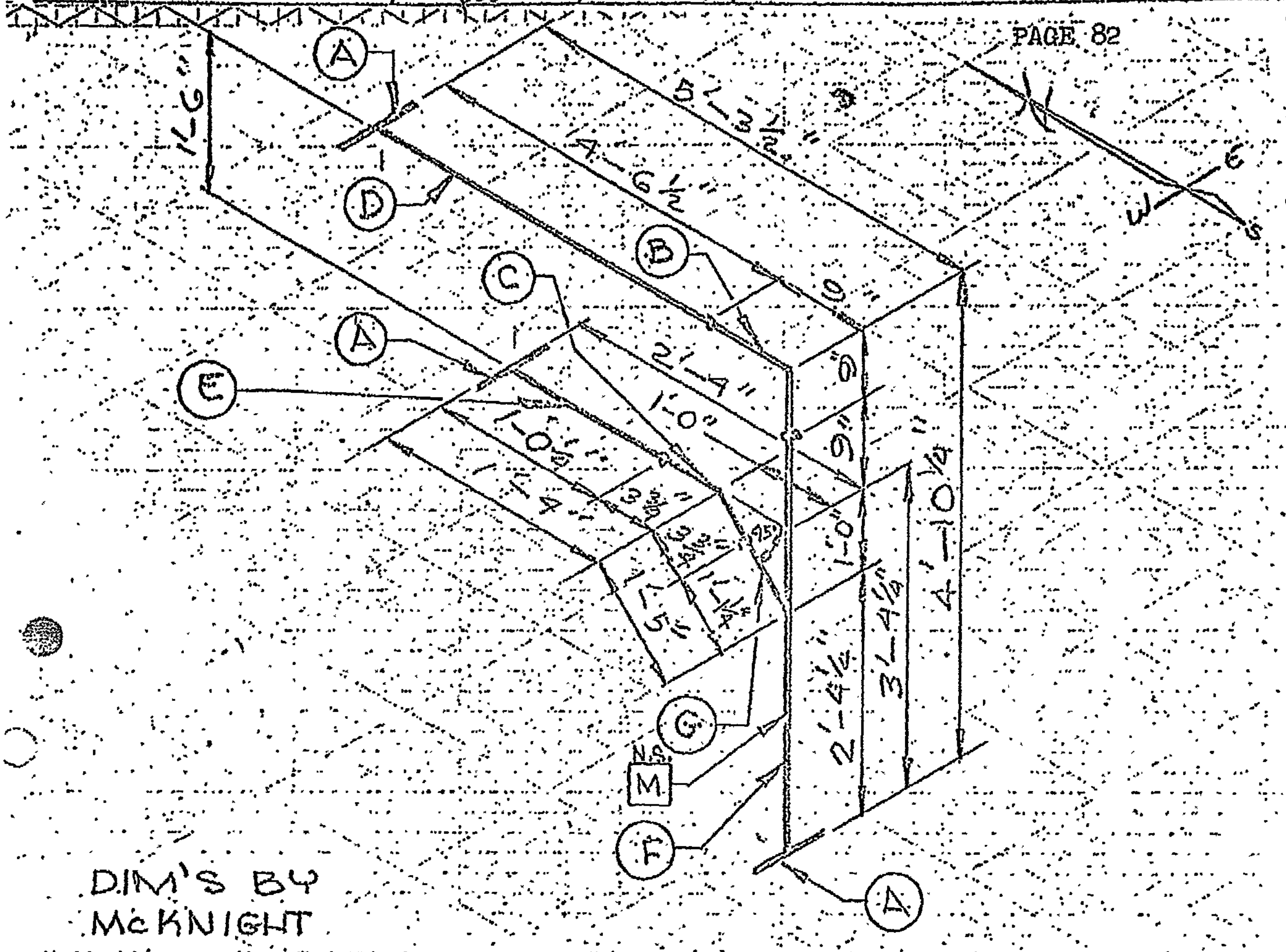
DIM'S BY
McKNIGHT

REQ'D 1 MARK PS.1016-4 SPEC U-15 STRESS RELIEVE NO

ITEM NO	REQ'D FOR ONE	SIZE	SCH OR BORE	WT OR CLASS	GRADE	TYPE	DESCRIPTION	FUR BY
A	2	6"		150#		RFWN	FLANGE	B/M 425
B	1	6"		STD		LR90°	WELD ELL	B/M 425
C								
D								
E								
F								
G								
H								
							FIGURE 23	

WA-TEX 001287

CHARGE EST9593	BY LAM	TITLE @ FCCU V-406	TEXACO LA
REF DWG	DATE 8-18-67	RELIEF VALVE SYSTEMS	PS-1016-5
APPD	CHKD	D/M 4285	DATE ISSUED



REQ'D 1 MARK PS 1016-5 SPEC U-15 STRESS RELIEVE NO

ITEM NO	REQ'D FOR ONE	SIZE	SCH OR BORE	WT OR CLASS	GRADE	TYPE	DESCRIPTION	FUR BY
A	3	6"		150#		RFSO	FLANGE	B/M 425
B	1	6"		STD		LR90°	WELD ELL	
C	1	6"		STD		LR45°	WELD ELL	
D	1	6"	40			SMLS	PIPE (B/E-P/E) 4'-6"	
E	1	6"	40			SMLS	PIPE (B/E-P/E) 11 3/4"	
F	1	6"	40			SMLS	PIPE (B/E-P/E) 4'-0 3/4"	
G	1	6"	40			SMLS	PIPE (B/E-S/E) 1'-1 1/4"	B/M 425
H								
							FIGURE 24	

STE 10

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. A-15

SUBJECT: MEASURING AND LAYOUT METHODS AND TOOLS

a. MEASURING:

(1) Principles of piping measurement, like piping prints, may at first glance seem somewhat complicated when a number of lines are involved. However, when the job is taken a section at a time, it will be found that developing measurements are relatively simple.

(2) The greater majority of piping jobs in a refinery will normally be replacement or addition to existing lines.

b. REFERENCE POINTS:

(1) In order to make accurate piping measurements, it is necessary to know and accurately locate the points from which measurements are taken. These are known as reference points.

(2) Reference points may be center lines, flange faces, vessel walls or stanchions.

c. LAYOUT METHODS AND TOOLS:

(1) Top and side center lines may be easily located with a carpenter's square and level as shown in the following Figure 1.

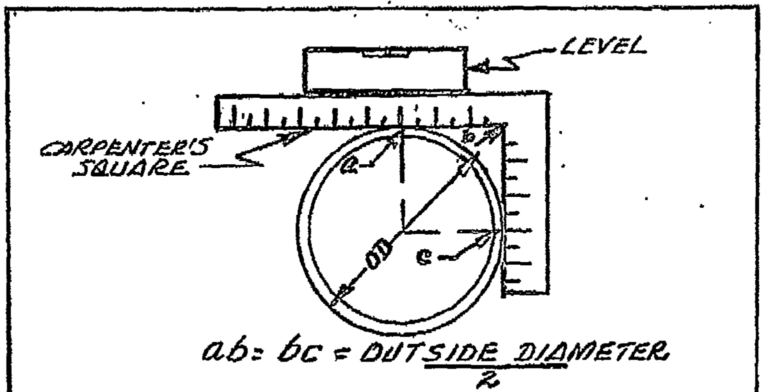


FIGURE 1

The inside angle of the square is placed against the pipe and the top leg levelled. One point on the center is located under the scale at a distance from the inside angle of the square, equal to 1/2 the outside diameter (OD) of the pipe.

Repeating the process at another section of the pipe will locate a second point, and a line connecting the two points will be the top center line. Applying the same method to the vertical leg of the square will locate the quarter point center lines.

Bottom center lines may be easily located by dropping a plumb line from the top center points, and making the points of intersection on the bottom of the pipe, shown in following Figure 2:

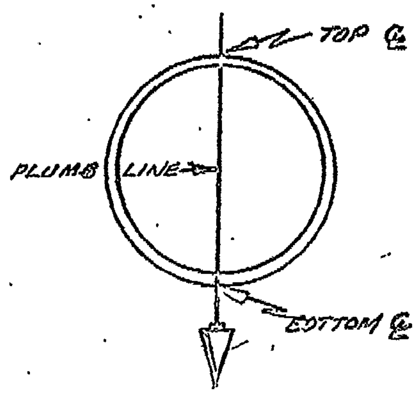


FIGURE 2

(2) The measurement between two lines with different elevations can be found with a straight edge and level as shown in following drawing. (Figure 3)

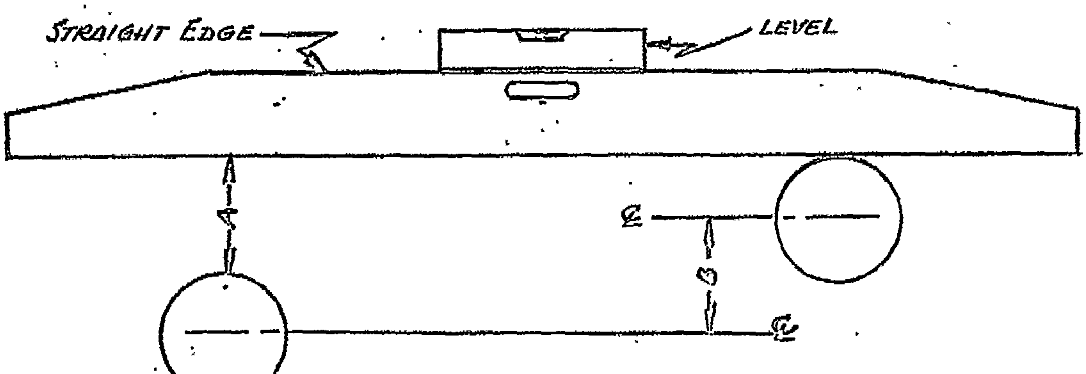


FIGURE 3

Place a straight edge on the top of the high elevation and across the top of the low elevation.
Level the top of straight edge.
Take a measurement at point "A", from top of low elevation to bottom of straight edge.
Point "A" is the same measurement as point "B". Giving you the center to center elevation difference between the two lines.

(3) In determining the Angle of intersection, where the angle of intersection is unknown, it must of course be determined before proceeding with the measurement and layout of the job.

The angle of intersection may be determined by stretching chalk lines in the position so that the center lines of the proposed piping job will be located. Use a protractor to measure the angle of intersection directly. See following drawing (Figure 4):

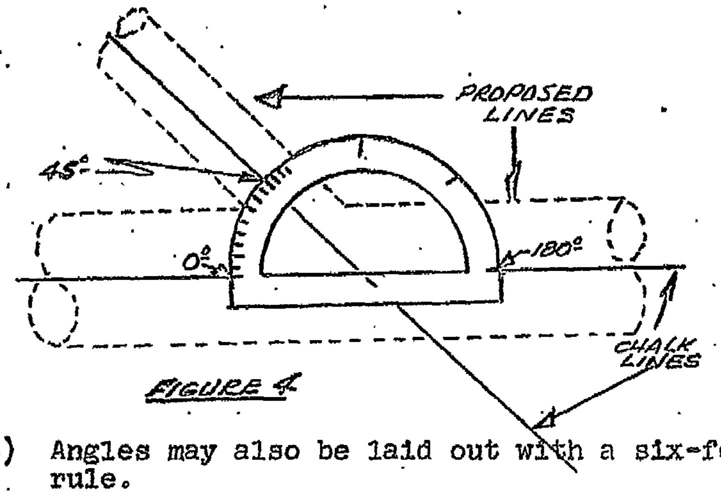


FIGURE 4

(4) Angles may also be laid out with a six-foot folding rule.

Settings for Various Angles

Degrees	Set On
5	24
10	23-15/16
15	23-7/8
20	23-23/32
22-1/2	23-23/32
25	23-5/8
30	23-1/2
35	23-3/8
40	23-3/16
45	22-31/32
50	22-3/4
55	22-1/2
60	22-1/4
65	21-15/16
70	21-11/16
75	21-3/8
80	21-1/32
90	20-9/32

For a 45 degree angle, bend the rule at the first and second joints, setting the end on 22 and 31/32 inches as indicated in Table above. The desired angle will be formed as shown in following drawing. (Figure 5)

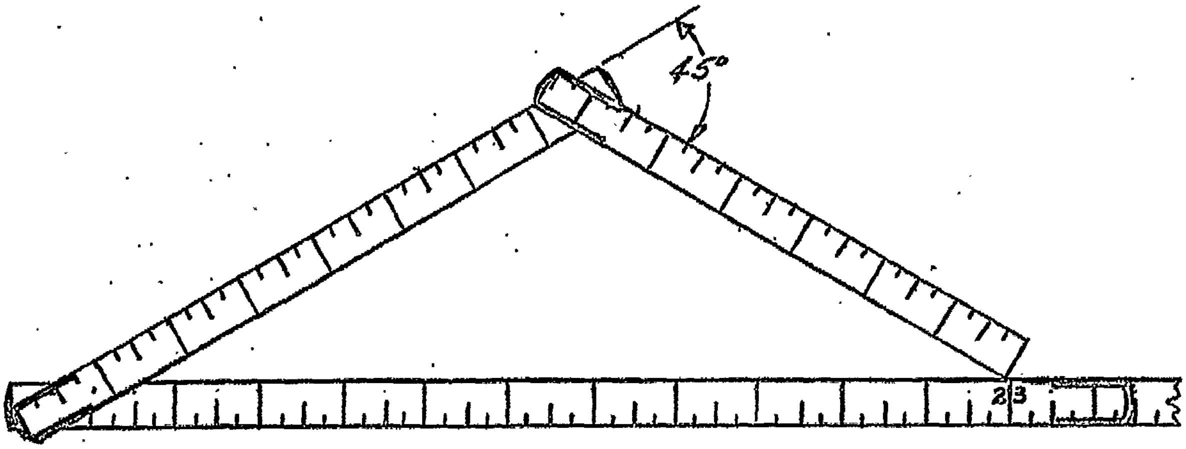


FIGURE 5

(5) When necessary to layout to cut odd-angle elbows, reference should be made to the tables shown in the "PipeFitters and Pipe Welder's Handbook" on pages 31, 32, 33 and 34.

(6) Patented bending machines are available and are used to a great advantage, especially for bending small pipe sizes.

These bending machines are mechanically operated by leverage.

Accurate bends can be obtained with the machine and either hot or cold bending methods may be used.

The machine has a separate form for each radius bend. The pipe is forced around this form by a bending shoe, which fits the outside radius of the bend. This helps to prevent the pipe from flattening.

The bending process is one involving skills that must be learned in actual practice on the job. For example, when a bend is cooling, it has a tendency to straighten, and therefore must be bent to an arc slightly greater than that of the template.

It is recommended when bending small pipe that a wire template be made of the degree of bend to be made to use for reference.

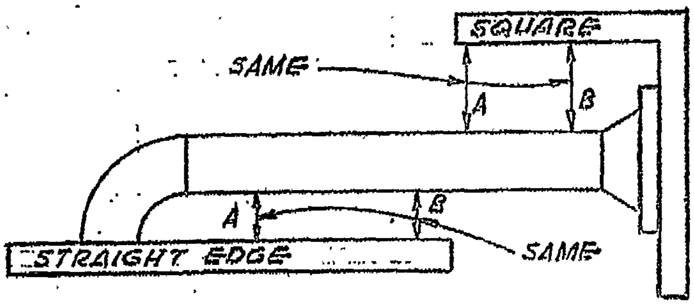


FIGURE 1

As seen in Figure 1, the measurements of A & B must be the same in order for the flange and 90° ell to align properly with the pipe and each other.

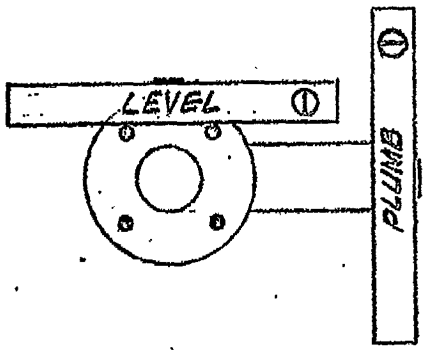


FIGURE 2

In Figure 2, the flange must be two holed or leveled, as shown above, with 90° ell being plumbed. This way the 90° ell will be aligned properly with flange.

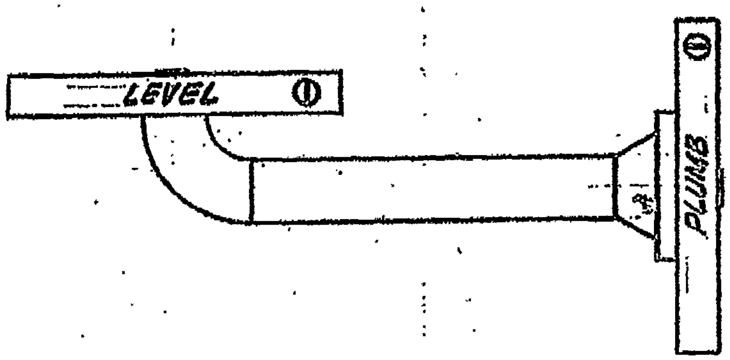


FIGURE 1

As seen in Figure 1, you can level 90° ell and plumb flange to align properly with the pipe and each other.

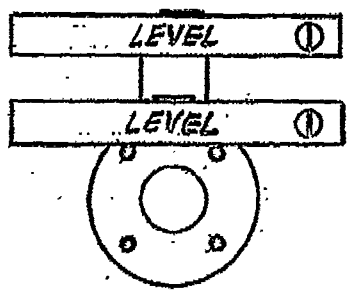


FIGURE 2

In Figure 2, the flange must be two holed or leveled with 90° ell being leveled to properly align flange with 90° ell.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. A-16

SUBJECT: CARE AND PURPOSE OF SHOP EQUIPMENT

A. PURPOSE

(1) The hacksaw is to be used to cut 1/4" to 6" pipe, flat bar, roll and angle stock. The hacksaw can be set to cut 90°, 45°, and 22½° angles. Be sure to use oiler.

(2) The pipe machine is used to thread ½" to 2" pipe. The pipe dies have to be set to the size pipe you have to thread. A sample thread should be run to be sure dies are set right. Be sure to use oiler.

(3) The power grinder is to be used to sharpen tools, bevel pipe, flat bar, etc. and clean up material. Wear goggles at all times. Use front, not side, of grinder.

(4) The iron worker is used to punch holes, cut flat bar, angle and round stock. Read instructions on machine for maximum capacity.

B. CARE

(1) The hacksaw is to have a sharp blade in it in order to get a straight and clean cut. Check to be sure oil level in tank is okay, if not, use soluble oil C and mix 30-1 and put into tank. Keep area clean.

(2) The pipe machine is to have dies cleaned before each use. Check dies to be sure none are broken or chipped. Be sure oil level is okay, if not, use cutting oil Sultex-340. Area is to be kept clean at all times.

(3) The power grinder is to be kept round by a wheel dresser kept at the machine. Check for cracks or chips. Keep area clean.

(4) The iron worker should be checked for broken or chipped punches and dies. Keep machine greased and area cleaned.

TRAINING DETA..S

DEPARTMENT: PIPE DATE: J.. . .. 19.9
CLASSIFICATION: PIPEFITTER (TRAINEE)

ITEM NO. A-17 SUBJECT: TAKING FIELD MEASUREMENTS AND JOB PLANNING

a. FIELD MEASUREMENTS

(1) This unit of instruction will be devoted to the illustration of various reference points from which measurements are taken.

(2) As seen in Figure 1, the measurement "M" is taken from center to center, and will give the proper information in calculating cuts for any connections between the two lines. The same measurement can be obtained at "O" without locating center lines.

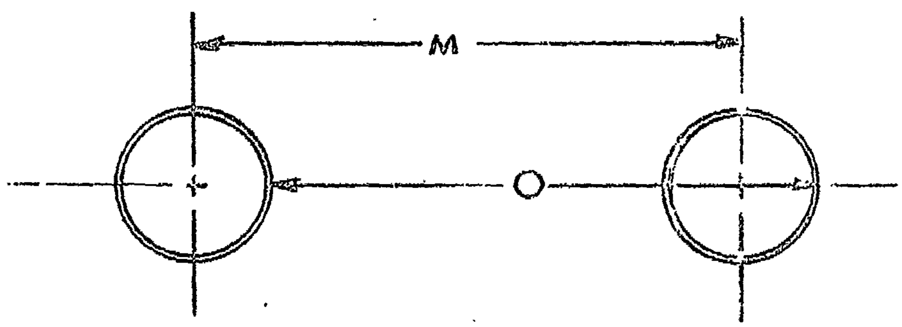


FIGURE 1

(3) In Figure 2, a connection is to be made between the two lines illustrated. The measurement "M" is a Face to Center measurement. "C" is a center to center measurement, but allowances would have to be made for the weld neck flange and welded ell already in place.

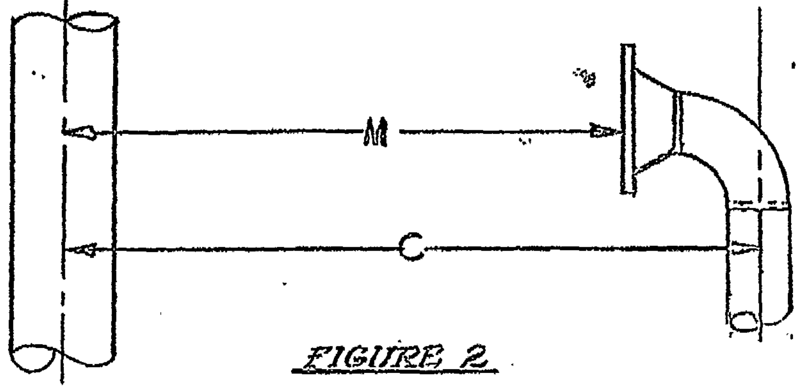


FIGURE 2

(4) Figure 3, illustrates a measurement taken between two flange faces, which could be a Face to Face measurement.

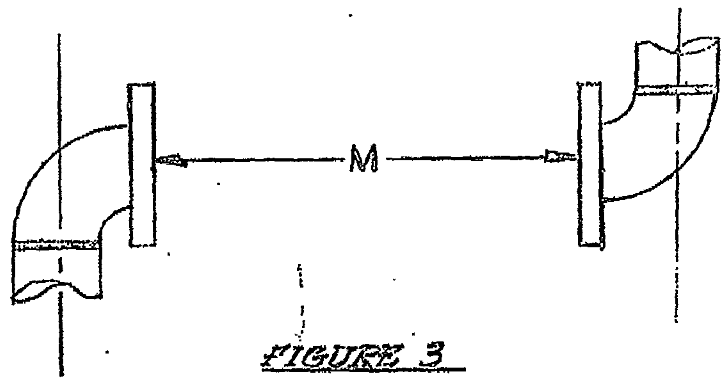


FIGURE 3

(5) In Figure 4, the welded ell dimension "F" is deducted from the measurement "M" to determine the length of the cut "C". The dimension "F" is known as the "take off". The "M" measurement is a center to end measurement.

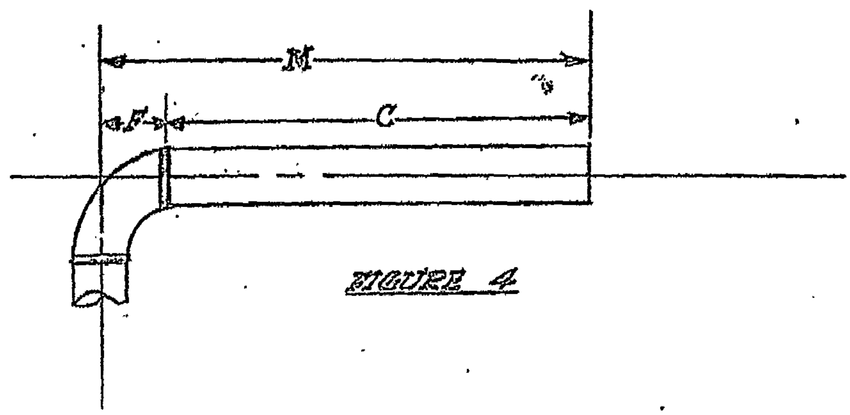


FIGURE 4

(6) Many variations of reference points will be found in taking field measurements. These 4 illustrations show the basic measurements used:

Figure 1 - Center to Center (℄ to ℄)
Figure 2 - Center to Face (℄ to F)
Figure 3 - Face to Face (F to F)
Figure 4 - Center to End (℄ to E)

b. FITTING ALLOWANCES

(1) In calculating cuts for piping installations, it is of course necessary to deduct from field measurements the space that will be taken up by the fittings to be installed.

(2) Manufacturers of pipefittings have standardized dimensions on all types, classes and weights of welded fittings. For example, all welded ells of the same classification and size are made to uniform dimensions. See chart "Dimensions of Valves and Fittings."

(a) Using the fitting dimensions table, determine the fittings needed, and the cuts of pipe needed to install the job shown in Figure 5, Installing 6" 300# Steel Gatevalve. Center to Center measurement "M" between the existing lines is 78 inches.

(b) It would be difficult to remember all dimensions of all sizes and types of fittings, so hand books and manuals are provided with tables of dimensions. i.e. (Pipe Fitters Manual-Tube-Turn, Welding Fittings and Flanges), (The Pipe Fitter's and Pipe Welder's Handbook).

Dimensions of Valves and Fittings

Welding Fittings, Tube Turn (Center to End)

Pipe Size, In.	W.I. with S.O.	Tee	S.R.E.	L.R.E.	45° E.	Weld Neck 15	Weld Neck 30	Weld Red. Size
½				1½	⅝	1⅞	2 1/16	
¾		1⅛		1⅛	7/16	2 1/16	2¼	
1		1½	1	1½	⅞	2 3/16	2 7/16	2
1¼		1⅞	1¼	1⅞	[illegible]	2¼	2 9/16	2
1½		2¼	[illegible]	2¼	[illegible]	[illegible]	[illegible]	2½
2	3 3/16	2½	2	3	1⅜	2½	2¾	3
2½	4 5/16	3	2½	3¾	1¾	2¾	3	3½
3	5 1/16	3⅜	3	4½	2	2¾	3⅛	3½
3½	5 9/16	3¾	3½	5¼	2[illegible]	2 15/16	3 5/16	4
4	6 3/16	4⅛	4	6	2½	3	3⅜	4
5	8 1/16	4⅞	5	7½	3[illegible]	3½	3⅞	5
6	9 9/16	5⅝	6	9	[illegible]	3½	3⅞	5½
8	12 9/16	7	8	12	[illegible]	4	4⅜	6
10	15 1/16	8½	10	15	[illegible]	4	4⅝	7
12	18 3/16	10	12	18	7½	4½	5⅛	8
14	21 3/16	10⅞	14	21	8¾	[illegible]	5⅝	13
16	24 3/16	12	16	24	10	5	5⅝	14
18	27 3/16	13½	18	27	11 3/16	5½	6¼	15
20	30 3/16	15	20	30	12½	5 11/16	6⅞	20
24	36 3/16	17	24	36	14 15/16	[illegible]	[illegible]	20

Steel Fittings

Pipe Size, In.	C to F 15	C to F 30	Gates 15	Gates 30	Globes 15	Globes 30	Flg. Diam. 15	Flg. Diam. 30	B.C. 15	B.C. 30	No. & Size Bolts & Studs 15	No. & Size Bolts & Studs 30	Gaskets 15/30
½							3½	3¾	2⅜	2⅝	4–½x1½ 2¼	4–½x2 2½	½x1⅜ 2⅝
¾							3⅞	4⅝	2¾	3¼	4–½x1¾ 2½	4–⅝x2 3	¾x2¼ 2⅞
1	3½	4					4¼	4⅞	3⅛	3½	4–½x1¾ 2½	4–⅝x2¼ 3	1x2⅝ 2⅞
1¼	3¾	4¼					4⅝	5¼	3½	3⅞	4–½x2 2½	4–⅝x2¼ 3	1¼x3 [illegible]
1½	4	4½					5	6⅛	3⅞	4½	4–½x2 2¾	4–¾x2½ 3½	1½x[illegible]
2	4½	5	7	8½	8	10½	6	6½	4¾	5	4–⅝x2¼ 3	8–⅝x2½ 3¼	2x[illegible]
2½	5	5½	7½	9½	8½	11½	7	7½	5½	5⅞	4–⅝x2½ 3¼	8–¾x3 4	2½x[illegible]
3	5½	6	8	11⅛	9½	12½	7½	8¼	6	6⅝	4–⅝x2½ 3½	8–¾x3¼ 4¼	3x5 [illegible]
3½	6	[illegible]	8½	11½	10½	13½	8½	9	7	7¼	8–[illegible]	8–¾x3¼ 4¼	3½x[illegible]
4	6½	7	9	12	11½	14	9	10	7½	7⅞	8–[illegible]	8–¾x3½ 4½	4x6⅞ 7⅛
5	7½	[illegible]	10	15	14	15¾	10	11	8½	9¼	8–[illegible]	8–¾x[illegible] 4¾	5x7¾ 8½
6	8	[illegible]	10½	15⅞	16	17½	11	12½	9½	10⅝	8–[illegible] 4	12–¾x4 4¾	6x8¾ 9⅞
8	9	[illegible]	11½	16½	19½	22	13½	15	11¾	13	8–[illegible]	12–[illegible] 5¼	8x11 12⅜
10	11	[illegible]	13	18			16	17½	14¼	15¼	12–[illegible]	16–[illegible]	[illegible]x13⅜ 14⅛
12	12	[illegible]	14	19¾			19	20½	17	17¾	12–[illegible]	16–1¼x[illegible]	12x16⅛ 16⅝
14	14	[illegible]	[illegible]	30			21	23	18¾	20¼	12–[illegible]	20–1¼x[illegible]	[illegible]x17⅝ 19⅛
16	15	[illegible]	16	33			23½	25½	21¼	22½	16–1[illegible]	20–1¼x[illegible]	[illegible]x20⅛ 21¼
18	16	[illegible]	17	36			25	28	22¾	24¾	16–1[illegible]	24–[illegible]	17⅞x21⅝ 17x23¼
20	18	[illegible]	[illegible]	39			27½	30½	25	27	20–[illegible]	24–[illegible]	19⅞x23⅞ 19x25¾
24	22	[illegible]	[illegible]	[illegible]			32	[illegible]	29½	32	20–[illegible]	[illegible]	23⅞x28¼ 23x30½

Screwed Fittings

Pipe Size, In.	Thread Penetration	Exposed Length Thread-Short Nip.	Std. Mal. Iron C to E	300 Mal. Iron C to E	3000 Forg'd St'l C to E	F.S. Union E to E	M.I. Union 300# E to E
½	½	½	1⅛	1¼	1⅛	1 15/16	1 15/16
¾	½	1	1 5/16	1 7/16	1⅜	2¼	2¼
1	⅝	¾	1½	1⅝	1½	2 7/16	2 7/16
1¼	⅝	1¼	1¾	1 15/16	2	2 13/16	2 13/16
1½	11/16	1¼	1 15/16	[illegible]	2¼	3	3
2	¾	1	2¼	2½	2⅜	3⅜	3⅜
2½	1	1	2 11/16	2 15/16	3¼	4	4
3	1	1	3 1/16	3⅜	3¾	4 5/16	4 5/16
3½	1⅛	1⅜	3 7/16	4⅛			
4	1⅛	1½	3 13/16	4½			
5	1¼	2	4½	5[illegible]			
6	1¼	2	5⅛	6[illegible]			

BASE ELLS

Pipe Size	Supp't Pipe	Plate Size
1½	[illegible]	[illegible]x5"
2	[illegible]	[illegible]x5"
3	[illegible]	[illegible]x5"
4	2	[illegible]x6"
6	[illegible]	[illegible]x7"
8	4	[illegible]x8"
10	[illegible]	[illegible]
12	[illegible]	[illegible]x12"

Handwheels and **Pipe Wall Thick. A.S.A. Std. Sched.**

Pipe Size, In.	Gate 15 L	Gate 15 D	Gate 30 L	Gate 30 D	Globe 15 L	Globe 15 D	Globe 30 L	Globe 30 D	Wall 40	Wall 80
½									.109	.147
¾									.113	.154
1									.133	.179
1¼									.140	.191
1½									.145	.200
2	16¼	8	18¼	8	13¾	8	17¾	9	.154	.218
2½	17½	8	21¼	9	14½	8	19	10	.203	.276
3	21	9	25	10	16½	9	20½	10	.216	.300
3½	22½	9	26¼	10	17¼	9	22¼	12	.226	.318
4	26	10	31	12	19¾	10	24¾	14	.237	.337
5	31	12	34½	14	23	10	26½	16	.258	.375
6	34½	12	38½	16	24½	12	29½	18	.280	.432
8	42½	14	48	20	26	16	35½	24	.322	.500
10	51½	18	50	24					.365	.593
12	59¼	20	66¼	24					.406	.687
14	70¼	22	74¼	27					.437	.750
16	80	24	80½	27					.500	.843
18	89	27	91	30					.562	.937
20	97¼	30	100¼	36					.593	1.031
24	[illegible]	30	120¼	36					.687	1.218

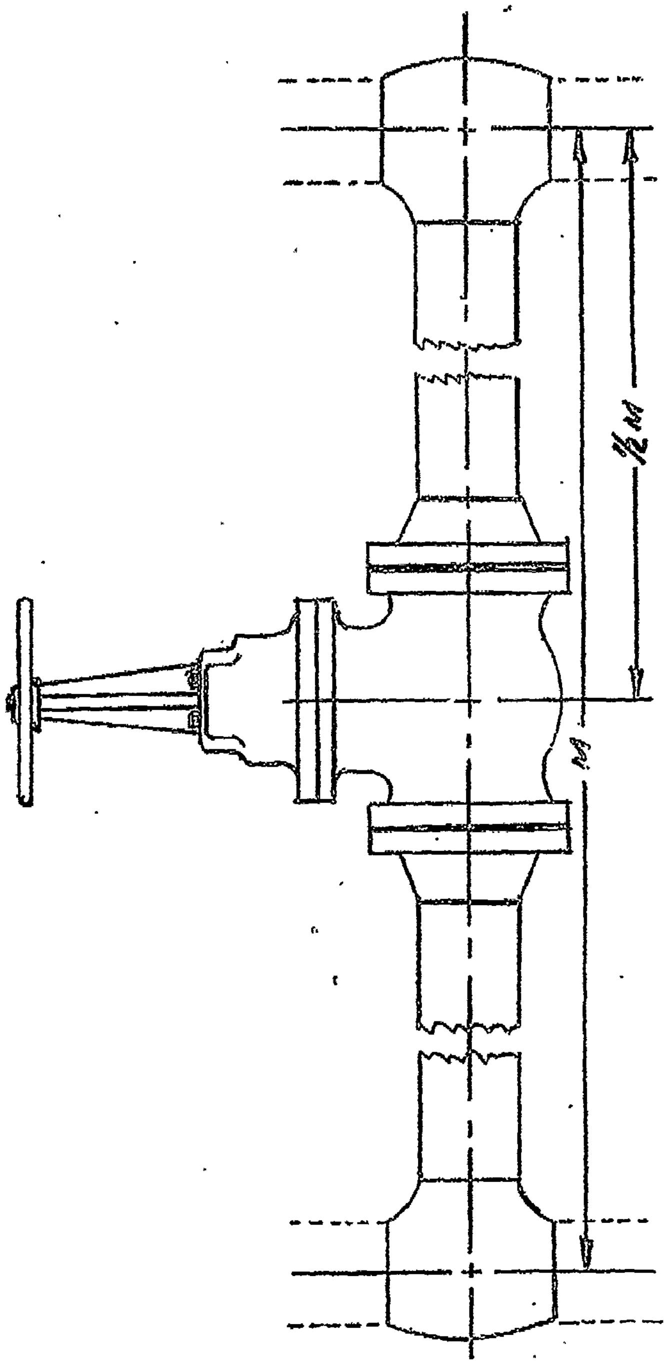


FIGURE 5

c. JOB PLANNING:

(1) Before measuring or laying out a pipe job, you should pick a route for the new line. Be sure you have a clear path from starting point to finish point. Avoid running lines that will cause stumbling hazards such as, too low across aisleways, across ladders and cat walks. Also leave head room for over-head valves and lines.

(2) It is important that field measurements be recorded in a manner that may be easily understood in figuring cuts to assemble the job. A simple field sketch will serve the purpose, making sure that all dimensions are recorded, size and schedule of pipe, size and weight of valves and fittings.

(3) Compile a list of equipment and material needed for the job before ordering.

(4) Lines or vessels must be gas freed before making a new tie-in on existing equipment. Obtain a safety work permit from operations to blind and steam.

(5) When welding is to be done, all sewers and drains must be covered in the immediate area to prevent escaping gas fumes from flashing during welding operation.

(6) After steaming is completed a Hot Work permit must be obtained from operations. A gas test must be taken, and Gas Tester must O.K. and sign the permit before the equipment can be cut into with a cutting torch or pipe cutters.

CAUTION: READ PERMIT AND MAKE SURE ALL SAFETY PRECAUTIONS OR SPECIAL EQUIPMENT REQUIRED AS LISTED ON THE PERMIT ARE FOLLOWED.

(7) In some cases when a line cannot be gas freed, a Hot Work Permit can be issued to cold cut. In order to weld on this line, a welding plug or pipe plug must be inserted into the line. Run a hose from the pipe plug connection a safe distance away from the area of welding. Gas test then must be taken around the pipe plug to be sure no gas fumes are escaping.

CAUTION: IT IS ADVISABLE THAT SLIP-ON-WELD FLANGES ONLY USED ON THIS TYPE OF JOB. ONE TO THE INSIDE WELD BEAD ON HIGH HUB WELD FLANGES PIPE PLUGS ARE VERY DIFFICULT TO EXTRACT FROM LINES.

d. JOB PLANNING-WORKING FROM BILLS OF MATERIAL AND PRINTS:

(1) Read the Bill of Material to be sure the proper fittings and pipe have been ordered to complete

or start a job. Some items will have a storehouse order number, check to see if material has been received or when it is expected to be received.

(2) In most cases, a print is provided with the Bill of Material. Read every detail on this print, trace the lines out from starting point to finish point to insure a clear layout path.

(3) After completing job, return all tools, equipment and excess material to its proper storage area. Clean up the job and leave it in a safe working condition

e. SCREWED PIPE AND FITTINGS:

(1) In Figure 6, showing a screwed fitting, "F" represents the fitting dimension and "M" the measurement.

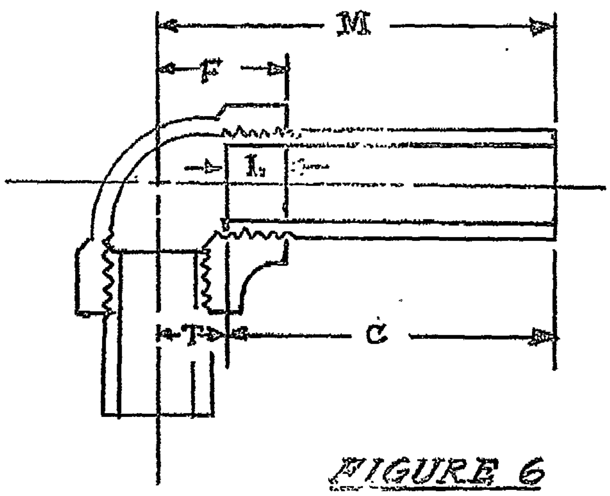


FIGURE 6

(2) To determine take-off "T", subtract "L" (thread make-up) from "F". The cut length "C" is determined by subtracting "T" from "M".

(3) This principle applies to installation of all screwed fittings.

(4) Face to center measurements on screwed fittings as a rule are standard in dimension by weight and size. However, in some cases, fittings may vary slightly in dimension. The following tables are recommended:

TAKE-OFF TABLE
SCREWED FITTINGS
125-POUND CAST IRON

SIZE	90°	TEE	45°
1/4"	3/8"	7/8"	3/8"
3/8"	1/2"	1-1/8"	7/16"
1/2"	5/8"	1-1/4"	3/8"
3/4"	3/4"	1-1/2"	1/2"
1	7/8"	1-5/8"	1/2"
1-1/4"	1-1/16"	2-1/8"	5/8"
1-1/2"	1-1/4"	2-1/2"	3/4"
2	1-1/2"	3"	15/16"
2-1/2"	1-3/4"	3-1/2"	1"
3"	2-1/8"	4-1/4"	1-1/8"
4"	2-5/8"	5-1/4"	1-1/2"
6"	3-3/4"	7-5/8"	2-1/4"
8"	5-1/8"	10-1/4'	2-3/4"

TAKE-OFF TABLE
SCREWED FITTINGS
250-POUND CAST IRON

SIZE	90°	TEE	45°
1/4"	7/8"	1-3/4"	
3/8"	1"	2"	
1/2"	3/4"	1-1/2"	1/2"
3/4"	7/8"	1-5/8"	9/16"
1"	15/16"	1-3/4"	5/8"
1-1/4"	1-1/4"	2-5/8"	7/8"
1-1/2"	1-7/16"	2-3/4"	1"
2"	1-3/4"	3-1/2"	1-1/4"
2-1/2"	2"	4"	1-5/16"
3"	2-3/8"	4-7/8"	1-1/2"
4"	3"	6"	1-11/16"
6"	4-5/16"	9-7/8"	2-3/4"
8"	5-9/16"	11-1/8"	3-3/16"

TAKE-OFF TABLE
FORGED STEEL SCREWED FITTINGS
3000-POUND W.O.G.

SIZE	90°	TEE	45°	UNION	COUPLING
1/8"	1/2"	1"	1/4"	1/2"	3/8"
1/4"	5/8"	1-1/4"	3/8"	3/4"	1/2"
3/8"	3/4"	1-5/8"	1/2"	15/16"	3/4"
1/2"	3/4"	1-5/16"	1/2"	15/16"	7/8"
3/4"	15/16"	1-7/8"	9/16"	1-1/8"	1"
1"	1-3/16"	2-1/8"	5/8"	1-1/16"	1"
1-1/4"	1-5/16"	2-5/8"	3/4"	1-5/16"	1-1/2"
1-1/2"	1-11/16"	3-1/2"	1"	1-5/8"	1-1/2"
2"	1-3/4"	3-1/2"	1"	1-7/8"	1-7/8"
2-1/2"	2-7/16"	5"	1-1/8"	2-1/8"	1-3/4"
3"	2-3/4"	6-1/2"	1-1/2"	2-5/16"	2-1/4"
4"	3-3/8"	6-3/4"	2"		2-1/2"

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTERS (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-1

SUBJECT: ASSEMBLE AND TRANSFER TOOLS AND EQUIPMENT

A. TOOLS

(1) When assigned a job, make a list of all the tools needed to complete the job. (other than tools provided in Pipefitter's tool box.) The portable tool room is usually spotted at the unit that is down for I & T. Most smaller tools can be obtained from the portable tool room. Larger tools and portable power tools may be obtained from the Main Tool Room. Call in a list of tools required to the Main Tool Room, giving the location or station where tools are to be delivered.

(2) Tools supplied from the tool rooms are checked out to the Pipefitter on the job and should be cleaned and returned to their proper place upon completion of the job.

(3) Broken or damaged tools should be reported to the tool-keeper so they may be repaired or replaced.

B. EQUIPMENT

(1) Several equipment storage areas are located throughout the plant for equipment such as field pumps, tuggers, pipe machines, pipe benches, and test pumps.

(2) The dispatcher should be notified by the person needing the equipment where the equipment is located and where it is to be delivered.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-2

SUBJECT: MOVE MATERIALS

A. PALLETS

(1) Flat pallets are provided for moving material packed in barrels, sacks and crates with a forklift.

(2) Straddle carrier pallets are provided for moving materials such as pipe, exchanger heads, motors, and pumps.

(3) Metal straddle carrier box pallets are provided for hauling valves, PRV's, large quantities of fittings and tools. This same type of pallet is provided on shutdowns for salvaging fittings and bolts.

B. BOLSTERS

(1) Bolsters are provided for moving pipe and plank with the straddle carrier.

C. BUNDLE RACKS

(1) Bundle racks are constructed to cradle a tube bundle and prevent rolling while moving with the straddle carrier.

D. SKIPS

(1) Skips are provided for moving material such as dirt, sand, broken concrete, and coke with the lugger truck. In some cases the lugger truck is also used for moving valves and pumps.

E. SMALL MATERIAL

(1) A route truck delivers material ordered from the Storehouse or tool rooms to job sites or stations near job sites. It also delivers tagged material from stations back to proper storage.

F. DISPATCHER

(1) When moving material on pallets, bolsters, bundle racks and skips, the dispatcher should be notified of the location of the equipment to be moved and the location for delivery. All material should be marked with a yellow tag showing the delivery location.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-3

SUBJECT: LOAD AND UNLOAD MATERIALS

A. LOAD

(1) When loading materials on trucks, place in a position where materials can be tied down. In case of smaller items, place so they cannot roll or bounce off the truck.

(2) Never drop or throw tools or materials onto truck beds, this may damage items being loaded.

(3) Place blocks or wedges under pipe to avoid rolling while hauling. Always center and block pipe when loading onto bolsters or pallets.

(4) Ask for help when heavy items are being loaded. Always lift with back in an upright straight position.

B. UNLOAD

(1) Unload material as near to job site as possible.

(2) Avoid dropping small pipe, tools, fittings, etc. from truck beds. Rolling small pipe from trucks may bend the pipe or bounce and cause injury to personnel.

The process of loading and unloading materials, equipment, and tools is the perfect setting for an injury or accident. Be alert for rolling pipe, burrs on metal, and above all, improper lifting.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-4

SUBJECT: DOPE AND WRAP PIPE

The surface of all piping must be clean before applying dope. Then apply an adhesive primer, commonly known as dope, to the pipe surface with a brush, spray, or swab. A swab may be made from rags attached to the end of a stick. The primer must be dry before wrapping.

The wrapping, commonly known as doping tape, is applied in a spiral motion in order to insure overlapping. For instance, if you are using 2" tape you will overlap 1", if you use 4" tape you will overlap 2", etc. Select your wrapping as follows:

Pipe Size	Size Tape
1/2" - 2"	2"
4" and 6"	4"
8" and larger	6"

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-5.

SUBJECT: STRING OUT PIPE

A. STRING OUT PIPE

(1) Two-wheel pipe carts are provided for stringing pipe in places where cranes cannot reach.

CAUTION: Avoid stringing pipe where it could cause a stumbling hazard, and make sure it's placed so it cannot roll.

(2) Cranes should be used where space permits them to operate.

(3) Tuggers may also be used for pulling pipe into position or along pipe ways. When pulling pipe with a tugger, follow closely to avoid hangups.

CAUTION: Always tie down loose pipe left laying in overhead pipe ways. Remove all excess pipe when the job is completed.

(4) Before connecting joints together, check to see that there are no foreign objects inside the pipe (often when moving or pulling pipe, gravel or dirt may be picked up in the ends of the pipe.)

(5) Avoid dropping pipe, this may bend the pipe or cause damage to the ends.

(6) When transporting threaded pipe, cover threads with a collar or pipe cap. If none is available, tie rags around threads to protect them from being damaged.

(7) When pipe is being strung out to be installed in a trench, lay blocking across trench, string out pipe along side the trench on the blocking. After piping has been jointed, roll the pipe over the center of the trench. Set *tripods astraddle the line. Using a cable sling and come-a-longs or chain falls, lift the line, remove the blocks and lower line into trench. In order to remove slings from the line, blocks should be set in the bottom of the trench to lower line into.

(*tripods are constructed with three legs hinged together at the top. The bottom of the legs spread, creating a tripod. A U-bolt is installed between top section of legs for rigging a come-a-long or chain fall.) (These are stored in one of the designated storage areas.)

NOTE: It is recommended that long runs of large pipe not be set on welding jacks for fabrication. Jacks may slip causing pipe to roll off and cause injury to personnel.

(8) When lifting single joints of heavy pipe, it is recommended a cable sling be used, making sure equal weight is balanced on both ends.

(9) When sliding pipe along pipe ways, trenchs, or on the ground, never put hands or fingers inside the pipe. If the end of the pipe strikes an object it could cut off fingers.

Be alert for and prevent pipe from rolling onto feet and insteps.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-6 SUBJECT: DISMANTLE PIPE AND FITTINGS

All pipe used in the refinery is either screwed or welded and fittings are either screwed, welded or flanged.

When dismantling screwed fittings, be sure you are using the right size wrench and that your pipe wrench has good jaws. Do not use a wrench as a hammer.

Screwed fittings include unions, valves, flanges, ells, tees, and nipples.

Be sure that all fittings are in good condition and properly doped if they are to be reinstalled.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-7

SUBJECT: SALVAGE PIPING

To prevent accumulation of second hand and salvaged materials, the following procedures shall be followed. All segregation of salvage and junk materials shall be done at the job site if possible.

A. PIPE

All reusable carbon steel pipe in sizes 2", 3", 4", 6" and 8" in lengths of 10 feet or more shall be salvaged and tagged for delivery to the Storehouse where it will be credited to stock. Useable carbon steel pipe 10" and larger should be stored in the Salvage Yard if 10' or more in length. All other carbon steel pipe shall be tagged for junk. (Mark with yellow paint with the word JUNK.) Disposition of Alloy pipe should be discussed with the Foreman-Pipe Department. Alloy pipe which is saved should be color coded.

B. VALVES

All diaphragm operated steel control valves should be salvaged, tagged and transported to the Instrument Shop for overhaul, identification, and storage in a designated area of the Storehouse Annex. The Instrument Foreman is responsible for maintaining an up-to-date list with complete identification of all available used control valves. All cast iron control valves shall be tagged for junk.

All 1-1/2" and 2" screwed carbon and stainless steel and brass globe and gate valves and all flanged steel globe, gate and check valves should be salvaged, tagged, and sent to the Valve Shop for reconditioning. Repaired valves are sent to the Storehouse and credited to stock. All cast iron and all other brass globe, gate and check valves should be tagged for junk.

All steel pressure relief valves shall be salvaged, tagged and sent to the Valve Shop for reconditioning as time permits. All cast iron PRVs shall be tagged for junk. All repaired PRVs are put in Storehouse Stock and stored in a suitable place.

C. FITTINGS AND FLANGES

In addition to all Ring Joint flanges and 900# ball joint slip flanges, the following carbon steel weld fittings and flanges shall be designated for salvage.

(a) Std. and XH 90° ells - 4", 6" and 8"
(b) Std. Tees -3", 4", 6" and 8"
(c) XH Tees -3", 4", 6" and 8"

(d) Series 150 and 500 slip-on flanges -3", 4", 6" and 8"
(e) Series 150 and 300 weld neck flanges -3", 4", 6" and 8"
(f) All cast iron blind flanges 125# and 250# only -All sizes through 8"
(g) All steel blind flanges -All sizes through 8"
(h) All other carbon steel fittings shall be tagged for junk.

D. CARBON STEEL FLANGES AND FITTINGS 600# AND HIGHER PRESSURE RATING

Save and salvage only materials for which specific requirements are known. When questionable cases arise, review with the Foreman for decision as to disposal.

When salvaging fittings and weld neck flanges a minimum of 3" of pipe shall be left beyond the weld, and when salvaging slip-on flanges, at least 8" of pipe shall be left with the flanges so that proper reconditioning may be done on the fittings and flanges.

RF flanges shall be salvaged only by the weld shop. Any RF flanges requiring facing by the Machine Shop shall be junked. All other salvaged fittings and flanges should be stored at the Salvage Yard for sale or reconditioning as determined by Plant Management. Reconditioned flanges and fittings shall be delivered to the Storehouse where they will be credited to stock.

E. ALLOY FLANGES AND FITTINGS - ALL PRESSURE RATINGS

Save and salvage all such material which is commonly used in the Plant. Reconditioned material shall be sent to the Storehouse. Materials questionable for salvage shall be discussed with the Supervisor of Maintenance for decision. All Alloy materials to be identified by Inspection Dept., marked and tagged.

F. GAUGE GLASSES

All reflex type gauge glasses shall be salvaged and tagged for delivery to the Valve Shop where they will be reconditioned as time permits. After repairs have been made, they shall be sent to the Storehouse. All transparent type gauge glasses shall be tagged for junk.

G. INSTRUMENTS

All instruments such as transmitters, flow recorders, temperature recorders, pressure gauges, leveltrols, etc., sutitable for reuse, shall be salvaged and tagged for delivery to the Instrument Shop for reconditioning. All instruments considered unsatisfactory for further use by the Instr.-Electr. Foreman or his Assistant shall be tagged for junk.

The salvage or junking of items or equipment not covered by the above instructions shall be referred to the Supervisor of Maintenance.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-8

SUBJECT: USE HAND DIES

a. STOCK AND DIES

(1) Hand pipe threading dies and stocks (handle) are available in the Main Tool Room in sizes from 1/8" through and including 2".

(2) Pipe to be threaded should be cut square. Pipe threaded without a square end causes poor penetration into screwed fittings.

(3) The stock has a built-in lever for reverse and forward.

(4) Threads are cut in a clockwise motion.

b. CUTTING THREADS

(1) Place dies on end of pipe to be threaded. Apply pressure with heal of hand on the end of dies while moving the stock in a clockwise motion. This helps dies to begin cutting the thread.

(2) Apply cutting oil often to dies while cutting. This serves as a lubricant and helps to cut a smooth uniform thread. Cut threads to desired length, reverse lever and turn stock in a counter-clockwise motion to remove dies from pipe. Threads are tapered to assure a tight fit into a fitting. (Avoid over threading, this can cause threads to penetrate too far into a fitting and not complete a leak-proof seal.)

NOTE: It is recommended that a fitting be screwed on the first thread cut to be sure the dies are in adjustment.

CAUTION: Brass pipe is very soft, the end being threaded may easily be egg shaped. It is recommended that a spud wrench be inserted through the dies into the end of the pipe.

c. FIELD DIES

Field dies are available in the Main Tool Room in four sizes: 3", 4", 6" and 8". These dies may be manually operated with a ratchet handle or power operated with an air motor. Pipe to be threaded should be cut square. Take offs for threaded fittings should be figured before threading pipe. All rust scale and dirt should be cleaned from the pipe at least 8" from the end. Each set of dies has a threaded nipple built into it to run the dies in and out. One end of this nipple has 3 set screws or bolts to grip onto the pipe to hold the dies in position while threading. The cutting dies are attached to the other end of this nipple. Dies should be unscrewed off the nipple far enough to cut the thread. Measuring the exposed threads determines the length of travel of the dies.

d. CUTTING THREADS

(1) Figure the length of thread to be cut.

(2) Back the dies off the nipple far enough to allow dies enough travel to cut the proper length of thread.

(3) Place the dies on the pipe, set screw end first, with the dies against the end of the pipe. Tighten the set screws, making sure of equal distance between the pipe and nipple holding the set screws.

NOTE: It is very important that dies be square on pipe before threading. If set screws are tightened without equal spacing between the pipe and nipple, it will cause the dies to cut deep threads on one side of the pipe and shallow threads on the opposite side. This weakens the strength of the metal and may cause the threads to leak.

(4) Cut threads by turning dies in a clockwise motion. Always cut the first two or three threads with a ratchet handle, before attaching air motor. Always use thread cutting oil when cutting threads. Thread oil is available at the Portable and Main Tool Rooms.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. #9

SUBJECT: OPERATE POWER TOOLS

A. POWER TOOLS

(1) Be sure that you have the right tool for the job. That includes the right drill, tap, saw blade, etc. Also be sure to have the right tool capacity for the job. When you have these right you will work more efficiently and do a safer job.

(2) All power tools shall be returned to the proper tool room after the job is completed and the tool has been properly cleaned.

B. PNEUMATIC TOOLS

(1) Before hooking up any pneumatic tool, the air hose to be used should be blown out to remove all dirt, rust and water.

(2) An oiler should be installed in the line to insure proper lubrication. Pig tail hoses are provided at the Portable and Main Tool Rooms with attached lubricators for most pneumatic tools. Larger lubricators are available on the Knocker wagon when using Knocker motors. These lubricators should be checked and refilled several times each shift while being used.

Note: When using a power hack saw, use cutting oil on the saw blade.

(3) Pneumatic sump pumps should be suspended a few inches from the bottom of ditches and holes when pumping out liquid. This keeps dirt from being sucked into motor.

C. ELECTRIC TOOLS

(1) The Electrically Controlled Tube Rollers has a ground wire attached to it and must be connected to the equipment being worked on.

(2) Electric drill motors have a three wire system built in, one being the ground wire.

(3) Electric recepticles are located throughout operating units to hook up power tools. Extension cords are provided and may be found on electric storage pallets.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-10

SUBJECT: OPERATE PUMPS

PUMPS

A. Sump Pumps

(1) Are used to pump water, oil, etc.

(2) We have gas and air operated sump pumps.

(3) Be sure to have sufficient suction and discharge hose.

B. Test Pump

Test pumps are a dangerous piece of equipment and should be operated with care. Be sure a relief valve set at testing pressure is installed on test pump. Before starting pump, open bypass valve and know testing pressure. Be sure all air is out of system. Pipefitter running test must stay with test pump. Close bypass valve slowly and raise to testing pressure.

All sump and test pumps should be drained and cleaned after job is completed. Return pumps to storage area.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-11

SUBJECT: OPERATE COMPRESSOR

A COMPRESSOR

Start gas operated motor and let it run until it is warmed up. Then engage compressor clutch and let it build up pressure. Connect your equipment and it is ready for use. Be sure tractor is out of gear before engaging compressor.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-12

SUBJECT: OPERATE HOISTS

A. AIR HOIST

Connect air hose and be sure hose is long enough for travel and safety wire is put in hose connection. Be sure load is properly rigged before lifting.

B. ELECTRIC HOIST

Check capacity of hoist and insure that load is properly rigged before lifting.

C. AIR TUGGER

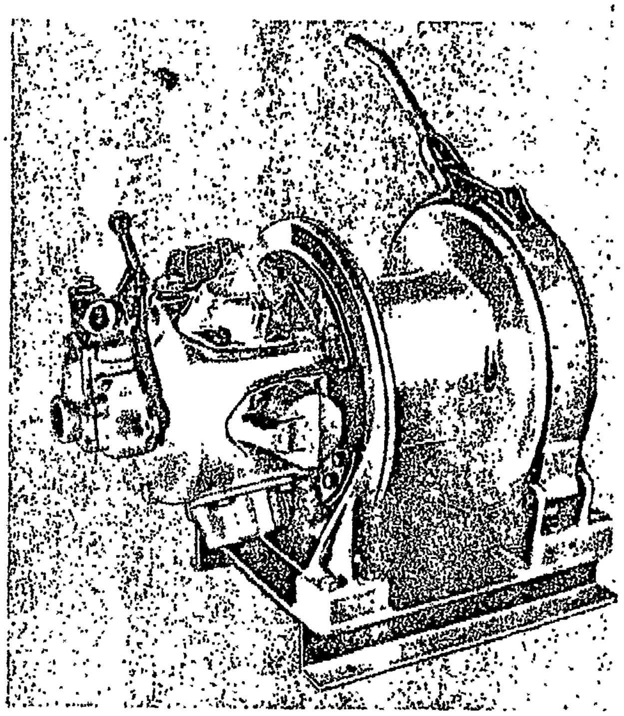
Tie tugger down with a cable to tugger anchor just out from unit slab. Run cable through pulley at base of tower to top of tower through pulley and down to job site. Be sure capacity of cable will lift your load.

All portable hoists and tuggers should be returned to storage area after being properly cleaned.

UTILITY AIR HOISTS
5000 lbs. (2268 kg.)
sizes K6UA and K6UAL

Both of these heavy-duty Hoists offer big capacity, yet retain the adaptability, portability and flexibility of smaller Ingersoll-Rand Utility Hoists. Both have a rated capacity of 5000 lbs. (2268 kg.) with a rope speed of 95 feet (28.9 meters) per minute. Both are virtually identical in construction and features except that Size K6UAL incorporates a rope drum that is twice as long as the drum on the Size K6UA and consequently can wind twice as much wire rope. Among their many important features are:

- Powerful, six-cylinder, piston-type reversible motor—permits full control of the load by the throttle at all times.
- Heavy-duty, two-segment, self-energizing, high-capacity brake.
- Three-stage gear reduction, with power transmitted to the rope drum through balanced planetary gearing.
- Rubber-faced throttle valve—assures a positive seal at all times, never needs lapping, and greatly reduces maintenance.
- Sealed gear case—gear case is sealed around rope drum to keep dirt out of the rope drum ring gear.
- Rope drum—rotates on large roller bearings mounted on a drum shaft that is rigidly supported at each end.



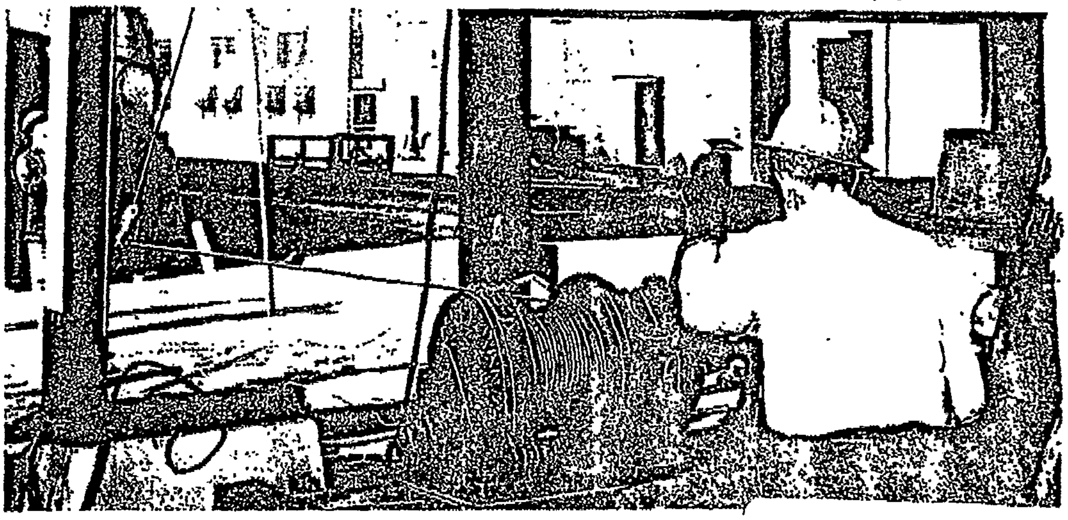
Size K6UA Hoist

SPECIFICATIONS—performance figures are at 80 psi (5.6 kg/cm²) air pressure

SIZE	K6UA		K6UAL	
Capacity	5000 lbs.	2268 kg.	5000 lbs.	2268 kg.
Rope speed per min. at rated load	95'	28.9 meters	95'	28.9 meters
Size and maximum length of wire rope	⅝" x 600' ¾" x 420'	⅝" x 183 meters ¾" x 128 meters	⅝" x 1200' ¾" x 840'	⅝" x 366 meters ¾" x 256 meters
Weight without wire rope	1315 lbs.	596 kg.	1550 lbs.	703 kg.

Both sizes have a 1¼" hose connection pipe tap; 1½" (38 mm) hose is recommended.

Size K6UA Hoist used to lift materials to various working levels on a large construction project.



TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-13

SUBJECT: CUT GASKETS

a. GASKET CUTTER

A manually operated gasket cutter is mounted on a work bench at the east end of the pipe shop. Sheet gaskets material in thicknesses of 1/16" and 1/8" is provided at this location. The storehouse stocks gasket material if none is available in the pipe shop. A measuring slide bar is installed on the gasket cutter with a screw down guide to hold the gasket material in position at the measurement required. A 1/4" x 2" round peg is located on the end of the measuring bar with a hold down nut on top. This holds gasket material on measuring bar. The cutting blade works on an up and down lever. A handle is attached to cutting blade. This serves not only to cut the material, but to turn the gasket material into the cutting blade.

b. HOLE CUTTER

A hole cutter is provided with the gasket cutting machine. A sleeve on the cutter rod has an up and down sliding motion. Two stops on the cutting rod about 12" apart stop the sleeve on the up and down motion. The sleeve and bottom stop serves as a hammer when cutting a hole. Place the gasket material on the block of lead provided for cutting. Holes may be cut by placing the cutter rod on the gasket material and bringing the sleeve down against the bottom stop sharply.

c. CUTTING GASKET

(1) Cut a square piece of gasket material slightly larger than the OD (outside diameter) of the gasket to be cut. Locate the center of the piece of gasket material. Cut a hole in the center of the material with the hole cutter provided at the work bench. Cut off the corners of the gasket material to within a slightly larger OD of the gasket to be cut. Set the measuring bar at 1/2 the OD of the gasket being cut, lock the guide in position. Set the center hole of the gasket material on the measuring bar peg and install hold down nut. (It is recommended that a measurement be taken from the cutter blade to the center hole to assure the gasket cutter is in adjustment). Lower the cutting blade onto the gasket material. Turn cutting hand in a clockwise motion to cut gasket.

hole to assure the gasket cutter is in adjustment., Lower the cutting blade onto the gasket material. Turn cutting hand in a clockwise motion to cut gasket.

CAUTION: ALWAYS CUT THE OUTSIDE DIAMETER OF A GASKET FIRST

(2) After the gasket has been cut to the O.D. size, remove excess gasket material leaving the gasket attached to the measuring bar. Unlock measuring guide on the measuring bar and set at 1/2 the measurement of the I.D. (inside diameter) of the gasket being cut. Then follow the cutting procedure.

d. PORTABLE GASKET CUTTER

A portable gasket cutter is provided at the pipe shop for cutting small gaskets. A measuring bar is built in the gasket cutter with a centering peg on one end and a lock screw to hold measuring bar on the proper dimension. A retractable cutting blade is built in the gasket cutter. A gasket cutting board is also provided at the portable tool room. A center hole is drilled on this board to fit the measuring bar centering peg. The centering peg is pointed on one end to penetrate the gasket material, allowing the gasket cutter to turn in a rotating motion.

e. CUTTING GASKET

Set the measuring bar at 1/2 of the O.D of the gasket to be cut and lock the guide in position. Measure in from two sides of the gasket material allowing enough material for 1/2 the OD of gasket being cut and mark an "X" for the center hole. Punch a hole through the gasket material at the "X" with the pointed centering peg. Place gasket material on cutting board, with gasket cutter on top of material. Put centering peg through guide bar, through center hole in gasket material and into center hole or cutting board. Turn gasket cutter in clockwise motion to cut material. To cut the I.D. of the gasket, set the measuring bar at 1/2 the I.D. and follow the cutting in instructions above.

CAUTION: DO NOT CUT METAL GASKETS WITH THESE GASKET CUTTERS.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-14

SUBJECT: USE HAND TOOLS

a. CARE OF HAND TOOLS

(1) Knowledge of the proper tools to use and how to use them is necessary to good handling of pipe and fittings. Select the right type and right size tool for each piping job.

(2) Wrenches are used on practically every piping job, and if used improperly can cause serious damage to materials and tools. They also cause accidents.

(3) Tools should be kept clean and stored in an orderly fashion in a pipe fitters tool box.

(4) Tools should be regularly inspected for worn or damaged parts, and replacements made as necessary.

(5) When tools are lost, a lost tool slip must be filled out by the pipefitter and signed by his Craft Supervisor before the tool will be replaced by the Main Tool Room. A broken or damaged tool slip must be filled out and signed by the pipefitter for replacement of such tools.

b. USE OF HAND TOOLS

(1) The pipe wrench is designed for use on pipe and screwed end fittings. Due to design of the wrench, the jaws have a squeezing action. If sufficient pull is applied, this squeezing action does severe damage to valve bodies, particularly the softer alloys such as brass.

Note: Never use a pipe wrench as a hammer.

(2) Strap wrenchs are designed for use on polished or plated surfaces to prevent marring. They are also useful in close places that won't accomodate a pipe wrench.

(3) Pipe tongs are of the chain type or scissor type, and are generally used for large pipe diameters.

(4) Open or box end wrenches and socket wrenches are necessary when tightening flange bolts. It is important to use the right size wrench since slippage is dangerous to personnel and damaging to material. When possible, use a box end wrench for tightening bolts and the open end for a back up.

Note: Never pull on a wrench directly toward your face. If the wrench slips, it could cause serous injury.

(5) There are two types of common vises. The pipe vise is used to hold pipe only. The combination vise may be used for other purposes. Valves or fittings should never be placed in the vise to make up a joint. There is too much danger of distorting the fittings or forcing valve parts out of working alignment.

Note: Always open a valve part way before screwing it on a pipe joint. If a nipple or joint of pipe is screwed too far into a valve, damage is done to the paddle seat. If the valve is in the closed position, this would lock the valve closed.

Always place the pipe in the vise, then make up the fitting. Place the wrench on the end of the fitting next to the joint being made up. This lessens possibility of distorting the fitting and gives better leverage.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-15

SUBJECT: SHARPEN TOOLS

a. GRINDING

(1) Stand aside from the wheel when starting it up.

(2) Use the work rest whenever possible. It helps to hold the work and gives added protection.

(3) If the tool is too large to be sharpened with the work rest in place, remove it entirely and replace it after the job is finished. Make sure the rest is properly adjusted and securely tightened.

(4) Don't use the side of the wheel for heavy removal of stock. The side/of a wheel should be used only when it is necessary for/finished grinding of an object that must be flat and smooth. If the sides become grooved from abuse, they will be useless for that purpose in the future.

(5) When a great amount of stock is to be removed, use only a moderate pressure against the wheel and move the work from side to side across the face of the wheel. This will cause the wheel to wear evenly and prevent grooving.

(6) When grinding thin material, such as sheet metal, flat edged, or pointed tools, such as a screwdriver or a scriber, do not hold the work at the top with the flat c pointed end near the work rest. The work may become wedged between the wheel and the work rest, pulling your hand into the wheel and causing a serious injury.

This type of work whould be held with the thin edge up or at least 45° above the horizontal and with the hands in a safe position so that they will not be pulled into the wheel.

(7) When grinding the contour of thin metal objects such as shims, hold the work firmly and flat against the work rest. Under no circumstances tilt it up. The wheel will knock it out of your hands and may cause an injury. If the rest is not convenient, hold it above the rest and tilt it slightly downward or turn it 90° and grind in a verticle position.

CAUTION: EVEN THOUGH GOGGLES ARE WORN, A GRINDER SHOULD NEVER BE USED UNLESS IT IS PROPERLY EQUIPPED WITH A GUARD. IN CASE

THE WHEEL SHOULD BREAK, THE GUARD W... HOLD THE PIECES FROM FLYING OFF AND CAUSING A SERIOUS INJURY.

SAFETY: Do not use gloves for holding small objects or at any other time that the hands must be held near the grinding wheel. If the gloves get caught in the grinder, they will pull the hands in with them.

(8) Grinding friction creates an enormous amount of heat. A metal object held firmly against a grinding wheel may be seen to turn red at the point of contact in a short time.

(9) The heat generated by grinding is detrimental to both the work and the operator. The heat makes the work hard to hold if the object is small and the operator is attempting to hold it in his hands.

Ordinarily this would not cause an unsafe condition, although it may spoil the work due to the operator turning the work loose when he burns his fingers. But if the work is being ground on the side of the wheel, when the operator drops it, it may fall inside of the guard, in which case, it will cause quite a commotion and may even break the wheel.

(10) Hold small work in some clamping device, preferably the self-locking pliers. Ordinary pliers will not hold. The high frequency rate of vibration will gradually work the piece out of the grip of ordinary pliers.

(11) The heat from grinding is harmful to the work because it causes expansion at the point of heat which may cause the work to crack.

(12) Be especially careful when grinding sharp edged tools. If the metal heats to the point that it becomes colored, the temper of the tool will be ruined.

(13) Keep the tool cool by immersing in water often. Do not cool suddenly from a high temperature as this will cause the tool to "check." Checking is the formation of many tiny cracks too small to be seen with the naked eye, which nevertheless weakens the edge to such an extent that it chips away under the least working strain.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-16

SUBJECT: CLEAN UP SHOP AND WORK AREAS

The Shop should be kept clean and orderly at all times.

In addition to the general departmental housekeeping practices listed on pages 10 and 11 of this manual, the following practices will be observed by every pipefitter and pipefitter helper:

1. All pipe and fittings will be returned to the proper bins after use.

2. Each pipefitter's personal tool box will be kept at the designated area, clear of all walkways when it is in the shop.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-17

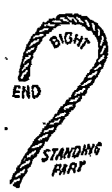
SUBJECT: TIE KNOTS AND HITCHES

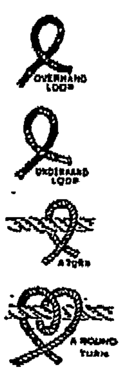
There are many different knots and hitches that a Pipefitter should know in order to do a particular job most effectively and safely. Following are several illustrated examples with instructions on the proper way to tie the various knots and hitches that are most commonly used in Pipefitters work.

USEFUL KNOTS
AND HOW TO TIE THEM

IN KNOTTING—A Rope Has 3 Parts

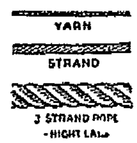
1. **THE END** is the end of the rope with which you are working when you tie a knot.
2. **THE STANDING PART** is the inactive length of the rope.
3. **THE BIGHT** is the central part of the rope between the working end and the standing part.





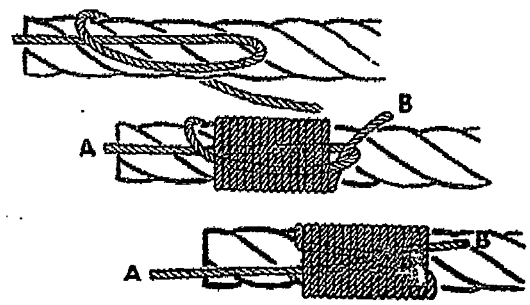
AN OVERHAND LOOP is made by crossing the end over the standing part.
AN UNDERHAND LOOP is made by crossing the end under the standing part.
A TURN is taken by looping the rope around an object—often another section of itself.
A ROUND TURN is taken by looping the rope twice around an object, as shown.
"OVER-AND-UNDER" SEQUENCE. In tying a knot, whenever two sections of the rope cross each other, one must go over and the other, under. Be careful to follow this "over-and-under" arrangement exactly—otherwise you get either an entirely different knot or no knot at all.
"DRAWING UP" Once formed, a knot must be "drawn up" or tightened, slowly and evenly to make sure that all sections of the knot arrangement keep their place and their shape. Quick or careless tightening may result in a useless tangle.

AND—YOU'LL FIND IT HELPS TO NOTE HOW ROPE IS CONSTRUCTED



STANDARD ROPE has three strands. A strand is made of a number of yarns twisted together.
THE LAY of a rope is the direction in which the strands are twisted. Most rope is "right-laid" — the strands spiraling upward to the right—when you hold it vertically.

WHIPPING
KEEPS ROPE ENDS FROM UNRAVELLING



A good rope deserves good care. One way to keep your rope in good condition is to "whip" or bind the ends to prevent unravelling. In Splicing the separate strangs of the rope are also whipped for the same reason.
To make the whipping, a fine yarn, marline or spunyarn, is generally used. The ordinary whipping is made by placing the end of the yarn at the end of the rope and then laying a loop along the rope. You then wind the yarn tightly around both loop and rope, thus binding them together. Wind to a distance roughly equal to the diameter of the rope you are whipping.
The whipping is finished by putting the winding end B through the loop—then pulling end A tight, until the loop is drawn back out of sight. Both ends are then cut short to make a neat finish.

USE STOPPER KNOTS

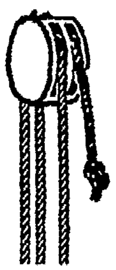
TO KEEP ROPE ENDS FROM SLIPPING THROUGH AN OPENING

End or Stopper Knots are generally tied to keep a rope end from slipping out of a hole or a pulley—also to stop a rope end from sliding through the loop of another knot and thus untying. Stopper Knots are often used to keep the ends of cord or twine from fraying.

THE OVERHAND KNOT

This is the simplest and smallest of all knot forms and the beginning of many more difficult ones. In general, use it only on small cord and twine, since it jams and is hard to untie, often injuring the fiber. To Tie: Make an overhand loop. Pass the end under and up through the loop. Draw up tight.

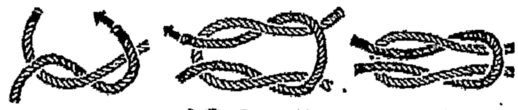
THE FIGURE EIGHT KNOT



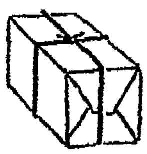
This is much easier to untie than the Overhand Knot—is larger, stronger and does not injure rope fibers. It is the best knot to use to keep the end of a rope or "fall" from running out of a tackle or pulley. To Tie: Make an underhand loop. Bring the end around and over the standing part. Pass the end under, and then up through the loop. Draw up tight.

USE BINDING KNOTS

TO TIE ONE OR MORE OBJECTS SNUGLY TOGETHER

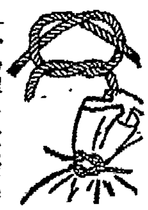


THE SQUARE OR REEF KNOT



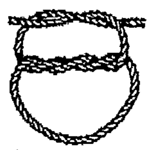
Used at sea in reefing and furling sails—ashore as the universal package knot for parcels and bundles. Though often used, it is a dangerous knot for tying two ropes together, since it unties easily when either free end is jerked. To Tie: Pass the left end over and under the right end. Curve what is now the left end towards the right. Cross what is now the right end over and under the left. Draw up tight.

DON'T TIE THE WEAK GRANNY KNOT



Remember that the Square Knot presents two ends lying together under one loop and over the opposite loop—while the Granny presents one end under and one over on both loops. Watch out for the Thief Knot, too. This has the two loose ends coming out of opposite sides — instead of from the same side as in the true Square Knot.

THE SURGEON'S KNOT

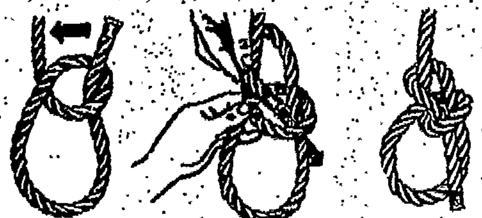


Often used for twine—chiefly to keep the first tie from slipping before the knot is completed. To Tie: With one end, take three turns about the other end. Bring both ends up. Pass one end over and under the other end. Draw up tight.

USE LOOP KNOTS

TO HOLD TO AN OBJECT WHEN SECURITY COMES FIRST

A Loop Knot, like a Hitch, fastens a rope to another object. But usually, the Loop Knot is first tied in the hand and then placed over the object—while the Hitch is tied directly around the object. In general, the Loop Knot is a more secure and permanent type of knot than the Hitch, because properly tied and drawn tight, it will not slip. Also, since it does not lose its shape, the same knot may be used many times over.

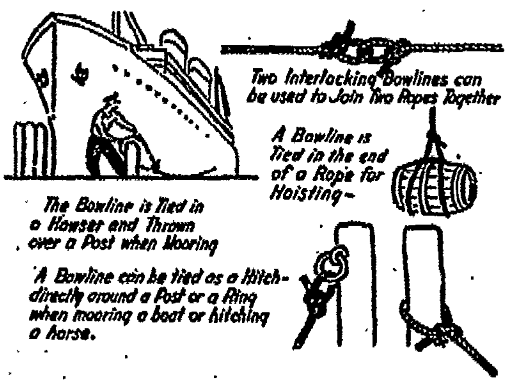


THE BOWLINE—USED FOR MOORING, HITCHING, LIFTING, AND JOINING

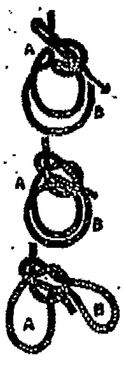
Sometimes called the "king of knots", the Bowline never jams or slips if properly tied. Generally tied in the hand, it can also be used as a hitch and tied directly around the object.

To Tie: Make an overhand loop with the end held toward you. Pass the end up through the loop, then up behind the standing part — then down through the loop again. Draw up tight.

SOME USES OF THE BOWLINE

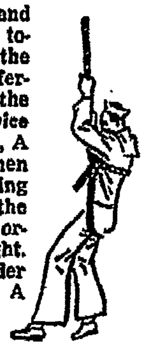


THE DOUBLE BOWLINE

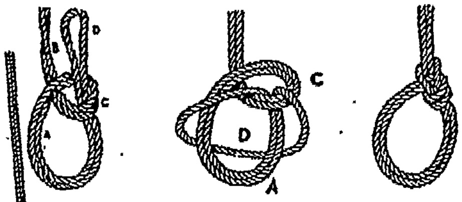


MAKES A GOOD SEAT SLING

To Tie: Make an overhand loop with the end held toward you, exactly as in the ordinary Bowline. The difference being that you pass the end through the loop twice —making two lower loops, A and B. The end is then passed behind the standing part and down through the first loop again as in the ordinary Bowline. Pull tight. Outside loop B goes under the arms — inside loop A forms the seat.



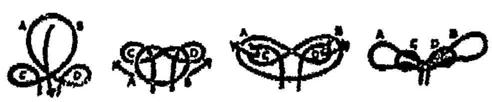
USE THE
BOWLINE ON BIGHT
TO LIFT AN INJURED MAN

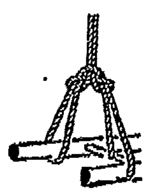


To Tie: Double the rope, make overhand loop C, and draw loop-end D up through it. Then pass loop end D, towards you, down and over loop section A. Bring up in back until D lies behind standing part A. Draw loop D tight by a slow even pull on upper right side of loop A. To use, one leg is put through each loop and loop D passed under arms as shown at right.

THE

LIFTS A MAN OR SLINGS A LADDER

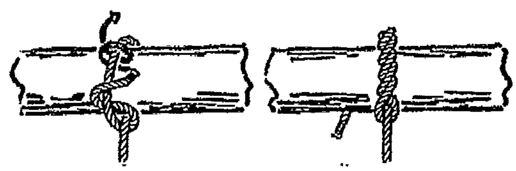




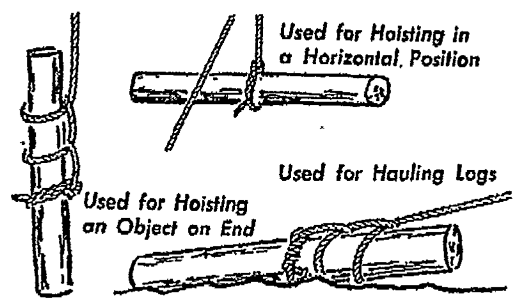
Form three loops, as shown, in any central section of the rope. Turn the large center loop A-B down. Enlarge it so that it encircles the smaller loops C and D. Put your hands through each of the small loops C and D, grasp each side of large loops A and B . . . pull up through to complete the knot.
Used to lift an injured man like the Bowline on Bight, above—or to sling a ladder as shown.

TIMBER HITCH

USED FOR TOWING AND HOISTING



This is a simple, convenient Hitch which does not jam, and come undone readily when the pull ceases. It is used mainly to tow or hoist cylindrical objects, such as logs, spars, etc., also in handling cargo, to hoist small crates and bales. It is used with one or more Half Hitches made with the standing parts, for towing a spar or hoisting a timber on end.
To Tie: Pass a rope around the object and take a turn with the end around the standing part. Then, as shown in the diagram, twist or turn the end back on itself. Three turns back are sufficient and they should follow the lay of the rope.



TEXACO, INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-18

SUBJECT: RIGGING AND HOISTING OF MATERIAL, TOOLS AND EQUIPMENT

RIGGING

Rigging is a very important job and extreme care must be taken in doing the job. The right size choker with enough capacity to do the job must be used. Never put choker around an "I" beam, angle or channel without a wooden block between choker and sharp edge.

Check choker and cable capacity and methods for rigging as illustrated here or in rigging book in pipe library.

HOISTING

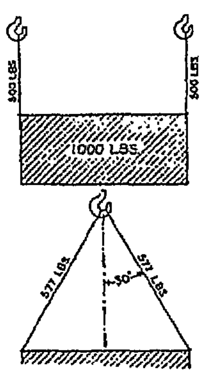
Due allowance must be made for all variations and unusual conditions of operation of the particular sling application. As in all wire rope practice, the handling of the load should provide a slow smooth start with no jerks, and the rate of acceleration and deceleration must be within reasonable limits.

All slack in the sling should be carefully taken up before beginning the lift, as slack taken up suddenly will affect the sling much as a bundle wrapper snaps twine. Much damage is done to slings by carelessly attaching over rough or sharp corners. Therefore, suitable blocking should be used.

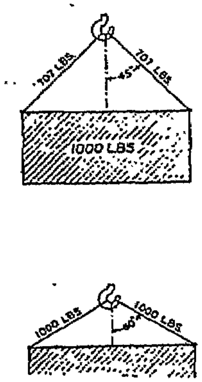
SLING ANGLES

How do you carry two buckets of water? The above illustrations typify the stresses imposed on slings when the legs are attached to the load at various angles.

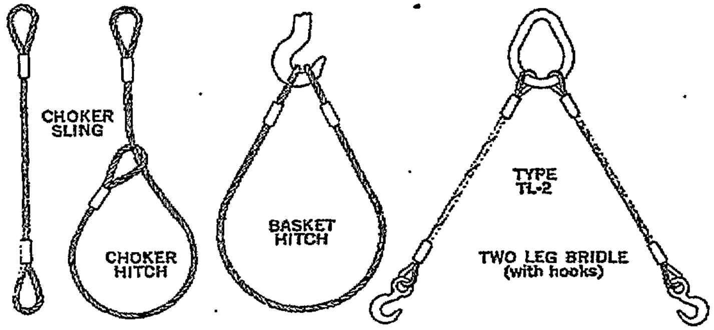
Wherever head room permits, it is recommended that the angle with the vertical not exceed 45° , except in the case of crate slings and slings for handling steel plates where gripping power of sling is based upon a wider angle. Where head room is small and sling must be spread at an excessive angle, special care must be used in selecting a sling.



Sling Angle with Vertical	Stresses per Sling Leg Per 1000 Lbs. Total Load
0	500
5	502
10	508
15	518
20	532
25	552
30	577
35	610
40	653
45	707
50	778
55	872
60	1000



THRIF-T-LIFT
THE ECONOMY SLING

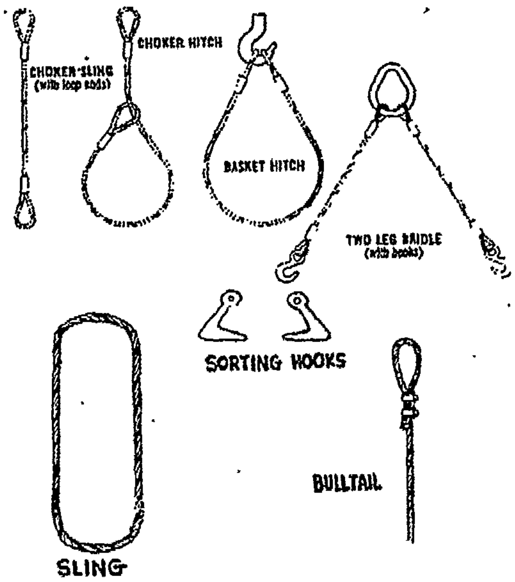


ROPE DIAMETER	RATED CAPACITIES IN TONS OF 2,000 POUNDS†						LOOP DIMENSIONS	
	Single Sling		TWO LEGS OR BASKET HITCH*					
INCHES	Straight Pull	Choker Hitch	Vertical	30°	45°	60°	W Inches	L Inches
1/8	.19	.14	.38	.33	.27	.19	1½	3
3/16	.29	.22	.58	.50	.41	.29	1½	3
1/4	.52	.39	1.0	.86	.71	.52	2	4
5/16	.80	.60	1.6	1.4	1.1	.80	2½	5
3/8	1.1	.82	2.2	1.9	1.5	1.1	3	6
7/16	1.6	1.2	3.2	2.8	2.3	1.6	3½	7
1/2	2.0	1.5	4.0	3.5	2.8	2.0	4	8
9/16	2.6	1.9	5.2	4.5	3.7	2.6	4½	9
5/8	3.2	2.4	6.4	5.5	4.5	3.2	5	10
3/4	4.5	3.4	9.0	7.8	6.4	4.5	6	12
7/8	6.1	4.6	12.2	10.6	8.6	6.1	7	14
1	7.9	5.9	15.8	13.7	11.2	7.9	8	16
1-1/8	10.0	7.5	20.0	17.3	14.1	10.0	9	18
1-1/4	12.3	9.2	24.6	21.3	17.4	12.3	10	20

*BASKET HITCH: When a sling is used in a basket hitch the rated capacities at the various angles with the vertical as indicated above apply, provided radius of curvature at point of sling contact with the load is a minimum of ten times the diameter of the individual component rope. Shorter radii or contact with any sharp corner will reduce sling capacity accordingly.

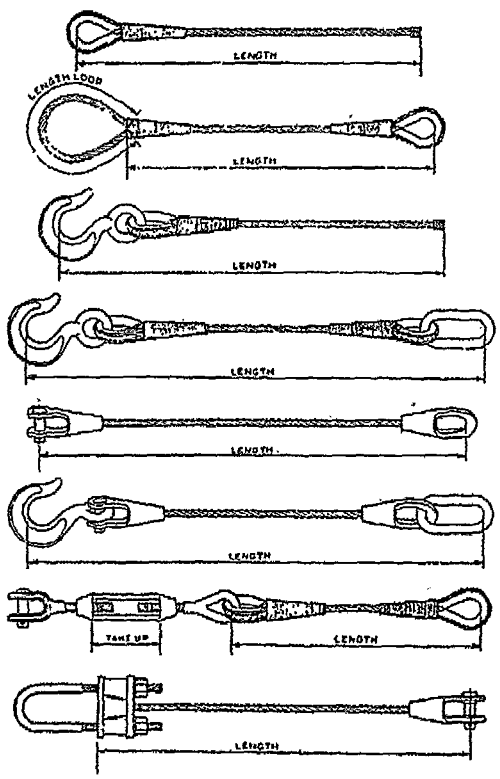
†Sling made with wire rope core will have a rated capacity 7½% greater than above.

WIRE ROPE SLINGS



Rope Diameter Inches	Rated Capacities in Tons of 2,000 pounds †						Loop Dimensions	
	Single Sling		Two Legs or Basket Hitch*					
	Straight Pull	Choker Hitch	Vertical	30°	45°	60°	W Inches	L Inches
1/8	.19	.14	.38	.33	.27	.19	1½	3
3/16	.29	.22	.58	.50	.41	.29	1½	3
¼	.52	.39	1.0	.86	.71	.52	2	4
5/16	.80	.60	1.6	1.4	1.1	.80	2½	5
3/8	1.1	.82	2.2	1.9	1.5	1.1	3	6
7/16	1.6	1.2	3.2	2.8	2.3	1.6	3½	7
½	2.0	1.5	4.0	3.5	2.8	2.0	4	8
9/16	2.6	1.9	5.2	4.5	3.7	2.6	4½	9
5/8	3.2	2.4	6.4	5.5	4.5	3.2	5	0
¾	4.5	3.4	9.0	7.8	6.4	4.5	6	12
7/8	6.1	4.6	12.2	10.6	8.6	6.1	7	14
1	7.9	5.9	15.8	13.7	11.2	7.9	8	16
1 1/8	10.0	7.5	20.0	17.3	14.1	10.0	9	18
1¼	12.3	9.2	24.6	21.3	17.4	12.3	10	20

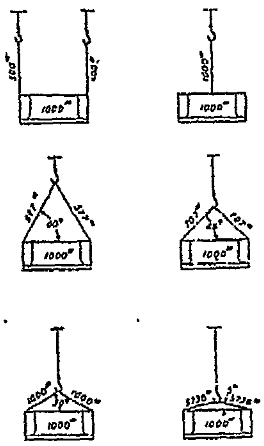
Measurement for Lengths of Rope with Fittings on the Ends



There are many requirements for slings with demand for innumerable designs, but a very large proportion of sling use can be adapted to use some more or less standard types. A separate pamphlet showing numerous designs covers this specialty more fully. Factors of safety may run from 4 for some special cases to 8 or more — usually averaging 5½.

First consideration, however, must be given to the angle at which the slings depend the load from the lifting hook.

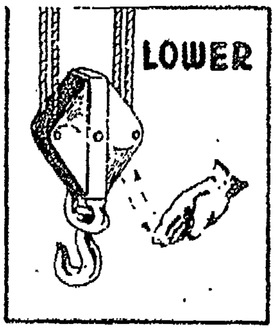
The sketches below show how sling stresses increase with shortening the distance between the load and hook, the load lifted in each case being the same.



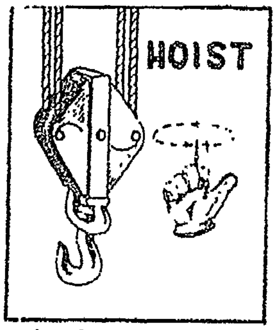
Angle Sling Leg Makes With Horizontal. Degrees	Load per Leg for Each 1000 lbs. Load Lifted lbs	Safe Load Per Leg in Per Cent of Load Carried by 90° Angle
5	5736	8.7
10	2878	17.3
15	1931	25.9
20	1460	34.2
25	1183	42.2
30	1000	50.0
35	872	57.3
40	778	64.3
45	707	70.7
50	653	76.5
55	611	81.5
60	577	83.6
65	552	90.6
70	538	93.0
75	518	96.5
80	508	98.4
85	502	99.6
90	500	100.0

STANDARD CRANE SIGNALS

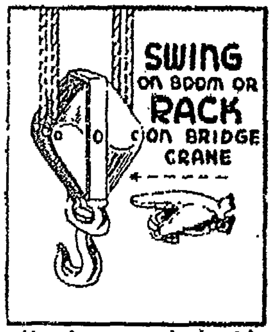
For use with power equipment and rigs.



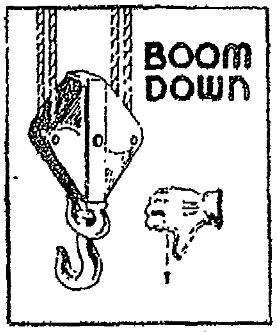
Circular motion with hand with fingers pointing downward



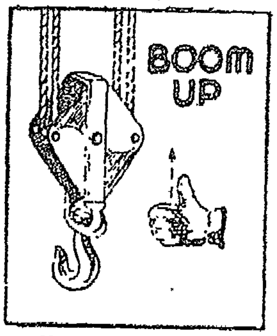
Circular motion with hand with finger pointing upwards



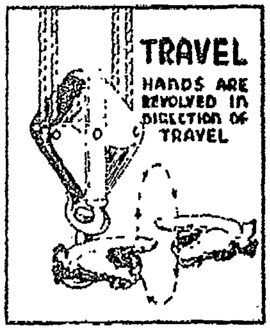
Hand outstretched with finger pointing direction of travel



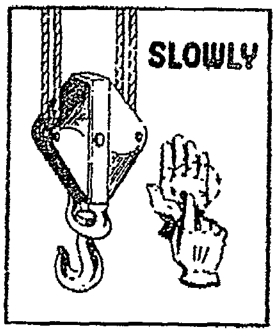
Hand outstretched thumb indicating boom down



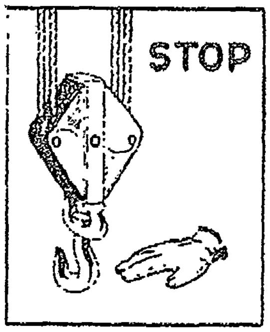
Hand outstretched thumb indicating boom up



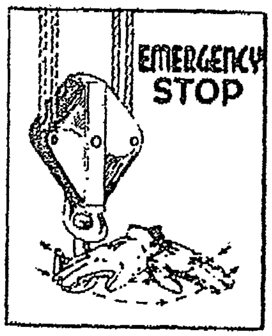
Rotate hands in direction of travel desired



Finger to palm of other hand and make circular motion. Use preceding and in conjunction with regular signal.

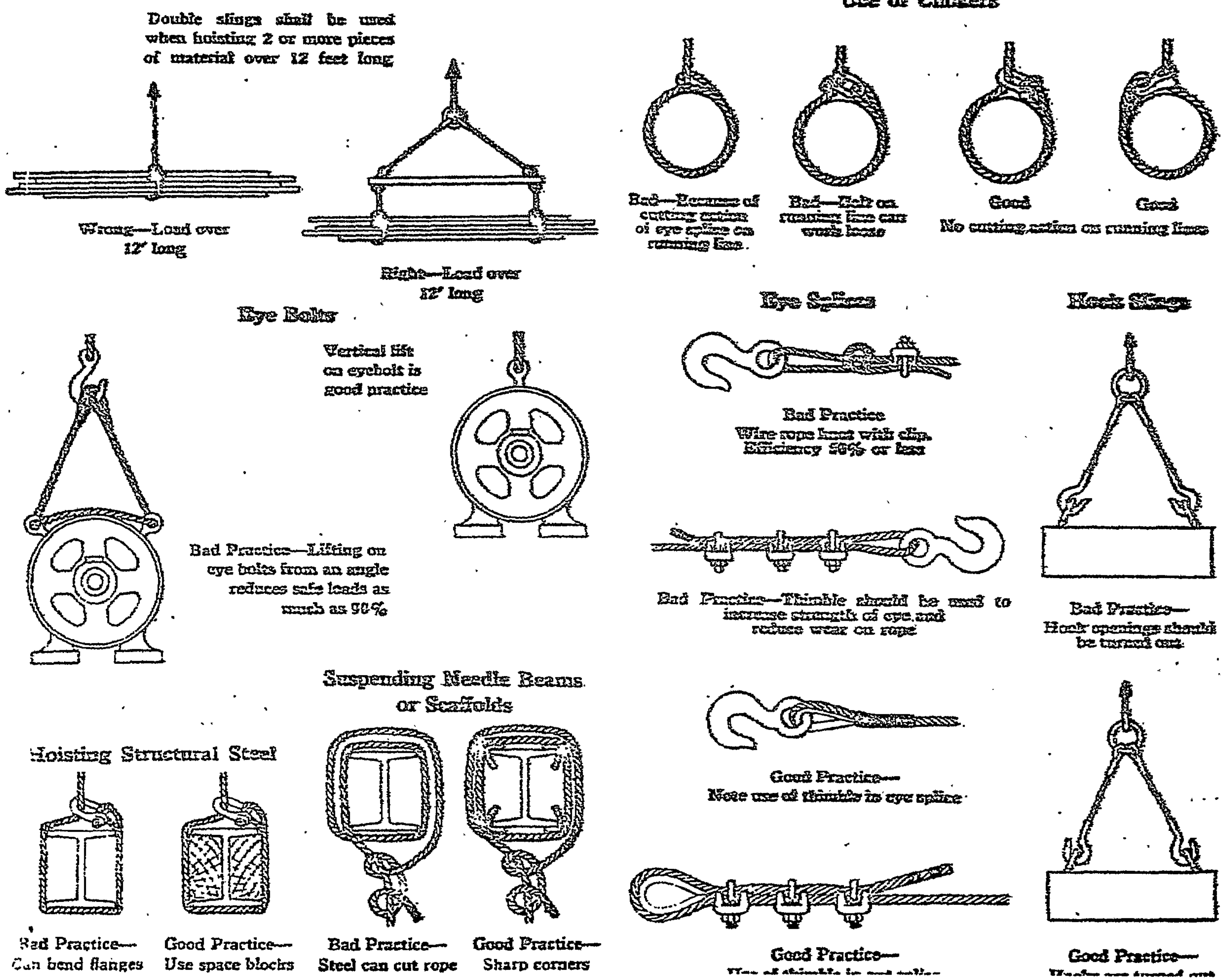


Hand outstretched palm down wave hand back and forth



Both hands outstretched palms down and wave back and forth

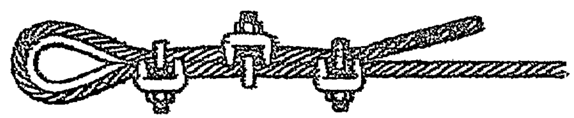
GOOD AND BAD RIGGING PRACTICES



APPLICATION OF WIRE ROPE
U-BOLT CLIPS
Crosby Clips

1. CORRECT METHOD—U-Bolts of clips on short end of rope.
   (No distortion on live end of rope.)

2. WRONG METHOD—U-Bolts on live end of rope.
   (This will cause mashed spots on live end of rope.)



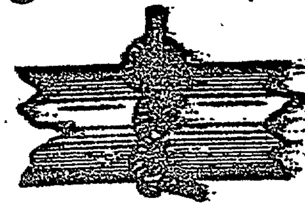
3. WRONG METHOD—Staggered clips; two correct and one wrong.
   (This will cause a mashed spot in live end of rope due to wrong position of center clip.)

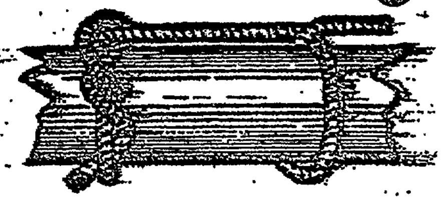
4. After rope is in service, and is under tension, tighten clips to take up decrease in rope diameter.

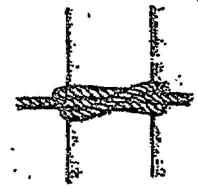
Number of Crosby or Safety Clips and Distance Between Clips Needed for Safety

Diameter of Rope (Inches)	Number of Clips	Distance Between Clips
¼ – ⅜	3	2¾"
7/16 – ⅝	3	3¾"
¾ – 1⅛	4	6¾"
1¼ – 1½	5	9"
1⅝ – 1¾	6	10½"
2" and over	7	6 times diam. of cable

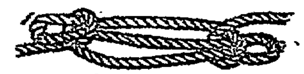
KNOTS


Timber Hitch

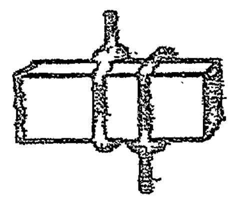

Timber Hitch and Half Hitch

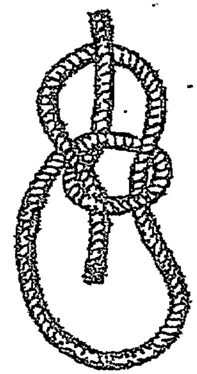

Clove Hitch

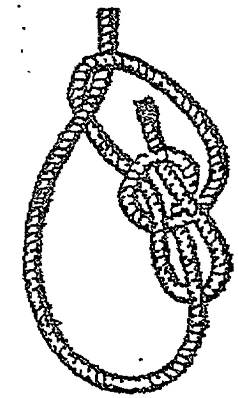

Square or Reef Knot

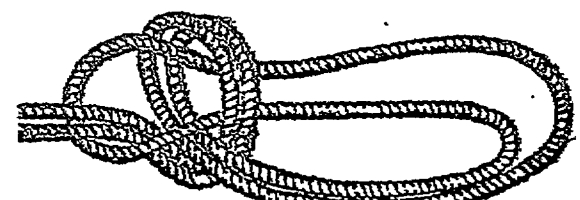

Sheepshank


Stopper Hitch


Scaffold Hitch


Bowline


Running Bowline


Bowline on a Bight

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE DATE: JULY 1, 1970
CLASSIFICATION: PIPEFITTER (TRAINEE)

ITEM NO. B-19 SUBJECT: CHECK TOOLS

A Pipefitter should periodically go through his toolbox and inspect the tools that have been assigned to him for use in his personal job performance.

Inspect for:

1. Chisels with mushroomed heads.
2. Loose hammer heads.
3. Pipe wrenches with worn out jaws.
4. Channel locks that either have a loose rivet or worn out adjusting positions ~~or~~ both.
5. End wrenches that are stripped or cracked.
6. Dull hacksaw blades.

If any of the above are detected, they should be immediately replaced.

All tools should always be cleaned after use and before putting them away in your toolbox.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-20

SUBJECT: INSTALL AND REMOVE BLINDS AND ORIFICE PLATES

BLINDS

(1) Blinding is a large portion of the pipefitters work at a refinery. It is by blinding that we are able to enter and work on various types of equipment.

(2) A Safety Work Permit must be obtained.

(3) Blinding is done by loosening the bolts on the flange and taking out one less than half of the bolts, spreading the flange with a wedge or flange spreader, removing old gasket, cleaning both flange faces with scraper, putting pancake blind or figure eight blind in between flanges with gasket on both sides of blind, tightening bolts on flange by snugging them evenly on all four sides first and then going back and tightening all bolts sufficiently.

(4) Be sure to loosen the bolts on the opposite side of the flange than you are on. This way the pressure will blow away from you.

ORIFICE PLATES

(1) Orifice plates are normally inspected during shutdown of the units. Pipefitters remove and install them after calipering.

(2) A Safety Work Permit is required.

(3) Installation and removal of orifice plates require the same procedures as blinding noted above.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-21

SUBJECT: UNHEAD AND HEAD-UP VESSELS AND SIMILAR EQUIPMENT

Heading and unheading equipment is done by having the right tools for the job, knowing the size bolts and nuts, and having the right size gaskets for the head. Be sure the surface of the heads are clean and properly lined up.

When working on vessels and similar equipment there are certain safety precautions to be taken. First, obtain a Safety Work Permit, Form R-241-A. The permit will state the precautions that must be taken to unhead equipment.

SECTION 1
Heat Exchanger Nomenclature

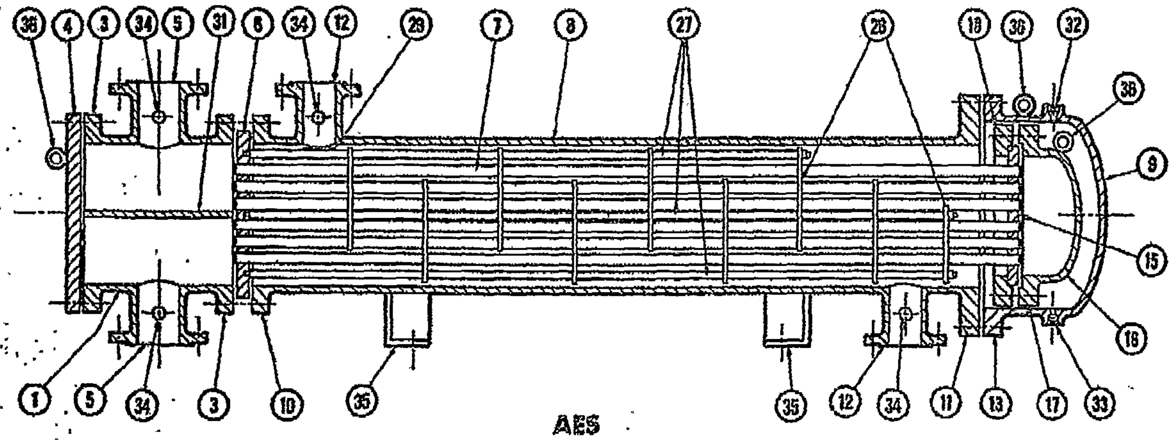
N-2 NOMENCLATURE OF HEAT EXCHANGER COMPONENTS

For the purpose of establishing standard terminology, Figure N-2 illustrates various types of heat exchangers. Typical parts and connections, for illustrative purposes only, are numbered for identification in Table N-2.

TABLE N-2

1. Stationary Head—Channel
2. Stationary Head—Bonnet
3. Stationary Head Flange—Channel or Bonnet
4. Channel Cover
5. Stationary Head Nozzle
6. Stationary Tubesheet
7. Tubes
8. Shell
9. Shell Cover
10. Shell Flange—Stationary Head End
11. Shell Flange—Rear Head End
12. Shell Nozzle
13. Shell Cover Flange
14. Expansion Joint
15. Floating Tubesheet
16. Floating Head Cover
17. Floating Head Flange
18. Floating Head Backing Device
19. Split Shear Ring
20. Slip-on Backing Flange
21. Floating Head Cover—External
22. Floating Tubesheet Skirt
23. Packing Box Flange
24. Packing
25. Packing Follower Ring
26. Lantern Ring
27. Tie Rods and Spacers
28. Transverse Baffles or Support Plates
29. Impingement Baffle
30. Longitudinal Baffle
31. Pass Partition
32. Vent Connection
33. Drain Connection
34. Instrument Connection
35. Support Saddle
36. Lifting Lug
37. Support Bracket
38. Weir
39. Liquid Level Connection

FIGURE N-2



AES

WA-TEX 001343

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-22

SUBJECT: MOVE AND ASSEMBLE ONE AND TWO STAGE SCAFFOLDS

The following illustrations give in detail the proper assembly of Safway scaffolds anc accessories.

All planking must be of sound quality, rough grained and free from knots. Also it should overlap at least 12 inches and be cleated at both ends.

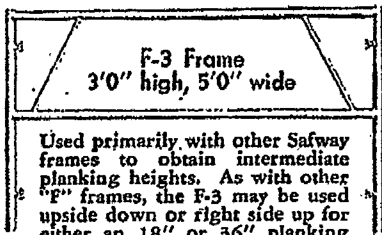
SAFWAY SCAFFOLDS

SAFETY RULES & REGULATIONS

Safway equipment is designed and constructed with the utmost consideration for safety. However the high degree of safety constructed into the equipment cannot offset carelessness *on the part of the* erector or *workman*. With this thought in mind the manufacturer calls attention to the following rules and regulations which should be strictly adhered to.

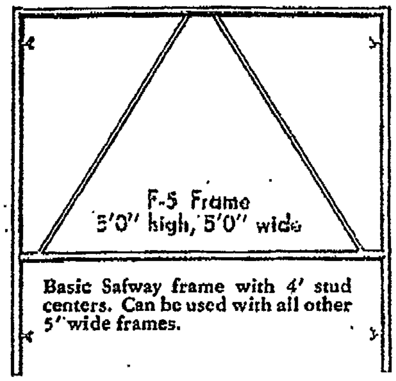
1. Provide sufficient sills or under-pinning in addition to standard base plates and all scaffolds to be erected on filled or otherwise soft ground.
2. Compensate for unevenness of ground by using adjusting screws rather than blocking.
3. Be sure that all scaffolds are plumb and level at all times.
4. Anchor running scaffold to wall approximately every 28′ of length and 20′ of height. Use additional care when using pulley arms.
5. Do not force braces to fit. Adjust evenness of scaffold until the proper fit can be made with ease.
6. Guard railing should be used on all scaffolds regardless of height.
7. Use ladders when climbing scaffold rather than the cross braces.
8. Do not use putlogs as side brackets without putlog supports and thorough consideration for loads to be applied.
9. Never tie two putlogs together to accommodate spans of greater than 20′. No putlog should have less than 12″ of overhang at point of support.
10. Always use putlog supports where spans are greater than 16′.
11. When using 16′ and 22′ putlogs in parellel, be sure to brace between them.
12. Do not omit or fail to tighten all bolts and wing nuts that are a part of the scaffold.
13. Horizontal bracing should be used to prevent racking of the structure.
14. All planking used on a scaffold should be of sound quality, straight grained, and free from knots. All planking should have at least 12″ overlap or be cleated at both ends. Secure all exterior planks to scaffold.
15. Handle all rolling towers with additional care.
    (a) Towers of a height greater than three times the minimum base dimension must be guyed at all times.
    (b) Apply all caster brakes when not in motion.
    (c) Do not ride towers.
    (d) Look where you are going with a rolling tower.
    (e) Don't attempt to move a rolling tower without sufficient help.
    (f) Provide unit lock arms on all towers.
    (g) Do not extend adjusting screws more than 12″.
    (h) Use 5″ casters on towers under 36′ in height and 8″ casters on everything over 30′.
    (i) Horizontal bracing is to be used at the bottom, top and at intermediate levels of 30 feet.
    (j) Do not use brackets on rolling towers.
16. Guy all fixed towers every 30′ of elevation.
17. Do not attempt to use Safway Scaffolds as material hoist towers or for mounting derricks without first determining the loads and stresses involved.
18. Inspect all equipment before using. Keep all equipment in good repair, avoid rusting — the strength of rusted material is not known.
19. Never use any Safway equipment that is damaged or deteriorated in any way.
20. If in doubt as to ability of Safway to do a particular job, consult the Home Office. Don't take chances.
21. Familiarize yourself with the Safety requirements of the State Codes and be governed accordingly.
22. Contractors do not rent or loan Safway equipment to others.
23. Do not permit Safway equipment to be used by anyone not familiar with these rules.
24. Establish the location of overhead ELECTRIC POWER LINES on every job where scaffolding is to be used. CALL POWER SERVICE COMPANY FOR ADVICE.

SAFWAY STEEL PRODUCTS, Inc., originated sectional tubular steel scaffolding with the F-5 mason frame, which was designed to eliminate the hazards of wood scaffolding. Through the years, Safway developed almost two dozen other types of frames and a complete line of accessories to meet every scaffolding requirement. Each frame is constructed from highest quality structural steel tubing, fabricated under quality controlled conditions, and tested and approved by the Pittsburgh Testing Laboratory and Underwriters' Laboratories, Inc.



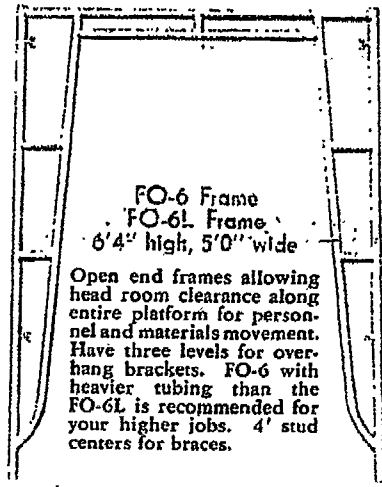
F-3 Frame
3'0" high, 5'0" wide

Used primarily with other Safway frames to obtain intermediate planking heights. As with other "F" frames, the F-3 may be used upside down or right side up for either an 18" or 36" planking height. Has 2' stud centers for braces.



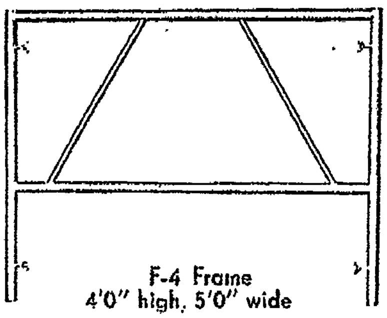
F-5 Frame
5'0" high, 5'0" wide

Basic Safway frame with 4' stud centers. Can be used with all other 5' wide frames.



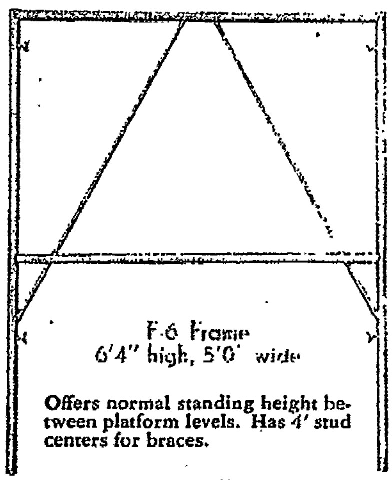
FO-6 Frame
FO-6L Frame
6'4" high, 5'0" wide

Open end frames allowing head room clearance along entire platform for personnel and materials movement. Have three levels for overhang brackets. FO-6 with heavier tubing than the FO-6L is recommended for your higher jobs. 4' stud centers for braces.



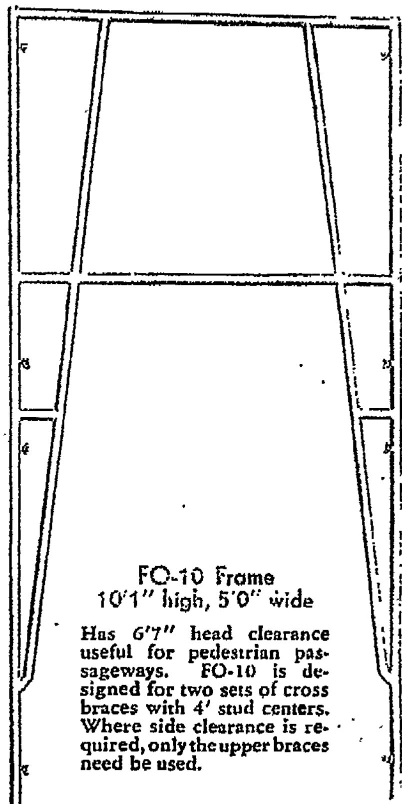
F-4 Frame
4'0" high, 5'0" wide

Offers the useful 4' planking height required by many trades. Has 3' stud centers for braces.



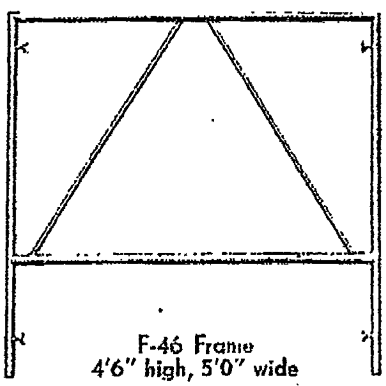
F-6 Frame
6'4" high, 5'0" wide

Offers normal standing height between platform levels. Has 4' stud centers for braces.



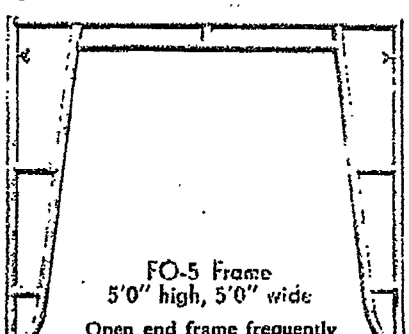
FO-10 Frame
10'1" high, 5'0" wide

Has 6'7" head clearance useful for pedestrian passageways. FO-10 is designed for two sets of cross braces with 4' stud centers. Where side clearance is required, only the upper braces need be used.



F-46 Frame
4'6" high, 5'0" wide

For specific use in those areas requiring a 4'6" planking height. 3'6" stud centers take the B-736 brace only, making a scaffold section 5' x 7' x 4'6" high.



FO-5 Frame
5'0" high, 5'0" wide

Open end frame frequently used for straddling equipment on inside jobs. Has 4' stud centers for braces.

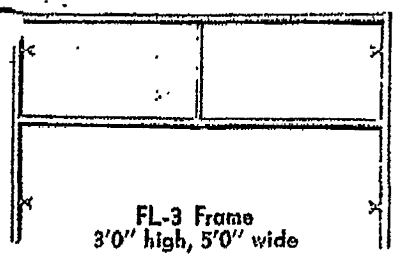
ALUMINUM SCAFFOLDING

Where extreme light weight or extra good appearance is desired, Safway offers the following frames and accessories in aluminum (the prefix "A" indicates aluminum):

AF-3, AF-5, AF-6, AFL-5, AFL-6, ALSB-1, ALS-5, ALS-6, AB-72, AB-74, AHB-5, AGR-1, AGR-5, AGR-7, AAL-1, ASU-5, ASU-6, AP-22 and ACP.

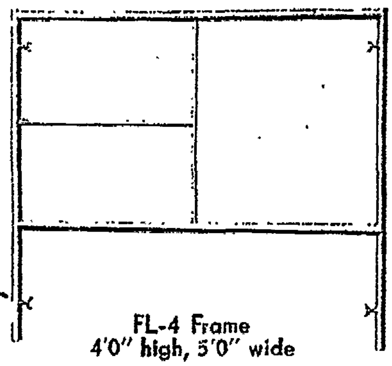
WN WING NUT

For utmost rigidity, safety and reliability, wing nut assembly for attaching cross braces is still favored in many areas. An unthreaded lead-in makes wing nut attachment quick and easy. Deep threaded studs and complete weldments to the frame provide safe, stable connections. All frames illustrated in this catalog are shown with standard Safway wing nuts. Unless "Quick-Locks" are specified, all frame orders will be shipped with wing nut attachments.



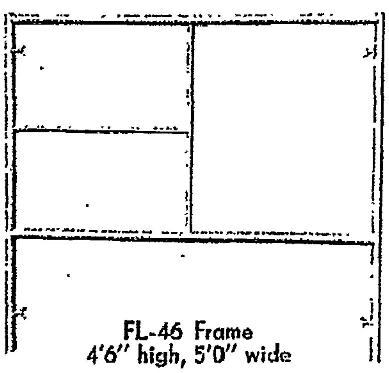
FL-3 Frame
3'0" high, 5'0" wide

Ladder frames provide multiple planking levels within each frame. The FL-3, lowest of the group, has 18" or 36" levels. May be used with other frames for intermediate planking heights. Has 2' stud centers for braces.



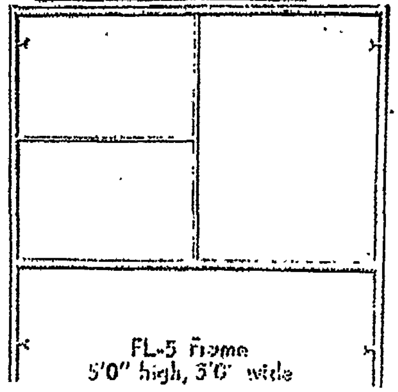
FL-4 Frame
4'0" high, 5'0" wide

Provides three planking levels. 4' high mason frame is preferred in many areas. Has 3' stud centers for braces.



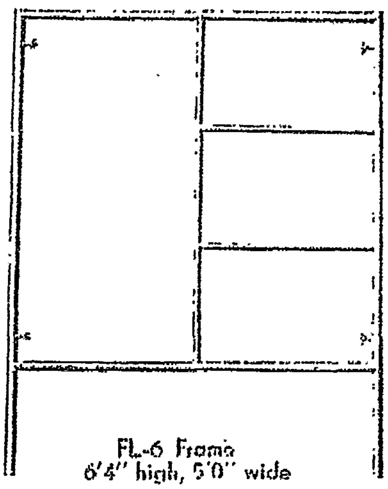
FL-46 Frame
4'6" high, 5'0" wide

Ideal as a mason frame in those areas desiring a 4'6" high lift between full planking levels. Has 3'6" stud centers for only the B-736 brace.



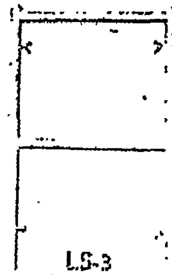
FL-5 Frame
5'0" high, 5'0" wide

This size of frame is preferred by most scaffold users as basic equipment. May be used with all other Safway frames. Has 4' stud centers for braces.

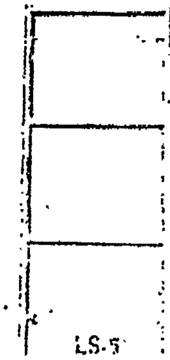


FL-6 Frame
6'4" high, 5'0" wide

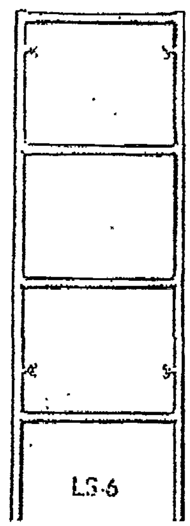
Provides head room clearance between full planking levels and three intermediate planking levels. Permits personnel movement along entire platform length. Has 4' stud centers for cross braces.



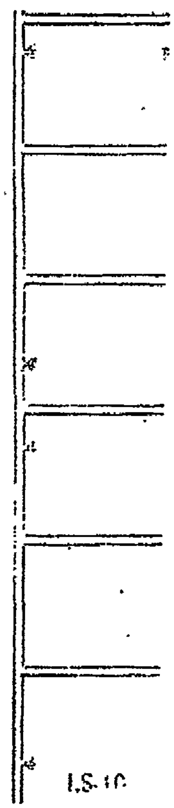
LS-3



LS-5



LS-6

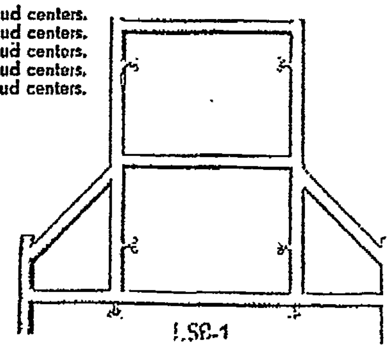


LS-10

LADDER SECTIONS

2' wide ladder sections may be assembled into separate scaffolds or used with 5' wide frames to fit around obstructions. Ideal for narrow working areas. The LSB-1 wide base section permits building higher independent rolling towers. Ladder section frames accept all standard Safway accessories. Specifications:

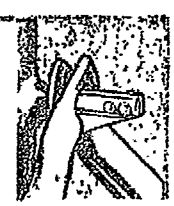
LS-3....... 3' 0" high, 2' 0" wide......2' stud centers.
LS-5....... 5' 0" high, 2' 0" wide......4' stud centers.
LS-6....... 6' 4" high, 2' 0" wide......4' stud centers.
LS-10......10' 1" high, 2' 0" wide......4' stud centers.
LSB-1...... 3' 7" high, 4' 0" wide......2' stud centers.



LSB-1

QL QUICK-LOCK

For fastest possible scaffold erection, Safway's Quick-Lock stud is highly recommended. The built-in gravity latch locks the brace in place with the frame either right side up or upside down. With Quick-Lock you can attach cross braces with only one hand. Just slipping the brace over the stud (even from a lower level) locks the braces firmly in place. To remove the brace, raise the latch and the brace comes off. All Safway frames are available with Quick-Locks or



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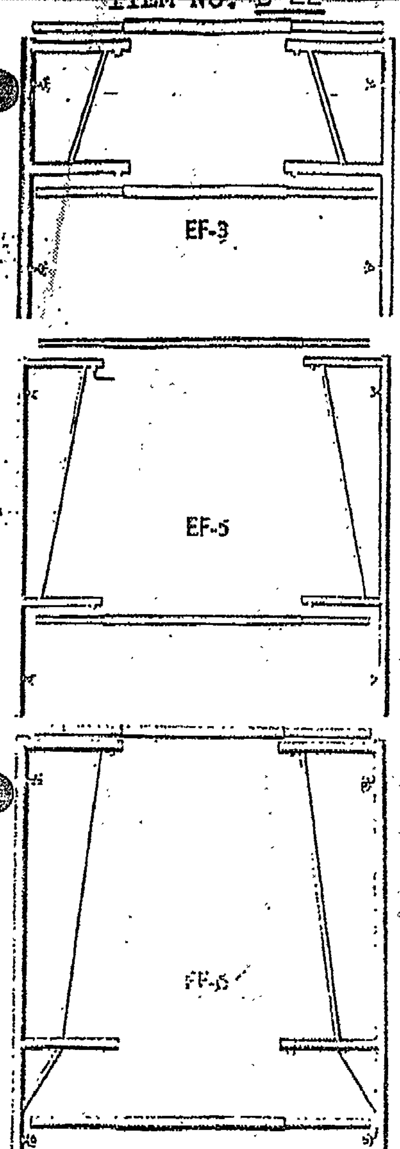


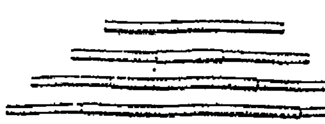
SPECIFICATIONS:

EF-3...3'0" high...2' stud centers
EF-5...5'0" high...4' stud centers
EF-6...6'4" high...4' stud centers

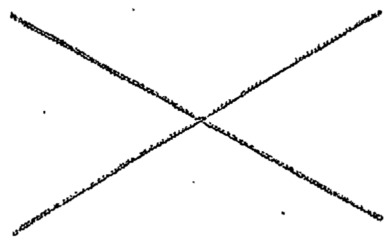
Extendable end frames are specially designed to permit getting scaffolds through small openings for normal sized assembly within, such as setting up scaffolds within boilers. Frame horizontals extend to limits of the couplers, from 2'3" to 6':

C-23..........................2'3" to 3'
C-34..........................3' to 4'
C-45..........................4' to 5'
C-56..........................5' to 6'

Two of each needed per frame.



C-23, C-34, C-45 and C-56

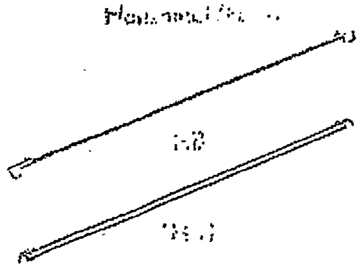


Cross Braces

Cross braces join together any two Safway frames of the same size, attaching to the frames with wing nuts or Quick-Locks. All Safway tubular steel braces are center pivoted with aircraft-type rivets, increasing stability and load distribution. Stud centers on each frame and the distance to be spanned between frames determine the proper size of cross brace. Specifications:

Frame Height	Brace Number	Distance Spanned	Stud Centers
For 3' high frames	B-32	3'	2'
	B-42	4'	2'
	B-52	5'	2'
	B-62	6'	2'
	B-72	7'	2'
	B-82	8'	2'
	B-102	10'	2'
For 4' high frames	B-73	7'	3'
For 4'6" high frames	B-736	7'	3'6"
For 5', 6'4" and 10'1" high frames	B-34	3'	4'
	B-44	4'	4'
	B-54	5'	4'
	B-64	6'	4'
	B-74	7'	4'
	B-84	8'	4'
	B-104	10'	4'

Horizontal Braces



Reinforce scaffolding subject to unusual stress. Provide increased rigidity and stability, particularly on high towers. Substitute for cross braces when open areas between frames are desired, provided each adjacent bay is cross braced. Specifications:

HB-5, 7 and 10....Horizontal Braces....5', 7' and 10' long.

HBS-5, 7 and 10....Spring-Loaded Horizontal Braces....5', 7' and 10' long.

HDBS-5, 7 and 10....Horizontal Diagonal Spring-Loaded Braces....5', 7' and 10' long.

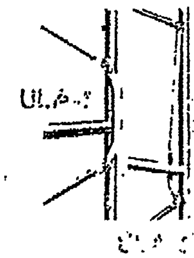
Coupling Pin

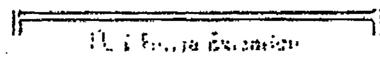
CP

Connects two frames vertically. Of slightly smaller diameter than the frame legs, coupling pins fit into legs. Legs of the next higher frame fit over the pins. Pins extend 4" into each leg, providing a safe, stable connection. The 1" swaged collars on the pins separate the frame legs and must be considered when figuring height of desired scaffolds. Semi-fixed coupling pins available upon request.

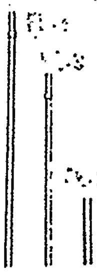
Unit Lock Arms

Positively lock two vertical scaffold legs by connecting together the studs on each leg with a steel strap. ULA-5 locks together 3', 4', 4'6" and 5' high frames, and any of these frames on top of 6'4" frames. ULA-6 locks 6'4" high frames together or to any smaller frame below.



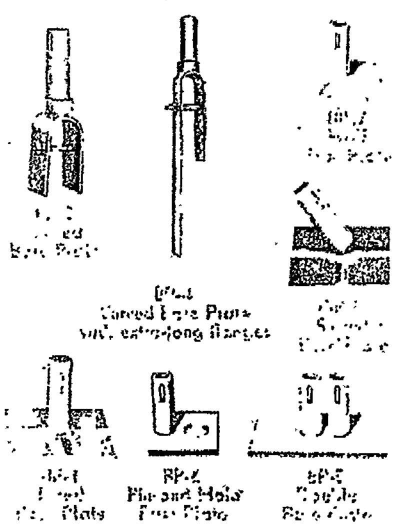


Frame Extension



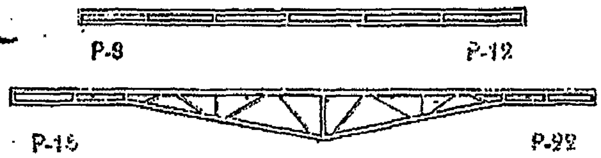
FE-1 provides extra 5" high planking platform when placed upon coupling pins at highest work level. *Extension post.* (FE-3 and FE-4), used with the appropriate *sleeve* size (FE-5) provide 2" increments of height adjustment up to 2? Extension posts and sleeves also may be used on lower scaffold legs to adjust for uneven ground.

Base Plates



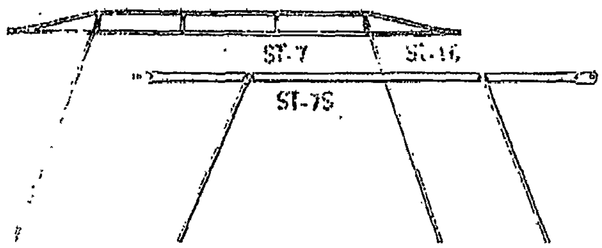
Fit into legs of all Safway frames to provide a stable footing for built-up scaffolds. On soft ground, sills are recommended under base plates. BP-1 is used on level ground; BP-2 on sloping ground; BP-3 for offsetting frames to reach receding structures, i. e spires, obelisks, etc.; BP-4 is same as BP- with extra long flanges; BP-5 permits setting two frames close together; BP-6 permits setting two frames close together on top of another frame; BP-7 permits setting frame leg close to walls or obstructions.

Putlogs

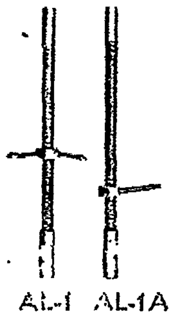


Used as structural spanning members between scaffold towers, reducing need for solid built-up scaffolding. Also used to provide cantilevered platforms and to erect finely adjusted staggered towers built upon other scaffold towers. Four sizes of putlogs are available: 8', 12', 16' and 22' long. Each putlog requires two putlog hangers to attach putlogs to frame scaffolding.

Straddle Trestles



Substitute for cross braces to provide open area between frames. Useful for building platforms over fixed equipment or obstructions. One type for 10' spacing (ST-10); two types for 7' spacing, one with single horizontal bar (ST-7S), other with double horizontal bar (ST-7).

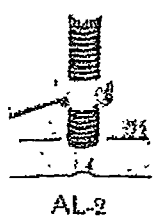


Adjustable Screw Jacks

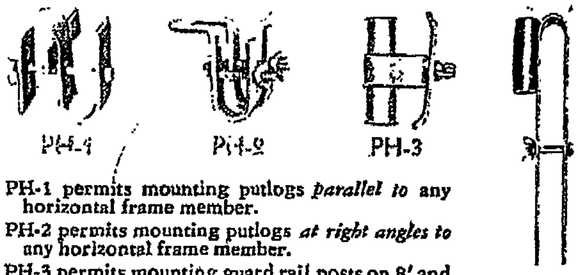
Used to level scaffolding on uneven terrain and to finely adjust scaffold shoring under formwork. Have maximum adjustment range of 18". AL-1A has removable handle and is recommended near pedestrian traffic or confined areas. Both jacks can be used with casters or base plates.

Combination Adjustable Jack and Base Plate

Frequently used where repeated usage allows the AL-2 to be used and stored in the set position. Has maximum adjustment range of 5".



Putlog Hangers



PH-1 permits mounting putlogs *parallel to* any horizontal frame member.

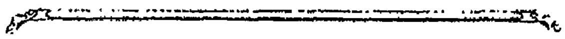
PH-2 permits mounting putlogs *at right angles to* any horizontal frame member.

PH-3 permits mounting guard rail posts on 8' and 12' putlogs, and on end sections of 16' and 22' putlogs.

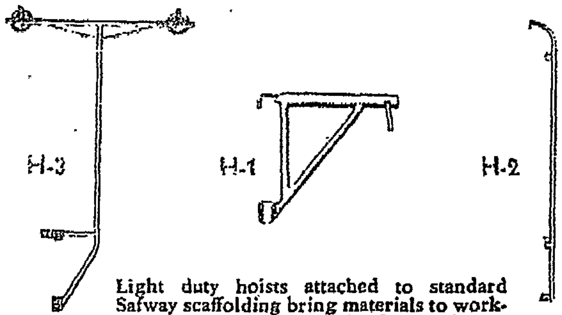
PH-4 permits mounting guard rail posts on deeper center sections of 16' and 22' putlogs.

PH-5 Putlog Support

Used for putlog bracing as extra safety equipment.



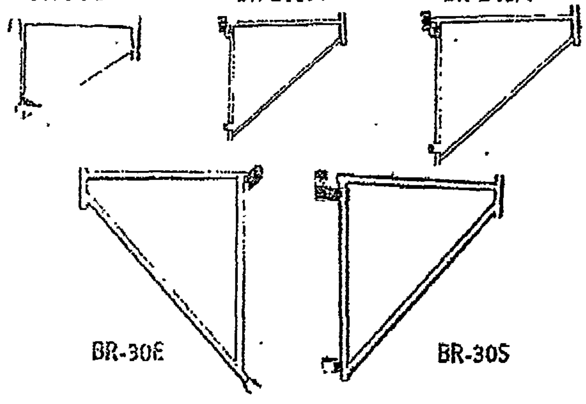
Hoists



Light duty hoists attached to standard Safway scaffolding bring materials to working platform at waist level. H-1 attaches to standard guard rail post. H-2 and H-3 attach to a frame leg.

Overhang Brackets

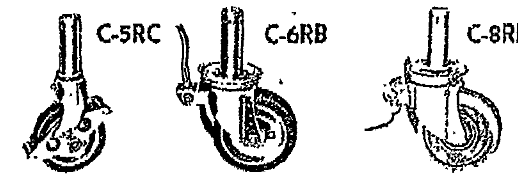
Fit on any horizontal frame member to provide additional work platforms or extended material platforms at various height levels. Help locate planking between pilasters, over beams or around other obstructions. Three sizes of *side brackets* attach parallel to the frame, and two sizes of *end brackets* fit at right angles to the frame.



WA-TEX 001349

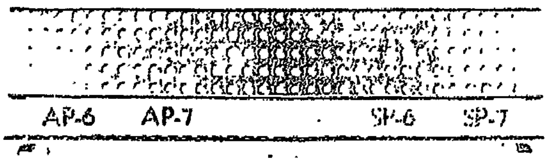
OTHER ACCESSORY EQUIPMENT

Swiveling Casters



Inserted into the legs of frames, casters provide rolling scaffold towers. Double brakes lock both wheel and swivel. When released, casters roll and swivel easily through 360°. Available in 5", 6" and 8" wheel diameters; steel, solid rubber or composition tires.

Aluminum and Steel Plank



Sturdy, lightweight steel or aluminum plank have rough, raised surfaces for safe, secure tread. Made for 6' or 7' spans. Ideal for rolling towers. AP . . . aluminum plank. SP . . . steel plank.

Plank Clip

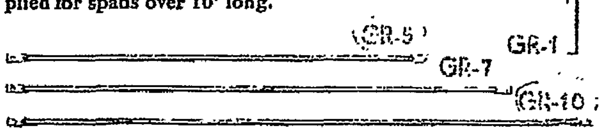
Locks planking where desired on scaffold as extra safety precaution. Also a quick, simple means for attaching toe boards to guard rail posts.

Guard Rail Post

Provides support for two guard rails, 22" and 40" above frame legs. With a base similar to a coupling pin, the posts fit into the top of frame legs. Guard rails attach to posts with standard wing nuts. Many areas require guard rails for scaffolds over 5' high.

Guard Rails
GR—(length of span)

Attach to guard rail posts with wing nuts. Available in 2', 3', 4', 5', 6', 7', 8' and 10' lengths. Safety chains are supplied for spans over 10' long.

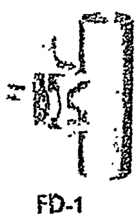


Guard Rail Clamp

Provides a wing nut and stud for attaching guard rails or cross braces to any part of a scaffold frame or accessories.

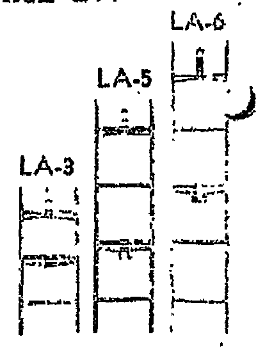
Folding Device

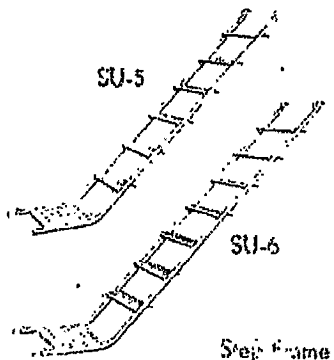
Attaches over wing nut stud, permitting assembled scaffold sections to fold into narrow units for passing through such openings as doorways, etc. Particularly useful with rolling towers. FD-1 must be attached to each frame stud. Special diagonal braces, DB-57 for 7' spans and DB-510 for 10' spans, lock the scaffold sections in position.



Climbing Ladders

With their equal distance between rungs, climbing ladders are recommended for climbing and descending scaffolds. Individual sections fit together to form a continuous ladder as high as the scaffold. Self-locking devices securely attach the ladders to the end frames. Five ladder heights offered: 3', 4', 4'6", 5', 6'4".



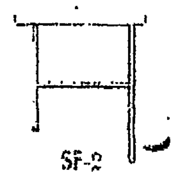


Steel Stair Units

Provide an interior stairway within scaffold bays. SU-5 is designed for 5' high frames, SU-6 for 6'4" high frames. Both units are built for 7' long spans. SUH-5 *horizontal braces* must be used on the bottom frame for attaching the lowest stair unit.

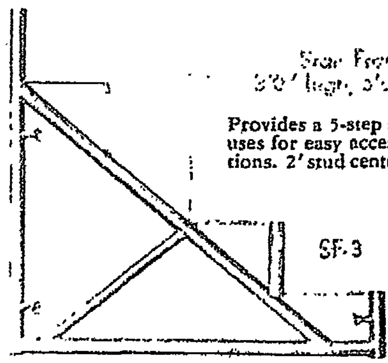
Step Frame
18" high, 2'0" wide

By insertion in the top of frame legs, the SF-2 provides a "foot scaffold" or storage space for mortar boards or other materials at a good working height. Curved plank supports prevent planks from sliding off. May be used on either frame leg.



Stair Frame
3'0" high, 3'0" wide

Provides a 5-step stairway with many uses for easy access to 3' high elevations. 2' stud centers for braces.



Frame Clamp

Steel clamp for tying adjacent frame legs together. May be used on all other adjacent parts of Safway frames.

"L" Brace Bracket

Permits attachment of guard rails or cross braces at right angles to the frame. Also used for "tying in" with guard rails.

Horizontal Brace Bracket

Allows cross braces to be placed horizontally between frames where additional rigidity is desired. HBB attaches to frame studs. For use with B-74 braces.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE DATE: JULY 1, 1970
CLASSIFICATION: PIPEFITTER (TRAINEE)

ITEM NO. B-23 SUBJECT: INSTALL LUBRICATORS

Oil lubricators are installed in service air lines to lubricate air operated tools. Lubricators used at Puget Sound Plant are screwed and must be placed in line in the upright position just before the service connections.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-24

SUBJECT: LAYOUT AND PREFABRICATE PIPEWORK

Layout and prefabrication of piping is covered extensively in Basic Training Item A-15 and Item A-17. In addition, you should always remember the following:

A. Welded

When you are fabricating welded pipe, leave a 3/32" gap between all fittings and pipe to be welded so that a welder can get good penetration.

Also, all fittings and pipe are to be plumbed, leveled and square.

B. Screwed

When you are fabricating screwed pipe, put the right amount of threads per inch on the pipe. Set dies so they don't cut too deep a thread. You should be able to screw fittings three turns by hand.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE DATE: JULY 1, 1970
CLASSIFICATION: PIPEFITTER (TRAINEE)

ITEM NO. B-25 SUBJECT: OPERATE PIPE MACHINE

PIPE MACHINE

(1) The pipe machine is used to put threads on pipe. Our pipe machines thread 1/2" to 2" pipe. The dies for the machines are adjustable and there are three sets for each machine. They are 1/2" and 3/4", 1" and 1-1/4", and 1-1/2" and 2". Extreme care should be taken when threading pipe to be sure [illegible] are set for the right pipe size.

(2) Listed below are standard pipe threads:

Nominal Diameter Inches	Threads Per Inch
1/8	27
1/4	18
3/8	18
1/2	14
3/4	14
1	11-1/2
1-1/4	11-1/2
1-1/2	11-1/2
2	11-1/2

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-26

SUBJECT: BEND PIPE

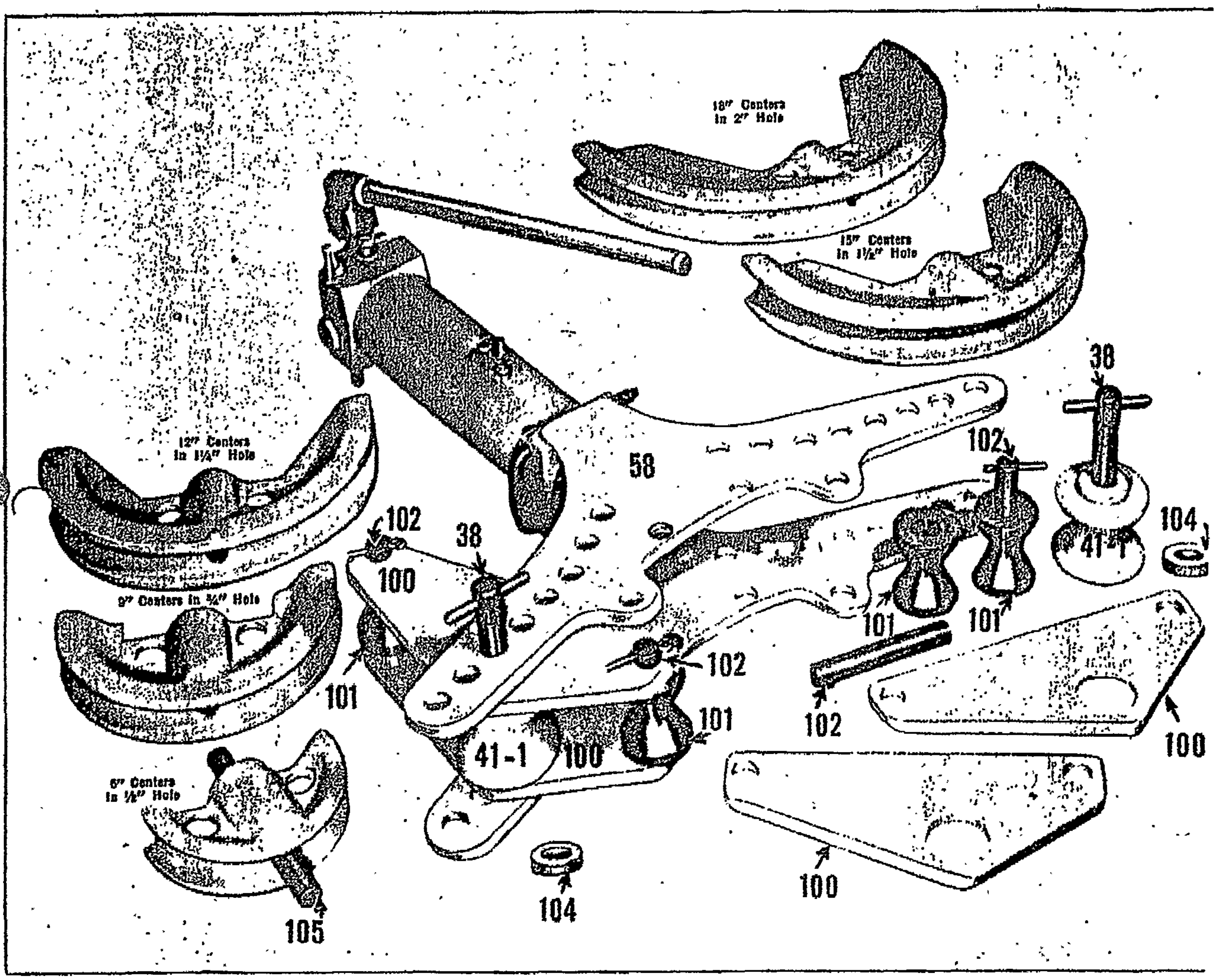
Bending pipe is a good method of installing pipe; there are fewer fittings required, therefore, less time is required for the installation and there is less resistance to product in the line. Primarily, pipe bending is used on lines for catalyst and steam tracing.

The following pages illustrate the operation and application of pipe benders.

METHOD OF USE

OF THE

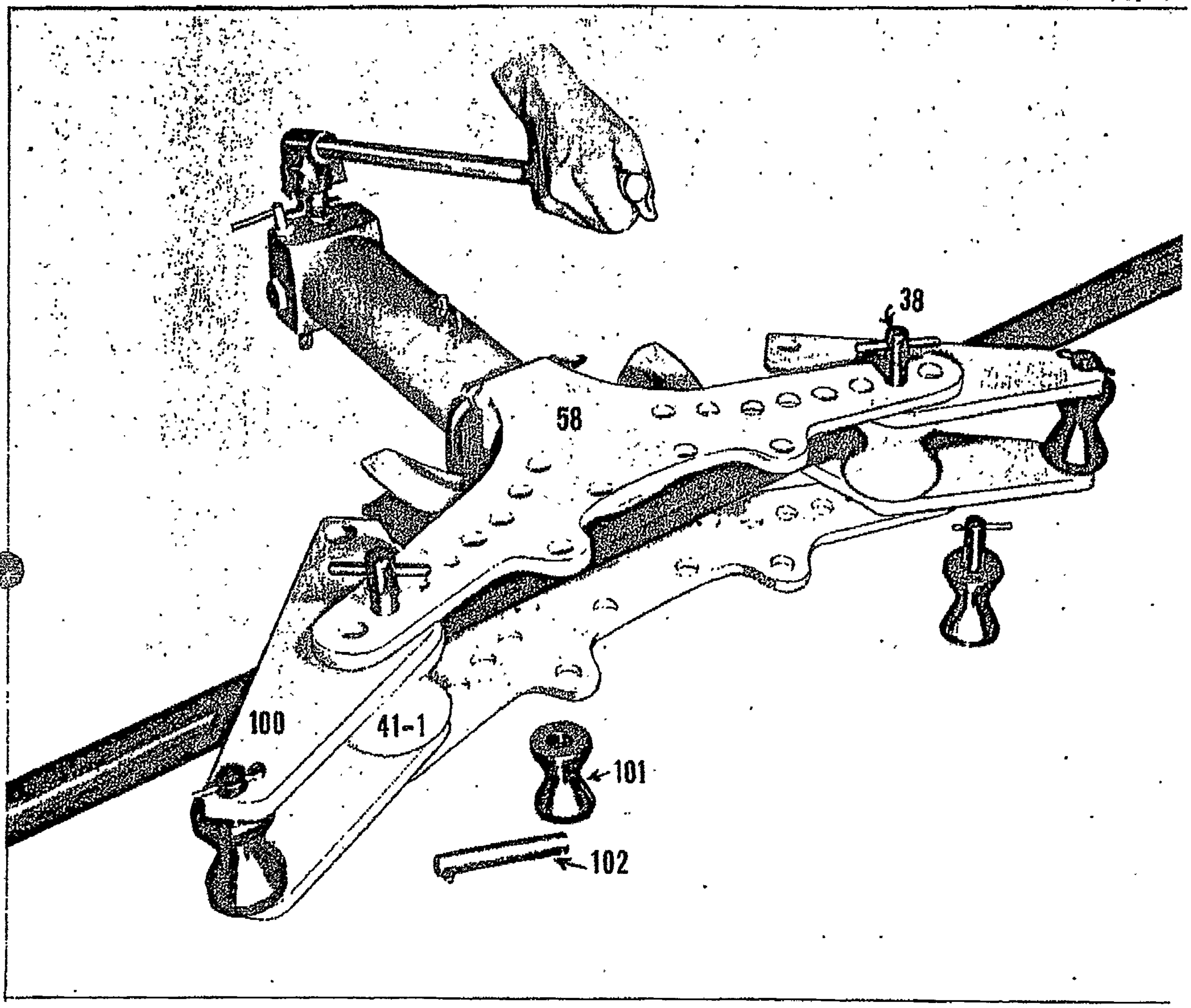
Newly Designed Attachment for Making 180° Bends With Tal Pipe Benders



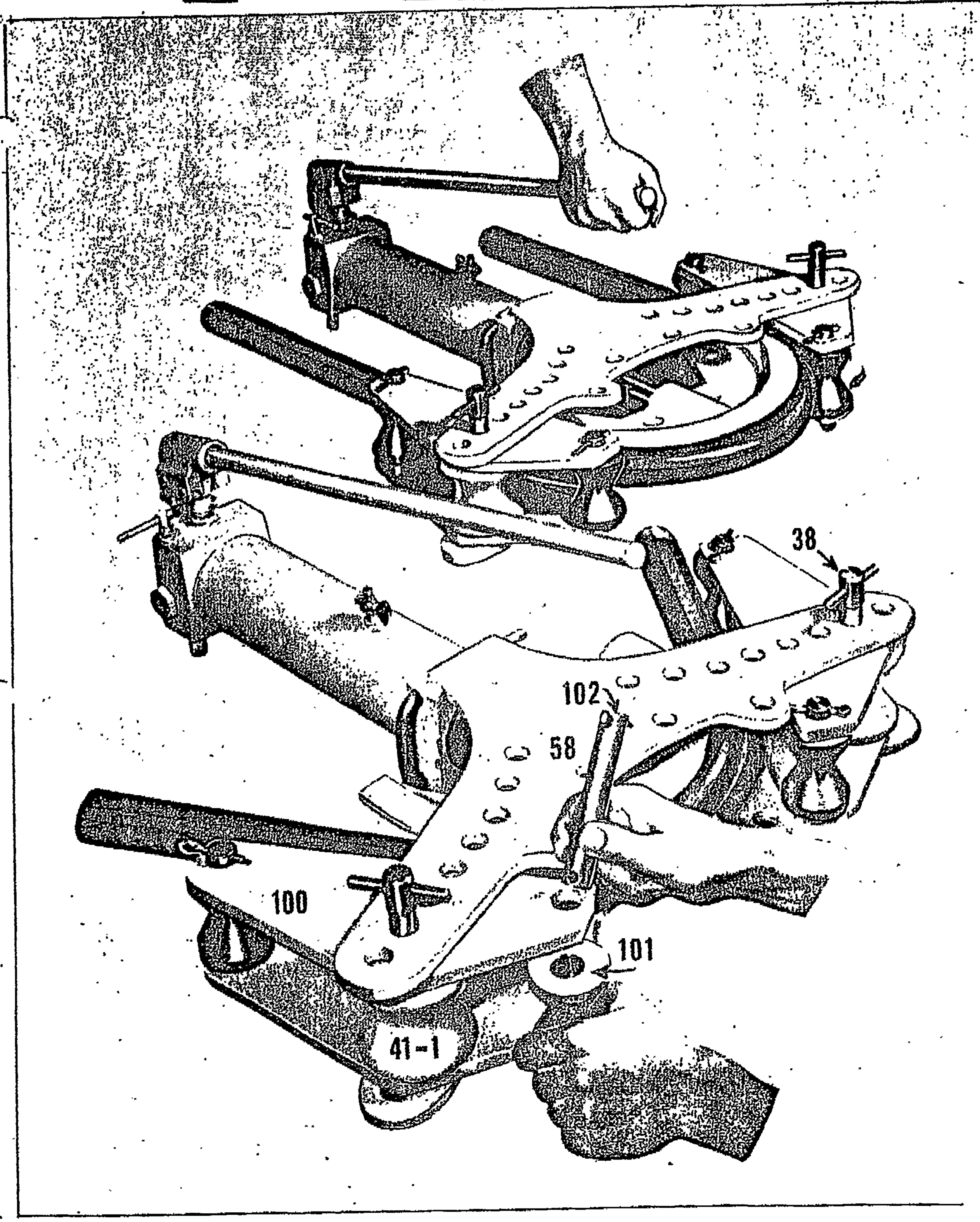
The 180° attachment consists of the following parts:

#100	4 Guiding Plates, 2 on each side.	#41-1 #38	2 Corner Formers and 2 Corner Former Pins 1 on each side.
#101 #102	4 Rollers and 4 Roller Pins 2 on each side, front and rear.	#105	Pipe Release Pin
		#104	2 Spacers to be used with 3" Pipe Bender. One under each corner former.

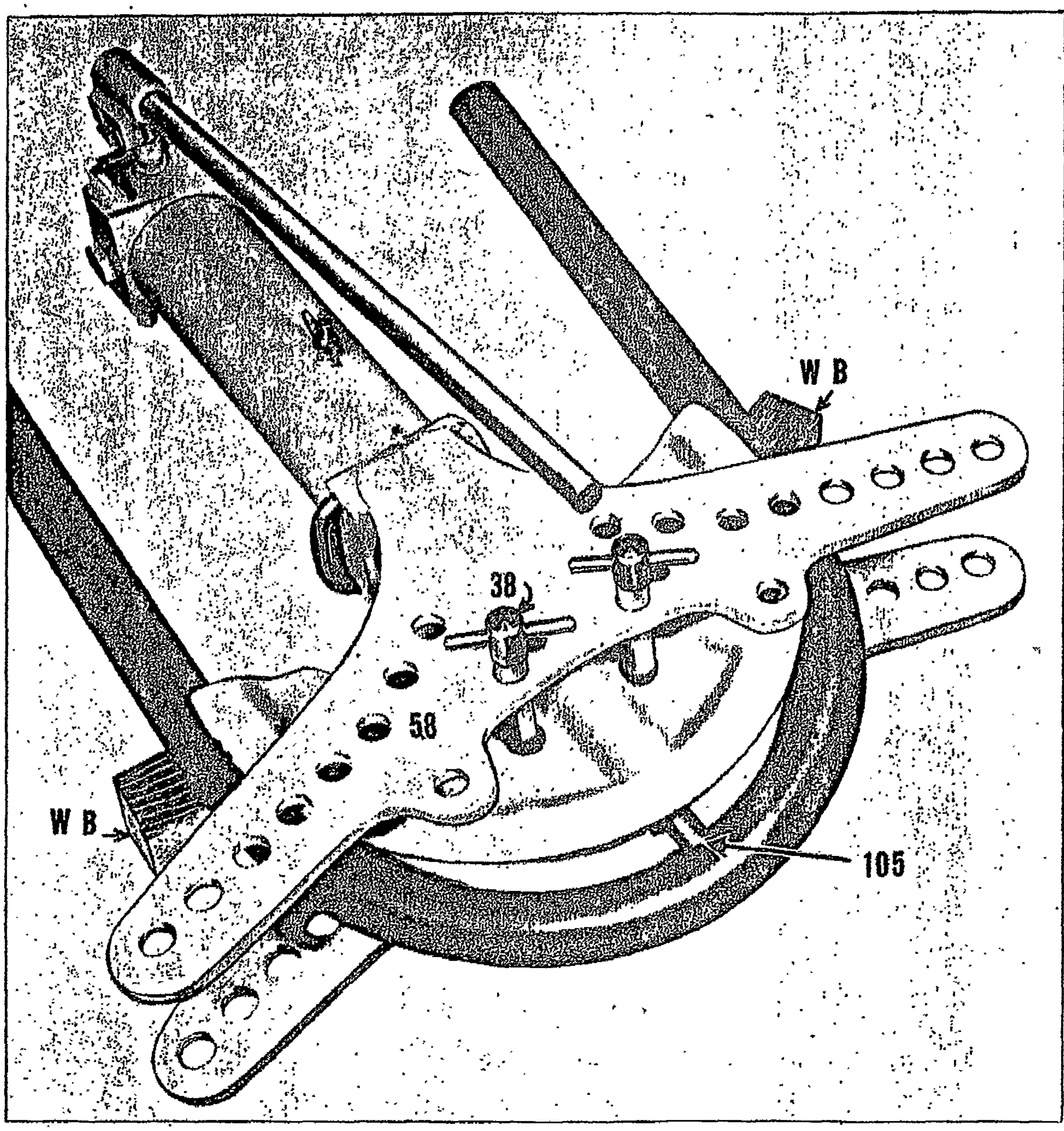
WA-TEX 001355



Before starting bending, 180° attachment should be set up as in Illustration 2, with rear rollers and pins (#101-102) out.



Bend to approximately 130° and release ram. Rotate guiding plates bringing short side in front. Insert rollers with pins (#101-102) on both sides and complete bend. Allow for spring-back by bending past 180°.



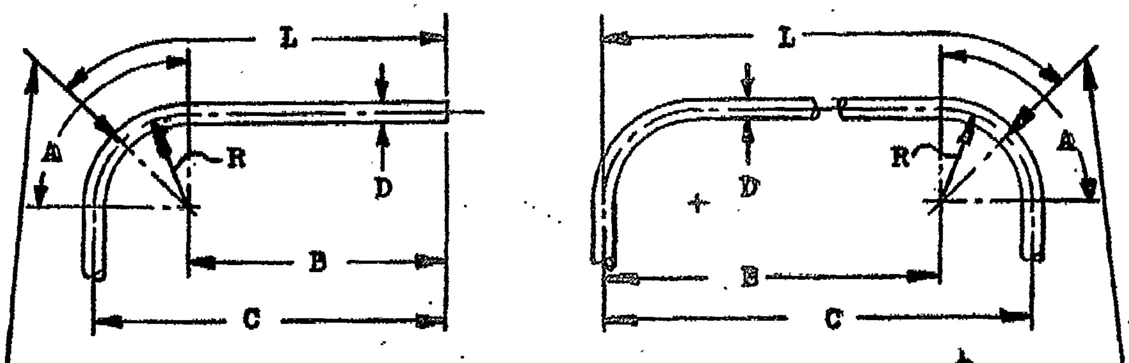
In the event that the pipe lodges in the former due to an oversize condition, use pipe release pin (#105). Insert pin (#105) through the back of former, anchor former to frame. Place blocks (W.B.) under former bringing same in right position against pipe bender ram. Proceed to pump pipe out.

BENDING INSTRUCTIONS
for
PIPE, TUBING, and CONDUIT when using TAL HYDRAULIC PORTABLE BENDERS

The following illustrations, table, and examples will simplify the calculations for obtaining dimensions to measure and mark the right locations of BEND starting points. Locations of these BEND starting points are to the center of completed bends converted to straight or linear figures for lay-out and marking on a straight length. It is important that after straight lengths are marked with the bend locations these marks are centered on the Ram and Former of the Tal Bender. To obtain dimensions for the location of the bend start point's it is necessary that the following are known.

"A" angle of bend
"B" or "C" distance to completed bend
"R" radius of bend

With these values known, and with the proper use of the table, the bend setting dimensions can be obtained for marking on straight lengths for a multiplicity of bends in any plane in any one length before any bend is made so that all bending can be done successively one after another, or one at a time by measuring and marking from a bend already made, making the new bend and repeating, for as many as can be accommodated in a single length.



Bend starting points on straight lengths. Place on ℄ of Ram and Former.

Above illustrations are for single and multiple bends where "A" angle of bend is 90 degrees. Since "L" represents the bend setting location on a straight length, then since "D" represents the diameter of the pipe or tube, and "R" the bend radius both are known. "B" or "C" are also known since they locate the completed bend which is governed by your requirement.

$$L = B + x$$

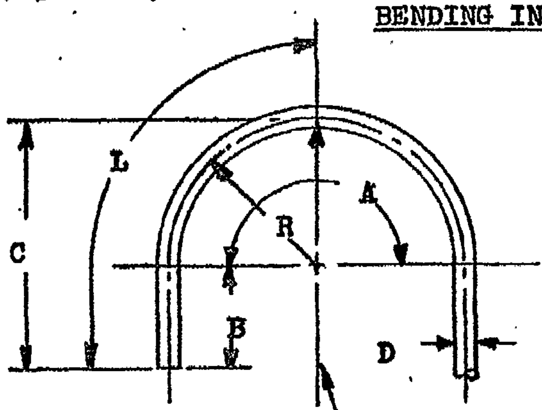
$$L = C - y$$

The values for x and y are obtained from the Table on Page 3. Example: A 2" pipe is to be bent. The radius is 8" (R). The distance to the bend is "B" = 10" or "C" = 18" whichever can be determined most conveniently. Then by finding x or y in the table and substituting numbers for the letters

$L = 10" + 6\frac{9}{32} = 16\frac{9}{32}$ and or $L = 18" - 1\frac{23}{32} = 16\frac{9}{32}$

WA-TEX 001359

BENDING INSTRUCTIONS



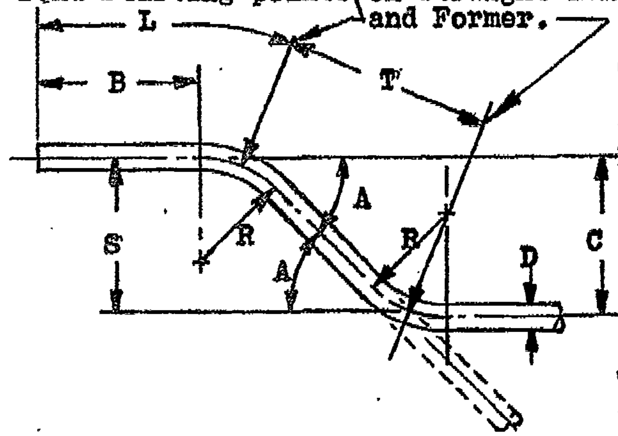
To obtain straight line dimension for laying-out 180° bends

$L = C + q$

$L = B + 2x$

The values for q and x are obtained from the Table on Page 3.

Bend Starting points on straight lengths. Place on ℄ of Ram and Former.



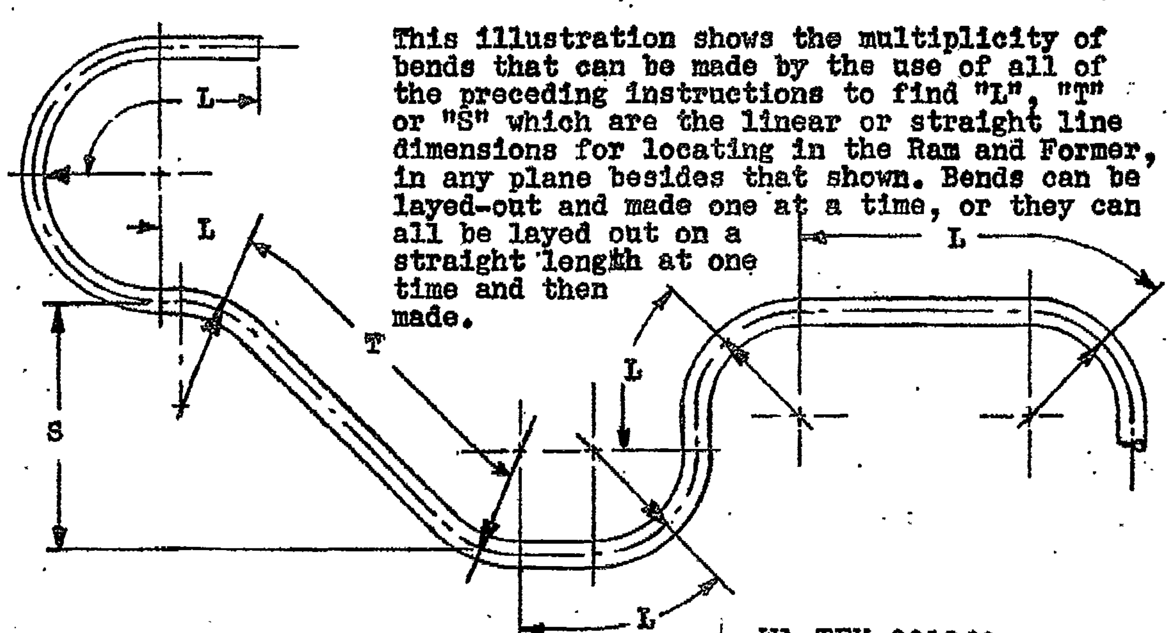
To obtain straight line dimensions for laying-out OFFSETS to angles shown in Table on Page 3.

$L = B + z$

$S = C - k$

$T = C - f \times n + 2z$

The values for z, k, and f are obtained from the Table on Page 3.



This illustration shows the multiplicity of bends that can be made by the use of all of the preceding instructions to find "L", "T" or "S" which are the linear or straight line dimensions for locating in the Ram and Former, in any plane besides that shown. Bends can be layed-out and made one at a time, or they can all be layed out on a straight length at one time and then made.

TABLE FOR USE WITH BENDING INSTRUCTIONS - TAL BENDER INC. MILWAUKEE WIS.

PIPE-TUBING-E.M.T.-RIGID CONDUIT

OFFSETS

D	R	180°		90°		60° n=1.155				45° n=1.414				30° n= 2				22½° n=2.613				11¼° n=5.126			
		2X	g	X	Y	Z	2Z	K	§	Z	2Z	K	§	Z	2Z	K	§	Z	2Z	K	§	Z	2Z	K	§
3/8	1½	2 11/32	27/32	1 11/64	21/64	25/32	1 9/16	13/64	1½	19/32	1 3/16	7/64	7/8	25/64	25/32	3/64	13/32	9/32	9/16	1/32	7/32	9/64	9/32	1/64	1/16
1/2	2	3 1/8	1 1/8	1 9/16	7/16	1 1/16	2 1/8	17/64	2	25/32	1 9/16	5/32	1 11/64	17/32	1 1/16	1/16	17/32	25/64	25/32	3/64	5/16	3/16	3/8	1/64	3/32
3/4	2½	3 15/16	1 7/16	1 31/32	17/32	1 5/16	2 5/8	11/32	2½	1	2	3/16	1 29/64	21/32	1 5/16	5/64	11/16	1/2	1	3/64	3/8	1/4	1/2	1/64	3/32
1	3½	5½	2	2 3/4	3/4	1 27/32	3 11/16	15/32	3½	1 3/8	2 3/8	17/64	2 1/16	15/16	1 7/8	1/8	15/16	45/64	1 13/32	1/16	17/32	11/32	11/16	1/64	1/8
3/8	4	6 11/32	2 9/32	3 11/64	53/64	2 3/32	4 3/16	17/32	4	1 9/16	3 1/8	5/16	2 11/32	1 3/64	2 3/32	9/64	1 1/16	25/32	1 9/16	5/64	5/8	25/64	25/32	1/64	5/32
1¼	4½	7	2 9/16	3½	1	2 3/8	4 3/8	39/64	4½	1 3/4	3½	11/32	2 3/8	1 3/16	2 3/8	5/32	1 7/32	57/64	1 25/32	3/32	11/16	7/16	7/8	1/64	3/16
1	5¾	9	3 9/32	4½	1¼	3	6	49/64	5¾	2¼	4½	7/16	3 3/8	1½	3	13/64	1 7/32	1 1/8	2¼	7/64	7/8	9/16	1 1/8	1/32	7/32
3/8 - 1/2 - 3/4 - 1½	6	9 7/16	3 7/16	4 23/32	1 9/32	3 9/64	6 9/32	13/16	6	2 23/64	4 23/32	23/64	3½	1 9/16	3 1/8	13/64	1 5/8	1 11/32	2 11/16	7/64	29/32	43/64	1 11/32	1/32	7/32
1¼	7¼	11 3/8	4 1/8	5 11/16	1 9/16	3 3/4	7½	31/32	7¼	2 7/8	5 3/4	9/16	4 1/4	1 7/8	3 3/4	1/4	1 15/16	1 7/16	2 7/8	9/64	1 1/8	23/32	1 7/16	1/32	9/32
2	8	12½	4 9/16	6 9/32	1 25/32	4 3/16	8 3/8	1 1/16	8	3 1/8	6 1/4	39/64	4 11/16	2 3/32	4 3/16	9/32	2 1/8	1 9/16	3 1/8	5/32	1 7/32	25/32	1 9/16	3/64	5/16
1½	8¼	13	4 29/32	6½	1 13/16	4 5/16	8 5/8	1 7/64	8¼	3¼	6½	5/8	4 13/16	2 5/32	4 5/16	9/32	2 7/32	1 5/8	3¼	5/32	1¼	13/16	1 5/8	3/64	11/32
1/2 - 3/4 - 1	9	14 1/8	5 1/8	7 1/16	1 15/16	4 11/16	9 3/8	1 13/64	9	3½	7	11/16	5 9/32	2 11/32	4 11/16	5/16	2 13/32	1 3/4	3½	11/64	1 3/8	7/8	1 3/4	3/64	11/32
2	9½	14 7/8	5 7/16	7 7/16	2 1/16	5	10	1 9/32	9½	3 3/4	7½	23/32	5 9/16	2½	5	21/64	2 9/16	1 7/8	3 3/4	3/16	1 7/16	15/16	1 7/8	3/64	3/8
2 - 2½	10	15 3/4	5 23/32	7 7/8	2 1/8	5 5/8	10 1/4	1 11/32	10	3 7/8	7 3/4	49/64	5 7/8	2 9/16	5 1/8	11/32	2 11/16	1 15/16	3 7/8	3/16	1 17/32	31/32	1 15/16	3/64	25/64
1	10½	16½	6	8¼	2¼	5 15/32	10 15/16	1 13/32	10½	4 1/16	8 1/8	51/64	6 1/8	2 23/32	5 7/16	23/64	2 13/16	2 1/32	4 1/16	13/64	1 29/32	1 1/64	2 1/32	3/64	13/32
1/2 - 3/4 - 1 - 3	12	18 7/8	6 27/32	9 7/16	2 9/16	6¼	12½	1 39/64	12	4 3/4	9½	29/32	7 1/32	3 1/8	6¼	13/32	3 7/32	2 3/8	4 3/4	15/64	1 15/16	1 3/16	2 3/8	1/16	15/32
1¼	13 1/8	20 5/8	7½	10 5/16	2 13/16	6 7/8	13 3/4	1 3/4	13 1/8	5 1/8	10 1/4	1	7 11/16	3 7/16	6 7/8	7/16	3½	2 9/16	5 1/8	1/4	2	1 9/32	2 9/16	1/16	1/2
2½ - 3	15	23½	8 9/16	11 3/4	3 1/4	7 7/8	15 3/4	2	15	5 7/8	11 3/4	1 9/64	8 25/32	3 15/16	7 7/8	33/64	4	2 15/16	5 7/8	9/32	2 9/32	1 15/32	2 15/16	5/64	9/16
1½	15¾	24 3/4	9	12 3/8	3 3/8	8 1/4	16½	2 7/64	15¾	6 3/16	12 3/8	1 13/64	9 1/4	4 1/8	8 1/4	17/32	4 7/32	3 3/32	6 3/16	19/64	2 13/32	1 35/64	3 3/32	5/64	19/32
3½	18	28 1/4	10 9/32	14 1/8	3 7/8	9 7/16	18 7/8	2 13/32	18	7 1/16	14 1/8	1 3/8	10 9/16	4 21/32	9 5/16	5/8	4 13/16	3½	7	11/32	2 3/4	1 3/4	3½	3/32	11/16
2	21¼	33 1/4	12 1/8	16 5/8	4 5/8	11 1/8	22 1/4	2 27/32	21¼	8 3/8	16 3/4	1 41/64	12 7/16	5 9/16	11 1/8	23/32	5 11/16	4 3/16	8 3/8	13/32	3 9/32	2 3/32	4 3/16	7/64	13/32
4	23	36	13 5/32	18	5	12	24	3 3/32	23	9	18	1 3/4	13½	6	12	25/32	6 3/16	4½	9	7/16	3½	2¼	4½	7/64	7/8
5	29¾	46½	17	23¼	6½	15½	31	3 63/64	29¾	11 5/8	23¼	2 17/64	17 7/16	7 3/4	15½	1 1/64	7 31/32	5 13/16	11 5/8	37/64	4 17/32	2 29/32	5 13/16	5/32	37/32
6	36	56½	20½	28¼	7¾	18 7/8	37 3/4	4 13/16	36	14 1/8	28½	2 3/4	21 1/16	9 7/16	18 7/8	1 15/64	9 5/8	7 1/16	14 1/8	11/16	5½	3 17/32	7 1/16	3/16	1 3/8

WA-TEX 001361

INSTRUCTIONS FOR OPERATION OF THE TAL COPPER TUBE BENDER

Your Tal Copper Tube Bender comes to you assembled with one former in place.

TUBE BENDING OPERATION:

Assuming the bend is to be Right Hand, swing the roller to the left side approximately 90° to center line of machine:

Remove the Radius Key, push the Slide Bar out and place the tube under the Slide Bar and Ring Gear between the Roller and Former Shoe.

Press the tube firmly back into the Former Shoe groove, at the same time holding the tube as level as possible with the machine.

Move the Slide Bar back into place and insert the Radius Key.

Place the tube against the Grip Bar Shoe, press the Grip U-Clamp down over the tube and Grip Bar Shoe.

REMOVING FINISHED BEND:

Before removing the handle, return the Former Roller to its starting point. Remove Radius Key and Grip U-Clamp drop finished bend out of machine.

OPERATOR MUST STAND ON FLOOR PLATE WHEN INSERTING AND REMOVING TUBING AND DURING BENDING OPERATION.

TO CHANGE OVER FROM ONE SIZE TO ANOTHER:

Remove the Spring Key from the Center Post.

Remove Slide Bar and Ring Gear.

Remove Former Shoe and replace with desired Former, making sure same sets down over the Angle Pin.

DO NOT use a hammer on the Radius Key or the Grip U-Clamp.

To make a 180° bend, it is necessary to bend the tube more than 180°, allowing for "Springback."

CHART

Pipe Size	Degree of Bend	GAUGE FACTOR Plumbing and Heating	GAUGE FACTOR Electrical	Pipe Size	Degree of Bend	GAUGE FACTOR Plumbing and Heating	GAUGE FACTOR Electrical	Pipe Size	Degree of Bend	GAUGE FACTOR Plumbing and Heating	GAUGE FACTOR Electric
⅜"	22½°	1"		1"	22½°	3⅜"	3⅜"	2"	22½°	5⅛"	5⅛"
	45°	1¾"			45°	4⅝" ★★	4⅞"		45°	7"	7⅛"
	90°	3"			90°	6¾" ★★	7½"		90°	10¼"	10⅜"
½"	22½°	2⅛"		1¼"	22½°	4"	4"	2½"	22½°	6⅛"	6⅜"
	45°	3"			45°	5⅝" ★★	5⅝"		45°	9"	9⅛"
	90°	4⅞"			90°	8" ★★	8¾"		90°	14¼"	14½"
¾"	22½°	2¾"		1½"	22½°	4⅝"	4⅝"	3"	22½°	7"	7"
	45°	3⅞"			45°	6¼" ★★	6⅜"		45°	10"	10⅛"
	90°	6⅛"			90°	9¾" ★★	9⅞"		90°	15¼"	15½"

No. 3 PH — 3" PIPE BENDER

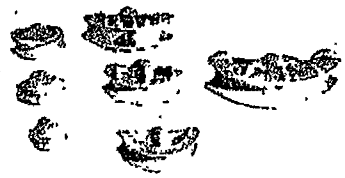
Bends standard pipe ⅜" to 3" (X to 2½", XX to 1½"). Includes SEVEN short radius bending shoes ⅜" to 2" (Box II), plus two standard radius: 2½" and 3"* (below) Heaviest part 57 lbs.

No. 3 PHX incl. parts for Radiant Heat.

Specs. of Radiant Heat Shoes on page 4.

No. 2 PH — 2" PIPE BENDER

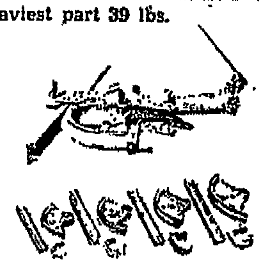
Bends standard pipe from ⅜" to 2", (X to 2", XX to 1½"). Includes SEVEN short radius Bending Shoes ⅜" to 2" (below). Heaviest part 39 lbs.



Seven Short Radius Shoes for pipe.

No. 2 CT — 2" COPPER TUBE BENDER

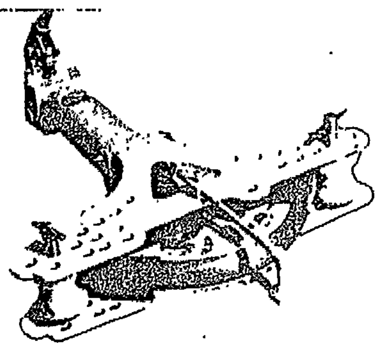
Includes FOUR bending shoes, bars, and clamps FOR HARD & SOFT COPPER TUBING K & L: 1" to 2". Heaviest part 39 lbs.

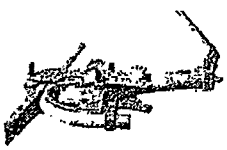


Shoes Bars and Clamps for Tube Bender

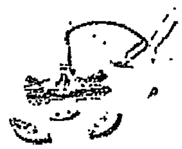
All No. 2 & No. 3 benders have only two main parts: ONE hydraulic unit and ONE universal frame (page 4). They are assembled with a U key in less than ONE MINUTE.

THIS IS THE BASIC PIPE BENDER USED WITH ALL VARIATIONS shown





Same bender used as Copper (CT) or Steel Tube (EMT) bender.

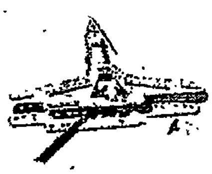


Same bender with Remote Control RC (page 4).

Same bender with Motor pump No. MP-26 (page 4).

No. 3 C — 3" RIGID CONDUIT BENDER

Includes FOUR bending shoes FOR RIGID CONDUIT: 1" to 2" (Box V), plus TWO: 2½" and 3"* (Box 1). For extra long radius bending shoes see page 6. Heaviest part 57 lbs.

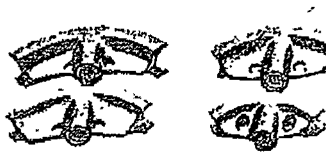


No. 3 C BB for Rigid Conduit

No. BB 2 or 3 Bus Bar Dies

No. 2C — 2" RIGID CONDUIT BENDER

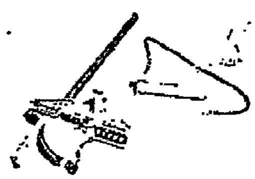
Includes FOUR bending shoes FOR RIGID CONDUIT: 1" to 2" (below). Heaviest part 39 lbs. For extra long radius bending shoes, see page 6. For bending Bus Bar with No. 2 bender, order No. BB 2 (Box IV).



Four Standard Elbow Radius Shoes

No. 2 EMT—2" THINWALL CONDUIT BENDER

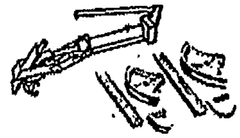
Includes FOUR bending shoes, bars and clamps FOR THINWALL CONDUIT: 1" to 2" (Page 6). Heaviest part 39 lbs.



No. RC 2 EMT shown with remote control.

No. 3 CT — 3" COPPER TUBE BENDER

Includes 4 bending shoes, bars and clamps FOR HARD OR SOFT COPPER TUBING K & L: 1" to 2", and TWO 2½" and 3"* (shown). Heaviest part 44 lbs., Benders for 2½" and 3" Copper tubing have a special frame (shown). Larger sizes obtainable.



WITH FRAME NO. 2533

No. 2 PH/CT — COMBINATION 2" PIPE & 2" COPPER TUBE BENDER

Incl. 7 short radius shoes: ⅜" to 2" (Box II), plus 4 bending shoes, bars, and clamps FOR COPPER TUBING type K & L 1" to 2" (Box III). Heaviest part 39 lbs.

USED AS PIPE BENDER

No. 3 PH/CT — COMB. 3" PIPE & 2" COPPER TUBE BENDER

Incl. 7 short radius shoes: ⅜" to 2" (Box II), TWO: 2½" and 3"* (Box I), plus 4 shoes, bars and clamps FOR COPPER TUBING: 1" to 2" (Box III). Heaviest part 57 lbs.

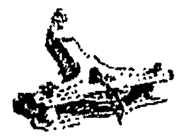
No. 33 PH/CT — COMB. 3" PIPE & 3" COPPER TUBE BENDER

is as No. 3PH/CT above, plus extra frame No. 2533 (Box VII) and parts for 2½" and 3" copper tubing.

USED AS TUBE BENDER

No. 2 C/EMT — COMB. 2" RIGID & 2" THINWALL CONDUIT BENDER

Incl. 4 standard elbow radius shoes FOR RIGID CONDUIT: 1" to 2" (Box V), plus 4 bending shoes, bars and clamps FOR THINWALL CONDUIT: 1" to 2" (Box III). Heaviest part 39 lbs.

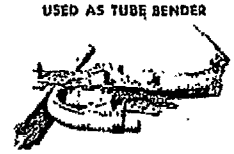


USED AS PIPE BENDER

No. 3 C/EMT — COMBINATION 3" RIGID & 2" THINWALL CONDUIT BENDER

Includes 6 standard elbow radius shoes FOR RIGID CONDUIT: 1" to 3" (see Box IV & V), plus 4 shoes, bars and clamps FOR THINWALL CONDUIT: 1" to 2" (Box III). Heaviest part is 57 lbs.

USED AS TUBE BENDER



No. 2 PH/C — COMBINATION 2" PIPE & 2" RIGID CONDUIT BENDER

Includes 7 short radius bending shoes FOR PIPE: ⅜" to 2" (Box II), plus 4 shoes FOR RIGID CONDUIT: 1" to 2" (Box V). Heaviest part 39 lbs.

Patented QUICK RELEASE SHOES

Short radius for Piping — Std. radius elbows for Electr.

No. 3 PH/C — COMBINATION 3" PIPE & 3" CONDUIT BENDER

Includes 7 short radius shoes FOR PIPE: ⅜" to 2" (Box II), plus 6 shoes for RIGID CONDUIT: 1" to 3" (Boxes IV & V). (2½" and 3"* shoes have same radius for pipe and conduit.) Heaviest part 57 lbs.

No. RC 3 PH/C with Remote Control

No. 2 PH/C — CT-EMT — COMBINATION 2" PIPE, 2" RIGID CONDUIT 2" COPPER & 2" THINWALL CONDUIT BENDERS

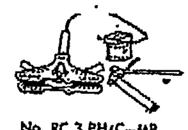
Includes 7 short radius shoes FOR PIPE: ⅜" to 2", plus 4 shoes FOR RIGID CONDUIT: 1" to 2" plus 4 EACH bending shoes, bars and clamps, FOR COPPER TUBING AND THINWALL CONDUIT: 1" to 2" Heaviest part is 39 lbs.

Shown with motor pump only.

No. 3 PH/C — CT-EMT — COMB. 3" PIPE, 3" RIGID CONDUIT, 2" COPPER & 2" THINWALL CONDUIT BENDERS

Includes 7 short radius shoes FOR PIPE: ⅜" to 2", plus 6 FOR RIGID CONDUIT: 1" to 3"*, plus 4 EACH shoes, bars and clamps FOR COPPER TUBING & EMT: 1" to 2" Heaviest part 57 lbs.

No. 33 PH/C — CT-EMT is as No. 3 above, plus parts for 2½" & 3" copper tubing and special frame as shown in Box VII.

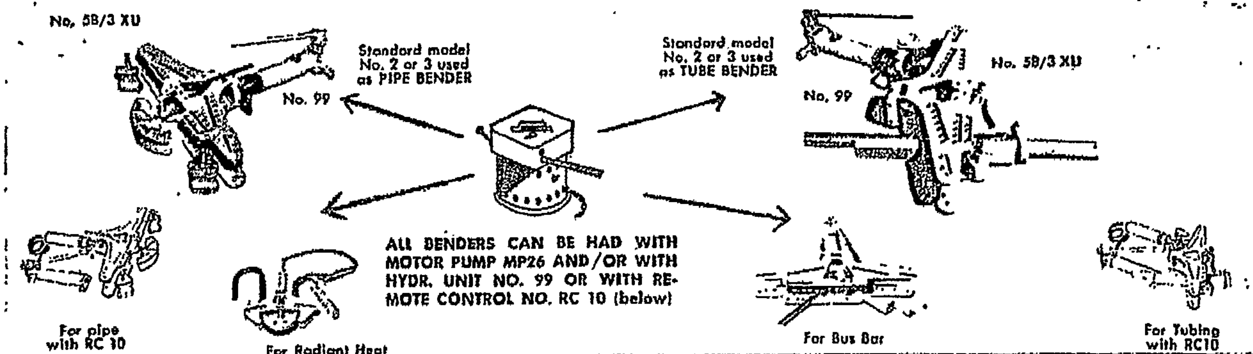


No. RC 3 PH/C—MP with remote control and motor pump.

No. 99 Standard 25 Ton Hydraulic Unit and Ram, and No. 58-XU ALL PURPOSE FRAME

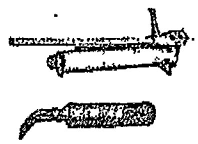
No. 58-2XU for all 2" Benders (net wgt. 28 lbs.) **No. 58-3XU for all 3" Benders (net wgt. 57 lbs.)**

No. 99 Hydraulic Unit (net wgt. 39 lbs.) and No. 58 ALL PURPOSE FRAME are the TWO main parts of all No. 2 and 3 Benders. LESS THAN ONE MINUTE to assemble these two parts, ready for use. Change over from one size to another in HALF A MINUTE. A ONE MAN OPERATION.



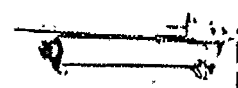
No. RC 10 REMOTE CONTROL 10 TON, 2 SPEED, HYDR. JACK

INCL. SEPARATE RAM, 6 foot hydr. hose and coupling.
These powerful, lightweight units can be used with all No. 2 and 3 benders, in any position. Wgt. 37 lbs.
Same price, whether benders are ordered with the standard hydraulic unit No. 99 (above), or with the RC 10, shown.



No. RC 11 10 TON, TWO SPEED HYDR. JACK

The LIGHTEST EVER BUILT. Net wgt. 10 lbs.
Pressure up to 10,000 p.s.i. for any mfg's. hydr. bender, arbor or punch presses, wheel pullers, pulley pushers, clamps for forms, etc. For pushing, pulling, lifting, straightening, pressing, etc.

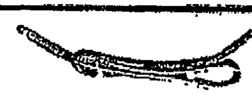


No. RC 123, same as RC 11, includes coupling and hose.

No. 12 COMPLETE QUICK SELF SEALING COUPLING

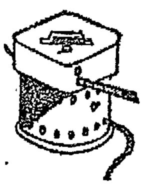
Incl. No. 12 M male and No. 12 F female part (3/8" pipe thread).

No. 14 SIX FOOT HYDR. HOSE with coupling connections



No. MP 26 — 1/2 HP LIGHTWEIGHT HYDR. POWER PUMP

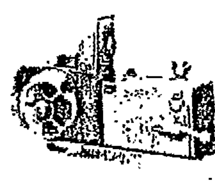
Incl. 6' Hydr. hose and couplings. Increases production up to 10 times. Highly recommended with hydr. benders from 2" to 5", or any other hydr. system. Pump develops maximum pressure — for intermittent service 10,000 p.s.i. — for continued service 5000 p.s.i. with 1/2 Hp 110-115 V. AC/DC motor, 1750 RPM.



Gr. Wgt. 70 lbs.

No. MP 30 2 HP POWER PUMP

Incl. 6' hydr. hose and couplings, is the power unit for 6" & 8" benders, or for any other hydr. equipment. The double-piston, single valve, high pressure pump, with two V-belts, is driven by a 2 HP, 60 cycle, 3 phase motor 1750 RPM for 220-440 volts, developing up to 10,000 lbs. pressure. Gr. wgt. 355 lbs.



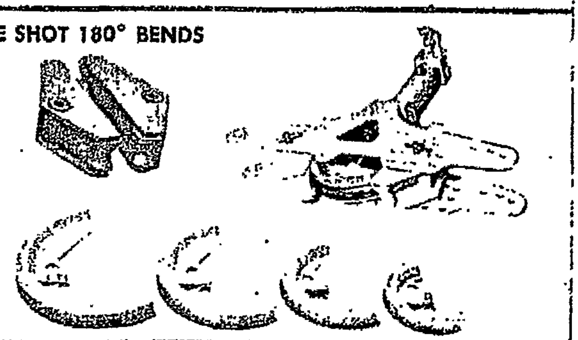
RADIANT HEAT WINGS & SPECIAL BENDING SHOES FOR ONE SHOT 180° BENDS

These wings for any bender, make complete 180° bends in many different centers, IN ONE SHOT, & IN LESS THAN ONE MINUTE (with motor):

WINGS No. 82X for No. 2 Bender
No. 83X for No. 3 Bender
No. 84X for No. 400 Bender

180° bending shoes can be ordered separately as per requirements in the following pipe sizes and centers:

Centers:	6"	9"	12"	15" & 18"
Pipe sizes:	1/2"—3/4"	3/4"—1"	3/4"—1" 1 1/4"—1 1/2"	3/4"—1"—1 1/4"

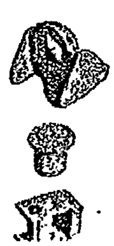


No. TBA 123/2 or 3 Connecting Parts for Tube Benders consisting of:

No. TBA-3-2 or -3 Hydr. Unit Connection

No. TBA-1-2 or -3 Roller

No. TBA-2 Connection

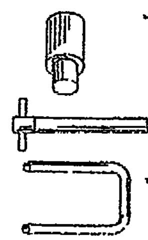


No. 115/2 and No. 50/3 Ram Extension

No. 38 Pair End Casting pins for No. 2 and 3

No. 37 U locking pin for No. 2 & No. 3

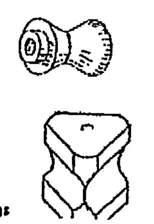
No. 438 End Casting pins for No. 400.



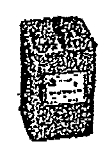
No. 41/2 Pair End Castings for No. 2

No. 41/3 Pair End Castings for No. 3

No. 441 Pair End Castings



No. 00 Hydraulic oil—especially prepared for Hydr. Benders and motor pumps.



WA-TEX 001365

TAL 4" 5" 6" 8" & LARGER ONE SHOT BENDERS

ALL LARGER BENDERS **HAVE BOTH:** MANUAL OPERATION **AND** PROVISION FOR TAL POWER PUMP

WITHOUT MANUAL OPERATION, ON REQUEST ONLY

FOR: PIPE (X & XX), RIGID AND THIN WALL CONDUIT, COPPER, STEEL AND ALUMINUM TUBING, BUS BAR, RADIANT HEAT (180°) BENDS, SHAPES, ETC.,

IN SIZES FROM ⅜" TO 8" AND UP, COLD, WITHOUT FILLING OR MOVING THE PIPE

Very Important! The Pioneers of the Portable "One Shot" TAL Benders Offer the Following Exclusive Features:

- THE ONLY PORTABLE BENDER powerful enough to bend in one shot X pipe, and adaptable for XX pipe.
- BENDING IN CLOSE QUARTERS! Provided with casters for easy moving, also while bending. Benders will rotate with one end of the pipe, while the other end can remain stationary.
- THREE MAIN PARTS ONLY: One hydraulic unit incl. ram and two frame plates assure easy and quick assembly.
- MOST ECONOMICAL PRICE-WISE and in PERFORMANCE: It takes 3 min. actual bending time — on the job — to complete a 90° bend in 8" XX pipe.
- SAVINGS UP TO 90% on welding or threading and on expensive handling and assembling of unecessary cut-up pipe with costly fittings, elbows, couplings and nipples.
- WITHOUT EXPERIENCE perfect, identical bends are guaranteed because of: Patented, tight-fitting, quick releasing bending shoes, Bend-Indicator and Bending Chart. (Copyright 1956).

NO. 400 - 4" BENDER

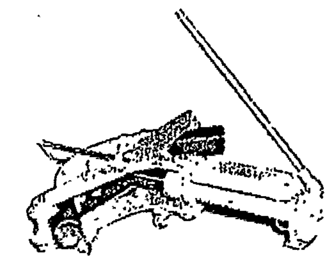
MANUALLY OPERATED, HAS A BENDING RANGE FROM ⅜" TO 4" CONDUIT OR STD. PIPE (X or XX).

Bending shoes not included; to be selected from the sets listed on next page.

For 4" XX Pipe, stronger 4" shoe and frame available.
ACTUAL BENDING TIME for 90° Bend in 4" XX Pipe:

No. 400/26 with ½ HP motor, 5 min.
No. 400/30 with 2 HP motor, 1 min.
No. 400 hand operated, 18 min.

Note: Max. radius for 90° elbows IN ONE SHOT in any pipe size is 30" (with appropriate bending shoes.)



NO. 400 MANUAL OPERATION

NO. 500 - 5" BENDER

MANUALLY OPERATED, HAS A BENDING RANGE FROM ⅜" TO 5" CONDUIT OR STD. PIPE (X or XX).

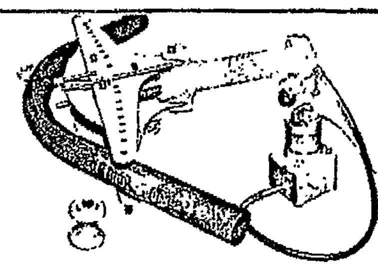
Bending shoes not included; to be selected from the sets listed on next page.

This bender has a small extension-ram to make full 90° bends in 5" pipe without moving the pipe.

ACTUAL BENDING TIME for a 90° Bend in 5" Conduit:

No. 500/26 with ½ HP motor, 6½ min.
No. 500/30 with 2 HP motor, 2 min.
No. 500 hand operated, 25 min.

Note: Max. radius for 90° elbows, IN ONE SHOT in any pipe size is 30" (with the appropriate bending shoes).



NO. 400 MP WITH ½ H.P. MOTOR PUMP
(non-manual operation)
NO. 500 SAME AS NO. 400 BELOW
Proportionally smaller

600-30 - 6" BENDER

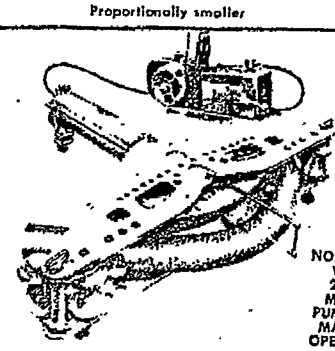
WITH 2 HP MOTOR PUMP, HAS A BENDING RANGE FROM ⅜" TO 6" STD. PIPE (X or XX).

Bending shoes not included; to be selected from the sets listed on next page.

For 6" XX Pipe, stronger 6" shoe and frame available.
ACTUAL BENDING TIME for 90° bend in 6" XX Pipe:

No. 600/30 with 2 HP motor, 2 min.

Note: Max. radius for 90° elbows IN ONE SHOT in any pipe size is 36" (with the appropriate bending shoes).



NO. 600/30 WITH 2 H.P. MOTOR PUMP AND MANUAL OPERATION

 See Sec. C for small remote control and

NO. 800-8" BENDER

INCLUDING 2 H.P. MOTOR PUMP, AND AN 8" BENDING SHOE

(Requirements for other sets of shoes, from ⅜" and up, to be selected from the list below). MADE ON THE SAME PRINCIPLES AS ALL OTHER TAL HYDRAULIC BENDERS.

FOR ITS OUTSTANDING FEATURES see under "LARGER ONE SHOT BENDERS" on page 5.

For 8" XX, stronger 8" shoe and frame available.

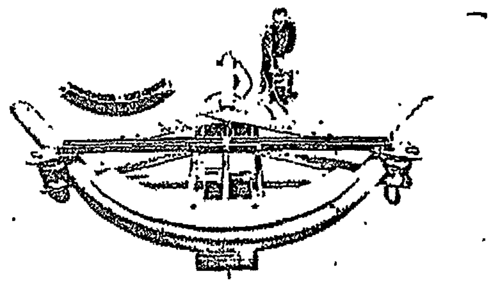
ACTUAL BENDING TIME for complete 90° Bends in 8" XX pipe is **3 MINUTES.**

The hydraulic ram has a bore of 4½", travels 56" and operates at a pressure of 5000 psi. The double-piston single valve pump operates at 10,000 psi intermittent, or 5000 psi constant, has 2 V-belts, has a Universal 2HP, 60 cycle, 3 phase motor for 220/440 volts.

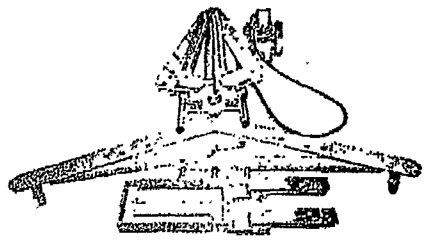
The Bending Frame consists of 4 sections connected to an upper and lower plate, and fastened with pins to the hydraulic unit. The overall width is 10½'.

THIS FRAME CAN BE FOLDED TOGETHER ONTO THE HYDRAULIC UNIT, IF STORED. THE FEW PARTS CAN BE ASSEMBLED IN 30 MINUTES.

BY FAR THE SMALLEST, LIGHTEST AND MOST ECONOMICAL PIPE BENDER IN THIS CAPACITY EVER MANUFACTURED ANYWHERE.



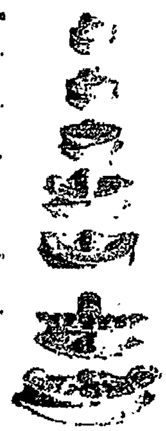
NO. 800 BENDER WITH 2 H.P. MOTOR PUMP



SAME AS ABOVE BUT WITH TOP WINGS FOLDED TOGETHER

Select The Sets of Required Bending Shoes From The List Below

FOR PIPE (SHORT RADIUS)



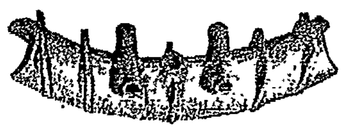
Set	Size	Radius
SET No. 0	⅜"	1½"
SET No. 0	½"	2"
SET No. 0	¾"	2½"
SET No. 0	1"	3½"
	1¼"	4½"
SET No. 25 PH	1½"	6"
SET No. 25 PH	2"	8"

STD. RADIUS—FOR BOTH CONDUIT & PIPE

Size	Radius
2½"	10"
3"	12"

SET No. 3

PIPE SIZE	3½" — 4"	5"	6"	8"
RADIUS	18" — 23"	30"	36"	60"
SET	No. 4	No. 5	No. 6	No. 8



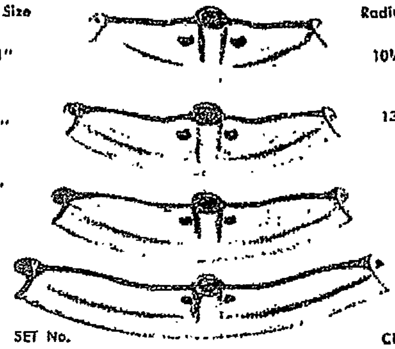
FOR STD. CONDUIT ELBOWS.

Set	Size	Radius
SET No. 2 / SET No. 25C	1"	5¾"
SET No. 2 / SET No. 25C	1¼"	7¼"
SET No. 2 / SET No. 25C	1½"	8¼"
SET No. 2 / SET No. 25C	2"	9½"

TAL manufac... to your specs. **ONE SHOT SHOES IN AN** ... SIZE e.g. Conduit elbows up to 48", 180° loops, etc.

The snug fitting, **PATENTED, TAL SHOES,** assure perfect bends and have easy pipe release.

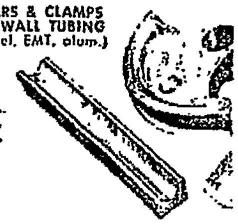
SPECIAL LONG RADIUS FOR CONDUIT



Size	Radius
1"	10½'
1¼"	13½
1½"	1?
2"	

SET No. CL9

SHOES, BARS & CLAMPS FOR THIN WALL TUBING (copper, steel, EMT, alum.)



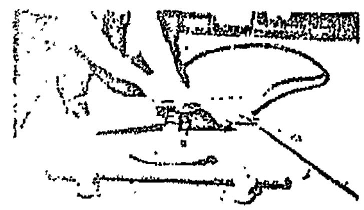
No.	Nom. Size	Radius
2245	1"	5-¾"
2244	1¼"	7-¼"
2243	1½"	8¼"
2242	2"	10"
2282	2½"	15"
2283	3"	15"

Set 20 EMT: 1", 1¼", 1½", 2" } thin wall conduit
Set 25 EMT: 1¼", 1½", 2"
Set 20 CT: 1⅛", 1⅜", 1⅝", 2⅛"
Set 35CT: 1⅛", 1⅜", 1⅝", 2⅛", 2⅝", 3⅛"

TAL "ONE SHOT" new RC Remote Control Benders

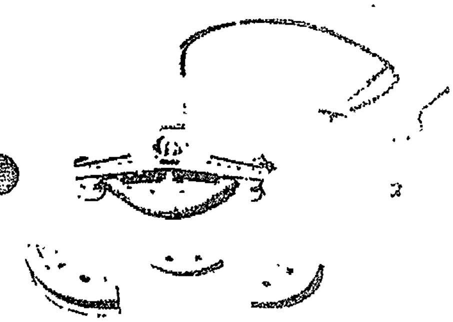
WITH ALL OF THE FOLLOWING OUTSTANDING FEATURES

- TWO SPEEDS — accelerates bending time.
- FRAME WITH REMOVABLE TOP PLATE allows THREE WAYS to insert pipe in bender: Drop in from the top, slide in from the side or hook the bender over installed pipe.
- MAKES 180° BENDS for Radiant Heat in many different sizes and centers.
- BENDS EASILY REMOVED FROM SHOES because of push-out pins and push-out holes in shoes.
- EASY ASSEMBLING AND DURABLE CONSTRUCTION: No threads, the few parts are assembled with pins. For multiple purposes: Pushing, pulling, lifting, straightening, as arbor press or punch press, etc.



... TOP PLATE of Frame facilitates inserting or removing pipe.

RC 200



Tal patented Bending Shoes are scientifically designed, with tight fit and easy pipe release. Guarantee round bends. All main parts are made in aluminum.

ALL THIS
WITH ONE AND THE SAME
BENDER
WITH ONE AND THE SAME
FRAME

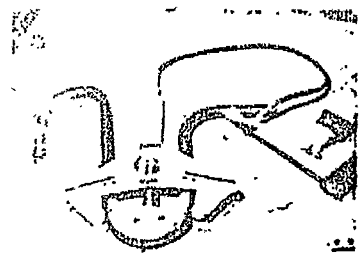
TOTAL WEIGHT 68 lbs., the lightest of all "ONE SHOT" Benders, and the most economical.

USE same Bender "WITHOUT CHANGES" for Bus-Bar and Radiant Heat.

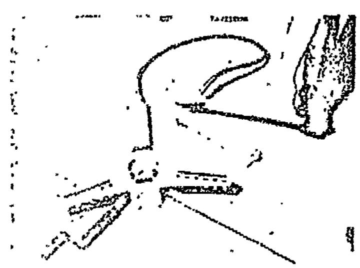
ASSEMBLY, LESS THAN 1 MINUTE

RC 200 PH for pipe with 6 short radius bending shoes for ½" to 2"

RC 200 C for rigid conduit with 4 standard elbow radius bending shoes for 1 to 2".

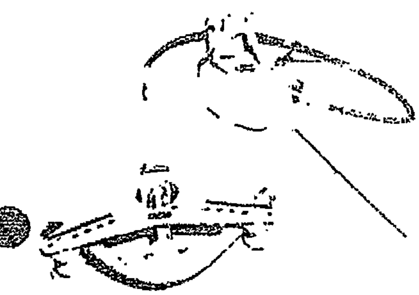


RC 200 PH-X with 180° attachment, for many ... "ONE SHOT" Radiant Heat Bends.

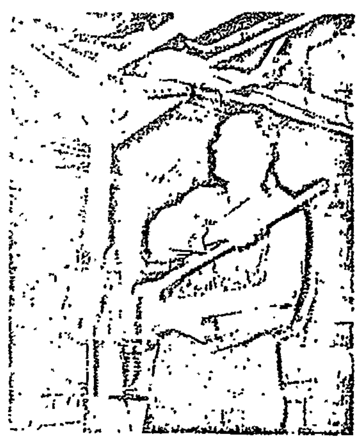


RC 200 C-BB for rigid conduit and bus-bar.

RC 226



The RC 200 SAVED ONE THIRD on cost of material and time on cutting, threading, material handling and assembling, on the piping installation of this remodeling job in an old basement.



CAN BE USED • ON THE FLOOR • IN THE ... • AT THE CEILING • down or up ... down • against the wall • horizon... • IN ANY POSITION

With motor pump, the Actual Bending Time for a 90° bend in 2" pipe is less than 1 min. Hand operated max. 3 min.

RC 226-PH for Pipe } is RC 200 with
RC 226-C for Conduit } motor pump MF-25

Pat. & Patents Pend.

Catalog No. 16-Sec. C
See Sec. A for 2" and 3" Hydr. Benders
See Sec. B for 4" to 8" Benders

TAL Manual ONE-SHOT BENDERS

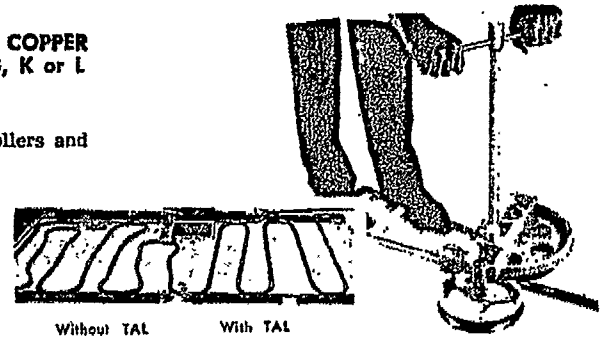
CT-1 180° Tube Bender

Here's the ANSWER to ALL your RADIANT HEAT & OTHER COPPER TUBING JOBS . . . with SOFT OR HARD COPPER TUBING, K or L in many different radii.

Produces SMOOTH, CLEAN bends right on the spot.
Basic machine available with all or any of the following rollers and bending formers:

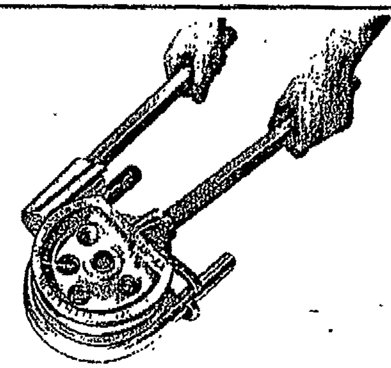
Roller Sizes	Bending Formers Centers
⅜"	4" 6"
½"	6" 9" 12"
¾"	6" 9" 12"
1"	9" 12"

Simple, light weight. easy to carry. In sturdy wooden tool box. BENCH ATTACHMENT AVAILABLE.



BENDS ON THE FLOOR OR BENCH FLUSH TO WALL AND CORNER

TAL TT-57 Tube Bender



Bends ⅝" and ⅞" O.D. HARD AND SOFT COPPER TUBING . . .

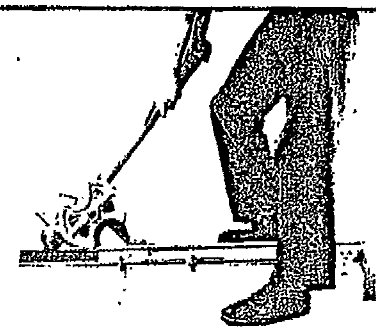
Has one Forming Section with Two Grooves for Both Sizes.

EASY QUICK EFFICIENT LOW COST

The bender is made of light weight aluminum with ONLY TWO LOOSE PARTS.

Nominal Tube Size	Outside Diameter of Tube	Radius to Center of Bend
½", ¾"	⅝", ⅞"	3"

No HB 2100 Handy Bendy



FOR EMT THINWALL & RIGID CONDUIT

Makes perfectly smooth uniform Bends and Offsets ½" & ¾" Thinwall and Rigid Conduit. Up to 90° with one pull. No flattening or other Distortion.

A great money saver when used on Open or Slab Work, or any other jobs requiring a larger number of identical Bends. Bench Attachment available. Light weight, easy to carry.

TAL 6-Way Bender

GUARANTEED AGAINST BREAKAGE "FOR LIFE"!

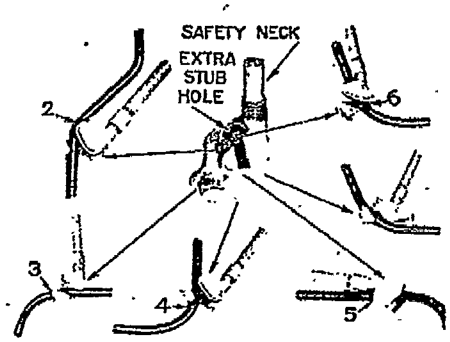
An EXTRA STUB HOLE for bending very short offsets and for straightening or bending conduit protruding from concrete.

ITS SIX WAY NON-SLIP SHORT BENDING JAWS make it an ideal tool for all types of bends.

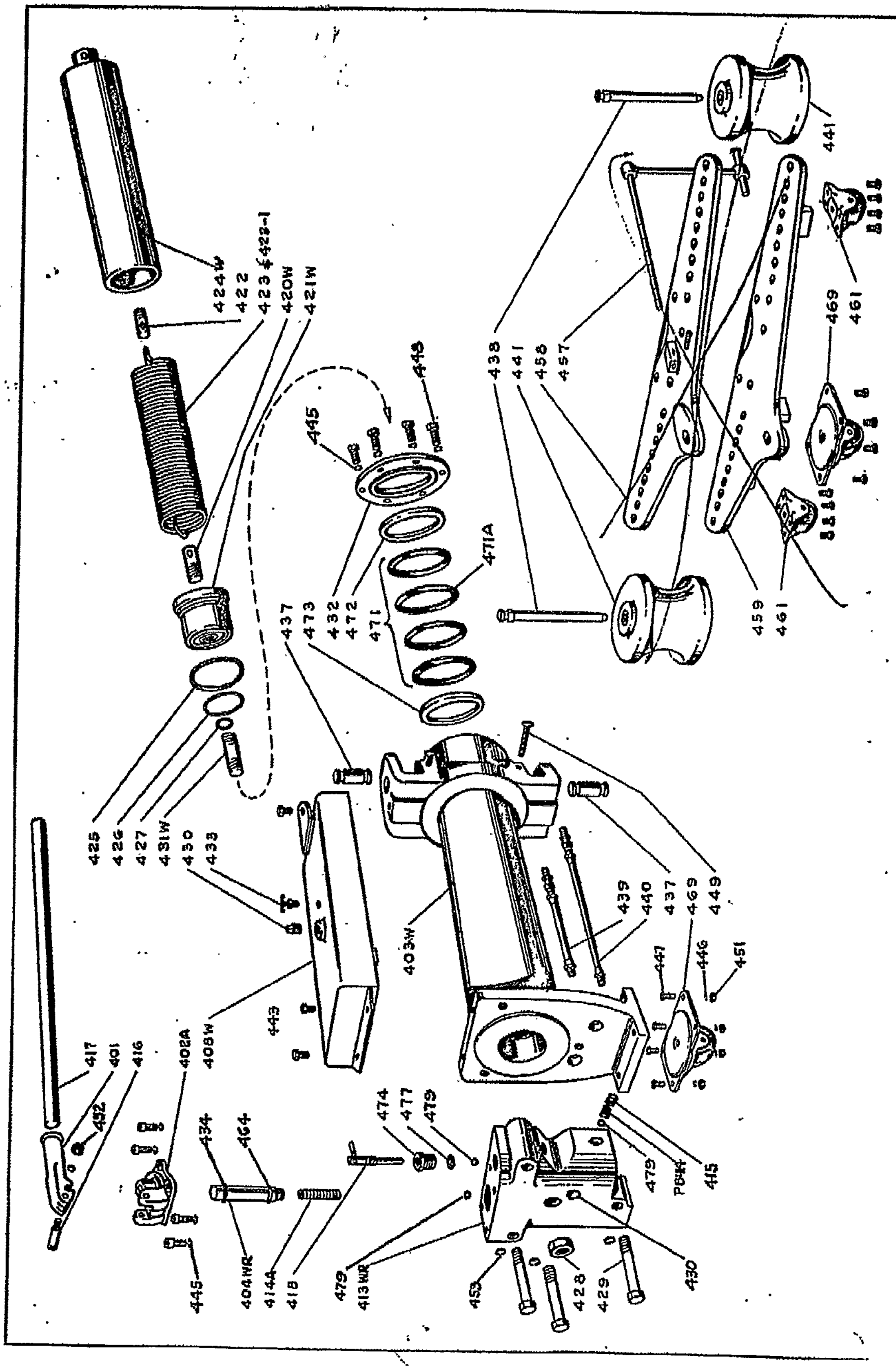
PERFECT FOR BENDING IN CLOSE QUARTERS!

The long SAFETY NECK avoids accidents caused by breakage.

Nos.	Size	Weight
50	½"	3 lbs.
75	¾"	5 lbs.
100	1"	8 lbs.



WA-TEX 001369



6" HYDRAULIC PIPE BENDER PARTS DRAWING — TAL BENDING EQUIPMENT, INC., MILWAUKEE 2, WISCONSIN

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-27

SUBJECT: FABRICATE TUBING

BENDING

(1) Bending of tubing should be done with extreme care as it is easy to crimp or flatten the tubing.

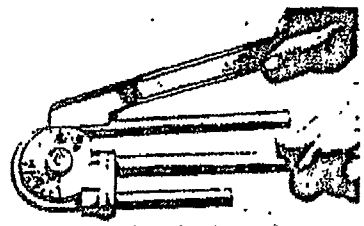
(2) There are four sizes of tubing benders: these being 1/4", 3/8", 1/2" and 3/4". The settings are marked on the tubing bender for the angle you desire the bend to be.

(3) It is important to start on one end of tubing fabrication and continue to measure and bend tubing in one direction until fabrication is complete.

TUBE BENDERS

IMPERIAL HAND TUBE BENDERS. Designed to simplify bending of larger sizes of tubing. Bender may be locked in vise if desired. Center pin may be lifted to release tubing.

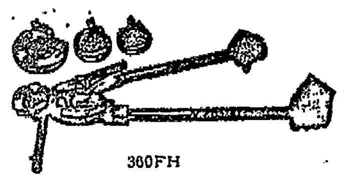
		Wt.	Dir.	Ind.	Ret.
364FH	Bends 1/4" tubing to radius of 9/16".	3/4 lbs, ea	IEK	CAE	ea 12.75
364FH	Bends 5/16" tubing to radius of 11/16"	1¼ lbs.	TKRE	TYRI	15.40
364FH	Bends 3/8" tubing to radius of 15/16"	1¾ lbs.	CYK	TKIC	14.85
364FH	Bends 1/2" tubing to radius of 1½".	1¾ lbs.	TQAK	TUCA	24.50
364FHA	Bends 5/8" tubing to radius of 2¼"	10 lbs.	RTQK	RAUQ	32.50
364FHA	Bends 3/4" tubing to radius of 3"	11 lbs.	ADEK	AUCE	52.00



Imperial Hand Tube Bender

IMPERIAL HEAVY-DUTY TUBE BENDING TOOLS. Long leverage and adjustable operating lever makes it possible to apply force with little effort, avoiding sudden strains which might injure tubing. The smallest bends are made with perfect accuracy in the heaviest tubing. Right or left hand bends. Removable handles. Furnished in steel chest.

360FH Bends 3/8",1/2",5/8", 3/4" O.D. sizes Wt. ea 20 lbs. ea QUKY UAUK ea100.00



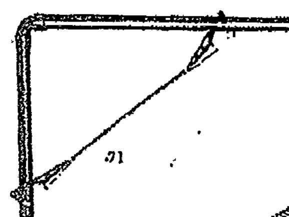
360FH

TUBE BENDER. Imperial. External spring type. Budget priced tools for hand bending soft tubing to any shape. Keeps tube perfectly round. Special spring steel. Nickel finished. End is belled for quick tube removal. Size is for outside tube diameter.

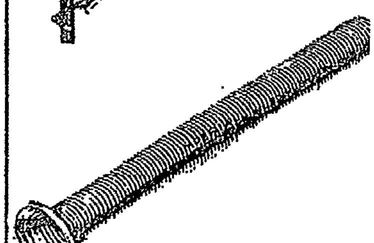
No.	Size	Length	Wt.				
□102F	1/4"	10"	3 oz.	ea	AI	DA	ea .57
	5/16"	10"	3		AI	DA	.57
	3/8"	10"	4		DY	DC	.66
	7/16"	12"	6¼		EY	QT	.92
	1/2"	12"	6½		QK	QY	.99
	5/8"	12"	8		QK	QY	.99

RIDJIG. Ridge Tool Co. Designed to hold copper tube in place while being soldered. O.D. capacity 3/8" through 7/8".

71 Packed 12 in display carton 1-1/2 lbs. ea TKD TRK ea 1.56



71



Bends tube without collapsing walls

102F

ALUMINUM TUBING

ALUMINUM TUBING. Pacific Metal Co. For gas heater and range connections. Soft AGA approved.

		Full Coil	Cut Coil		Ret.
3/8" OD x .035 x 50 ft.	100 ft	TEYI	TIUK	ft	.23

COPPER DRAINAGE TUBING

DWV COPPER DRAINAGE TUBING is for Soil, Waste, and Vent Lines, - above ground only. 20 foot lengths.

Size	Wall thicknes	Wt. per ft.		Dealer less 1000'	Dealer cut	Retail Full lgth.		Ret. cut
1-1/4"	.040	.650 lb.	c ft	†QIKQ	ITQU	102.09	ft	1.23
1-1/2"	.042	.809		†UYTD	CREU	115.71		1.39
2"	.042	1.07		†TKRTQ	TYREC	153.24		1.84
3"	.045	1.69		†TQTEQ	TCAIU	242.34		2.91

† DWV 1000 ft or more. less TK%

□ Basic Stock Turnover Item

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-28

SUBJECT: INSTALL BELL AND SPIGOT PIPEWORK

FABRICATE

You must have piping aligned properly with spigot all the way into the hub. You then put enough oakum around spigot to seal the joint. Lead is then poured into hub to seal and lock oakum in the joint.

(a) When joint is ready, you put in one small oakum ring at a time. Using caulking tool and hammer, you go around joint tamping lightly after each ring. You do this until you come to within one inch of hub end. Increase tamping pressure as you come to end of hub.

(b) When oakum is within one inch of the end of hub pour lead in to fill the hub. The lead is then ready to be caulked with cauling tool which makes the joint tight and helps seal the oakum.

INSTALL

To use bell and spigot piping for sewer and drains, be sure to have the proper fittings and the proper drop in the line to gravitate the material and still float it also. The right amount of drop to get proper gravity flow and still float the material is one-eighth inch drop to two feet of pipe.

Attached is a commercial standard regarding dimensions, tolerance and installation of bell and spigot pipework.

COMMERCIAL STANDARD CS188-66
Supersedes CS188-59

CAST IRON SOIL PIPE AND FITTINGS

[Effective July 1, 1966]

1. PURPOSE AND SCOPE

1.1 PURPOSE.—The purpose of this commercial standard is to establish standards covering material, principal dimensions, and dimensional tolerances for extra heavy and service weight cast iron soil pipe and fittings, in accordance with general needs of producers, distributors, and users. It is intended to serve as a basis for common understanding between buyers and sellers. Through certification, the purchaser may receive advance assurance that the provisions of this standard are fulfilled.

1.2 SCOPE.—This standard covers pipe and fittings of the following patterns and, when so designated, may apply to any other patterns that conform with the requirements given herein.

	Tables
Pipe:	
Extra heavy, 5-foot and 10-foot lengths	1, 3
Service weight, 5-foot and 10-foot lengths	2, 3
Nominal Shipping Weights	55, 56
Outside dimensions (for detailing)	Appendix
Fittings:	
¼ bends; long ¼ bends	4, 5
Long low-hub ¼ bends	6
¼ bends, low heel; high heel ¼ bends	7, 8
¼ bends, short sweep; long sweep ¼ bends	9, 10
⅕ bends	11
⅙ bends; long ⅙ bends	12, 13
⅛ bends; long ⅛ bends	14, 15
1/16 bends	16
Y branches	17
Y branches, cleanout	18, 19
Y branches, inverted	20
Y branches, combination ⅛ bends	21
Y branches, combination ⅛ bends, cleanout	22
Y branches, upright	23
Sanitary T branches	24
Sanitary T branches, cleanout	25
Fittings:—cont'd	
Tapped sanitary T branches	26
T branches, tapped T branches	27, 28
T branches, cleanout	29
Vent branches	30
Offsets, regular	31–35
Offsets, ⅛ bend	36–40
Double hubs, long double hubs	41, 42
Reducers	43
Increasers	44, 45, 46
S traps; full, ¾, ½	47, 48, 49
Running traps	50
Screw plugs (brass)	51
Plugs, for hub	52
Iron-body ferrules	53
Side inlets	53 (note 2)
Tapping bosses	54
Nominal Shipping Weights	57–106

2. REQUIREMENTS

2.1 GENERAL REQUIREMENTS

2.1.1 *Material, general.*—The pipe and fittings shall be iron castings suitable for installation and service in drainage, waste, vent and sewer lines, and shall meet all applicable requirements and tests given herein.

2.1.2 *Cast iron.*—The castings shall be made of gray cast iron, produced by an established commercial method that provides adequate control over chemical and physical properties. The castings shall be sound, true to pattern, and of compact close grain which permits drilling and cutting by ordinary methods. The interior surface shall be reasonably smooth and free from defects which would render the castings unfit for the use for which they are intended.

2.1.3 *Marking.*—Each length of pipe and each fitting shall be plainly marked with the manufacturer's initials or registered trademark by which he can be readily identified, and with letters to indicate the proper weight classification, as follows:

XH——— Extra Heavy
SV——— Service weight

If pipe is marked on the barrel the marking shall begin about 2 inches beyond the base of the hub and extend along the barrel not more than 12 inches. On fittings, the markings shall be located away from the spigot end so as not to interfere with proper joining upon installation. The marking may be cast, stenciled, or otherwise applied on the pipe, so as to be clear and legible at the time of installation. The marking shall be cast on fittings.

2.1.4 *Coating.*—The pipe and fittings shall be uniformly coated with coal tar pitch, or similar bituminous material suitable for the purpose, that is adherent and without a tendency to scale or become brittle. The coating shall be applied to all surfaces except in threaded openings.

2.2 PIPE.—

2.2.1 *Ends of pipe.*—Single-hub pipe shall have a hub at one end and a spigot at the other. Double-hub pipe shall have a hub at each end. Hubs shall have lead grooves. Spigot end may be either with or without a bead, and inner end of hub may be either with or without a centering recess, all combinations of which shall make a satisfactory leakproof joint. Hub and barrel shall be cast in one piece. (See Fig. 1.)

shall not exceed ½ inch for sizes 4 inches and larger, nor exceed ⅜ inch for smaller sizes.

2.2.4 *Weight of pipe.*—The weight of individual lengths of pipe, without coating, shall be not more than five percent (5%) under the nominal shipping weight as listed in tables 55 and 56.

2.3 FITTINGS.—

2.3.1 *Dimensions of fittings.*—All fittings shall conform to the dimensions specified for hub and spigot ends in tables 1 and 2, as applicable. Fittings of the patterns specified herein shall conform to the applicable dimensions in tables 4 to 54, inclusive, and to the tolerances in table 3. Other patterns [1] shall conform to tables 1 and 2, as applicable, for hub and spigot dimensions, and for wall thickness throughout, and to dimension R′, tables 24 and 26, for the minimum radius of any drainage inlets that such fittings may provide. All fittings shall have spigot ends of sufficient length to provide adequate room for making proper joints. All dimensions given herein shall apply to fittings before any coating is applied.

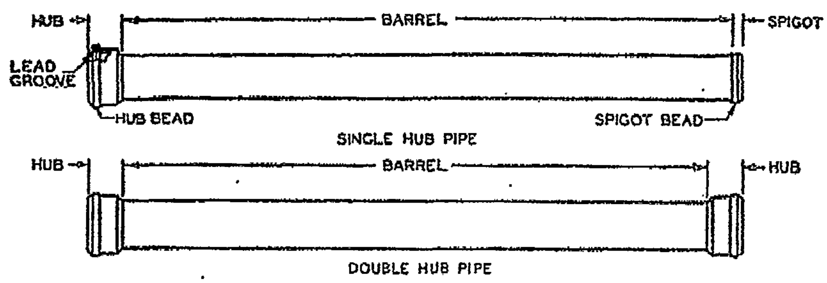


FIGURE 1. Single hub and double hub cast iron soil pipe.

2.2.2 *Dimensions of pipe.*—Single hub pipe shall be of 5 foot and 10 foot nominal laying lengths. The laying length shall be measured as shown in the figures above tables 1 and 2, and shall be within the tolerances on laying length specified in table 3. Double hub pipe shall be of the same overall length as single hub pipe of the same size. Its laying length shall be 5 feet minus the telescoping length (dimension Y), or 10 feet minus the telescoping length (dimension Y). Other dimensions shall be as specified in tables 1 and 2 as applicable, and be within the tolerances specified in table 3. The dimensions shall apply to pipe before any coating is applied.

2.2.3 *Straightness of pipe.*—Pipe shall be straight to the extent that any deflections in the barrel of a 5-foot length of pipe shall not exceed ¼ inch for sizes 4 inches and larger, and shall not exceed ³⁄₁₆ inch for smaller sizes; for 10-foot lengths, deflections in the barrel

2.3.2 *Water seal of traps.*—Traps shall provide water seals as follows:

Trap Size	Minimum Water Seal
inches	inches
2	2
3 to 6, inclusive	2½
8 to 12, inclusive	3
15	3½

2.3.3 *Ends of fittings.*—Hubs shall have lead grooves and spigot end may be either with or without a bead and inner end of hub may be either with or without a centering recess, all combinations of which shall make a satisfactory leakproof joint. Tapped openings shall conform to 2.3.4.

[1] Such as, for example, fittings known in the trade as "specials," when designated as being in conformity with this standard.

2.3.4 *Pipe threads.*—Screw plugs and tapped openings in fittings shall have American Standard taper pipe threads. The threads shall be in accordance with the American Standard for Pipe Threads, B2.1[2], or with the National Bureau of Standards Handbook H28, Screw Thread Standards for Federal Services,[3] of the current issue.

2.3.4.1 Internal threads shall be chamfered at the entering end approximately to the major diameter of the thread, at an angle of approximately 45° with the axis of the thread, and the entering end of external threads shall be similarly chamfered approximately to the minor diameter of the thread, for easy entrance in making a joint and for protection of the thread. The chamfer shall be concentric with the thread and shall be included in measurements of thread length.

2.3.5 *Weight of fittings.*—The weight of individual fittings, without coating, shall be not more than five percent (5%) under the nominal shipping weight as listed in tables 57 through 106.

2.4 METHOD OF SPECIFYING FITTINGS.—

2.4.1 *Method of specifying sizes of fittings of more than one size.*—The sizes are designated by the order of listing, as follows:

(a) Branch and tapped fittings:
  (1) Size of run.[4]
  (2) Size of branch.

(b) Reducers, increasers, and offset fittings:
  (1) Size of inlet or run.[4]
  (2) Size of outlet or offset distance.
  (3) Length, if supplied in more than one length.

2.4.2 *Method of specifying hand of fittings with side inlets and outlets.*—When placed in the position described below, if the side inlet or outlet appears on the right, it is a right hand fitting; if on the left, it is a left hand fitting.

(a) Bends and offsets:
  Place the fitting with the hub facing toward the observer and the spigot end lower than the hub.

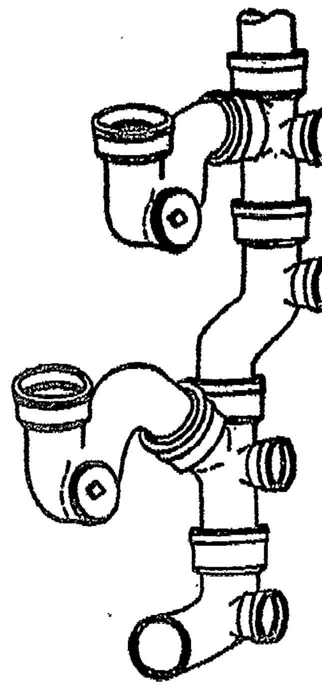
(b) Branch fittings:
  Place the branch toward the observer and the spigot end lower than the hub.

(c) Traps:
  Place in the position in which the trap is installed with the hub toward the observer.

[2] Copies may be obtained from American Standards Association, Inc., 10 East 40th Street, New York, N.Y., 10016.

[3] Copies may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402.

[4] The run is that portion of the fitting which forms part of the main drain, waste or vent line. The spigot end is ordinarily the outlet.



2.4.2.1 The fittings illustrated have right hand inlet or cleanout. Left hand fittings have these openings on the side opposite to that shown.

3. INSPECTION AND TESTING

3.1 *Inspection and test by the Manufacturer.*—Pipe and fittings shall be thoroughly inspected by the manufacturer before shipment. The manufacturer shall make all tests as specified herein, and the results of the tests shall be furnished to the purchaser upon request in accordance with mutually acceptable arrangements.

3.1.1 On the sample pieces selected for test, the inside diameter of the hub and barrel and the outside diameter of the spigot end and barrel shall be checked by suitable gages.

3.1.2 Fittings shall be inspected for soundness and brittleness by methods generally accepted as standard by the manufacturer and purchaser.

3.1.3 The minimum internal diameter of pipe and fittings shall be that dimension resulting from the subtraction of two times the nominal wall thickness from the minimum outside diameter using the dimensions and tolerances shown in tables 1, 2, and 3.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-29

SUBJECT: INSTALL PIPE AND FITTINGS

A. WELDED

To install welded pipe and fittings you should have a blue print which would indicate where the installation is to be made and the type gaskets, bolts, etc. to be used for the job.

In order to do the job safety and efficiently, be sure to use the proper tools and equipment.

B. SCREWED

To install screwed pipe and fittings you should know the location pipe is to be installed and the type of gaskets and bolts to be used. Use the right kind of pipe joint compound for the pipe threads before screwing into fittings.

The pipe should be screwed into the fitting until pipe threads are about flush with threads in fitting. Different fittings and manufacturers may cause pipe to screw more or less into fitting.

C. PLASTIC

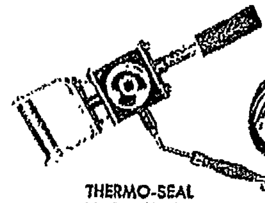
When installing plastic pipe the most important thing is to prevent breakage. When installation is under ground, sand must be under the pipe as well as over it. When being installed above ground, the pipe must have several hangers on it or a hanger runway constructed beneath.

There are two ways to fabricate plastic pipe - screwed and cemented.

When threading plastic, you must use extreme care. All materials should be Schedule 80 and a wooden plug put into the end of the pipe to prevent breakage and off-center threads. Be sure to use plastic threading lubricant. When screwing fittings onto pipe, tighten with strap wrenches. One or two threads past hand tight is adequate.

When cementing joints, all pipe ends must be square, saw marks and burrs removed. Follow all the other instructions on illustrated material shown herein.

How to Join Thermoplastic Piping


THERMO-SEAL
LP Gas Heat Tool
Pat. 3,147,794

One of the more important features of industrial thermoplastic pipe is the ease with which it lends itself to a variety of fabricating techniques. This versatility, plus the wide selection of fittings and other components now available, makes possible fast and economical installation, maintenance and modification of industrial pipe lines.

Solvent Cementing

The generally preferred method of joining rigid thermoplastics such as PVC and PVDC, solvent cementing gives a stronger joint than threading and is also considered faster and simpler. Additionally, solvent cementing permits the use of thinner walls, when compared to threaded connections, for equivalent pressure ratings.

Threading

As is the case with metal pipe, threading reduces the effective wall thickness of thermoplastic pipe and introduces notch effects which lower strength. Threaded connections should be used with Schedule 80 or heavier pipe. The chief advantage of threading is the ease of disassembly it offers.

Thermal Bonding

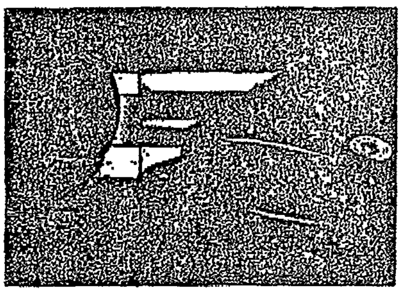
By taking advantage of the thermoplasticity o the materials, Cabot Piping Systems has perfect ed an advanced method of joining solvent-re sistant thermoplastics such as polyethylene, Pen ton, polypropylene, etc. The Cabot Piping Sys tems' THERMO-SEAL tool applies regulate heat uniformly and simultaneously to pipe an fitting mating surfaces so that true melting occur on the surfaces. Only hand pressure is needed t join the components and as the material cools, permanent homogenous bond results. Th THERMO-SEAL tool may be used on a stan for pre-fabrication or as a portable unit.

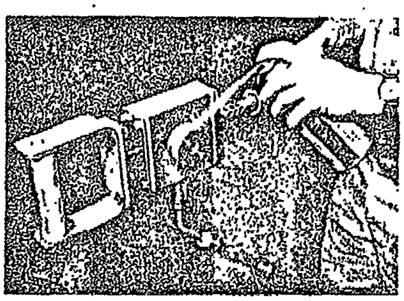
Flanging

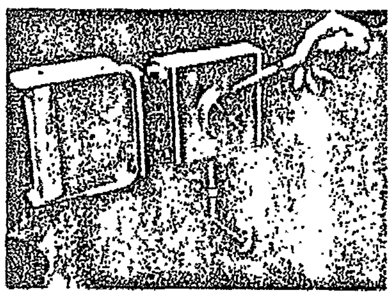
One of the earliest methods for joining thermo plastic piping, flanging continues to be use extensively for process lines. Thermoplasti flanges and flanged fittings are available in a ful size range and may be attached to pipe by solven cementing, by threading, or by thermal bonding as required by the particular thermoplastic ma terial.

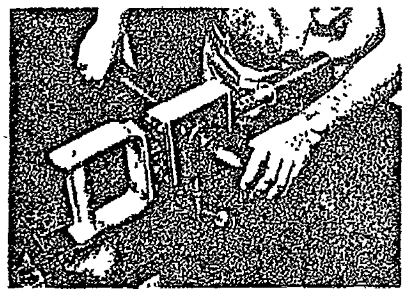
Thermal Bonded Joints (PENTON, POLYPROPYLENE)

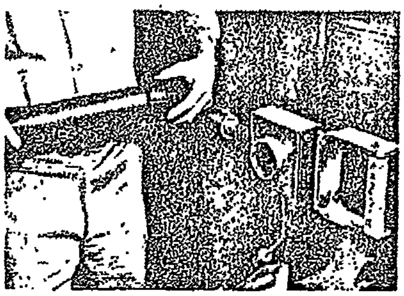
*"Tempilstik"—T. M. Tempil Corporatio

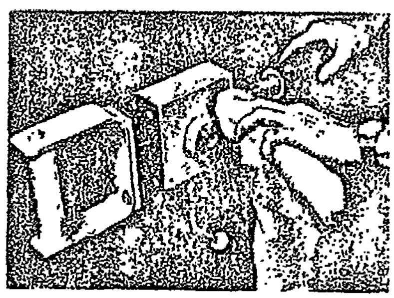

Saw pipe to desired length using either a hand saw and miter box or power saw. A square-cut end is of utmost importance. Remove saw marks and burrs with file, sharp knife or sandpaper.


While the tool is heating, spray heating element contact surfaces lightly with silicone release agent to prevent hot plastic material from sticking to the male and female tool pieces.

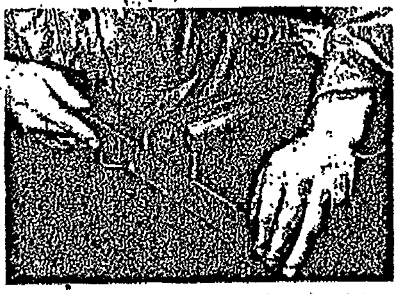

The THERMO-SEAL heat tool should be checke periodically with "Tempilstiks" to ensure the prop er temperature range. *Caution: Heating elemer reaches 510°F or more; avoid touching.*

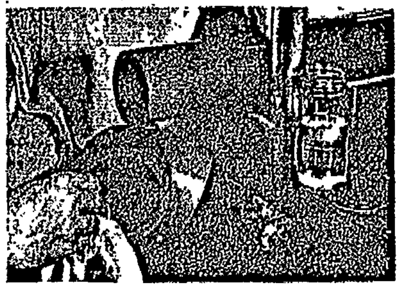

Place pipe and fitting squarely and fully on heating elements so that I.D. of fitting and O.D. of pipe are in contact with heating surfaces. Rotate components slowly and avoid overheating.


Remove pipe and fitting from tool simultaneously and immediately insert pipe—squarely and fully—into the socket of the fitting. Hold or block completed joint in place and avoid relative motion between components for at least 15 seconds.

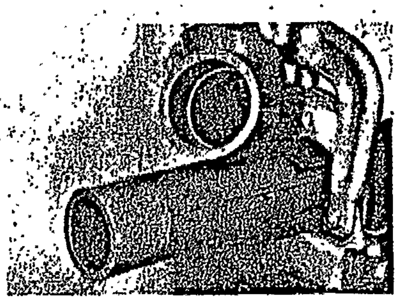

It is important that the tool pieces be kept clean a possible. The small amount of residue left on th tool pieces should be removed with a cloth. At th end of each day, further cleaning may be done wit fine steel wool. *Caution: Hot plastic material ca cause severe burns; avoid contact with it.*

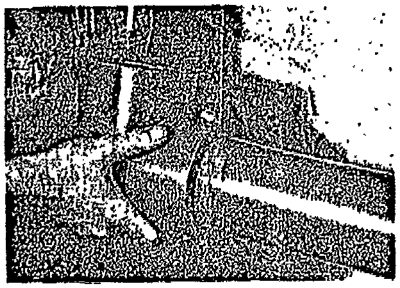
Solvent Cemented Joints (PVC, PVDC)

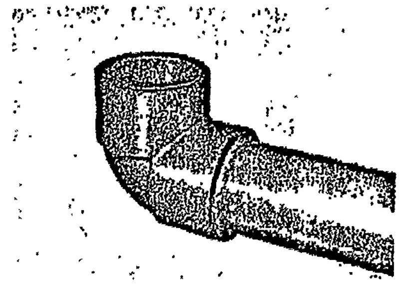

Make certain pipe end is square. Smooth with fine-tooth file. Remove saw marks and burrs with sharp knife or sandpaper.


Clean connecting surfaces of both the pipe and fittings with either methyl ethyl ketone or acetone.

Apply CPS Solvent Cement liberally with clean brus ... first to fitting and then to pipe (O.D. and end)

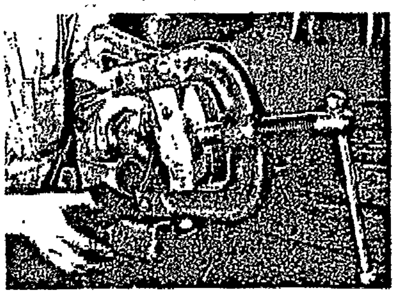

Cement should be applied to all of pipe O.D. to be covered by fitting. Allow ¼" to ½" lap for better seal.

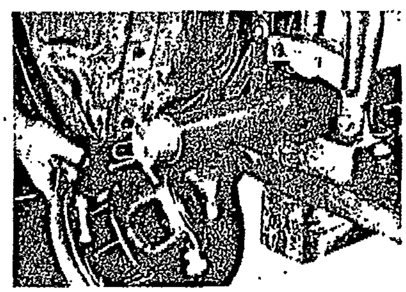

Join pipe and fitting ... be sure pipe is WELL SEATED into fitting ... twist ½ turn to distribute cement.

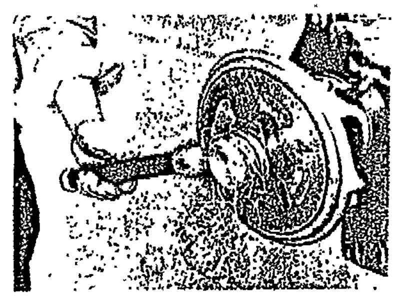

If correctly assembled, a small "fillet" or bead wi appear between pipe and fitting.

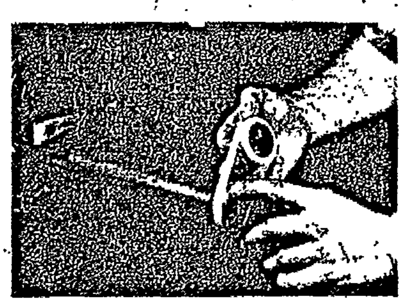
When making Sch 40 PVC joints, follow above procedure except Sch 40 Solvent Cement is applied to the pipe only, not the fittings.

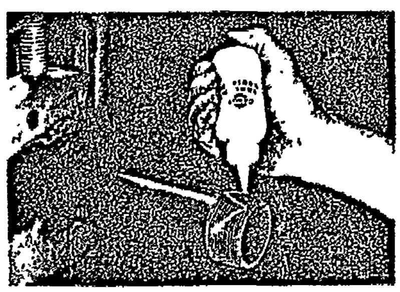
Threaded Joints (ALL MATERIALS, SCH 80 PIPE ONLY)


Use standard steel pipe threading equipment. An insert should be used in vise jaws to prevent scoring of pipe.


Insert wood or aluminum plug (longer than cutting dies) into pipe end. This prevents distortion of pipe walls and avoids off-center threads.


Dies should be clean and sharp, and those with 5° 10° front rake angle give best results. With pow tools, use 5° negative front rake dies.


Starting with entry thread, wrap Thread Tape tightly, covering all threads. Overlap each wrap a quarter-inch ...


or apply CPS Thread Lubricant to threads. It is inert and acts as lubricant as well as a seal.


Screw fitting onto pipe and tighten with str wrenches. Avoid excessive torque; one to two threa past hand tight is adequate.

When threading "Penton", use lubricant of 50% Lusol and 50% water.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-30

SUBJECT: REMOVE AND INSTALL VALVES

A. GATE, GLOBE, COCK AND CHECK

Before starting the job, secure a safety work permit, Form R-241-A. To remove and install these valves you remove all but two bolts from the flange, put the rigging in place, remove the bolts, and then remove the valve. After the valve is out, clean gasket surfaces of both flanges. Brush and clean bolts and then apply graphite to them. Install valve with proper gaskets and tighten flange evenly.

B. REGULATORS

To remove regulators be sure that the instrumentation is first disconnected. Then proceed as in Paragraph A.

C. RELIEF VALVES

Extreme care should be used when removing and installing relief valves. A bump or a hard jar can change the setting. Be sure to have proper equipment to handle the valve. Then, proceed as Paragraph A. All relief valves tied to the flare system must be removed with a gas mask. Follow the instructions in Standing Instruction No. 21.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-31

SUBJECT: MAKE HYDROSTATIC TEST

It is the job of a Pipefitter to make hydrostatic tests on boilers, heaters, vessels, piping systems, etc.

This consists of running test pumps, filling system with water, removing all air from the system and being able to follow out and know the system to be tested. Also the Pipefitter must be able to read testing diagrams.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-32

SUBJECT: RENEW TUBES

The steps in changing a tube in an exchanger bundle are as follows:

(1) Cut tube on one end just inside tube sheet. Use internal cutting tool powered by an electric or air drill motor.

(2) Remove the tube from the bundle with a hydraulic pulling tool.

(3) Inspect the hole for cleanliness and imperfections after tube and tube stub have been removed.

(4) Install new tube using a plastic guide in the end. This will guide the tube through the baffles.

(5) Measure the I.D. of the hole and also the I.D. and the O.D. of the tube.

(6) After installation, roll the tube with a rolling tool on each end of the exchanger to a predetermined thickness.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-33

SUBJECT: BURNERS - GAS AND OIL

A. REMOVE AND INSTALL

Disconnect gas, oil, air and steam lines from burner, loosen nuts on packing ring around burner barrel, have proper rigging, remove burner from boiler or heater. After burner is cleaned and repaired, clean flange surfaces, unions and bolts. Then install burner in boiler or heater, connect gas, oil, air and steam lines. When flangingup gas, tighten bolts up evenly. Tighten nuts back up on packing ring.

B. CLEAN AND REPAIR

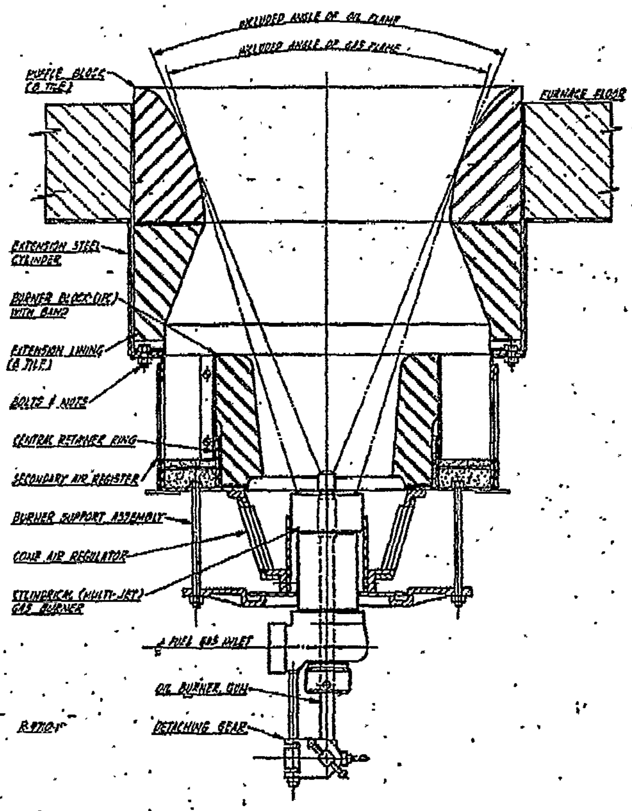
When equipment is down we will go into boiler or heater to clean gas burners. Clean scale off the burner tip, then get correct sized drill bit and angle of gas outlets. Insert bit in hand drill and carefully run bit through gas outlet being careful not to change the angle or size of the hole.

When it is necessary to pull burner in order to clean, use the same procedure as above and then blow burner with air and steam.

To repair burners, the Pipefitter will be instructed by the inspector what has to be repaired or renewed. If burner tip needs repairing, it is screwed on and then is seal welded, you have to grind off weld and screw off tip to repair, which in most cases would be a new tip. Screw tip on burner barrel, seal weld and it is ready for service.

NATIONAL AIROIL BURNER COMPANY

INSTALLATION AND OPERATION INSTRUCTIONS
MODEL C-P TANDEM COMBUSTION UNIT FOR
COMBINATION NON-AERATED GAS AND OIL FUELS



NATIONAL AIROIL BURNER C-P TANDEM UNITS

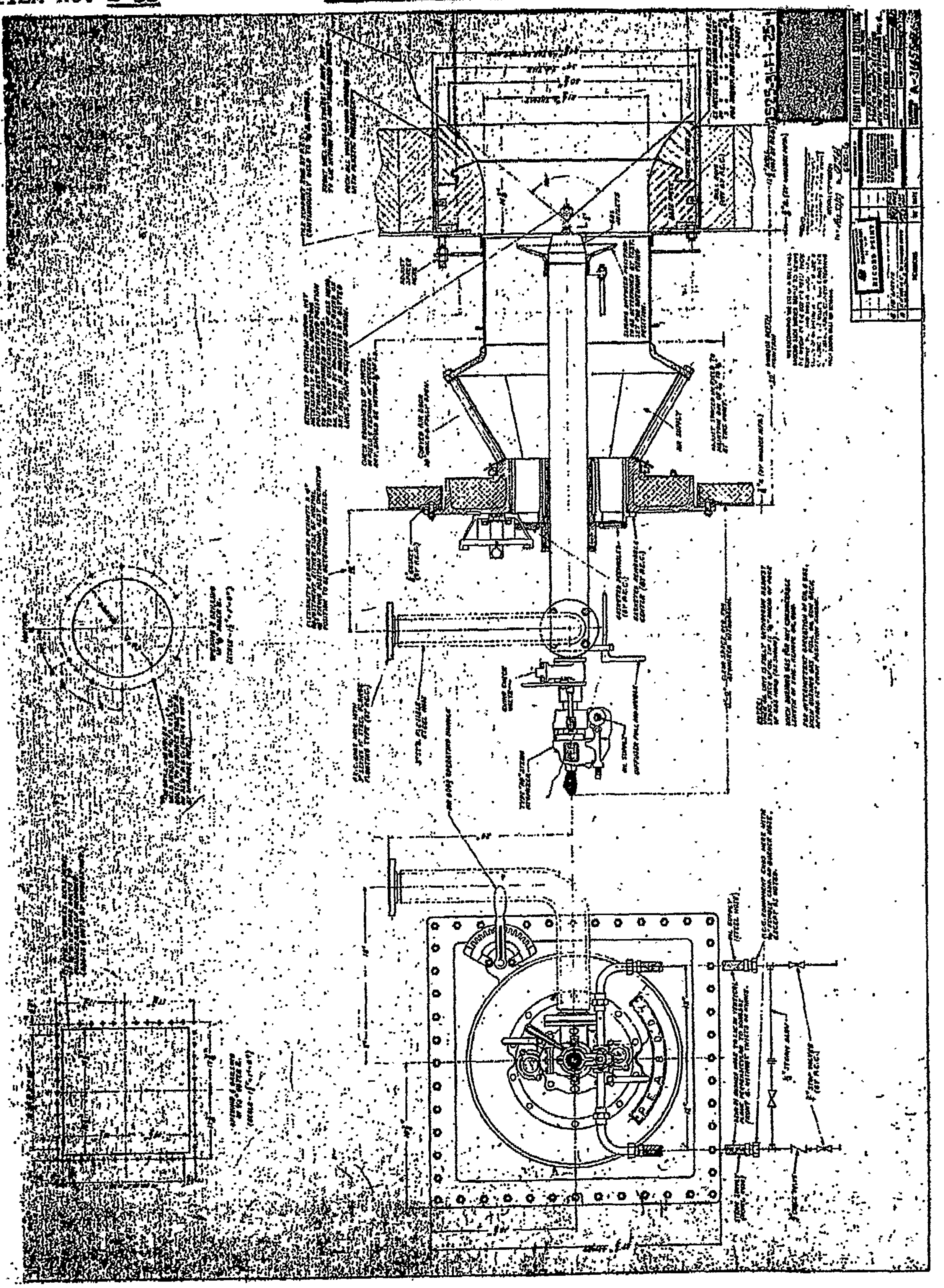
Established 1912—Incorporated 1917

INDUSTRIAL OIL BURNERS, GAS BURNERS AND FURNACE EQUIPMENT

1284 E. SEDGLEY AVENUE PHILADELPHIA 34, PA., U.S.A.

SOUTHWESTERN DIVISION—2512 SOUTH BOULEVARD, HOUSTON 6, TEXAS

Form 523 November, 1957



TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-34

SUBJECT: COILS

A. REMOVE AND INSTALL

In order to remove a coil it is necessary to either break bolts on flanges or have a welder cut the pipe with a cutting torch.

To install a coil, flanges must be cleaned, then bolted up evenly. If pipes were cut to remove the coil, then the pipe must be cleaned of all slag and beveled before it can be welded again.

B. REPAIR

To repair a coil, either install a new pipe or ells in the coil.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-35

SUBJECT: STEAM AND AIR TRAPS

A. REMOVE AND INSTALL

To remove traps, make sure traps are out of service, then loosen unions on inlet and outlet of the trap. When installing traps, be sure union faces are clean, then insert trap and tighten unions.

B. The following information and illustrations describe in detail the design, operation and maintenance of various steam traps.

The Why and How of Steam Trapping

I. Types of Traps

By JOHN W. WELKER*

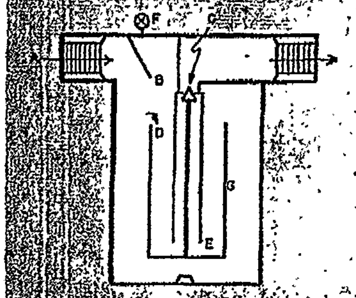


Fig. 1. Mechanical type trap of open top float or bucket design

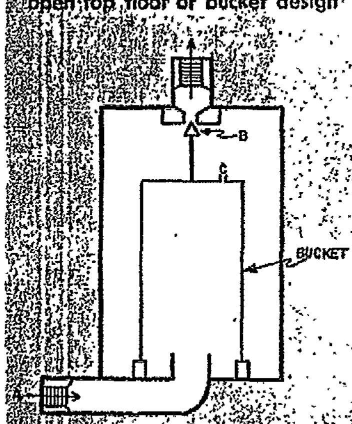


Fig. 2. Another type of mechanical trap. Inverted bucket design

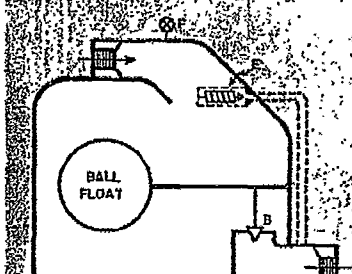


Fig. 3. Another mechanical type trap. Closed ball float design

MANY YEARS AGO steam was allowed to blow free to the atmosphere because it was inexpensive to produce. Later as costs became more of a factor, devices such as ordinary cocks or simple valves were used in an attempt to trap steam in process equipment, and at the same time to allow condensed steam (condensate) to escape. These devices were adjusted to function under average conditions, but could not be counted on to function unattended as desired under varying loads.

In this article we will give a brief description of the main types of steam trap in use today. They will not be in any particular chronological order.

A steam trap by definition, is an automatic device for draining condensate and air from any space where steam is condensed. Steam condensing in heating equipment must be drained to maintain maximum heat transfer. Condensate in steam mains must be drained to prevent water hammer and other dangers created by slugs of water. Air must be eliminated to prevent dilution of steam, reduction of heat transfer, and in some cases corrosion. At the same time in any of the above cases steam should not be allowed to escape. A good trap meets all these requirements.

If condensate is allowed to remain in steam-heated equipment, the capacity of the equipment is reduced. Condensate by filling possible steam space acts as an insulator between steam and the material being heated, and has very little usable heat when it is compared to an equal weight of steam. Heat required to raise water to the boiling point is sensible heat; heat to change water to steam at the boiling temperature is latent heat. This latent heat which is lost almost instantaneously when steam condenses, amounts to several times the sensible heat which is lost only slowly as water cools from the boiling point to a lower temperature. It is therefore desirable to eliminate condensate as soon as formed. At this point about 75 per cent of the usable heat has been lost, and condensate becomes a detriment to efficiency.

This article deals solely with non-return designs which discharge to pressures less than inlet pressures. A non-return trap does not initiate the action but allows steam pressure on trap inlet to force condensate and/or air through it to a disposal or return system, and at the same time it prevents escape of steam.

Steam traps may be classified in several ways but the most practical classification is on the basis of operating principle. Thus: —

Mechanical Type — operates on difference in density of steam and condensate. (Open Bucket — Inverted Bucket — Closed Ball Float.)

Thermostatic Type — operates on difference in temperature of steam and condensate. (Balanced Pressure —Liquid Expansion — Metallic Expansion)

Thermodynamic Type — operates on the difference between the behavior of steam and the behavior of condensate when passing through two orifices in series (Impulse — Labyrinth); or operates on the difference in the internal energy of steam and condensate when passing through a nozzle (Kinetic Energy).

There are certain combinations of these basic types. The following description of each type will provide a better understanding of how they are

*Application Engineer, Yarnall-Waring Company

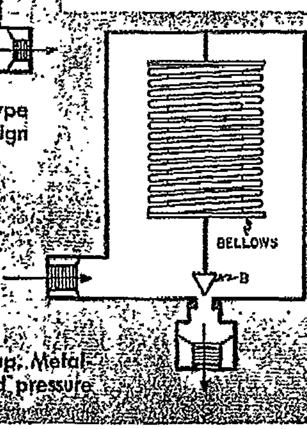


Fig. 4. Thermostatic trap. Metallic bellows or balanced pressure

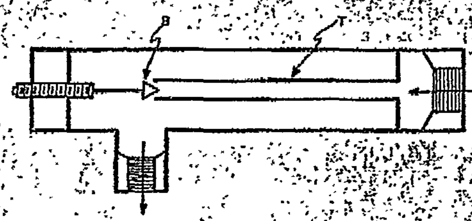


Fig. 5. Another thermostatic type trap. Metallic expansion design

constructed and how each operates. Illustrations are diagrammatic, and in no way present details of design. They are used to illustrate in simple terms the basic design and operational characteristics.

Mechanical Traps

The mechanical trap differentiates between condensate and steam by virtue of the difference in weight between the two fluids.

Open Top Float, Bucket Type (Fig. 1)

Condensate flows into the trap at A, and is usually deflected downward by a baffle B. The body of the trap fills with condensate, and the empty bucket G is buoyant and floats upward closing the valve C. The bucket is now at its highest position and as additional condensate enters the trap it begins to spill over into the bucket at D. The bucket then fills to a point where it is no longer buoyant, and sinks, opening valve C. Steam pressure at A then forces the condensate out of the bucket through C. The bucket again becomes buoyant and rises before it is completely empty so that a water seal is maintained at E to prevent escape of steam. On start-up and frequently during operation this type of trap will become filled with air which must be released to permit sufficient condensate to enter trap to make it operate. An air release valve F, usually manually operated, is necessary. This valve is opened to purge air, but must be closed to prevent steam loss.

The discharge is intermittent and the trap cycles at intervals determined by the amount of condensate handled per unit time. The weight of the bucket, which is a constant, must oppose the force created by the valve seat area multiplied by the operating pressure. The weight of the bucket establishes one of two limiting possibilities — the maximum operating pressure for a given seat area, or the maximum valve area for a given operating pressure.

Inverted Bucket Design (Fig. 2)

On start-up, the open-bottomed bucket is resting on the bottom of the trap body which means that valve B is open. Condensate entering through A drives air out of body through B. Air in the bucket escapes upward through the fixed orifice C in the bucket top. After residual steam in the bucket condenses, condensate ultimately fills the trap body and bucket, and discharges through B. If steam reaches the trap it displaces the condensate in the bucket, and even though a small amount of steam escapes through C, the bucket becomes buoyant and valve B is closed.

As condensate follows, a point is again reached where buoyancy is lost, and valve B again opens to allow condensate discharge in cycles. The size of the orifice C determines at a given operating pressure the air handling capacity. Steam loss through this orifice is determined in an inverse fashion. In some designs this orifice is closed by a simple thermostatic element which must be sensitive to a small increment of temperature between hot condensate surrounding the bucket and steam temperature within. The weight of the bucket opens the trap valve B, and its buoyancy when filled with steam closes the valve. As with the open bucket, the area of valve and operating ratios are established by the weight of the bucket.

Closed Ball Float Design (Fig. 3)

At start-up the float is at its lowest position, and valve B is closed. If there is a lot of air in the system, a manual vent F must be opened to allow condensate to fill the trap. Almost all ball float steam traps today are - equipped with high capacity auxiliary air vents operated thermostatically or by other automatic means. These vents are designed to release air at temperatures approaching saturation temperature so that they will release air on starting and during operation.

To prevent steam blow through the trap, valve B is usually covered by condensate before the float rises to open the valve. The float rises in proportion to the amount of condensate entering the trap, and so long as condensate flows to the trap, discharge is continuous. A ball float is sometimes guided so as to seal the valve itself, but most often it operates a lever system as shown. Closing power is a function of the weight of the float; opening power is a function of the buoyancy of the float combined with the mechanical advantage of the lever system when used. These factors combined determine capacity and operating pressure ranges.

The valve opening, at any load within its rated capacity, is a function of the rate of flow of condensate into the trap (a function of the load, in fact).

Thermostatic Traps

The thermostatic trap differentiates between steam and condensate by virtue of the temperature difference between the two.

Balanced Pressure (Metallic Bellows) Design (Fig. 4).

These traps are operated by a sealed thermostatic element, usually called a bellows, having a flexible wall of a metal suitable for the operating conditions.

The wall thickness of the flexible bellows is designed to give maximum resistance to the pressure differentials it must withstand and, at the same time, maximum resistance to fatigue.

The sealed element or bellows contains a liquid, which may be pure water, a mixture of water and a suitable volatile fluid, or a volatile fluid alone, depending on the characteristics of the element design.

One end of the bellows is rigidly fixed to the trap body; the other end has the valve attached and is free to move. When cold, the bellows has a length permitting valve B to be open to pass air and condensate. As it becomes hotter the bellows lengthens, and finally at a temperature approaching that of steam the valve is closed.

Because of the lower boiling point of the mixture inside the bellows, a vapor pressure differential between inside and outside is established just before steam temperature is reached in trap body. The differential pres-

Fig. 6. Liquid-filled thermostatic type. Liquid expansion trap.

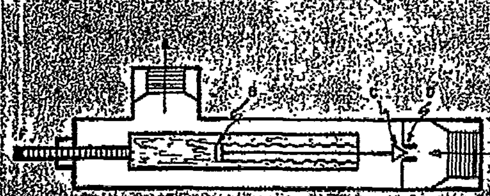
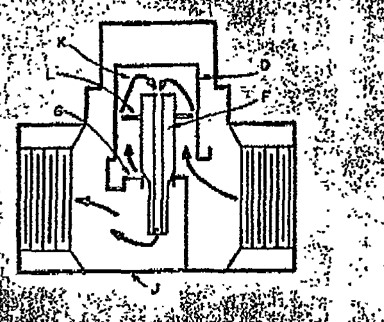


Fig. 7. This impulse design trap uses orifice-in series principle



sure causes expansion of the bellows and closes the valve to prevent escape of steam. Condensate in the trap must subcool to a temperature where internal vapor pressure in the bellows balances that outside before the trap will again open. Vapor pressure temperature curves for water and the mixture in the bellows are essentially parallel. This fact insures a positive differential pressure available for closing the trap independent of the operating pressure.

Balanced pressure elements filled with pure water are expanded by the spring properties of the bellows wall.

Bellow straps are normally not recommended for superheat operation. Superheat creates excessive vapor pressure and tends to rupture the bellows. Discharge from a bellows trap is usually intermittent. Where condensate formation and temperature are constant, continuous flow can result.

Balanced pressure traps do not need auxiliary air vents, for they are wide open when cold and freely release air up to temperatures approaching saturation.

Metallic Expansion Design (Fig. 5)

On start-up air passes through the valve B. Condensate follows and as it becomes hotter tube T (which forms a valve seat at one end) through which it is flowing, expands. This ultimately results in the seat being closed against the valve. The valve is adjustable to permit setting for closure just as steam temperature is reached. Such a trap has good characteristics so long as steam pressure is constant. If pressure increases, the trap will close prematurely because closing temperature will be lower than steam temperature unless the valve is reset for higher pressure (and temperature) conditions. If pressure decreases, the trap valve will not be closed when steam reaches the trap resulting in steam blow through the trap. In order to have appreciable expansion for valve movement, the metallic expansion tube must be long which results in an abnormally long trap. Discharge is continuous and at a set pressure, it can be set to discharge at any temperature up to steam temperature.

Liquid Expansion Design (Fig. 6)

This type consists of a liquid-filled thermostatic element which expands and contracts on a temperature difference between condensate and steam. Liquid is used to obtain greater expansion per degree of temperature difference; thus greater valve movement and a more compact design is achieved than with metallic expansion.

On start-up air passes through the trap followed by condensate. As condensate becomes hotter, the liquid in the thermostatic element expands. Piston B which is free to move slowly closes valve C against seat D as the liquid expands. The thermostatic element is on the outlet end of the trap

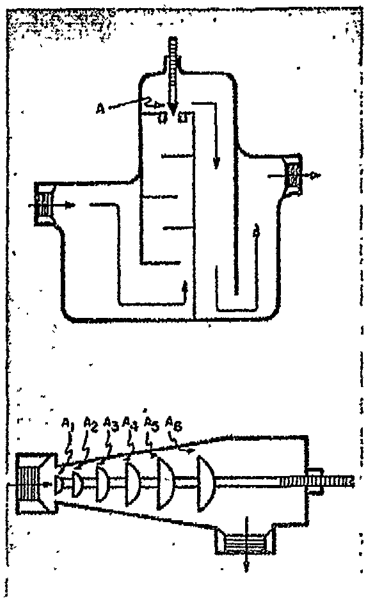


Fig. 8, Above. A "labyrinth" type trap. Below. An "orifice" type

valve, and as steam reaches here, the valve closes tightly. Gradually the element cools, contracts and opens the valve once more. It will continue to sample the medium entering at A; if steam is still at the trap the valve will immediately close, but if condensate is there it will stay open to a degree inversely proportional to condensate temperature. The adjustment at F permits setting the trap to operate at a definite temperature.

This type discharges continuously except under light load when it has a sampling or intermittent action. Capacity is determined by both steam pressure and condensate temperature. It will close at a temperature below 212 F (assuming atmospheric discharge).

Liquid expansion traps should be used only on applications where condensate can be held in the heating surface until it cools to below 212 F. Unless this can be done, a cooling leg must be provided between apparatus and trap to provide subcooling between the desirable condensate temperature and 212 F.

Thermodynamic Traps

The operation of this type of trap depends on thermodynamic properties of hot condensate and/or steam as either or both pass through some form of orifice or orifices.

Impulse Design (Fig. 7)

Whether valve F is seated on G or open is determined by pressure in chamber K above disk L. In either position part, or (if valve is closed) all of the condensate passes upward through the annular space between disc L and tapered cylinder D into control chamber K. This portion of the condensate is known as the control flow, and the annular space is the first of the series of two orifices through which it passes. The second is the control orifice in the center of valve F. As condensate passes into chamber K and then through the control orifice into trap discharge, pressure is reduced. When hot water under pressure passes into a lower pressure it will flash to a greater or lesser degree depending on initial temperature and the pressure drop.

The degree of flash determines the pressure in chamber K; this pressure in turn determines whether valve F is seated or open. Cool condensate flashes little, chamber pressure is low, and the valve is open; this results in the trap floating on the load and passing cool condensate as fast as formed. The trap is designed so that condensate close to steam temperature will flash sufficiently to raise pressure in control chamber so as to exert sufficient differential pressure between top and bottom of disk to close valve before steam arrives at trap inlet. Control flow through the two orifices in series continues at all times and represents only a few per cent of total trap capacity. This flow makes the trap continuously and immediately responsive to slow or rapid changes in medium reaching trap.

New High Capacity Impulse Design (Fig. 9)

Recent modification of the two-orifice-in-series design of Fig. 7 has resulted pipe size for pipe size in a much higher-capacity impulse trap. This design incorporates the same two-orifice-in-series principle for control of trap operation. However, in this design 100 per cent of flow passes through the two orifices, instead of only a small percentage as is true with the original design of Fig. 7. In Fig. 10, the trap is shown in the closed position. The two valves, one conically-shaped A, the other flat-disk B, are mounted on a common valve disk which raises and lowers as a lever at a fulcrum point C.

When steam is turned on, upward pressure of air and accumulated condensate lifts valve A and simultaneously valve B; the mixture of air and condensate passes from line pressure at trap inlet through the

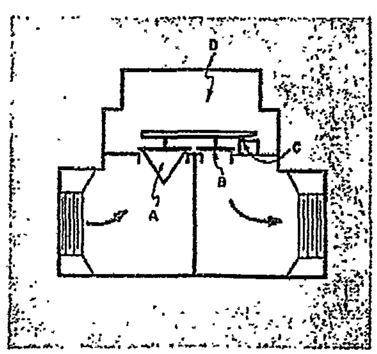


Fig. 9. Latest impulse design for high capacity service

first or inlet orifice into the intermediate pressure chamber D; thence through the second or outlet orifice into the low pressure of the return system.

Opening and closing of valves is controlled by the intermediate pressure in Chamber D. This pressure varies directly as the thermodynamic state of fluid passing through the two orifices in series. Therefore, as condensate temperature approaches steam temperature, flashing of condensate into steam increases in the lower pressure region on outlet side of valve B. This raises pressure in chamber D sufficiently to close valves A and B. In closed position, a small amount of condensate continuously flows through the two orifices to maintain control of trap operation. When condensate temperature drops a few degrees below steam temperature, the valves again open wide. Rapid discharge of condensate flowing to trap is obtained over complete temperature range from cold water to condensate near steam temperature.

New Low Capacity Impulse Design (Fig. 10)

The operating mechanism of this trap consists of a valve disc (A) mounted on a flat seat. This seat contains large inlet orifice (B), located slightly off center, and four smaller discharge orifices opening into annular discharge space below seat. (One shown — "C")

At start up, when pressure reaches trap, the valve disc tilts upward or rocks on its rounded fulcrum (D) edge, discharging condensate and air at full capacity. This tilting action is produced by the off-center force exerted on the under side of the disc due to the off-center location of the inlet orifice.

As condensate nears steam temperature, flashing occurs in discharge ports (C), choking the flow and raising pressure in control chamber (E) above disc. The instant steam reaches trap, it develops greater pressure on upper side of valve disc and snaps valve shut. This in turn relieves the back pressure in the discharge ports below disc and adds to the force holding valve shut.

Valve remains closed until pressure in control chamber is relieved

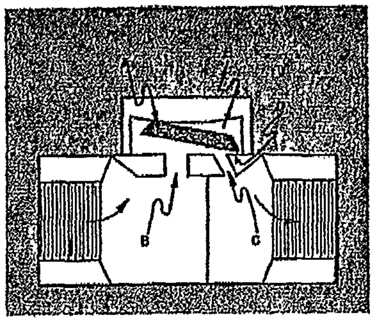


Fig. 10. Latest impulse design for low capacity services

due to condensation of steam in chamber and slight control flow between ground surfaces of valve and seat. Valve then reopens, condensate is discharged and cycle is repeated, with valve closing again when steam reaches trap.

Kinetic Energy Design (Fig. 11)

This trap consists of a body and cap, and a valve disk A. It employs the kinetic energy of the steam to close the valve.

In operation, pressure raises disk A from the seat to allow discharge of air and condensate at steam temperature. Steam follows, and its high velocity creates low pressure under the disk and builds up pressure in chamber F by recompression.

This pressure in chamber F, acting on the full top area of disk A, exceeds the combined force of the incoming steam and that in the low-pressure area, thus immediately forcing the disk down and closing the inlet. As condensation decreases the pressure in the chamber, the disk is raised and the cycle repeats. The trap is designed to close tight on no-load.

Other Orifice Designs (Fig. 8)

These traps are often called "labyrinth" traps. To understand the operation of this kind of trap it must be remembered that for a given weight of steam the higher the pressure the less room it requires; thus if discharged to a lower pressure, it will expand. Similarly, if condensate at or near steam temperature and pressure is discharged to a lower pressure, a certain amount flashes into steam by virtue of an excess of sensible heat at the lower pressure. The closer the condensate is to steam temperature, the higher the percentage of a unit weight will flash. Any orifice placed in the flow path of condensate will tend to regulate flow in inverse relation to condensate temperature.

Fig. 8 shows two designs. In one there is a labyrinth followed by an adjustable orifice A; in the second there is a series of orifices A_1, A_2, A_3, A_4, A_5, A_6. The second design has an expansion chamber between each orifice. When steam is turned on, air "cascades" through the orifice series, taking a pressure drop at each stage, but eventually is discharged through the outlet. Cold condensate follows and also passes through. As the temperature rises, flashing begins at a point determined by not only temperature but also by clearances and expansion volumes. These last two factors are manually adjustable; if too wide open, no control is possible and even steam will pass through the trap. If the setting is too close, only cool condensate can pass. This design can be set to pass condensate just below steam temperature at a given pressure. At a given setting, if pressure drops, steam can pass; if pressure rises only condensate at a lower temperature can pass. Discharge is usually continuous so long as condensate reaches the trap. Condensate pressure and temperature control the operation. Only a manual change in setting can upset these relations.

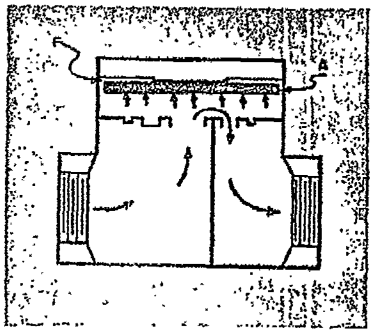


Fig. 11. Diagram of kinetic energy type of trap

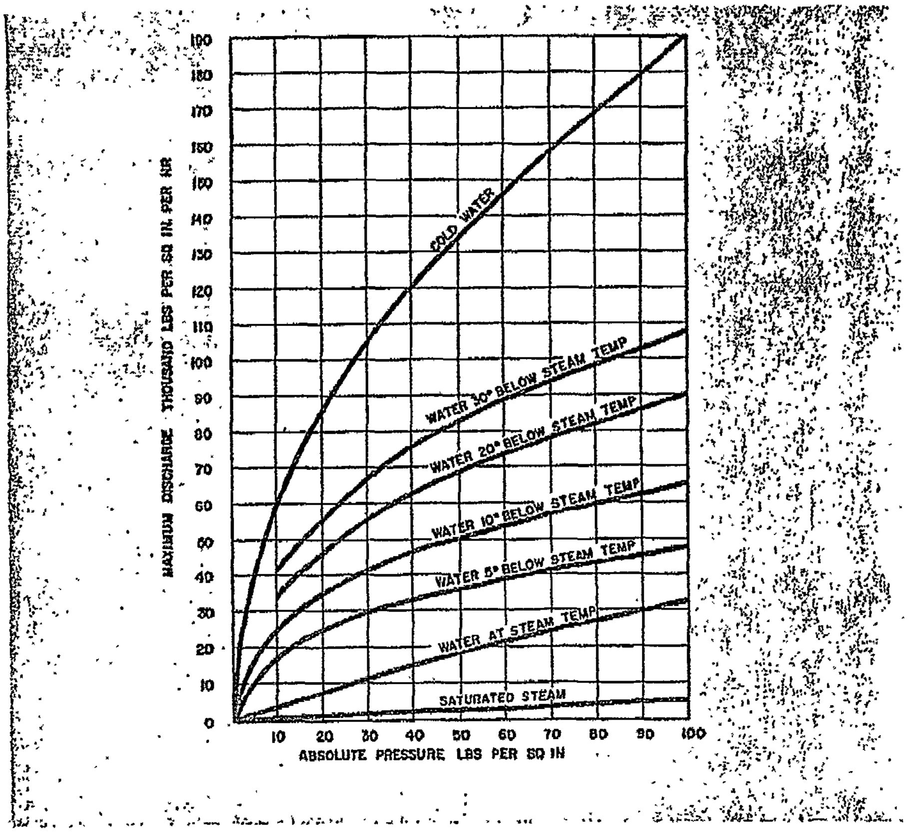


Fig. 1. Relation between condensate handling capacity at various condensate temperatures. Curves based on test data for an orifice with area of 1 sq in.

The Why and How of Steam Trapping

II. Selection—Sizing—Application

By JOHN W. WELKER *

Table I. Values of $x = (T-t)/L$ used in text formulas for figuring trap loading

Pressure, psig	Temperature rise, F 40	60	80	100	120	140	160	180	200
5	0.042	0.062	0.083	0.104	0.125	0.146	0.167	0.187	0.208
10	.042	.063	.084	.105	.126	.147	.168	.189	.211
15	.042	.064	.085	.106	.127	.148	.169	.191	.212
20	.043	.064	.085	.106	.128	.149	.170	.192	.213
25	.043	.064	.086	.107	.129	.150	.172	.193	.214
30	.043	.065	.086	.108	.129	.151	.172	.194	.215
35	.043	.065	.087	.108	.130	.152	.173	.195	.216
40	.044	.065	.087	.109	.130	.152	.174	.196	.218
50	.044	.066	.087	.110	.132	.154	.176	.198	.219
60	.044	.066	.088	.111	.133	.155	.177	.199	.221
75	.045	.067	.089	.112	.134	.156	.179	.201	.224
100	.045	.068	.091	.114	.136	.159	.182	.204	.227
125	.046	.069	.092	.115	.138	.162	.184	.207	.230
150	.047	.070	.093	.117	.140	.163	.187	.210	.234
175	.047	.071	.095	.118	.142	.165	.189	.213	.236
200	.048	.072	.096	.120	.144	.167	.191	.215	.239

NORMAL SELECTION OF a steam trap depends on the answers to two questions: (a). What type of trap can best be used? and (b). What is the correct size of trap to use?

To answer these questions the trapping problem frequently requires detailed analysis. Each type of trap has certain limitations. Here are some factors which govern selection, application, and successful and continuous operation of a trap.

1. Pressure or range of pressure at inlet: Pressure and condensate handling capacity are directly related in all traps. In some designs, varying pressure limits use. Only by change in valve parts can a bucket trap be used above a limiting pressure set by the weight of the bucket. In a metallic expansion trap at a given

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WA-TEX 001392

Table II. Data for use when heat exchanger has excess surface which heats liquid in less time than required by process

Pounds per hour per square foot

Mtd**	Btu/sq ft/hr	Steam pressure, psig: >1	5	25	50	100	150	200	250	300	350	400	450	500	600
10	280	.28	.29	.30	.31	.32	.33	.33	.34	.35	.35	.36	.37	.37	.38
20	930	.96	.97	1.00	1.02	1.05	1.08	1.11	1.14	1.16	1.18	1.20	1.22	1.24	1.28
30	1,900	1.96	1.98	2.03	2.08	2.16	2.22	2.27	2.32	2.36	2.41	2.45	2.49	2.53	2.61
40	3,100	3.20	3.23	3.32	3.40	3.52	3.62	3.72	3.78	3.85	3.92	3.99	4.06	4.13	4.25
50	4,500	4.65	4.68	4.82	4.93	5.11	5.25	5.38	5.48	5.58	5.69	5.80	5.89	5.99	6.17
60	6,250	6.45	6.51	6.69	6.86	7.10	7.30	7.47	7.62	7.76	7.92	8.06	8.18	8.33	8.58
70	8,000	8.26	8.33	8.57	8.77	9.08	9.34	9.56	9.75	9.94	10.15	10.32	10.47	10.65	10.97
80	10,400	10.73	10.83	11.13	11.40	11.80	12.14	12.43	12.67	12.92	13.17	13.40	13.62	13.85	14.26
90	12,500	12.90	13.00	13.37	13.70	14.20	14.60	14.94	15.24	15.53	15.83	16.13	16.36	16.65	17.15
100	15,000	15.47	15.62	16.05	16.44	17.03	17.50	17.90	18.28	18.63	18.97	19.34	19.64	19.97	20.57
125	22,400	23.10	23.30	23.95	24.55	25.45	26.15	26.75	27.30	27.80	28.35	28.90	29.30	29.85	30.73
150	30,000	30.95	31.20	32.10	32.90	34.10	35.20	35.85	36.60	37.30	38.00	38.70	39.30	39.95	41.15
175	40,000	41.30	41.65	42.80	43.80	45.40	46.70	47.80	48.75	49.70	50.65	51.60	52.40	53.30	54.85
200	50,000	51.60	52.10	53.50	54.80	56.75	58.30	59.70	60.90	62.10	63.30	64.50	65.50	66.60	68.60
250	82,000	83.70	85.30	87.75	90.00	93.10	95.70	98.00	100.00	102.00	103.70	105.70	107.30	109.30	112.50
300	100,000	103.30	104.00	107.00	109.50	113.50	116.60	119.40	122.00	124.20	126.50	128.80	131.00	133.30	137.00

* For copper, multiply table data by 2.0 ** Mean temperature difference, F = temperature of steam minus average liquid temperature
For brass, multiply table data by 1.6

Heat transfer data for calculating this table obtained from and used by permission of the American Radiator & Standard Sanitary Corp.

Table III. Radiation from heating surface $H(t_1 - t_2)/L$ in lb of condensate /hr/sq ft used in formulas for obtaining trap loads

Air temp, F	Steam pressure, psig: >1	2	5	10	15	20	25	50	75	100	150	200	250	300	350	400	450	500	600	
32	.53	.54	.57	.70	.74	.78	.81	1.02	1.13	1.30	1.46	1.70	1.86	1.97	2.31	2.41	2.52	2.62	3.14	
50	.48	.49	.52	.56	.68	.71	.74	.87	1.06	1.15	1.38	1.52	1.74	1.85	1.96	2.06	2.41	2.52	2.71	
60	.45	.46	.49	.53	.56	.59	.71	.84	1.02	1.10	1.34	1.47	1.58	1.80	1.91	2.00	2.35	2.46	2.65	
65	.44	.45	.47	.52	.55	.58	.69	.82	1.00	1.08	1.32	1.45	1.56	1.77	1.88	1.97	2.07	2.43	2.62	
70	.39	.40	.45	.50	.53	.56	.59	.80	0.98	1.06	1.21	1.43	1.54	1.75	1.86	1.95	2.04	2.39	2.59	
75	.38	.39	.44	.49	.52	.55	.58	.77	.88	1.05	1.19	1.40	1.52	1.62	1.83	1.93	2.02	2.11	2.56	
Value of heat loss used (H)	2.6				2.8			3.2		3.5			3.75			4.0			4.5	5.0

* Based on still air; for forced-air circulation multiply above values by 5

Table IV. Overall coefficients of heat transfer. (Under many conditions higher or lower values may be realized)

Type of heat exchanger	Free convection, K	Forced convection, K	Typical Fluid	Typical apparatus
Liquid to liquid	25– 60	150–300	Water	Liquid-to-liquid heat exchangers
Liquid to liquid	5– 10	20– 50	Oil	
Liquid to gas*	1– 3	2– 10	......	Hot-water radiators
Liquid to boiling liquid	20– 60	50–150	Water	Brine coolers
Liquid to boiling liquid	5– 20	25– 60	Oil	
Gas* to liquid	1– 3	2– 10	......	Air coolers, economizers
Gas* to gas	0.6– 2	2– 6	......	Steam superheaters
Gas* to boiling liquid	1– 3	2– 10	......	Steam boilers
Condensing vapor to liquid................	50–200	150–800	Steam to water	Liquid heaters and condensers
Condensing vapor to liquid................	10– 30	20– 60	Steam to oil	
Condensing vapor to liquid................	40– 80	60–150	Organic vapor to water	
Condensing vapor to liquid................		15–300	Steam-gas mixture	
Condensing vapor to gas*................	1– 2	2– 10	......	Steam pipes in air, air heaters
Condensing vapor to boiling liquid.........	40–100	......	......	Scale-forming evaporators
Condensing vapor to boiling liquid.........	300–800	......	Steam to water	
Condensing vapor to boiling liquid.........	50–150	......	Steam to oil	

*At atmospheric pressure

setting, correct operation depends on a constant temperature which means constant pressure. An impulse trap is designed for a wide range of pressure without adjustment or change of parts.

2. Amount of air to be handled: Bellows, impulse, orifice, metallic and liquid expansion traps all have excellent air handling capacity. Some bucket traps incorporate thermostatically controlled air vents to permit handling large volumes of air.

3. Heat-up time required: *If* heat-up time is not important, a trap can be appreciably smaller than if the abnormally high amount of condensate formed on start-up must be handled quickly.

4. Type of discharge desired (continuous or intermittent): Ball float, metallic or liquid expansion, and impulse traps are suitable for application where continuous condensate discharge handling is desirable. Bellows traps (except where flow and temperature are constant) and bucket traps normally have an intermittent discharge.

5. **Required discharge temperature of condensate:** Some traps handle condensate at or very near to steam temperature. Others require a differential in temperature called sub-cooling between closing on one cycle and opening on the next. Careful review of a trap should be made to determine condensate handling capacity at various temperatures below steam temperature.

6. **Back pressure in return system:** Increase in back pressure will normally decrease discharge capacity and in the case of some trap designs such increase is a limiting factor on proper application. This detail should be checked with the manufacturer.

7. **Available space:** Space normally is not a factor, but dimensions such as the length of a metallic expansion trap may be significant.

8. **Maximum temperature expected at trap inlet:** Bellows traps are not normally recommended for use on superheat, which places significance on maximum temperature to be expected at trap inlet.

9. **Installation cost:** Cost is usually insignificant when compared to the savings a properly applied trap can make. Certain types of traps that are comparatively large create excessive installation expense.

10. **Maintenance cost:** Simplicity of design, the number of moving parts, whether a trap can be serviced quickly under pressure — all are factors to be considered in maintenance. Once the type of trap has been selected, condensate load must be calculated to determine trap size. Trap catalogs tabulate capacity-pressure relations, and a study of such tables shows that capacity generally does not increase in direct proportion to the pressure differential across the trap. These tables will also show that body and pipe connection size are not true indices of capacity. In the case of the impulse design the manufacturer provides a very simple selector bulletin. Trap sizes can be determined quickly by using this selector without the necessity of first calculating amount of condensate. Load from steam apparatus is expressed in lb per hr of condensate formed. Load characteristics vary considerably. During start-up load is heavy as air as well as condensate must be removed in large quantities. Condensate is forming at a rapid rate during start-up because all parts of the apparatus and connected system must be brought up to temperature; and this condition usually results in a lower pressure at the trap inlet which reduces trap capacity when load is at its maximum.

When the system reaches operating temperature, condensate formation may be relatively constant, or it may vary considerably depending on the application. To compensate for some of these variables, a factor of safety must be used as a multiplier of calculated load to determine the final figure to be used as a selection from catalog capacity tables.

There are many methods to calculate load, but generally calculations involve the use of formulas such as those listed below — each formula designed for a specific type of application —

(1) $C = WSX$ Used for pressure vessels such as retorts, autoclaves, etc., where steam is applied directly to solid materials being heated.

(2) $C = WX + 970\ (W\text{-}D)/L$ Used for dryers, platen presses, etc., where steam loses its latent heat indirectly to solid material through metallic surfaces.

(3) $C = AY$ Used for pipe coils to heat air such as found in unit heaters and chamber dryers where steam loses its latent heat indirectly through a metallic surface.

(4) $C = KAX$ Used for submerged surface where quantity of liquid heated is unknown.

(5) $C = GWSX$ Used for submerged surfaces where the quantity of liquid heated is known. Here steam loses its heat through metallic walls of coil or other metal surface submerged in a vessel when liquid is being heated. Cookers, heat exchangers, etc., where steam loses its latent heat indirectly to a liquid through a metallic surface represent the type of equipment involved here.

Symbols used

C = Condensate lb per unit time

W = Weight of medium being heated in lb

S = Specific heat of substance being heated

X = (T-t)/L (Table I)

(T-t) = Temperature rise of substance heated in deg F (See Table I)

L = Latent heat of steam at trap operating pressure in BTU/lb

D = Weight of substance heated after drying — lb

A = Heating area — sq ft

Y = Radiation from heating surface H $(t_1\text{-}t_2)/L$ in lb of condensate/hr/sq ft (See Table III)

H = Heat loss expressed in Btu/sq ft/deg F/hr

t_1 = Steam temperature at trap pressure—deg F

t_2 = Ambient air temperature — F

K = Coefficient of heat transfer (See Table IV)

G = Gallons of liquid heated per unit time

w = Weight of liquid being heated — lb/gallon

The formulae and data given above when applied to a specific problem will produce condensate load. The load must then be multiplied by a safety factor before trap capacity tables can be used to size the trap. These factors vary between 2 and 5 and take care of variations in steam pressure, discrepancies between assumed and actual data (the latter of which is rarely known), unpredictable and abnormal operating conditions, etc. Generally a factor of 2 applies to submerged coils discharging to gravity, and pressure vessels.

Dryers, pipe coils in air and submerged surfaces draining to a trap located above the surface take a factor of 3. Coils over which air is forced usually take a factor of 5.

Catalog recommendations should be followed for the type of trap selected. It is important to ascertain the temperature base on which catalog capacity tables are calculated. Since capacity decreases with rise in condensate temperature, the lower the temperature base, the higher the factor of safety must be.

The relation between condensate handling capacity at various condensate temperatures is shown in Fig. 1. These curves are based on test data for an orifice having an area of one sq in. If the area of a trap orifice is known, these curves can be used to approximate capacity (at a given pressure) by multiplying the orifice area in sq in. by the rate of flow from the appropriate curve, and then by an appropriate orifice coefficient.

Frequently heat exchangers contain excess surface which results in heating a quantity of liquid in a time less than the process calls for. This results in condensate being formed at a more rapid rate than expected. Special care should be taken to calculate the load under these conditions so that condensate is withdrawn as soon as it is formed to maintain highest efficiency. In these cases do not use formulae 4 or 5 but multiply the submerged area by the applicable factor from Table II to obtain the load.

The Why and How of Steam Trapping

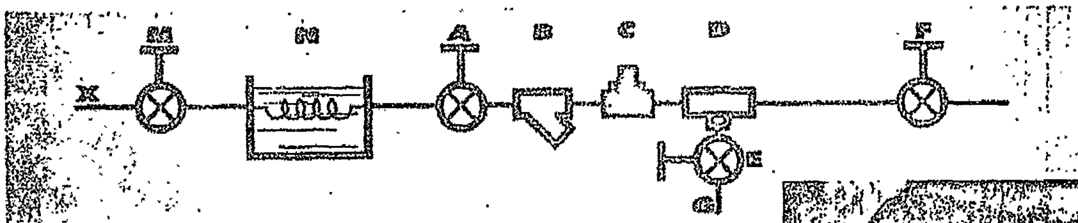

Fig. 1. Above. Basic trap hook-up. Trouble-shooting tests given in text

Fig. 2. Right. Taking in and out trap temperatures with contact pyrometer

III. Installation — Maintenance — Trouble Shooting

By JOHN W. WELKER*

INSTALLATION must be correctly made to take full advantage of a trap. This must be followed by adequate preventive maintenance schedules. A list of installation instructions below can be used as a general guide to good trapping.

1. Carefully check piping and blow it out under full steam pressure before connecting traps.
2. Check flow directional arrows or markings on trap bodies or nameplates.
3. Install a Dutch weave mesh strainer ahead of each trap.
4. Install test valve at a "T" fitting in discharge line to check operation.
5. Install traps at accessible locations.
6. Install traps where possible at lowest points in system.
7. Install traps (except thermostatic types) as close to equipment as possible.
8. Install shut-off valves on both inlet and outlet to enable isolation for maintenance purposes when required.
9. Trap each coil or each heating unit individually.
10. Where condensate is to be lifted above the trap, install a check valve between trap and riser.
11. Install only self-draining traps when they are subject to freezing conditions.
12. Pitch horizontal inlet lines to traps to keep them full of condensate and avoid steam binding.
13. When a group of traps discharge into a common header, install a check valve between each trap and the header to prevent reverse flow during shut-down.
14. Install larger traps on the first and possibly second coil of a number of coils which are in series with respect to air flow through them.
15. Be sure return line is no higher above trap than the level to which the lowest line pressure can lift condensate. Multiply lowest line pressure by 2 to determine maximum height.
16. Install unions on both sides of a trap to facilitate removal.
17. Never use piping smaller than the connections to the trap.
18. Keep return line piping large enough to prevent excessive back pressure. Use Fig. 3 to determine return line size. Enter chart from left at orifice area. Where this horizontal line intersects the "per cent of rated capacity" line draw a vertical line upward to the appropriate back pressure line. From this intersection draw a horizontal line to the right to the appropriate "length of pipe" line. Draw a line vertically downward to determine return line size. For more than one trap, work each one through the chart and add areas to get over-all pipe size. The "percent of rated capacity" line is determined by dividing 100 per cent by the factor of safety used.
19. Install a water seal to prevent steam binding when trap can only be installed above lowest point in apparatus. Water seal should be combined with a check valve to prevent back-flow.

Here are some maintenance and trouble shooting suggestions:

1. Check all traps at least once a year for cleaning and possible repair.
2. Check internal parts such as valves, seats, bellows, floats, etc., to be sure they are in good shape.
3. Clean or blow-out strainers at frequent intervals.
4. Certain tools are suggested for checking trap performance:

(a) Thermometers can be placed in thermo-wells before and after traps to check temperatures at these points – indices of performance.

(b) Pressure gage can be placed at inlet of trap to check actual pressure at trap which can in many cases be much lower than boiler pressure. The pressure at the trap inlet (not boiler pressure) determines trap capacity.

(c) A portable contact pyrometer is probably the best tool for checking trap performance. Temperatures on inlet and outlet can be closely esti-

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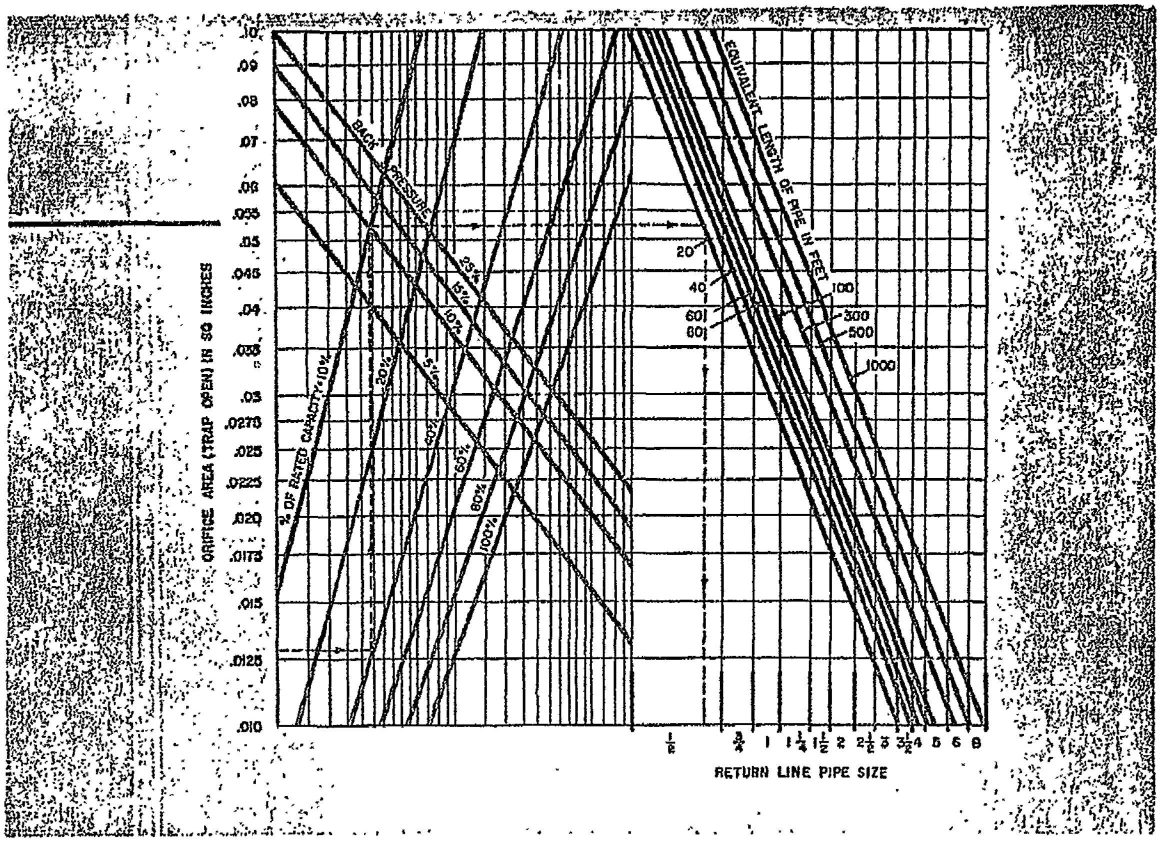


Fig. 3. Chart for finding the return line size. All return lines must be kept large enough to prevent excessive back pressure

mated by use of this instrument in contact with clean metallic surface.

5. A cleaning fluid is recommended for cleaning rust from trap parts.

6. A basic trap hook-up is shown in Fig. No. 1. To check performance of trap C (assuming valve M is open and normal pressure is at trap): —

(a) Close valve F tightly to prevent return line interference.

(b) Open valve E.

(c) If condensate comes out at G, trap is draining.

(d) At this point if equipment N is not up to temperature, the trap may be too small or the strainer B may be partially clogged.

(e) If nothing discharges at G (no pressure) there are three logical possible conditions — inlet valve M is closed or blocked, line or equipment between M and C is blocked, or strainer B is clogged.

(f) If nothing discharges at G with pressure at trap, the trap parts may be worn or defective. If a bucket trap is installed, pressure may be too high, orifice may be too large for the pressure or venthole in bucket may be plugged. If an impulse trap is installed, orifice may be clogged.

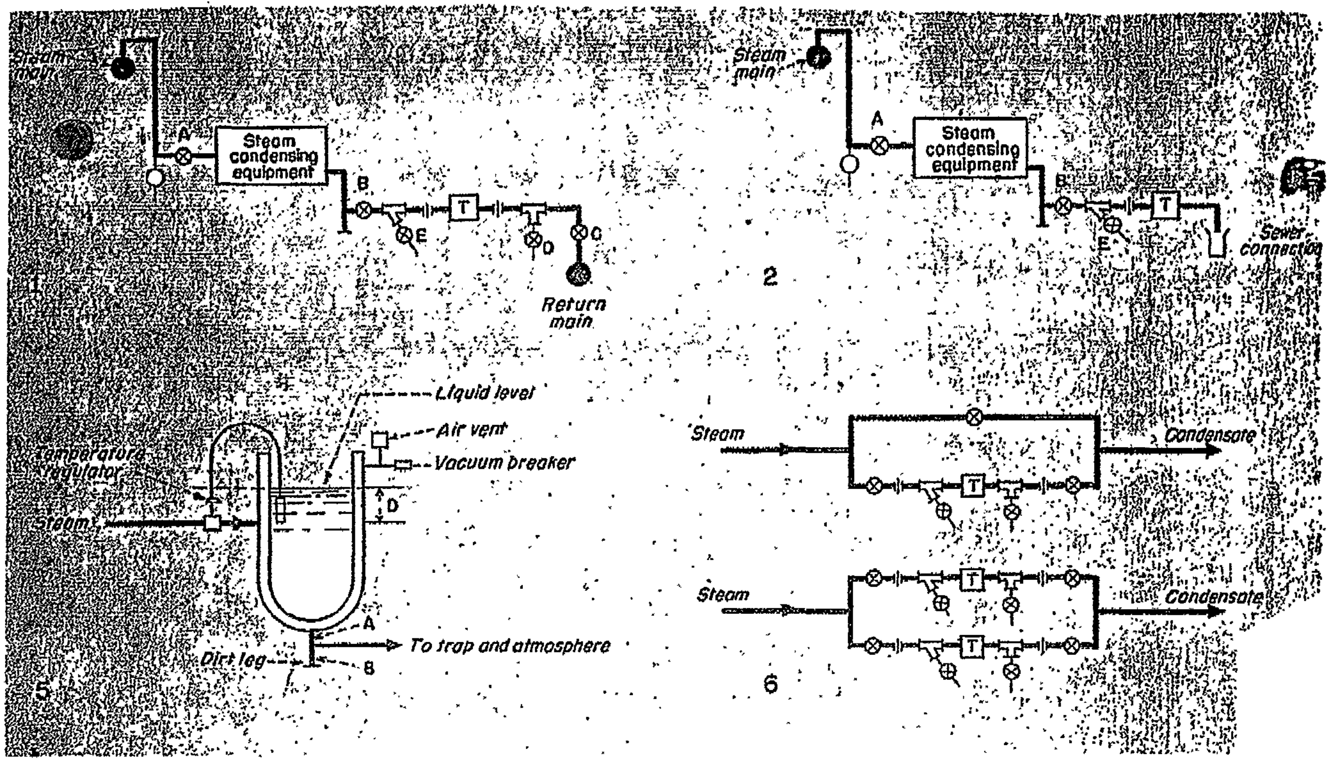
(g) If steam discharges at G, there are quite a few possibilities. Trap seat may be worn or wire drawn or held off seat by dirt. Mechanism may be holding valve off the seat. If a bucket trap is installed there is a possibility that there is no condensate in the trap body to float the bucket. In this case close inlet valve to apparatus for a few minutes to reestablish prime. With an impulse trap, the trap may be too large or back pressure too high.

7. If no "T" is available or trap discharges as shown at "D" in Fig. No. 1, a "phantom" test is available by using a contact pyrometer — an instrument used for measuring temperatures of metallic surfaces. By taking a temperature reading on cleaned surfaces at both trap inlet and outlet, trap performance can be analyzed. The inlet temperature should be essentially saturated steam temperature. The outlet temperature should be lower — the degree being partly determined by the type of trap. Impulse traps for example discharge almost continuously very close to steam temperature. On the other hand, bucket traps accumulate condensate which is discharged intermittently resulting in varying outlet temperature. With any trap if inlet and outlet temperatures are *exactly* the same, the trap is blowing steam. Fig. 2 shows a contact pyrometer in use.

8. If a trap drains continuously at constant rate, there is a good possibility that the trap is too small, or apparatus being drained, if heating a liquid, is ruptured and liquid is leaking into the line to the trap.

9. On observing trap discharge do not confuse flash steam with live steam. When the pressure of hot condensate is reduced as it passes through a trap, a certain amount of this condensate flashes into steam at the lower pressure. This is actually a good sign of efficient trap performance. Equipment cannot be kept hot with cold condensate. No flash steam indicates such a condition.

Most traps are small inexpensive devices. If they are properly selected, installed and maintained, they can contribute greatly to overall process efficiency. Much large and expensive equipment can only function efficiently by proper trapping. Thus trap application assumes a much greater importance than is indicated by the relatively small cost of the trap when overall economy of equipment operation throughout a plant is considered.



How routine maintenance keeps steam

You can step up the performance of steam-using equipment by seeing that its traps are working correctly. Here are tips on their care

▶TRAP MANUFACTURERS recommend that you inspect and, if necessary, maintain your traps at least once a year. They believe this procedure helps you get best efficiency from your traps. In a small plant, trap servicing is simple. But if a plant has more than 500 traps, the project may revert to little more than breakdown maintenance.

Steam waste is too common in plants using breakdown maintenance. Too often the bypass is left open or the trap fails in the open position. Equipment may operate all right, but much steam is wasted.

Routine or preventive maintenance is the best answer to these conditions. Here's a plan that gives the maximum in annual maintenance. You can vary it to suit your needs. When you make spot checks of the traps, only portions of the program may be necessary.

Maintenance program. To get this program rolling, existing installations may need certain changes. Though conditions vary, Fig. 1, 2 and 3 cover most plants.

For equipment, you'll need: a surface-contact pyrometer, a listening rod or trap stethoscope, steam-pressure gages, colored marking tags, repair parts, assorted fittings, steam-fitting tools and an overhaul bench on a small truck.

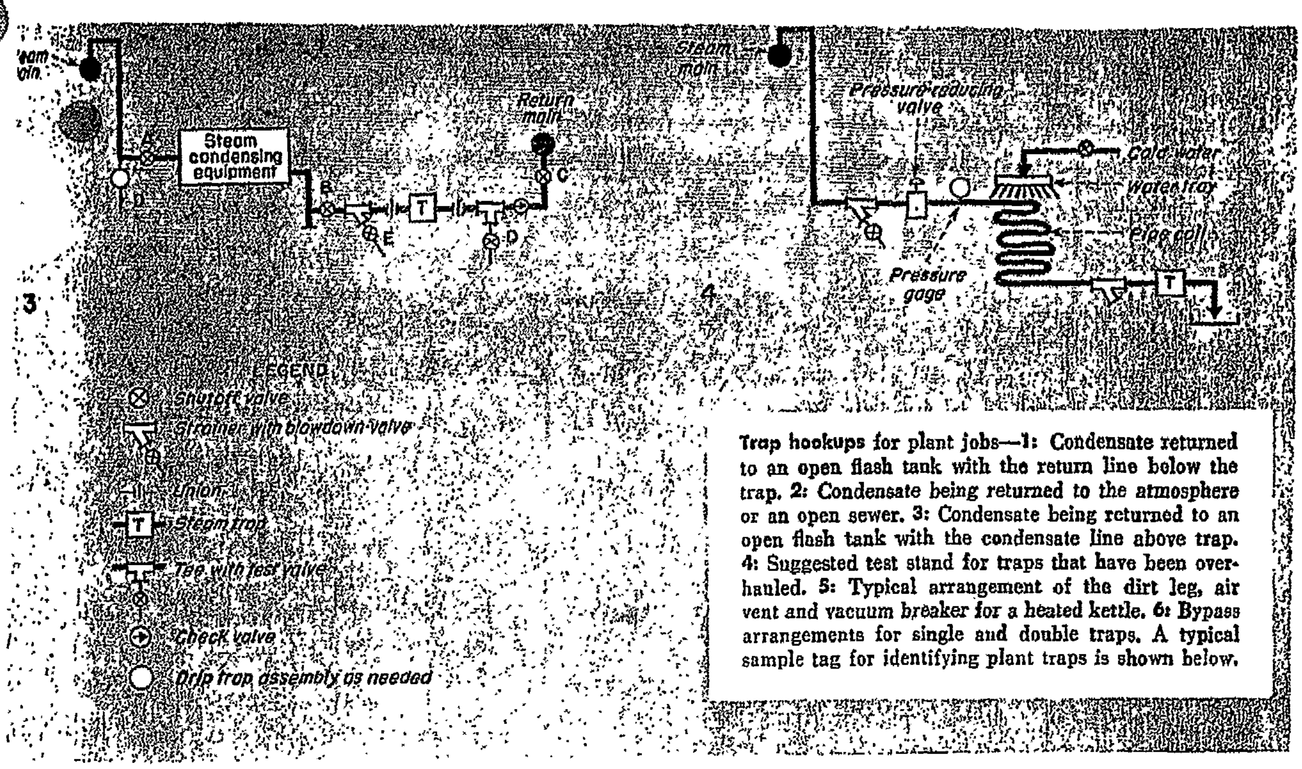
Checking traps. Use a sounding device like a *listening rod or stethoscope* to find out if trap opens and closes properly. Or you can do this visually, as shown in Fig. 1 and 3. Steps in checking are: (1) Close return-line block valve *C*, Fig. 1 and 3. (2) Open shut-off valve *D* from test tee. (3) Observe discharge.

Type of discharge varies with trap make. Get to know the discharge to be expected and learn the difference between live- and flash-steam discharge. *Steps 1 and 2 are not necessary in Fig.* 2 because the condensate is returning to an open drain or sewer.

Trap-size check. Process changes or poor selection may result in a trap being incorrectly sized. When watching the trap discharge, you may find an oversized trap remains closed for extended periods, while an undersized one stays open continuously.

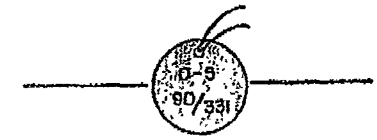
Oversized traps may become steam-bound, requiring much time to condense this steam before a new load of condensate can be handled. This reduces production efficiency. With an undersized trap, condensate merely backs up in the equipment drained. This also reduces efficiency.

Have the manufacturer size your traps, or employ a consulting engineer. Then you'll know your equipment will be properly drained. They should also check the size of the return lines when new equipment is added to an old system in your plant.



Trap hookups for plant jobs—1: Condensate returned to an open flash tank with the return line below the trap. **2:** Condensate being returned to the atmosphere or an open sewer. **3:** Condensate being returned to an open flash tank with the condensate line above trap. **4:** Suggested test stand for traps that have been overhauled. **5:** Typical arrangement of the dirt leg, air vent and vacuum breaker for a heated kettle. **6:** Bypass arrangements for single and double traps. A typical sample tag for identifying plant traps is shown below.

traps fit and on the job



BY GLEN CHASE
The Yarnall-Waring Company

Trap efficiency. Most traps lose efficiency when not serviced periodically, even though they seem to work fine. For example, if batch cooking of a product takes 30 minutes with new equipment, the operator can turn out 14 batches in a 7-hr day. If the trap loses efficiency to the point where a batch takes five minutes longer, there is a loss of two batches per day. When a number of kettles suffer from this trouble, the loss in yearly production can be tremendous. And it all traces to trap efficiency.

Best time to find expected efficiency with a given trap is when it and the equipment it serves are new. To make this check: (1) Be sure the steam header is correctly dripped. (2) Record inlet-steam pressure to the equipment. (3) Measure steam pressure at trap inlet, valve *E*, Fig. 1. (4) Measure return-line pressure, valve *D*, Fig. 1.

Take temperature readings with the pyrometer, zeroing it in at valve *A*, Fig. 1. Set pyrometer to read the saturated-steam temperature corresponding to line pressure. Take the readings on a clean surface.

Take another pyrometer reading at the nipple ahead of the steam trap. It should equal or be close to the steam temperature corresponding to strainer blowoff pressure. Third reading should be taken downstream of the trap. It should equal or be close to the saturated-steam temperature at the condensate-return-line pressure. These readings must be interpreted in terms of the size and type of heat-transfer area. Best equipment efficiency is obtained only when the temperature ahead of it is equivalent to the temperature upstream of the trap.

Record and file the temperature readings. Attach a colored tag ahead of the trap, showing the year the trap was installed in new, serviced or overhauled condition. See diagram for other tag data. Temperature recording on the tag may be necessary only for critical production equipment. When your files show a number of failures on the same equipment type, or at the same location, analyze the traps to see if they suit their job.

Starting a program of this type takes work. But the yearly checks are much easier. Select a trap that is easy to service or overhaul while it is still in the pipe.

Trap overhaul. Use a shop test stand, Fig. 4. Overhaul the trap in the way the manufacturer recommends. Sometimes a thorough cleaning is enough

(Continued on next page)

to bring the trap back to top performance. Each trap should be given an operating test in the test stand, as explained above. After the test, tag the trap for its pressure rating, overhaul date and suitability for use. Place trap in stock with other overhauled units.

Radiator traps, usually the bellows thermostatic type, should be checked during the summer. Keep a stock of replacement bellows on hand. Check old bellows on the test stand.

Accessories. While checking trap efficiency, it is good practice to look over the installation to see if any of the following accessories are needed.

Dirt leg, at *A*, Fig. 5, is easily installed using a tee and capped nipple. It will catch most of the sediment forming in the steam line and the equipment cavities. Clean the leg when trap is serviced.

Air vent on the equipment trapped often gives better operation, steps up output. In Fig. 5 the area lost to heat transfer when a vent is not used equals the product of *D* and the inside circumference of the kettle. Using the air vent greatly reduces the cooking time.

Vacuum breakers are used where temperature-control or motorized control valves are employed. In Fig. 5 the control valve closes after the process is up to temperature. Steam in the jacket condenses, creating a vacuum. Without a vacuum breaker the condensate does not drain out of the jacket for a prolonged period. Some traps may lose their prime without a breaker.

Check valves are important, preventing the discharge from one trap backing up into that of another. When condensate from a trap must be lifted, a check valve should also be used, as in Fig. 3. While manufacturers recommend individual trapping of equipment for most units, check valves should be selected where individual trapping is not possible or group trapping must be used. Install a check valve in the discharge line from each section of the steam-condensing equipment, ahead of the trap.

Fig. 6 shows the standard bypass arrangement. While the original idea of the bypass is good, too often an operator bypasses the trap, thinking he can increase production. If the safety factor for the trap is too low to allow the trap to handle the start-up load, the bypass can help. But if it is left open, it wastes steam. And if left fully or partly open, it either backs up condensate or wastes steam because a fixed orifice cannot handle variations in steam pressure and condensate load. Opening the bypass wide makes it impossible to maintain maximum pressure in the equipment, reducing production capacity.

Today many major steam plants do not use a bypass. On outside installations the trap can be bypassed by using the strainer blowoff. This acts as a signal, too, indicating the trap is out of service. If a trap cannot be spared while being serviced, it is advisable to use the double-trap bypass, Fig. 6. The additional trap often pays for itself in a few days, compared to standard bypassing.

Waste heat can be recovered from flash steam by a heat exchanger. The heat can be used to raise the temperature of boiler-feed water, hot-water heater feed, or any other preheat service. Recovering this heat improves plant efficiency.

Routine maintenance of traps can save money. Why not set up your program today?

OPERATION OF THE ARMSTRONG INVERTED BUCKET STEAM TRAP

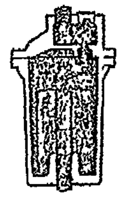


Fig. 2-1. "Bucket full of condensate"—trap discharging

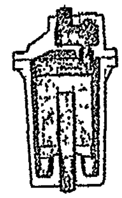


Fig. 2-2. "Bucket full of steam"—trap closed

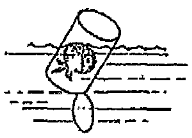


Fig. 2-3. A sort of inverted bucket

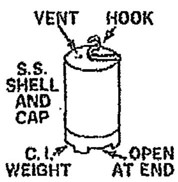


Fig. 2-4. The educated stainless steel tomato can

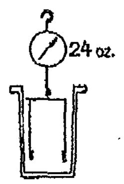


Fig. 2-5. 24 oz. bucket in air

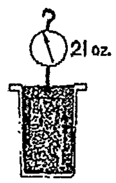


Fig. 2-6. Wt. reduced to 21 oz. when full and submerged

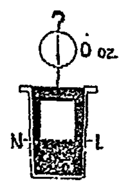


Fig. 2-7. Weightless bucket

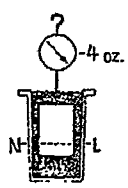


Fig. 2-8. Bucket is a float

In the Armstrong Steam Trap an inverted *submerged* bucket opens and closes the discharge valve. More is involved than the overly simplified statements, "When the bucket is full of condensate it sinks and opens the valve" and "when the bucket is filled with steam, it floats and closes the valve." These half-truths do not do justice to inverted bucket trap operation. Let's do a little homework to see what really goes on in an inverted bucket trap.

What small boy has not thrown an empty tomato can in the pond and observed that the can will float upside down because air is trapped in the can! And if he was a good shot with a BB gun a puncture near the end of the can let out the air and the can sank to the bottom.

The inverted bucket in an Armstrong Trap is an engineered stainless steel tomato can. When the trap is operating, the "can" is completely submerged in condensate. Under certain conditions the "can" is a float that will rise to close the trap valve. Other conditions make it a weight to sink and open the valve.

The Bucket Is a Weight, Is Neutral, is a Float

A No. 814 bucket, for example, weighs 24 ounces in air. When completely full of and submerged in cold water the bucket hook, shell and cast iron weight displace 3 oz. of water. So the bucket then weighs 21 oz. This is the maximum pull that the bucket can exert on the No. 814 trap lever.

Now if we introduce enough gas, air or steam into the inside of the bucket to displace 21 oz. of water, the buoyancy of the gas, 21 oz., will exactly balance the submerged weight of the bucket, 21 oz. The bucket has neither weight to pull down nor buoyancy to lift up. The liquid level inside the bucket is at the neutral line.

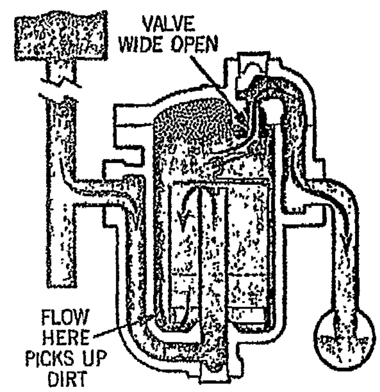
Displacing more liquid with gas causes the liquid level to drop below the neutral line. The buoyancy of the gas will exceed 21 oz., so the bucket will rise and lift the valve to its seat.

Thus our engineered stainless steel tomato can is a weight, is neutral, or is a float. Hooked on to the valve lever in an assembled trap the inverted submerged bucket will close the valve or open the valve depending on the water level inside of the bucket.

How the Bucket Controls the Trap Valve

In the 0-15 psi No. 814 trap the maximum opening or test pressure would be

Fig. 2-9.



1. Trap is installed in drain line between steam heated unit and condensate return header. Bucket is down and valve is wide open. The initial flood of condensate enters the trap and flows under bottom edge of bucket to fill trap body and completely submerge the bucket. Excess condensate discharges through wide open valve to return header.

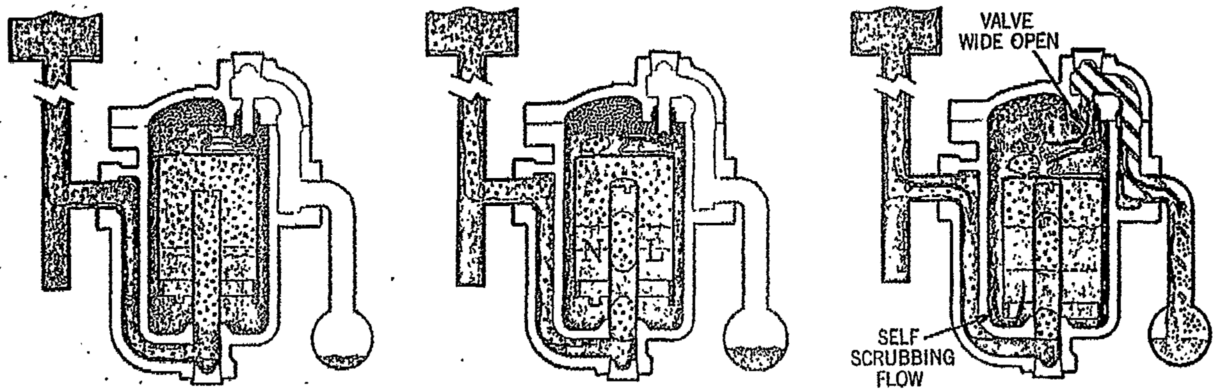
21 to 22 lbs., if the bucket were completely filled with water. There would be no margin of safety for higher steam pressures or for orifice enlargement due to normal wear. To insure long service life, the trap is offered for a maximum working pressure differential of only 15 pounds. Similar safety margins are provided in all sizes and pressures of Armstrong Traps.

Obviously at 15 pounds working pressure differential the full weight of the bucket is not required to open the valve. Instead of the 21 oz. weight to open at 21 psig only a 15 oz. weight is required for 15 psig. Fig. 3-1 shows the water levels in a No. 814 bucket required to open the valve at pressures from 15 psi down to only 1 psi.

Operating drawings 1 through 4 show the operating cycle at 15 psi or maximum pressure differential. With a condensate load proportionate to trap capacity the operation will be intermittent. But as the steam pressure is reduced to the 0–2 psi range (as with a temperature control

OPERATION AT PRESSURES CLOSE TO MAXIMUM

KEY: Steam, Condensate, Air, Flashing Condensate



2. When steam reaches trap it collects at top of bucket, imparting buoyancy. Bucket then rises and lifts valve towards its seat. Flow of condensate snaps valve tight shut. Air and carbon dioxide gas pass through bucket vent and collect at top of trap. Steam passing through vent is condensed by radiation from trap.

3. When entering condensate brings the condensate level slightly above the neutral line the bucket exerts a slight pull on the lever. But the valve does not open until the condensate level rises to the opening line for the existing pressure differential between the steam and the condensate return header. (See Fig. 3-1)

4. At this level weight of bucket, times leverage, exceeds the pressure holding valve to its seat. Bucket then sinks and opens trap valve. Any accumulated air is first discharged followed by condensate. Discharge continues until more steam floats bucket and the cycle is repeated.

NOTE: While the drawings above depict side inlet, side outlet traps, operation of bottom inlet, top outlet traps is identical.

valve) the trap operation changes character—it usually discharges continuously.

Continuous Discharge from Inverted Bucket Traps at Low Pressure

The terms "continuous discharge" and "Inverted Bucket Trap" will seem contradictory to many trap users. But an inverted bucket trap will discharge continuously at very low pressures or with very high back pressure.

Observation of a glass bodied/glass bucket trap shows that at very low pressure there is no change in bucket condensate level and no change in bucket position, which accounts for the observed continuous discharge.

Why? A No. 814 trap at .25 psi pressure has a continous discharge capacity of 1400 lbs. per hour. Using a 3 to 1 safety factor for .25 psi operation this size would be selected to handle 466 pounds or 7456 oz. of condensate per hour. This is slightly more than two ounces per second.

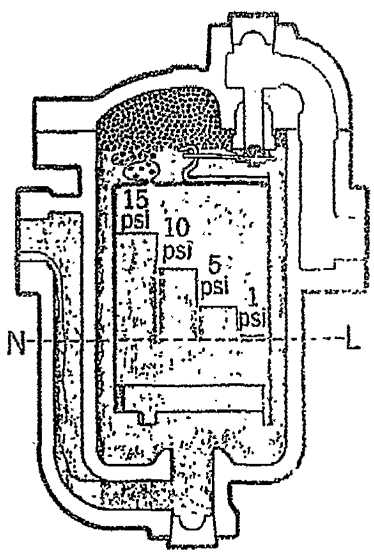


Fig. 3-1. Liquid levels in bucket for opening a ⅜" orifice No. 214 or No. 814 trap at working pressures indicated.

Only .25 oz. of water is required to open the valve at .25 psi. Thus 2 oz. per second of condensate divided by .25 oz. of water to open gives 8 discharges per second to handle the load. Now a 21 oz. submerged weight bucket is not going to rise and sink eight times a second. The inertia of the bucket submerged in condensate prevents this rapid operation. So the bucket merely positions the valve to give the observed continuous discharge.

High Back Pressure Operation

High discharge line pressure affects the force required to open the trap valve just the same as lowered steam pressure. As back pressure approaches that of inlet pressure, discharge becomes continuous, just as it does on very low pressure differentials.

Back pressure has no adverse effect on Armstrong Inverted Bucket Trap operation other than capacity reduction due to low differential. The trap will not fail to close and will not blow steam due to the high back pressure.

ARMSTRONG CAST IRON TRAPS FOR GENERAL SERVICE— DESIGN AND CONSTRUCTION

The Armstrong inverted submerged bucket steam trap is a mechanical trap that operates on the big difference in density between steam and water. Steam entering the inverted submerged bucket causes the bucket to float and close the discharge valve. Condensate entering the trap changes the bucket to a weight that sinks and opens the trap valve to discharge the condensate. But unlike other mechanical traps, air and carbon dioxide are vented continuously at steam temperature.

This simple principle of condensate removal was introduced by Armstrong in 1911. In today's Armstrong traps this proven principle has been the beneficiary of more than 50 years of improvement in materials and manufacturing technology. The result is a trap that we sincerely believe is unmatched for operating efficiency, dependability and long life.

"Frictionless" Free-floating Valve Mechanism

The heart of the Armstrong Steam Trap is its unique leverage system that multiplies the force provided by the bucket to open the valve against pressure. There are no fixed pivots to wear or create friction. It is designed to open the discharge orifice for maximum capacity. Wearing points are heavily reinforced for long life.

The use of a different leverage ratio for each orifice size makes it possible to open the maximum size orifice at any given pressure. The result is a trap that delivers big capacity in a small, economical package.

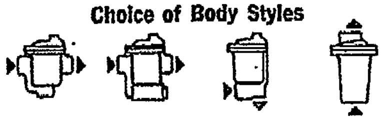
Long Life Parts

Except for valve seat construction in 1500 psi. and 2500 psi. traps, the mechanisms in Armstrong Traps for low and medium pressures are identical in design, workmanship and materials to those in traps for 1050°F, 2500 psig. Valve and seat are chrome steel hardened, ground and lapped. All other working parts are wear and corrosion-resistant stainless steel.

Simplicity

Only two moving parts, the valve lever assembly and the bucket. No fixed pivots, no complicated linkages, nothing to stick, bind or clog.

Choice of Body Styles



800 Series | 880 Series | No. 801 | 200 Series

Fig. 4-1.

Easy to Inspect and Maintain

Remove the cap and you lift out the entire mechanism. The body, full of hot water, need not be removed from the line. In the side inlet series and No. 801, the pipe connections do not have to be disturbed to service the trap.

Reliable Capacity Data

Capacity ratings of Armstrong traps have been secured by tests with traps discharging condensate as close as possible to steam temperature under actual operating conditions.

Guaranteed Quality

See the back cover for complete "Assurance of Satisfaction" which covers workmanship, materials, etc.

The "Frictionless" Free-Floating Valve Mechanism

The valve mechanism is the heart of the Armstrong Steam Trap. It makes possible high capacity in a small trap and long life with infrequent maintenance. A unique *two phase* leverage system is used in Nos. 213-813 and larger cast traps, and in the No. 312 and larger forged traps. Here's how it works:

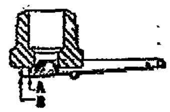


Fig. 4-2. Valve in closed position. The buoyancy of the bucket when steam is present, in combination with system pressure, holds the valve tightly against the orifice.

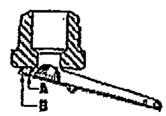


Fig. 4-3. As condensate enters the trap the bucket begins to sink and pulls down on the valve. High leverage fulcrum "A" bears against the face of the valve seat to give the power required to open the largest practical valve against pressure.

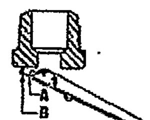


Fig. 4-4. After the valve is well open, lower leverage fulcrum "B" takes over, allowing the valve to travel further away from the orifice, to insure minimum restriction to condensate flow.

Internal Check Valves Save Fittings, Labor and Money

When either of the following conditions exists, check valves are needed between the trap and the unit drained:

1. Trap is installed above unit drained.
2. Sudden pressure drops may occur in the steam supply to the unit.

Armstrong spring loaded, stainless steel internal check valves screw directly into the trap inlet (Fig. 4-6) or into an extended inlet tube having a pipe coupling at the top (Fig. 4-7). This simplifies installation and saves time and money.

Fig. 4-5. Left—Armstrong stainless steel internal check valve.

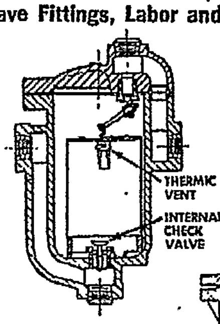


Fig. 4-6. Internal check valve installed in trap inlet.

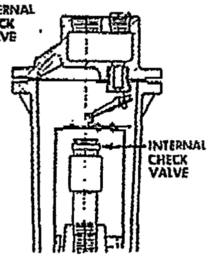


Fig. 4-7. Internal check valve installed in top of trap inlet tube.

OPTIONAL CONSTRUCTIONS

Traps With Thermic Vent Buckets Speed

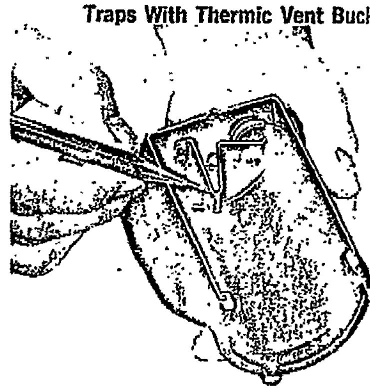


Fig. 4-8. Trap bucket equipped with bimetal controlled thermic vent.

Here's how Armstrong Inverted Bucket Steam Traps deliver everything you should get in trap

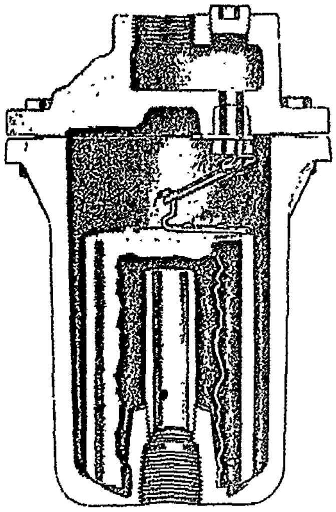


Fig. 5-1. 200 Series bottom inlet, top outlet Armstrong Trap.

1. No Steam Waste
Discharge valve is water sealed. Steam does not reach it.

2. Long Life and Dependable Service
Valve and seat are chrome steel, heat treated, ground and lapped. Free floating valve mechanism is "frictionless." Wear points are heavily reinforced.

3. Corrosion Resistance
All working parts are made of stainless steel.

4. Continuous Air Venting
Vent in top of bucket provides continuous automatic air venting. The steam passing through the vent is less than that required to offset radiation loss from the trap.

5. CO_2 Venting at Steam Temperature
Fixed vent passes CO_2 immediately—there is no cooling lag that would permit CO_2 to go into solution and form corrosive carbonic acid.

6. Operating Against Back Pressure
Since trap operation is governed solely by the difference in density of steam and water, back pressure in the return line has no effect on the ability of the trap to open for condensate and close against steam.

7. Freedom from Dirt Trouble
Condensate flow under the bottom edge of the bucket keeps sediment and sludge in suspension until discharged with condensate. There is no build-up of dirt. There are no close clearances to be affected by scale.

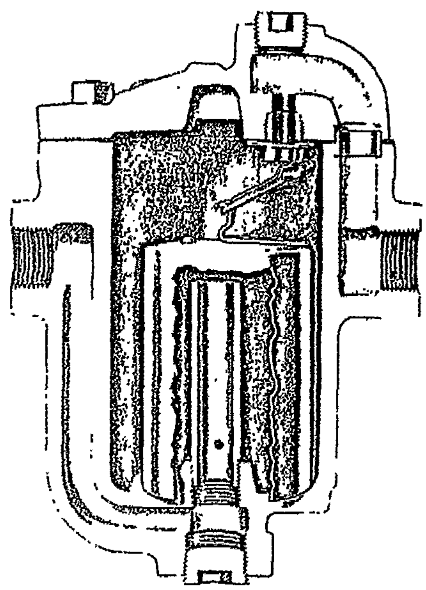


Fig. 5-2. 800 Series side inlet-side outlet Armstrong Trap. Equivalent sizes of 200 Series and 800 Series traps have identical mechanisms.

OR SPECIAL REQUIREMENTS

eating When Steam Is Turned On

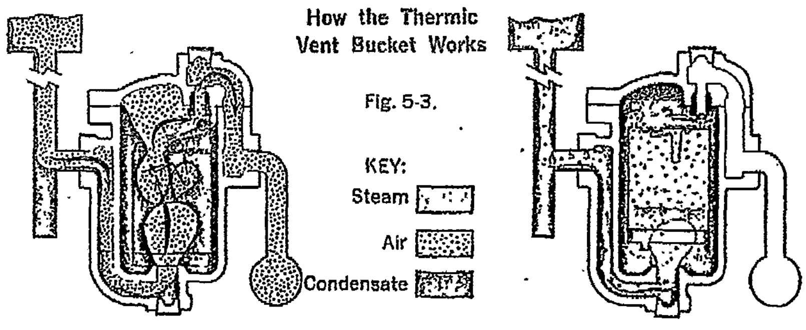
Wherever steam is turned on and off, air will accumulate in piping and steam equipment during the off period. A trap with a thermic bucket will discharge this air 50 to 100 times faster than a standard bucket, reducing heat-up time remarkably. Thermic vent buckets are available for all Armstrong traps for use at pressures up to 125 psig.

Where to Use: Single pipe coils; small on-and-off unit heaters; on-and-off multiple coils; drip points (particularly at ends of steam distribution mains); wherever air will pocket and be discharged ahead of incoming steam.

Operation of the thermic bucket trap is described at the right.

How the Thermic Vent Bucket Works

Fig. 5-3.



1. Trap cool. Air cannot collect at the top of the bucket because the large vent is wide open. The bucket stays down and holds the trap valve wide open allowing air to escape very rapidly until...

2. . . . steam reaches the bucket. The bimetal strip is heated by the steam. This closes the thermic vent. Steam will then collect in top of bucket to impart buoyancy and close the trap valve.

With thermic vent closed, the trap operates as a standard trap as shown in operating drawings on pages 2 & 3.

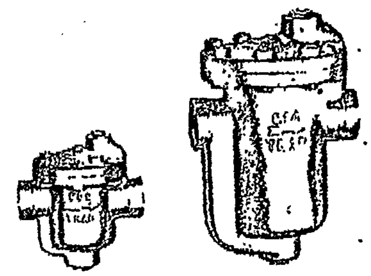
ARMSTRONG CAST IRON INVERTED BUCKET TRAPS FOR GENERAL SERVICE

for pressures to 250 psig . . . capacities to 20,000 lbs/hr

Table A-6. CAPACITIES, ARMSTRONG CAST IRON TRAPS

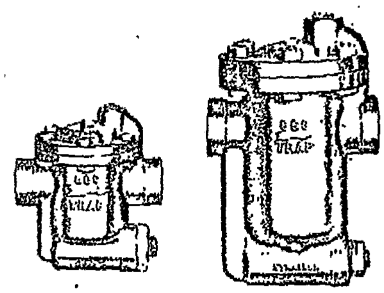
Capacities given are continuous discharge capacities in pounds of condensate per hour at pressure differential indicated. *Data based on repeated tests under operating conditions with condensate as close as possible to steam temperature.*

Trap No.	800 880 801	811 881 211	812 882 212	813 883 213	814 214	215	216
Pressure, psi 5	450	830	1600	2900	4800	7800	14600
10	560	950	1900	3500	5800	9000	17300
15	640	1060	2100	3900	6500	10000	19200
20	690	880	1800	3500	6000	8500	18500
25	460	950	1900	3800	6500	9200	20000
30	500	1000	2050	4000	6800	9800	18000
40	550	770	1700	3800	5800	8300	20000
50	580	840	1900	4100	6300	9000	18200
60	635	900	2000	4400	6800	9500	19800
70	660	850	2200	3800	6000	9200	18300
80	690	800	1650	4000	6400	9700	19000
100	640	860	1800	3600	6200	10400	18000
125	680	950	2000	3900	6700	10900	20000
150	570	810	1500	3500	5700	9500	18500
200	—	860	1600	3200	5300	9200	17500
250	—	760	1300	3500	5700	7000	19000



No. 800 No. 814

Fig. 6-3. Side inlet, side outlet traps. Cap and mechanism can be removed without disturbing pipe connections.



No. 880 No. 883

Fig. 6-4. Side inlet, side outlet traps with integral strainers. This type costs less than standard trap plus standard strainer. Saves fittings.

Table B-6. LIST OF MATERIALS, ARMSTRONG CAST IRON TRAPS

Name of Part	Material
Cap and Body	30,000 lbs. Min. Tensile Cast Iron
Inlet Tube*	Alloy Steel Pipe
Gasket	Compressed Asbestos
Bolt and Nut Set	No. 800, 801, 880, 811, 881, traps. 90,000 lb. tensile strength cap screws. All other cast body traps 80,000 lb. min. tensile machine bolts.
Valve Seat	Heat Treated Chrome Steel
Valve	Heat Treated Chrome Steel
Valve Retainer	Stainless Steel
Lever	Stainless Steel
Guide Pin Assembly	Stainless Steel
Bucket	Stainless Steel. Nos. 213, 813, 883 and larger buckets have cast iron weights.
Body Thimble	Stainless Steel
Internal Strainer	Stainless Steel
Bushing	Steel
Strainer Bushing Gasket	Stainless Asbestos

*Not standard in Nos. 800, 880 and 801 traps

Optional Accessories

Internal Check Valves are spring loaded stainless steel and screw directly into the trap inlet or into an extended inlet tube having a pipe coupling at the top to save fittings, labor and money.

Thermic Vent Buckets have a bi-metal controlled auxiliary air vent for discharging large amounts of air on start-up. Suitable for pressures up to 125 psig.

No. 801 Trap with Right Angle Connections

The No. 801 Trap has a side inlet and bottom outlet for use wherever right angle connections will save fittings and installation labor. It is identical to the No. 800 in connections, mechanism and capacity. Like the No. 800 it is available with internal check valve or thermic vent bucket but not with both.

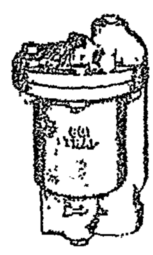


Fig. 6-1. No. 801 trap with right angle connections.

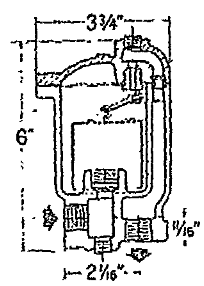
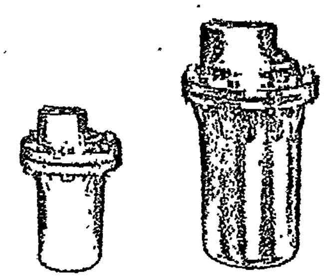


Fig. 6-2. Dimensions, No. 801 trap.

Table D-6. SERVICE PRESSURE RATINGS—ARMSTRONG CAST IRON TRAPS

Trap	450°F
800, 880, 801	150 psi
811-814 881-883	250 psi
211-216	250 psi



No. 211 No. 216

Fig. 6-5. Bottom inlet, top outlet traps. Cap and mechanism can be removed without taking body from the line.

All dimensions are approximate.

Table A-7, SIDE INLET, SIDE OUTLET CAST IRON TRAPS

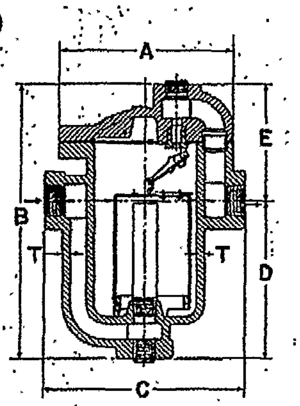


Fig. 7-1. Dimensions, No. 800-814 traps.

Add suffix "CV" to Trap No. for internal check valve, "T" for thermic vent bucket.

Trap No.	800*	811	812	813	814
Pipe Connections Available	½" or ¾"	½" or ¾"	½" or ¾"	¾" or 1"	1" or 1¼"
"A" (Flange Diameter)	3¾"	3¾"	5⅝"	7"	8"
"B" (Height)	5 7/16"	6⅞"	9 1/16"	11¾"	13⅜"
"C" (Face-to-Face)	5"	5"	6½"	7¼"	9"
"D" (Bottom to C/L Inlet)	2¾"	4½"	5⅜"	7 1/32"	7 13/16"
"T" (Body Wall Thickness)	5/32"	5/32"	¼"	9/32"	⅜"
Number of Bolts	6	6	6	6	8
Diameter of Bolts	¼"	¼"	⅜"	½"	½"
Weight	5 lbs.	6 lbs.	15 lbs.	27 lbs.	45 lbs.
Maximum Design Pressure, psi	**250	250	250	250	250

**Can NOT be furnished with both thermic vent bucket and check valve.*
***Maximum operating pressure: 150 psi*

Table B-7, SIDE INLET, SIDE OUTLET CAST IRON TRAPS WITH INTEGRAL STRAINERS

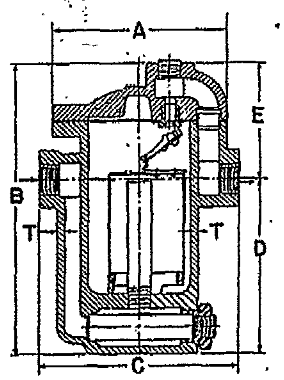


Fig. 7-2. Dimensions, No. 880-883 traps.

Add suffix "CV" to Trap No. for internal check valve, "T" for thermic vent bucket.

Trap No.	880*	881	882	883
Pipe Connections Available	½" or ¾"	½" or ¾"	½" or ¾"	¾", 1" or 1¼"
Strainer Blow-Down Connections	⅜"	⅜"	⅜"	½"
"A" (Flange Diameter)	3¾"	3¾"	5⅝"	7"
"B" (Height)	5 13/16"	7 1/16"	9⅜"	12⅝"
"C" (Face-to-Face)	5"	5"	6½"	7⅞"
"D" (Bottom to C/L Inlet)	3 3/16"	4 7/16"	5¾"	7⅝"
"T" (Body Wall Thickness)	5/32"	5/32"	¼"	9/32"
Number of Bolts	6	6	6	6
Diameter of Bolts	¼"	¼"	⅜"	½"
Weight	5½ lbs.	6 lbs.	16 lbs.	30 lbs.
Maximum Design Pressure, psi	**250	250	250	250

**Can NOT be furnished with both thermic vent bucket and check valve.*
***Maximum operating pressure: 150 psi*

Table C-7, BOTTOM INLET, TOP OUTLET CAST IRON TRAPS

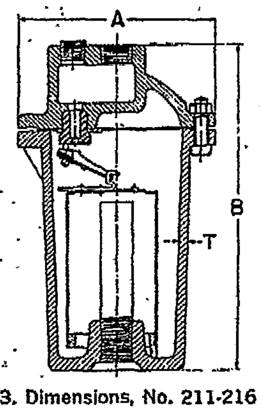


Fig. 7-3. Dimensions, No. 211-216 traps.

Add suffix "CV" to Trap No. for internal check valve, "T" for thermic vent bucket.

Trap No.	211	212	213	214	215	216
Pipe Connections Avail.	½"	½", ¾"	½", ¾", 1"	1", 1¼"	1", 1¼", 1½"	1½", 2"
"A" Flange Diameter	4¼"	5¼"	6⅜"	7½"	8½"	10 9/16"
"B" Height	6⅜"	8"	10¾"	12½"	14 5/16"	17"
"T" Body Wall Thickness	3/16"	¼"	9/32"	⅜"	⅜"	7/16"
Number of Bolts	6	8	6	8	8	12
Diameter of Bolts	5/16"	5/16"	⅜"	⅜"	½"	½"
Weight	6 lbs.	12 lbs.	21 lbs.	35 lbs.	47 lbs.	78 lbs.
Maximum Pressure, psi	250	250	250	250	250	250

Use certified print for exact dimensions.

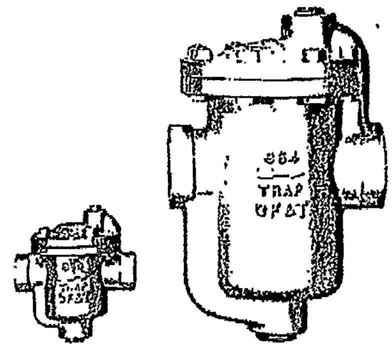
ARMSTRONG CAST IRON TRAPS FOR LOW PRESSURE SERVICE—PHYSICAL DATA

For pressures to 30 psig... capacities to 6,800 lbs/hr

Armstrong traps for low pressure service have been developed especially for draining unit heaters, preheat and reheat coils, converters, hot water generators, etc., where steam supply is intermittent. The design of these traps gives high air venting capacity on start-up and good condensate drainage characteristics.

Successful drainage of steam heated units under modulated steam supply requires careful attention to system design. See the following:

Preheat and reheat coils. . pages 30 & 31
Unit heaters. . . . . pages 32 & 33
Water heaters. . . . . page 40



No. 860T No. 864T

Fig. 8-2. Open float and thermostatic steam traps with side inlet and side outlet connections. Cap and mechanism can be removed without disturbing pipe connections.

Table A-8. CAPACITIES, ARMSTRONG TRAPS FOR LOW PRESSURE SERVICE

Capacities given are continuous discharge capacities in pounds of condensate per hour at pressure differential indicated.

Data based on repeated tests under operating conditions with condensate as close as possible to steam temperature.

Trap No.	860T		861T		862T		863T		864T	
Orifice Size	3/16"	1/8"	1/4"	3/16"	5/16"	1/4"	1/2"	3/8"	5/8"	1/2"
Pressure, psi (Static head in in. in parentheses) ¼ (7)	139	65	191	139	350	191	950	535	1400	950
½ (14)	200	100	300	220	580	380	1410	850	2160	1500
¾ (21)	240	125	395	280	740	500	1618	1040	2600	1900
1	270	145	450	320	850	600	1880	1200	2900	2150
2	340	195	590	425	1140	820	2300	1600	3700	2800
3	390	230	680	490	1320	960	2600	1850	4150	3250
4	425	250	750	540	1480	1070	2780	2060	4500	3600
5	450	275	830	580	1600	1170	2900	2233	4800	3900
10	560	350	950	700	1900	1470	3500	2800	5800	4800
15	640	400	1060	780	2100	1690	3900	3200	6500	5400
20	690	440		880		1800		3500		6000
25		460		940		1900		3800		6500
30		500		1000		2050		4000		6800

Armstrong 860T Series Traps

The Armstrong Open Float and Thermostatic Trap is an inverted bucket trap with three special features:

1. A thermostatic air vent for removal of large volumes of air encountered on start up.
2. Discharge orifices sized to remove large volumes of condensate at low pressures.
3. Pipe connections sized to meet piping requirements of low pressure service.

So designed, the Armstrong O.F.&T. trap provides the advantages of the inverted bucket trap in a "package" that is compatible with low pressure service requirements. Most important among these advantages are:

CONTINUOUS VENTING of air and carbon dioxide at steam temperature without a cooling lag.

SELF SCRUBBING ACTION handles dirt by keeping it in suspension in the turbulent flow of condensate under the bottom of the bucket.

CORROSION RESISTANCE is assured by all-stainless steel working parts (except for bi-metal strip of thermostatic vent).

DEPENDABILITY is assured by the ability of the trap to keep itself clean and the use of stainless steel parts. Additionally, O.F.&T. traps "fail open," a remote possibility but an important safety feature.

Table B-8. LIST OF MATERIALS

Name of Part	Material
Cap and Body	30,000 lbs. Min. Tensile Cast Iron
Inlet Tube*	Alloy Steel Pipe
Gasket	Compressed Asbestos
Bolt and Nut Set	No. 860T and 861T traps, 90,000 lb. tensile strength cap screws. All other cast body traps 80,000 lb. min. tensile machine bolts.
Valve Seat	Heat Treated Chrome Steel
Valve	Heat Treated Chrome Steel
Valve Retainer	Stainless Steel
Lever	Stainless Steel
Guide Pin Assembly	Stainless Steel
Bucket	Stainless Steel, No. 863T and larger buckets have cast iron weights.
Thermic Vent Bucket bi-metal	Corrosion resistant "Dura-flex"
Body Thimble	Stainless Steel

* *Integral raised inlet cast into body of No. 860T trap.*

Optional Internal Check Valve

Internal Check Valves are spring loaded stainless steel and screw directly into the trap inlet or into an extended inlet tube having a pipe coupling at the top to save fittings, labor and money. Available for all sizes except No. 860T.

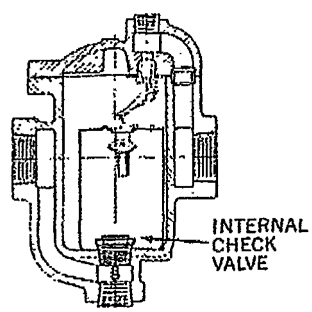


Fig. 8-1. No. 860 Series O.F.&T. trap with internal check valve.

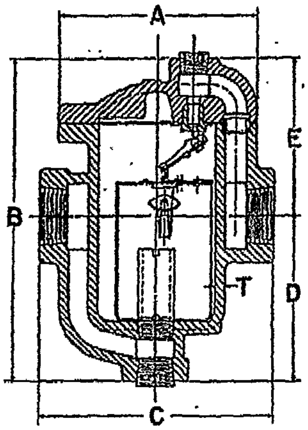


Fig. 9-1. Dimensions, No. 860T-864T.

Table A-9. CAST IRON OPEN FLOAT AND THERMOSTATIC TRAPS

Add suffix "CV" to Trap No. for internal check valve.

Trap No.	860T	861T	862T	863T	864T
Pipe Connections	3/4"	1"	1 1/4"	1 1/2"	2"
"A" Flange Diameter	3 3/4"	3 3/4"	5 5/8"	7"	8"
"B" Height	5 7/16"	6 13/16"	9 3/8"	11 3/4"	13 5/8"
"C" Face-to-Face	5"	5 1/4"	6 5/8"	8"	9 1/8"
"D" Bottom to C/L Inlet	2 13/16"	4"	4 11/16"	6 1/4"	7 1/16"
"T" Body Wall Thickness	5/32"	5/32"	1/4"	9/32"	3/8"
No. Bolts	6	6	6	6	8
Diameter Bolts	1/4"	1/4"	3/8"	1/2"	1/2"
Weight, lbs.	5	6	15	28	47
Maximum Design Pressure, psi	250	250	250	250	250
Maximum Operating Pressure, psi	30	30	30	30	30

All dimensions are approximate.
Use certified print for exact dimensions.

OPERATION OF ARMSTRONG 860T SERIES O. F. & T. TRAPS

Key: Condensate Steam Air

Operation Of The Thermic Vent — **Operation At Very Low Pressure** — **Operation with Static Head Only**

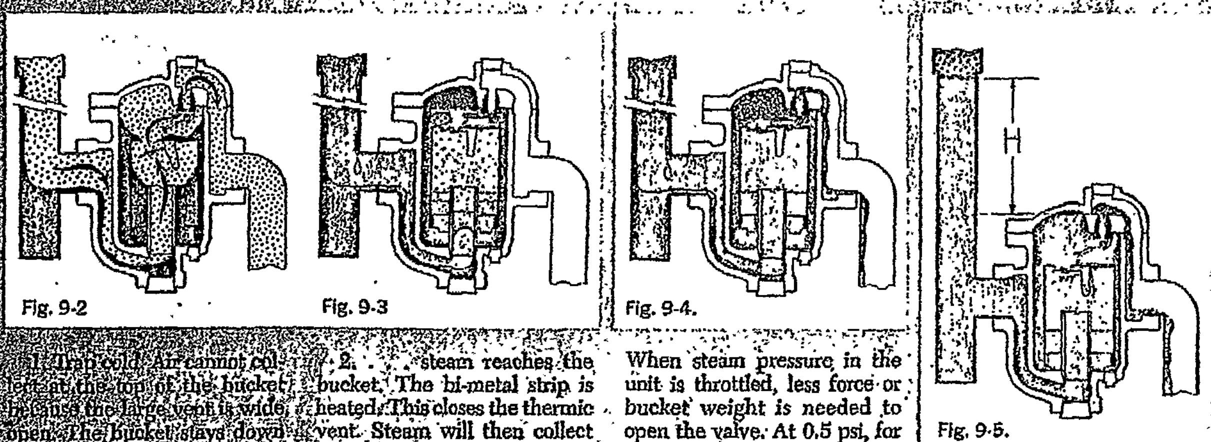


Fig. 9-2 Fig. 9-3 Fig. 9-4. Fig. 9-5.

1. Trap cold. Air cannot collect at the top of the bucket because the large vent is wide open. The bucket stays down and holds the trap valve wide open allowing air to escape very rapidly until . . .

2. . . . steam reaches the bucket. The bi-metal strip is heated. This closes the thermic vent. Steam will then collect in top of bucket to impart buoyancy and close the trap valve.

With thermic vent closed, and operating pressure close to maximum, the trap operates as a standard trap as shown in operating drawings on pages 2 and 3.

When steam pressure in the unit is throttled, less force or bucket weight is needed to open the valve. At 0.5 psi, for example, a half ounce of water will open the valve of the large No. 864T trap. With the condensate load for which this size is used, intermittent operation would require more than six discharges per second. Obviously, this is impossible. So, the bucket positions the valve to give continuous discharge.

At atmospheric pressure, condensate collecting in the drip leg prevents steam from reaching the trap. The trap body and bucket fill with water and the discharge valve opens wide. Condensate is discharged continuously with the trap functioning as a liquid seal.

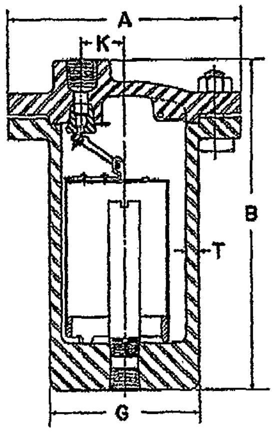


Fig. 11-1. No. 312-416 screwed connections.

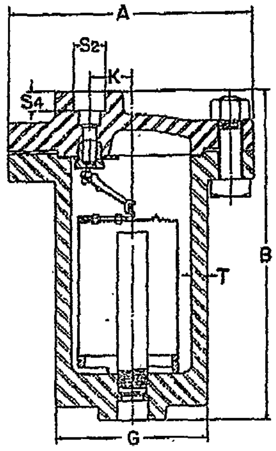


Fig. 11-2. No. 312-416 socket weld connections.

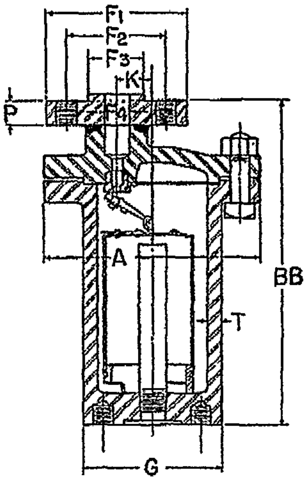


Fig. 11-3. No. 312F-416F flanged connections.

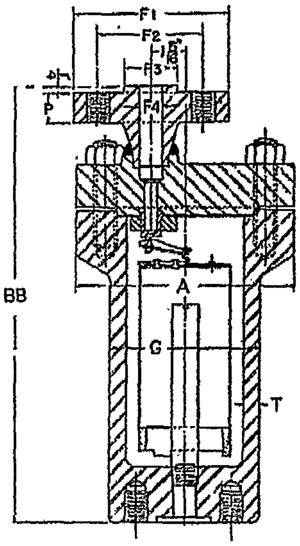


Fig. 11-4. No. 5133F, No. 5155F and No. 6155F with welded outlet flange and integral inlet flange. No. 5133F is shown, others similar.

Table A-11. SOCKET WELD DIMENSIONS

Pipe Size	S2	S-4 Min.
½"	.855	⅜"
¾"	1.065	½"
1"	1.330	½"
1¼"	1.675	½"
1½"	1.915	½"
2"	2.406	⅝"
2½"	2.906	⅝"
3"	3.535	⅝"

Table B-11. FLANGE DIMENSIONS

	Pipe Size	F-1	F-2	F-3	P		Pipe Size	F-1	F-2	F-3	P
600 lb. Std.	½"	3¾"	2⅝"	1⅜"	9/16"	1500 lb. Std.	½"	4¾"	3¼"	1⅜"	⅞"
	¾"	4⅝"	3¼"	1 11/16"	⅝"		¾"	5⅛"	3½"	1 11/16"	1"
	1"	4⅞"	3½"	2"	11/16"		1"	5⅞"	4"	2"	1⅛"
	1¼"	5¼"	3⅞"	2½"	13/16"		1¼"	6¼"	4⅜"	2½"	1⅛"
	1½"	6⅛"	4½"	2⅞"	⅞"		1½"	7"	4⅞"	2⅞"	1¼"
	2"	6½"	5"	3⅝"	1"		2"	8½"	6½"	3⅝"	1½"
900 lb. Std.	½"	4¾"	3¼"	1⅜"	⅞"	2500 lb. Std.	½"	5¼"	3½"	1⅜"	1 3/16"
	¾"	5⅛"	3½"	1 11/16"	1"		¾"	5½"	3¾"	1 11/16"	1¼"
	1"	5⅞"	4"	2"	1⅛"		1"	6¼"	4¼"	2"	1⅜"
	1¼"	6¼"	4⅜"	2½"	1⅛"		1¼"	7¼"	5⅛"	2½"	1½"
	1½"	7"	4⅞"	2⅞"	1¼"		1½"	8"	5¾"	2⅞"	1¾"
	2"	8½"	6½"	3⅝"	1½"		2"	9¼"	6¾"	3⅝"	2"

F-4 same as I.D. of pipe size used.

Table C-11. PHYSICAL DATA, FORGED STEEL TRAPS

Add suffix "CV" to Trap No. for internal check valve.

Trap No. SCREWED or SW	310	312	313	314	315	316	413	415	†416	5133	5155	6155
Trap No. FLANGED	310F	312F	313F	314F	315F	316F	413F	415F	†416F	5133F	5155F	6155F
Pipe Connections Avail.	½",¾"	½",¾"	½",¾",1"	1",1¼"	1",1¼",1½"	1½",2"	½",¾",1"	1",1¼",1½"	1½",2"	½",¾",1"	¾",1",1¼"	1",1¼"
"A" Flange Diameter	4½"	6¾"	8"	8⅝"	9¼"	11⅞"	8⅝"	10¾"	12½"	8½"	10⅜"	11¼"
"B" Height, Screwed or S.W.	7 15/16"	10 7/16"	11⅜"	13⅝"	15"	17⅛"	11⅞"	15"	17⅝"	14⅜"	16½"	24⅛"
"BB" Height, Flanged	11"	10 1/16"	11½"	14 5/16"	15"	17¾"	13"	16¼"	19⅛"	16¼"	20"	28¼"
"G" Body O.D.	3 1/16"	4⅝"	5⅛"	5¾"	6⅝"	8⅜"	5⅛"	6⅞"	8⅝"	5¼"	7"	7 9/16"
"K" C/outlet to C/inlet	9/16"	1¼"	1 7/16"	1½"	1¾"	2⅛"	1 7/16"	1¾"	2⅛"	1 5/16"	1¼"	1¾"
"T" Body Wall Thickness	¼"	5/16"	7/16"	½"	9/16"	11/16"	9/16"	11/16"	13/16"	⅝"	¾"	1"
Number of Bolts	6	6	8	8	9	10	8	9	12	8	10	10
Diameter of Bolts	⅜"	½"	⅝"	¾"	¾"	⅞"	¾"	1"	1"	⅞" Studs	1" Studs	1¼" Studs
Diameter of Bolt Circle	3¾"	5⅝"	6⅝"	7¼"	8"	10"	7⅛"	8¾"	10½"	6⅝"	8¼"	9⅜"
Weight, Scr. or S.W.	10 lbs.	30 lbs.	47 lbs.	75 lbs.	90 lbs.	160 lbs.	65 lbs.	122 lbs.	195 lbs.	98 lbs.	191 lbs.	295 lbs.
Weight, Flanged	12 lbs.	31 lbs.	49 lbs.	78 lbs.	95 lbs.	163 lbs.	73 lbs.	136 lbs.	200 lbs.	105 lbs.	208 lbs.	306 lbs.

†Fabricated trap.

All dimensions are approximate. Use certified print for exact dimensions.

ARMSTRONG DUCTILE IRON TRAPS

for pressures to 400 psig... capacities to 1060 lbs/hr

Armstrong stocks one size of ductile iron trap in two body styles—side inlet, side outlet or right angle with side inlet and bottom outlet. Capacity is identical to the Nos. 811, 211 and 881 for pressures of 250 psi or less. At pressures from 250 to 400 psi capacity is the same as the forged steel trap No. 310 as given on page 10.

Ductile iron traps may be substituted for the bottom inlet, top outlet No. 310 when straight through or angle piping is more economical. They are also used at pressures below 250 psi for those services where their exceptional shock resistance is needed for optimum safety.

The mechanism is identical to that used in the No. 310 forged steel trap. Recommended maximum working pressure on saturated steam or cold water is 400 psi. Maximum design pressure-temperature limitation is 400 psi at 650°F.

Table A-12. PHYSICAL DATA — DUCTILE IRON TRAPS

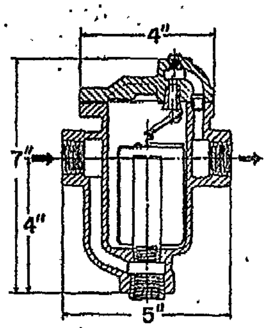


Fig. 12-1. Dimensions, No. 711 with horizontal straight through connections.

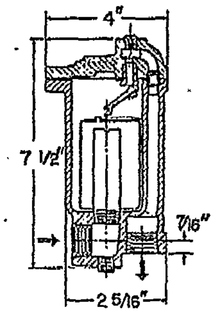


Fig. 12-2. Dimensions, No. 701 with right angle connections.

Trap No.		701	711
Pipe Connections Available		½", ¾"	½", ¾"
Bolting: 6—5/16"		Carbon Steel 120,000 T.S.	Carbon Steel 120,000 T.S.
Weight		7 lbs.	7 lbs.
Capacity	Pressure, psi 80	800	
	125	950	
	200	860	
	250	760	
	300	510	
	400	590	

All dimensions are approximate. Use certified print for exact dimensions.

ARMSTRONG CAST STEEL TRAP WITH INTEGRAL STRAINER

for pressures to 600 psi saturated steam . . . capacities to 4400 lbs/hr

For services up to 600 psi where horizontal in-line pipe connections are preferred, Armstrong offers the No. 983 cast steel trap with integral strainer. A choice of screwed or socket weld connections or welded-in flanges is offered. Capacity is the same as the No. 883 cast iron traps at pressures below 250 psi, the same as the No. 313 forged steel trap at pressures from 250 to 600 psi.

The No. 983 trap body and cap are ASTM A-216 WCB cast steel. The mechanism is identical to that in the No. 313 forged steel trap. Recommended maximum working pressure on saturated steam is 650 psi. Maximum working pressure on cold water is 1000 psi. While the design pressure-temperature limitation is 600 psi at 750°F, the No. 983 trap is not recommended for superheated steam service.

Table B-12. PHYSICAL DATA — NO. 983 CAST STEEL TRAP

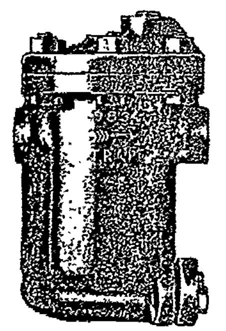


Fig. 12-3. No. 983 trap with screwed connections.

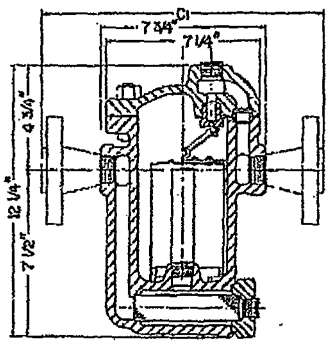


Fig. 12-4. Dimensions, No. 983 trap. Dotted lines show flanges welded to body.

Trap No.	983
Pipe Connections Available	½", ¾", 1"
"C" Face-to-face (flanged) ½" pipe size	11⅜"
¾" pipe size	11¾"
1" pipe size	12⅛"
Shipping Wt. (Screwed Conn.)	45 lbs.

Also available with American Standard raised face or flat face flanges or with tongue and groove, ring joint or concentric groove raised face flanges.

All dimensions are approximate. Use certified print for exact dimensions.

WA-TEX 001409

TRAPS FOR DRAINING WATER FROM COMPRESSED AIR

for pressures to 1000 psig

Armstrong compressed air traps are used to remove water from compressed air and other gases. They will not separate the moisture particles from compressed air but do provide dependable, automatic drainage of liquid from intercoolers, aftercoolers, receivers, separators and drips.

Heavy Oil and Water Service

Use Armstrong No. 213 BVSW Inverted Bucket Air Traps because the valve is at the top. Oil is discharged first and the inverted bucket floats and sinks freely when the body is full of water instead of cold heavy oil. The No. 213 size is the smallest trap that will give dependable service on a heavy cold oil-water mixture.

Operation. The No. 213 BVSW operation is quite similar to that of an inverted bucket steam trap (See page 3). However, the air that passes through the bucket vent cannot condense. Instead it is discharged intermittently ahead of oil and water. The volume of air vented is about 10 scfh.

Water Only Service

Use Armstrong Ball Float Compressed Air Traps.

No. 1-LD Liquid Drainer. This modestly priced free-floating lever air trap assures positive drainage of moderate volumes of water at pressures up to 250 psig.

Nos. 2-LD, 3-LD, and 6-LD Liquid Drainers answer large capacity requirements for positive automatic drainage at pressures to 250 psi. Available in forged steel as Nos. 32-LD, 33-LD, and 36-LD for pressures to 1000 psi.

No. 21 Ball Float Trap. The ball float and other working parts are made of stainless steel for long life. No. 21 traps are used to drain small separators, low points in air lines and drip pockets ahead of risers. Maximum operating pressure is 250 psi.

High Pressure Service. The No. 21-312, a forged steel version of the No. 21, but with a larger float, is good for pressures to 750 psi.

Operation. The discharge from the No. 21 is continuous. The opening of the valve is just wide enough to remove the water as fast as it comes to the trap. Thus, at times, the valve is barely cracked from its seat.

Grit Hazard. It is possible for grit or fine scale to lodge between the valve and seat of the No. 21 and thereby prevent closing when the load decreases. To answer this not uncommon problem, Armstrong offers the Snap Action No. 71 Trap.

No. 71 Snap Action Trap. In this design energy is stored in a flat stainless steel spring that replaces the conventional float lever. When the trap is nearly full of water, the spring snaps past dead center, opening wide the valve. During discharge the process is reversed. Do not use the No. 71 when the load exceeds 120 lbs/hr.

High Pressure Service. The No. 71-315 is a forged steel trap with the No. 71 snap action mechanism that operates at pressures as high as 1000 psig.

DETAILED INFORMATION ON LIQUID DRAINERS IS GIVEN IN BULLETIN NO. 401, AVAILABLE ON REQUEST

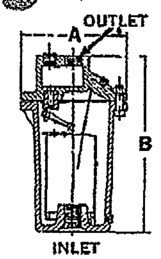


Fig. 14-1. No. 213 BVSW, cast iron.

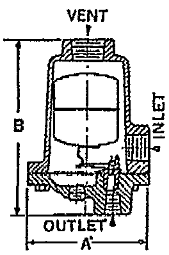


Fig. 14-2. No. 1-LD, cast iron.

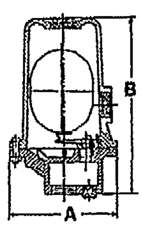


Fig. 14-3. Nos. 2-LD, 3-LD, & 6-LD cast iron.

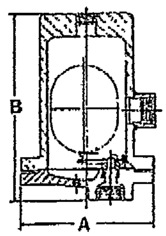


Fig. 14-4. Nos. 32-LD. 33-LD, & 36-LD forged steel.

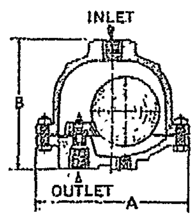


Fig. 14-5. No. 21. cast iron.

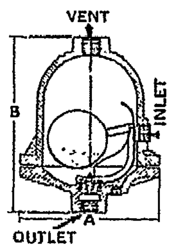


Fig. 14-6. No. 71. cast iron.

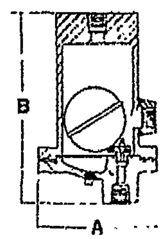


Fig. 14-7. No. 21-312. forged steel.

Table A-14. PHYSICAL DATA ARMSTRONG COMPRESSED AIR TRAPS

In ordering, specify trap number and maximum operating pressure and state "for water discharge."

		Inverted Bucket	Guided Free Floating Lever Drainers								Fixed Lever Drainers			
			Cast Iron (ASTM A-278 Class 30)				Forged 1030 Carbon Steel				Cast Iron		Forged Steel	
Model Number		213 BVSW	1-LD	2-LD	3-LD	6-LD	32-LD	33-LD	36-LD		21	71	21-312	71-315
Pipe Connections, in.		½, ¾, 1	½†	½, ¾	¾, 1	1½, 2	½, ¾	¾, 1	1½, 2		½, ¾	¾, 1	½, ¾	¾, 1, 1¼
"A" Diameter, in.		6⅜	3¼	5¼	6⅜	10$\frac{3}{16}$	6¼	8	11⅞		6¼	8¼	6¾	9¾
"B" Height, in.		10¾	5½	8	10⅝	17	10$\frac{3}{16}$	11$\frac{9}{16}$	17⅛		5¼	10⅜	10$\frac{3}{16}$	15⅝
Weight, lbs.		21	4	13	22	80	31	49	163		8	29	30	92
Max. Pressure, psi @ 100°F		250	250	250	250	250	500	900	1000		250	250	750	1000
tinuous charge p. in lbs. of Cold water per Hour	Press., psi 15	9100	375	3700	9500	45,000	3700	9500	45,000		1900	($\frac{3}{16}$")*	2500	($\frac{3}{16}$")*
	100	6000	950	2500	6000	24,000	3150	6000	24,000		800	(⅛")*	1630	(⅛")*
	250	5000	900	1800	(225) 5000	22,000	2450	3850	18,000		550	($\frac{5}{64}$")*	1150	($\frac{5}{64}$")*
	500	—	—	—	—	—	2600	3400	17,000		—	—	980	($\frac{1}{16}$")*
	1000	—	—	—	—	—	—	(900) 3500	14,500		—	—	—	($\frac{1}{16}$")*

*For optimum spring life snap action traps should not be used where load exceeds 120 pounds per hour.

†¾" outlet connection. All dimensions are approximate. Use certified print for exact dimensions.

WA-TEX 001410

[redacted]

VENTS FOR DISCHARGING AIR FROM LIQUIDS

for pressures to 1000 psig

Armstrong float type air vents are designed to vent air from hydronic heating systems, water service lines, water storage tanks, centrifugal pumps, gasoline lines, solvent filters, etc. Operation is completely automatic. Simple design and quality mechanisms make operation trouble-free and maintenance infrequent.

A variety of sizes and designs are available to meet service requirements:

No. 1-AV Automatic Air Vent is a compact vent designed and built for positive action and the overall reliability essential to automatic venting. Its float and free-floating lever are stainless steel. Valve and seat are heat treated chrome steel. It may be ordered with a ⅛" drilled and tapped test petcock connection in the cap, with or without petcock.

Nos. 2-AV, 3-AV, and 6-AV Automatic Air Vents are cast iron, free-floating lever vents for larger capacity requirements at pressures to 250 psi. Float and mechanism are stainless steel, valve and seat are heat treated chrome steel. Available in forged steel as Nos. 32-AV, 33-AV, and 36-AV for pressures to 1000 psi. All sizes utilize a guided free floating lever that provides reverse leverage on closing that multiplies the closing force to assure tight shut off of the valve.

No. 21-AR Automatic Air Vent is the deluxe vent that is widely used in critical services. The valve seat is fitted with a resilient Viton-B insert that assures leak-proof operation even if a particle of dirt or grit should become lodged in the valve. The float and direct acting single lever are stainless steel. Available with forged steel body as No. 21-312-AR.

More Detailed Information:

Bulletin No. 451, Venting any gas from any liquid.

Bulletin No. 454, No. 1-AV Vent

Hook-Ups of Air Vents

KEY: Water Air

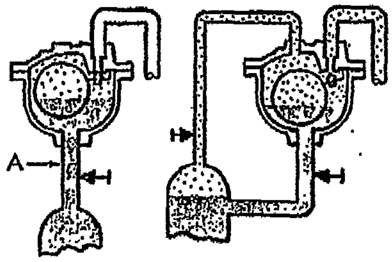


Fig. 15-1. After float closes valve, capacity of vent is limited to amount of air that can rise through water in connecting pipe A.

Fig. 15-2. With the 2-pipe hook-up shown, valve can open wide and air can enter through vent line to give capacities shown in Table A-15.

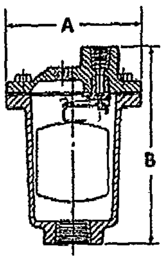


Fig. 15-3. No. 1-AV cast iron vent.

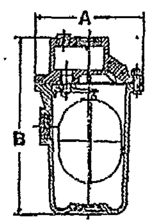


Fig. 15-4. Nos. 2-AV, 3-AV, & 6-AV cast iron vents.

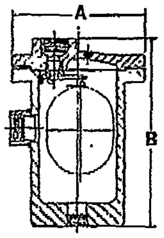


Fig. 15-5. Nos. 32-AV, 33-AV, & 36-AV forged steel vents.

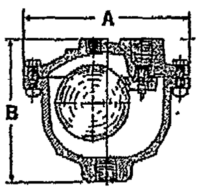


Fig. 15-6. No. 21-AR cast iron vent.

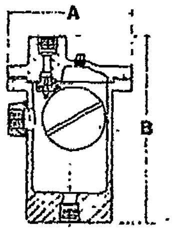


Fig. 15-7. No. 21-312 AR forged steel vent.

Table A-15. PHYSICAL DATA ARMSTRONG AIR VENTS

In ordering, specify vent number, maximum operating pressure, sp. gr. of liquid and state "for air venting."

		Guided Free Floating Lever Vents							Fixed Lever Vents	
		Cast Iron (ASTM A-278 Class 30)				Forged 1030 Carbon Steel			Cast Iron	Forged Steel
Model Number		1-AV	2-AV	3-AV	6-AV	32-AV	33-AV	36-AV	21 AR	21-312 AR
Pipe Connections, in.		½, ¾*	½, ¾	¾, 1	1½, 2	½, ¾	¾, 1	1½, 2	½, ¾	½, ¾
"A" Diameter, in.		3¾	5¼	6⅜	10 3/16	6¾	8	11⅞	6¼	6¾
"B" Height, in.		5½	8	10⅝	17	10 3/16	11 9/16	17⅛	5¼	10 3/16
Weight, lbs.		3¾	13	22	80	31	49	163	8	30
Max. Pressure, psi @ 100°F.		150	250	250	250	550	900	1000	250	600
SCFM at pressure shown, with traps back-vented, as shown in Fig. 15-2. 1.00 sp. gr. liquid	Press., psi 15	4.3	27	70	315	27	70	315	13	13
	40	8.0	32	72	289	50	72	289	8	12
	250	(150) 24	39	88	352	61	88	352	9	22
	600	—	—	—	—	(550) 64	91	460	—	23
	1000	—	—	—	—	—	(900) 104	460	—	—

*⅛" outlet connection. All dimensions are approximate. Use certified print for exact dimensions.

STEAM AT WORK . . . how the heat of steam is utilized

Heat always flows from a higher level to a lower level. Starting in the combustion chamber, heat flows through the boiler metal to the water. When the higher pressure in the boiler pushes steam out of the boiler into the distribution system, the steam in the pipes will be at a higher temperature than the surrounding air. Heat then flows from the steam through the walls of the pipe to the air. This loss of heat causes some steam to change back to water. Steam distribution pipes are insulated to minimize this wasteful and undesirable heat transfer.

When steam reaches the unit it is intended to heat, the story is different. Here the transfer of heat from the steam to the air passing through an air heater, to the water in a water heater or to the food in a cooking kettle is highly desirable. Nothing should interfere with this heat transfer.

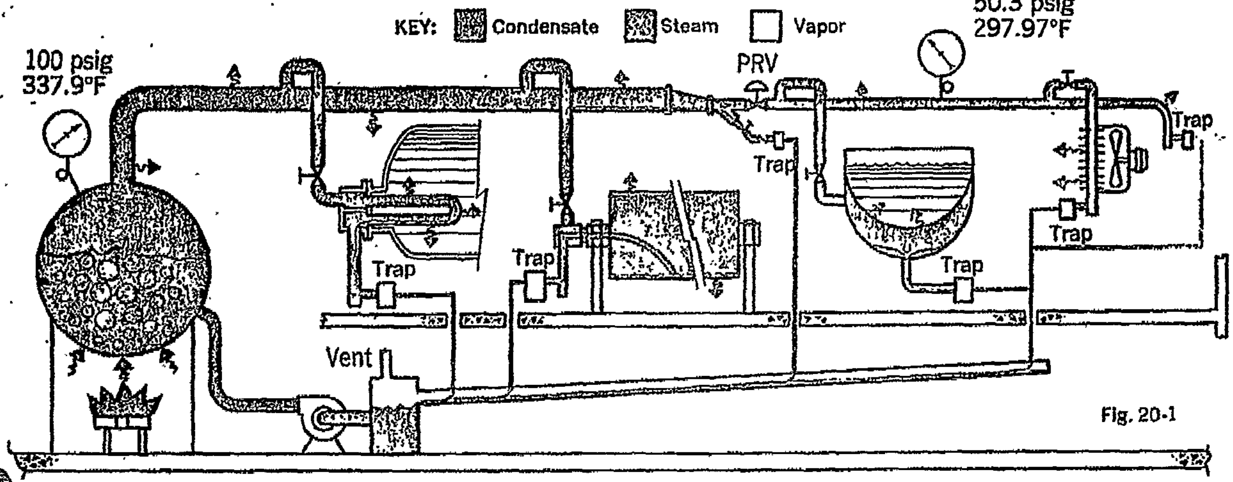


Fig. 20-1

CONDENSATE DRAINAGE . . . why it is necessary

Condensate is the by-product of a steam system used to distribute and transfer heat. Condensate forms in the distribution system because of unavoidable heat losses. And condensate forms in heating and process equipment because of heat transfer from the steam to the substance heated. All of this condensate must be removed.

The Need for Draining the Distribution System

Steam moves fast in mains or supply lines—often at 90 miles per hour or faster. A build up of condensate in these lines can be pushed along by the fast moving steam and turned into a battering ram that can damage pipe fittings and regulating valves or at least cause annoying noise. It is essential that this condensate be removed as a "heavy dew" before it can grow into a dangerous slug.

The Need for Draining the Heat Transfer Unit

Obviously, condensate in the heat transfer unit takes up space and, in effect, reduces the physical size and capacity of the equipment. It must be removed promptly so that the equipment can be kept full of steam. See Fig. 20-2.

Water Hammer. Hot steam in contact with condensate that has cooled below the temperature of steam may produce water hammer which is annoying and can shorten the life of coils and tubes. See Fig. 20-3.

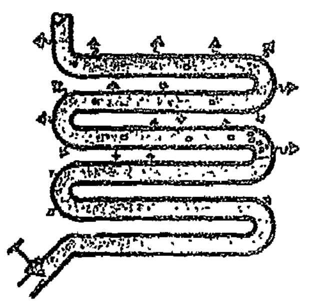


Fig. 20-2. Coil half full of condensate can't work at full capacity.

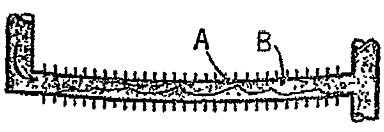


Fig. 20-3. Condensate allowed to collect in pipes or tubes is blown into waves by steam passing over it until it blocks steam flow at point A. Condensation in area B causes a pressure differential that allows steam pressure to push the slug of condensate along like a battering ram to cause water hammer.

The Need for Removing Air and CO_2

The drainage problem involves more than just condensate removal. Air and carbon dioxide gas must also be removed.

Air may be in the boiler feedwater and it is always present on start up. Carbon dioxide gas is released in the boiler from dissolved carbonates that may be in the boiler feed water.

Effect of Air on Steam Temperature. Table A-20 shows temperature reduction caused by various percentages of

Table A-20. TEMPERATURE REDUCTION CAUSED BY AIR

Pressure psig	Temp. of Steam, No Air Present	Temp. of Steam Mixed with Various Percentages of Air (by Volume)		
		10%	20%	30%
10.3	240.1	234.3	228.0	220.9
25.3	267.3	261.0	254.1	246.4
50.3	298.0	291.0	283.5	275.1
75.3	320.3	312.9	304.8	295.9
100.3	338.1	330.3	321.8	312.4

HOW TO TRAP STEAM MAINS

Selection of trap sizes to drain steam mains depends on the warm-up method that will be used—Supervised or Automatic.

Supervised Warm-Up is widely used for initial heating of large diameter or long mains. Such mains may be warmed-up "only once in a life-time." The engineer takes no chances with such mains.

The "drip valves for free blow to the atmosphere" as called for by the American Standard Code for Pressure Piping are opened wide before steam is admitted to the main. These drip valves are not closed until after all or most of the warm-up condensate has been discharged. Then, the traps take over the job of removing condensate that may form under operating conditions.

Warm-up of principal piping in a power plant will follow much this same procedure.

Automatic Warm-Up. Here the boiler is fired, letting the mains and some or all equipment come up to pressure and temperature without manual help or supervision.

Trap Selection for Automatic Warm-Up

Trap Spacing directly affects trap sizing. Under conditions of full pressure and low steam velocity, condensate will flow by gravity to the low spots in the main. You must provide drip legs and traps at all low spots or natural drainage points such as:

Ahead of risers
Ends of mains
Ahead of expansion joints or bends
Ahead of valves and regulators

Where there are no natural drainage points, drip legs and drain traps should be provided at intervals no longer than about 500 feet. Remember, steam main condensate should be drained while it is a "heavy dew" rather than a dangerous slug.

Drip Legs are provided to:

1. Let condensate escape by gravity from the fast moving steam.
2. Store the condensate until the pressure differential is great enough for the steam trap to discharge it.

Size of Drip Legs. Automatic warm-up systems should have drip leg the same diameter as the main and long enough to:

Table A-26. THE WARMING-UP LOAD, Schedule 40 Pipe.

Steam Pressure, psig		2	15	30	60	125	180	250
Pipe Size	Wt. of Pipe Per Ft. (lbs.)	Pounds of Water Per Lineal Foot						
1"	1.69	.030	.037	.043	.051	.063	.071	.079
1¼"	2.27	.040	.050	.057	.068	.085	.095	.106
1½"	2.72	.048	.059	.069	.082	.101	.114	.127
2"	3.65	.065	.080	.092	.110	.136	.153	.171
2½"	5.79	.104	.126	.146	.174	.215	.262	.271
3"	7.57	.133	.165	.190	.227	.282	.316	.354
3½"	9.11	.162	.198	.229	.273	.339	.381	.426
4"	10.79	.190	.234	.271	.323	.400	.451	.505
5"	14.62	.258	.352	.406	.439	.544	.612	.684
6"	18.97	.335	.413	.476	.569	.705	.795	.882
8"	28.55	.504	.620	.720	.860	1.060	1.190	1.340
10"	40.48	.714	.88	1.02	1.21	1.50	1.69	1.89
12"	53.6	.945	1.17	1.35	1.61	2.00	2.24	2.51
14"	63.	1.11	1.37	1.58	1.89	2.34	2.64	2.94
16"	83.	1.46	1.81	2.08	2.49	3.08	3.47	3.88
18"	105.	1.85	2.28	2.63	3.15	3.90	4.40	4.90
20"	123.	2.17	2.68	3.08	3.69	4.57	5.15	5.75
24"	171.	3.02	3.72	4.29	5.13	6.35	7.15	8.00

Table B-26. PIPE WEIGHTS PER FOOT in pounds.

Pipe Size	Schedule 40	Schedule 80	Schedule 160	XX Strong
1"	1.69	2.17	2.85	3.66
1¼"	2.27	3.00	3.76	5.21
1½"	2.72	3.63	4.86	6.41
2"	3.65	5.02	7.45	9.03
2½"	5.79	7.66	10.01	13.69
3"	7.57	10.25	14.32	18.58
3½"	9.11	12.51	—	22.85
4"	10.79	14.98	22.60	27.54
5"	14.62	20.78	32.96	38.55
6"	18.97	28.57	45.30	53.16
8"	28.55	43.39	74.70	72.42
10"	40.48	54.74	116.	
12"	53.6	88.6	161.	
14"	63	107.	190.	
16"	83.	137.	245.	
18"	105.	171.	309.	
20"	123.	209.	379.	
24"	171.	297.	542.	

Table C-26. ORIFICE CAPACITIES AT LOW PRESSURES. Use only for sizing traps for automatic warm-up.

Pressure psig.	.5	1.0	2.0
Orifice	Pounds per hour		
5/64"	37	52	71
No. 38	49	69	121
7/64"	73	103	140
1/8"	94	134	182
5/32"	148	209	284
3/16"	214	302	410
7/32"	291	411	559
1/4"	379	535	728
9/32"	482	680	925
5/16"	595	841	1,145
11/32"	715	1,010	1,370
3/8"	851	1,205	1,640
7/16"	1,160	1,640	2,230
1/2"	1,515	2,140	2,910
9/16"	1,875	2,650	3,600
5/8"	2,375	3,350	4,550
3/4"	3,100	4,160	5,400
7/8"	4,225	5,700	7,250
1 1/16"	6,240	8,400	10,700

Note: For higher minimum pressure use capacity ratings in chart on page 26. Be sure orifice selected will open at the maximum working pressure.

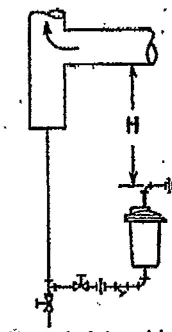


Fig. 26-1. Trap draining drip leg at riser. Distance "H" in inches ÷ 28 = psi static head for forcing water through trap.

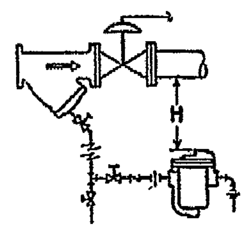


Fig. 26-2. Trap draining strainer ahead of P.R.V. "H" in inches ÷ 28 = psi for operating trap during automatic warm-up.

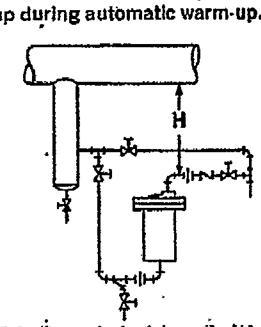


Fig. 26-3. Forged steel trap draining drip leg on main under supervised warm-up.

1. Provide storage of condensate until there is positive pressure.
2. Provide static pressure head so trap can discharge condensate before a positive pressure exists in the main. See dimension "H" in piping drawings.

Trap Sizing

Step 1. Use table A-26 to determine condensate produced in warming Schedule 40 pipe to 219°F or 2 psig. This is the warming-up load for steam trap sizing.

For steam pressures and pipe schedules not covered by the table, the warming-up load can be calculated using the following formula:

$$C = \frac{W \times (t_1 - t_2) \times .114}{L}$$

C = Amount of condensate
W = Total weight of pipe (See Table B-26 for pipe weights)
t_1 = Final temperature of pipe
t_2 = Initial temperature of pipe
L = Latent heat of steam at final temperature—See Steam Table on inside front cover.
.114 = Specific heat of wrought or steel pipe

Step 2. Divide warming-up load by number of minutes required to reach 219°F or 2 psig to get pounds per minute. Multiply by 60 to get pounds per hour.

Step 3. Pressure differential for trap sizing will be 1 psig for every 28″ of head between bottom of main and top of trap —See Fig. 26-1.

Step 4. Pick orifice size from Table C-26 and select trap size from the chart on page 26.

Example: "Automatic" warm-up load is 750 lbs/hr at warm-up pressure of 1 psig. Final pressure is 125 psig. Refer to the 1 psig column of Table C-26 where you find a 5/16″ orifice will handle 841 lbs/hr. Going up the 125 psig pressure line of the chart on page 26, you find that the No. 214 or No. 814 trap can open a 5/16″ orifice. This is the size to use.

The actual 841 ÷ 750 or 1.12 to 1 safety factor in the preceding example will result in a really generous safety factor because:

1. Pressure can not drop below the minimum or static head in drip leg.
2. As pressure rises in the main, trap capacity increases.
3. As pressure rises, warming-up load decreases faster than increase in radiation loss from insulated main.

Trap Selection for Supervised Warm-Up

Trap Spacing. Drip legs and traps should be located at all natural drip points or at intervals not to exceed about 500 feet.

Drip Legs for a supervised warm-up main need not be as large as for an automatic system. Here the emphasis is on removing condensate from the fast moving steam rather than on storage capacity. Even so, it is good practice to use pipe diameter drip legs up to 4″ pipe size and at least 4″ diameter legs for the larger pipe sizes.

Trap Sizing. If the warm-up is 100% supervised, traps will be selected merely to discharge condensate produced by radiation losses. Table B-27 shows condensate per lineal foot of insulated pipe. Insulation was assumed to be 75% efficient.

For pressures or pipe sizes not included in the Tables, use the following formula:

$$C = \frac{A \times U \times (t_1 - t_2) E}{L}$$

C = Condensate in lbs per hour
A = External area of pipe in square feet (see table on page 48)
t_1 = Steam temperature, degrees F
t_2 = Air temperature in degrees F
L = Latent heat of steam
U = Btu per sq. ft. per degree temperature difference per hour from Chart A-27
E = 1 minus efficiency of insulation (Example, 81% efficient insulation: 1 — .81 = .19 or E = .19

Safety Factors. Traps installed between the boiler and the end of the steam main: 2 to 1. Traps installed at the end of the main or ahead of reducing and shut-off valves that are closed part of the time: 3 to 1.

Replacing Existing Traps

If the trap to be replaced has never lacked capacity, you are perfectly safe in using an Armstrong that has an orifice size at least as large as in the trap replaced.

But if main drainage has not been satisfactory, follow the selection procedure given on these pages. Install a drip leg if needed.

Chart A-27. Btu HEAT LOSS CURVES. Unit heat loss per sq. ft. of surface uninsulated pipe of various diameters (also flat surface) in quiet air at 75°F for various saturated steam pressures or temperature differences.

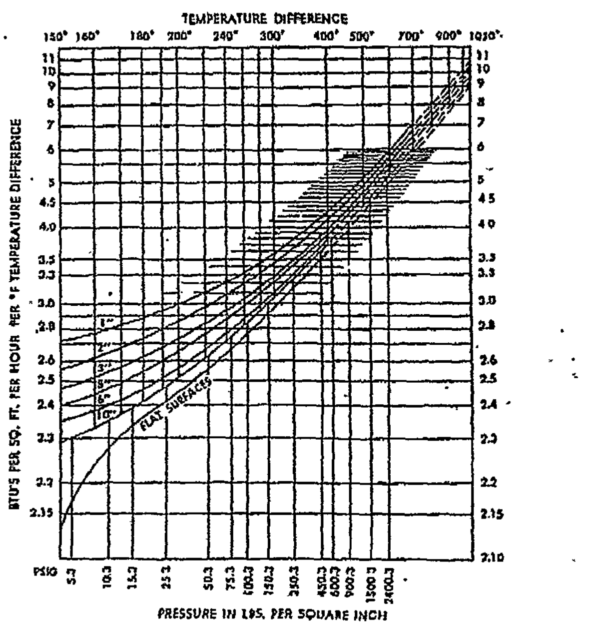


Table B-27. CONDENSATION IN INSULATED PIPES carrying saturated steam in quiet air at 70°F. Insulation assumed to be 75% efficient.

Pressure psig		15	30	60	125	180	250
Pipe Size	Sq. Ft. per Lineal Ft.	Pounds of Condensate per hr. per lineal ft.					
1″	.344	.05	.06	.07	.10	.12	.14
1¼″	.434	.06	.07	.09	.12	.14	.17
1½″	.497	.07	.08	.10	.14	.16	.19
2″	.622	.08	.10	.13	.17	.20	.23
2½″	.753	.10	.12	.15	.20	.24	.28
3″	.916	.12	.14	.18	.24	.28	.33
3½″	1.047	.13	.16	.20	.27	.32	.38
4″	1.178	.15	.18	.22	.30	.36	.43
5″	1.456	.18	.22	.27	.37	.44	.51
6″	1.735	.20	.25	.32	.44	.51	.59
8″	2.26	.27	.32	.41	.55	.53	.76
10″	2.81	.32	.39	.51	.68	.80	.94
12″	3.34	.38	.46	.58	.80	.92	1.11
14″	3.67	.42	.51	.65	.87	1.03	1.21
16″	4.20	.47	.57	.74	.99	1.27	1.38
18″	4.71	.53	.64	.85	1.11	1.31	1.53
20″	5.25	.58	.71	.91	1.23	1.45	1.70
24″	6.28	.79	.84	1.90	1.45	1.71	2.03

SIZING TRAPS FOR SUBMERGED EMBOSSED COILS

In general the drainage of embossed coils is similar to the drainage of pipe coils of the same configuration. Embossed coils can be of the multiple header type or serpentine type. They are either double or single embossed.

For maximum coil output, trap each coil independently. This is a "must" when coils are syphon drained.

Syphon Drainage. Embossed coils frequently are used for heating open tanks through which it is not practical to make a gravity condensate drain connection. Condensate must be syphoned from the bottom of the coil over the tank wall to the trap (See Fig. 35-3). To keep the coil drained, the minimum steam pressure in pounds should never be less than the syphon lift in feet. Use "LV" (enlarged vent) traps installed below the high point of the syphon.

Short Circuiting. When the embossed coil in Fig. 35-2 is suspended vertically in a tank, short circuiting complicates syphon drainage. Schematic drawing Fig. 35-4 shows channels 1, 2 and 3 replacing the multiple channels of Fig. 35-2. At start-up, condensate will fill the lower sections of channels 1 and 2 because steam can short circuit through channel 3 to close the trap. Condensate formed in channels 1 and 2 will rise to the drain point of channel 3 and be syphoned to the trap. Air accumulation in channels 1 and 2 reduces the heat transfer rate and, therefore, the pressure drop. Thus, increased pressure in channels 1 and 2 will force out condensate and vent the air. Once purged the process will be repeated.

Thermostatic Control. When tank temperature is regulated automatically, the temperature control valve frequently will close to the point where a vacuum will be formed in the coil. Drainage becomes impossible with negative coil pressure. A vacuum breaker check valve should be installed between the control valve and the coil to admit air to the coil when the vacuum forms. See Fig. 35-3.

As the control valve starts to reopen, incoming steam heats the air in the coil, causing the air to expand and build up enough pressure to force the water up the syphon and into the trap. Air quickly escapes through the "LV" trap bringing the coil to steam temperature.

Determining Load. The amount of condensate on which trap selection is based must be determined for each individual application. The consulting engineer or coil manufacturer should know the Btu per hour design heat transfer rate for the particular coil installations. Dividing this Btu figure by the latent heat of steam at the operating steam pressure will give a condensate load in pounds per hour. To size traps, use the recommended trap selection safety factors given in the captions with the drawings.

SAFETY FACTORS FOR SUBMERGED EMBOSSED COILS

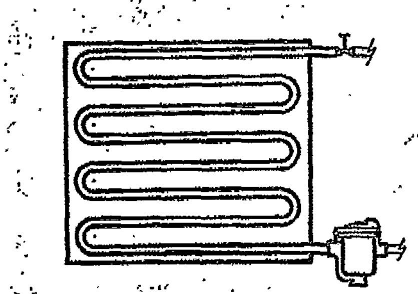


Fig. 35-1. Serpentine coil, gravity drained. Trap selection safety factor, 2 to 1.

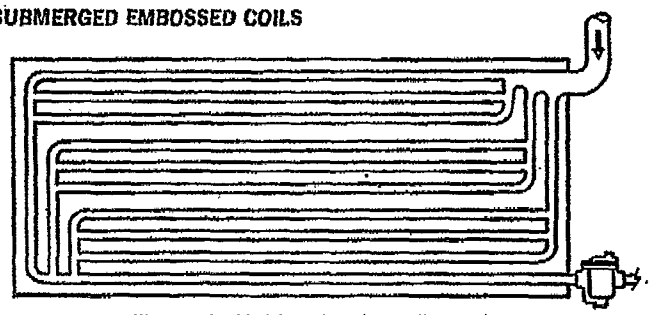


Fig. 35-2. Multiple header coil, gravity drained. Trap selection safety factor, 3 to 1.

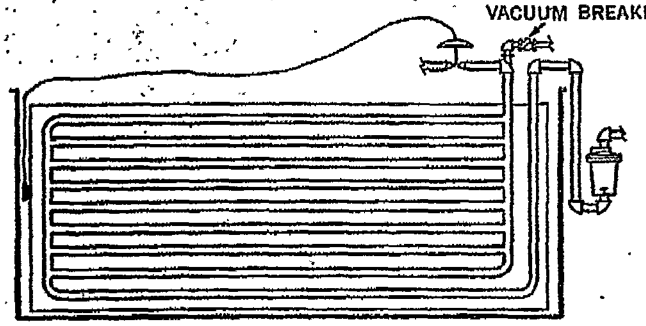


Fig. 35-3. Thermostatic controlled coil syphon drained. Use vacuum breaker check valve. Trap selection safety factor, 3 to 1 with "LV"—"CV" trap.

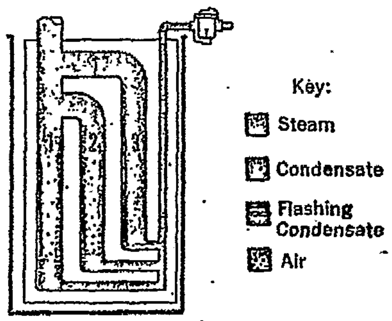


Fig. 35-4. Short circuiting of syphon drained coil. Trap selection safety factor, 4 to 1 with "LV"—"CV" trap.

NOTE: "LV" trap has enlarged bucket vent (see explanation under Syphon Drainage, page 39). "CV" indicates trap equipped with internal check valve.

SYPHON DRAINAGE AND HOW TO TRAP REVOLVING DRYERS

When condensate must be lifted above the gravity drain point to reach the trap, a syphon exists. Fig. 37-1 shows an external syphon – one surrounded by air. Fig. 37-2 depicts an internal syphon – one surrounded by steam.

External Syphon (Fig. 37-1). As soon as condensate fills the water seal, no more steam can flow to the syphon pipe. Radiation loss from the syphon causes condensation and a pressure drop. This allows full steam pressure in the unit to force condensate up the syphon pipe. The water seal may break and reform more than once before enough condensate has accumulated to fill the syphon and reach the trap.

Height Limitation. Theoretically, condensate will rise 28" in the syphon for every pound of pressure differential. To use all of the differential for elevating condensate would leave none for forcing condensate through the trap orifice. A safe rule is one foot of lift for every pound of pressure differential.

Flash Steam In External Syphon. As the pressure drops above the condensate in syphon pipe, flashing is likely to occur. Every 28" rise in condensate level requires a pressure drop of 1 psi. With condensate entering the syphon at, say, 15.3 psi a lift of 7 feet requires the syphon steam pressure to drop to 12.3 psi. Ignoring heat loss from the syphon some 0.64% of the condensate would flash into steam. (See discussion of flash steam formation on the inside front cover.)

With a condensing rate of 1000 lbs/hr there would be 6.4 lbs or 97 cu. ft. of flash per hour. This flash steam must be vented to keep it from closing the trap while condensate is waiting to be discharged.

Armstrong traps with enlarged bucket vents (LV suffix to Trap No.) are required to vent the flash steam that forms in syphon pipes. When ordering traps for syphon drainage indicate the condensate load, the maximum and minimum pressures and the amount of lift. With this information vent size can be determined accurately.

Where the trap is installed as in Fig. 37-1 it should be equipped with an internal check valve. Provide a loop ahead of 200 series traps as shown.

Internal Syphon (Fig. 37-2). Here there is no radiation loss from the syphon pipe surrounded by steam. Condensate rising in the syphon flashes readily aided by the small heat flow to the syphon. Venting of flash becomes imperative if sluggish drainage is to be avoided.

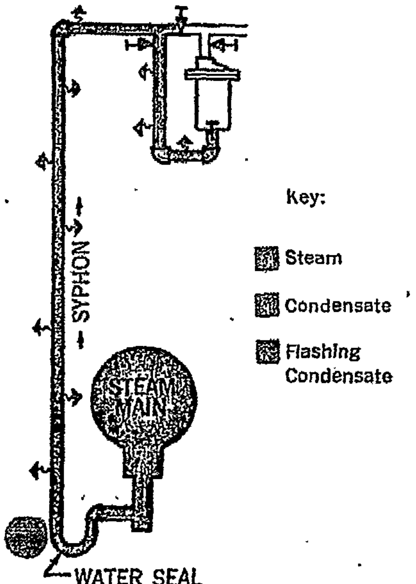


Fig. 37-1. Steam main in trench with trap installed at ground level—an EXTERNAL SYPHON. After water seal fills with condensate, radiation loss will lower the steam pressure in the syphon.

EFFECT OF SYPHON PIPE SIZE

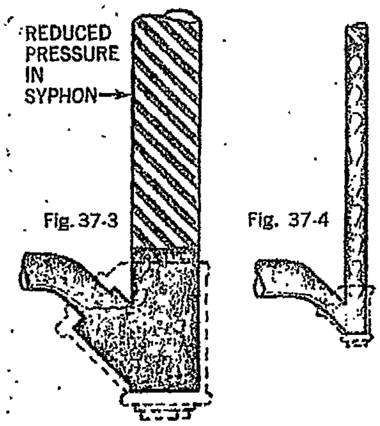


Fig. 37-3. Oversize syphon. Steam can bubble up through the condensate without changing its density. Condensate cannot reach trap until pipe is filled with condensate.

Fig. 37-4. In correctly sized syphon (one pipe size smaller than nominal trap size but not smaller than ½") steam bubbles, in effect, reduce the density of the condensate and help carry condensate along to the trap.

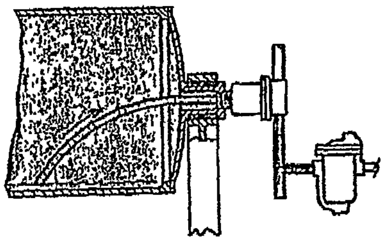


Fig. 37-2. A revolving cylinder drained with a syphon—an INTERNAL SYPHON surrounded by steam. No radiation loss from syphon—only from the external piping between cylinder and trap.

How to Trap Revolving Dryers

Traps for draining revolving dryers need enlarged bucket vents. When steam is first turned on the enlarged vents pass entrained air rapidly. When all air has been discharged the dryer reaches steam temperature and the capacity of the large vent is then needed to prevent flash steam from impeding trap operation.

Trap Sizing. Table A-37 shows experience-proven size recommendations by size and type of dryer. The order for traps should specify "For syphon-drained cylinder service." Also give the diameter and length of the dryer, condensate load, if known, as well as the maximum and minimum steam pressures.

Table A-37. TRAP SIZES RECOMMENDED FOR SYPHON DRAINED CYLINDERS

Type of Dryer	Pressure Range Psi	Trap Size
Dry Cans:		
23" x 50"	5—20	800 LV
	21—70	800 LV
23" x 60" and up	5—20	811 LV
	21—70	811 LV
Drum Dryers:		
24" x 40"	20—100	812 LV
28" x 72"	20—100	813 LV
36" x 84"	20—100	814 LV
42" x 120"	20—100	215 LV
Laundry Ironers—Cylinder Type:		
12" x 72"	100	811 LV
14" x 81"	100	812 LV
30" x 100" or 120"	100	813 LV
36" x 100" or 120"	100	814 LV
Paper Machine Dryers:		
36" x 72" and 42" x 120"	0—15	813 LV
	16—35	813 LV
	36—50	813 LV
	51—70	813 LV
48" x 180"	0—15	814 LV
	16—35	814 LV
	36—50	814 LV
	51—75	814 LV
60" x 240"	0—15	215 LV
	16—35	215 LV
	36—50	215 LV
	51—70	215 LV

PIPE SIZING STEAM SUPPLY AND CONDENSATE RETURN LINES

Definitions:

Steam Mains or mains which carry steam from the boiler to an area in which multiple steam-using units are installed.

Steam Supply Pipes which take steam from steam main to steam-heated unit.

Trap Discharge Lines which move condensate and flash steam from the trap to a return line.

Condensate Return Lines which receive condensate from many trap discharge lines and carry the condensate back to the boiler room.

Pipe Sizing

Select pipe sizes large enough to take care of reasonable future expansion.

Steam Mains. The sizing and design of high capacity steam mains is a complex problem that should be assigned to a competent engineer.

Tables A-40 through F-41 will prove helpful in checking steam main sizes or in determining main size for small plants. Example: An existing 3″ steam main may be supplying one department of a large plant with 3800 lb/hr at 180 psi. Question: Could the steam use of this department be increased to 8500 lbs/hr without a new supply line?

Table E-41 shows that 1 psi pressure drop is produced in 100 feet of 3″ pipe when supplying 3800 lb/hr. To increase the flow to 8500 lb/hr would produce a pressure drop of 5 psi per hundred feet. If the pressure drop and corresponding decrease in steam temperature is not objectionable, the existing 3″ pipe can be used. However, if this much pressure drop is not permissible, an additional 3″ main will have to be installed, or the existing 3″ main will have to be replaced with a 4″ main which can handle 8500 lb/hr with a pressure drop of only 1 psi per 100 feet.

Steam Supply Pipes. When a new heating or process unit is installed in an existing plant, Tables A-40–F-41 are entirely practical for checking the size of pipe to run from the steam main to the new unit. The use of the tables is best described by solving a typical problem:

Assume a steam main pressure of 101 to 105 psig. Unit is rated to condense 600 lb/hr, and 100 psig minimum is required at unit for quality production. Measurements show 75 feet of pipe required, involving three standard elbows plus a globe valve. Allowable pressure drop not to exceed 1 psi.

Assuming that a 2″ pipe will be required, use Table H-41 to determine equivalent length of pipe to be added to compensate for fittings.

3–2″ standard elbows at 4.3 =	12.9 ft.
1–2″ Globe valve =	46.0 ft.
Total for valve and fittings	58.9 ft.

Adding this to the length of the supply pipe gives a total effective length of 133.9 feet—call it 1.34 hundred feet. Dividing our maximum allowable pressure drop of 1 psi by 1.34 gives us an allowable pressure drop of ¾ psi per 100 feet.

Refer to Table C-41 for 100 psi steam. With a pressure drop of ¾ psi per 100 feet, a 2″ pipe will give a flow of 850 lb/hr. In fact, with a pressure drop of only ½ psi per 100 feet the flow would be 690 lb/hr. However, a 1½″ pipe would require a pressure drop of 2 psi per 100 feet for a flow of 680 lb/hr. 1½″ pipe is too small and the 2″ is the size to use.

In the example just cited, if the steam pressure in the unit is not critical, a 1½″ pipe could be used which would give a pressure drop of about 5 psi per 100 feet, or about 6⅔ psi for the effective length of 133.9 feet.

Trap Discharge Lines. Trap discharge lines usually are short. Assuming the trap is properly sized for the job, use a trap discharge line the same size as the trap connections. At very low pressure differentials between trap and condensate return pipe, trap discharge lines can be increased one pipe size advantageously.

Condensate Return Lines. Here again, for medium and large-sized plants, the services of a consultant should be employed to engineer the condensate return pipe or pipes. Table G-41 shows condensate return pipe capacities when pipe is new and with the pressure drops per 100 feet specified. Usually it is considered good practice to select return pipe one or two sizes larger to allow for (1) increase in plant capacity and (2) fouling of pipe with rust and scale.

Traps and High Back Pressure. Back pressures excessive by normal standards may be carried by design, or back pressures may increase due to fouling of return lines, increase in condensate load, or faulty trap operation.

Back pressure, high or low, has no adverse effect on the operation of an Armstrong trap. As back pressure goes up, discharges become shorter but are more frequent. However, the trap continues to perform its primary function of discharging condensate with no loss of steam. See explanation on page 3.

Back pressure does lower the pressure differential and, hence, the capacity of the trap is decreased. In severe cases, the reduction in capacity could make it necessary to use traps one size larger to compensate for the decrease in operating pressure differential.

STEAM SUPPLY AND CONDENSATE RETURN PIPE CAPACITIES

All capacities are shown in pounds per hour and are based on steam and condensate flowing in the same direction.

Table A-40. STEAM PIPE CAPACITY AT 5 PSI

Pipe Size in.	Pressure drop per 100 ft. of pipe length				
	⅛	¼	½	¾	1
½	4	6	9	11	13
¾	10	15	21	26	30
1	24	31	44	54	62
1¼	52	68	97	120	140
1½	81	100	150	180	210
2	160	210	300	370	430
2½	270	350	500	610	710
3	490	650	920	1,130	1,300
3½	730	970	1,370	1,680	1,940
4	1,040	1,370	1,940	2,380	2,750
5	1,930	2,540	3,600	4,410	5,090
6	3,160	4,170	5,910	7,250	8,360
8	6,690	8,680	12,310	15,090	17,400
10	12,020	15,840	22,460	27,530	31,760
12	19,290	25,420	36,050	44,190	50,970

Table B-40. STEAM PIPE CAPACITY AT 15 PSI.

Pipe Size in.	Pressure drop per 100 ft. of pipe length					
	⅛	¼	½	¾	1	2
½	5	8	11	14	16	23
¾	13	18	26	32	37	52
1	27	38	53	65	76	110
1¼	59	83	120	140	160	230
1½	91	130	180	220	260	360
2	180	260	370	450	520	740
2½	300	430	600	740	860	1,210
3	560	790	1,110	1,360	1,570	2,220
3½	830	1,180	1,660	2,040	2,350	3,320
4	1,180	1,660	2,350	2,880	3,330	4,700
5	2,180	3,080	4,350	5,330	6,160	8,700
6	3,580	5,060	7,150	8,750	10,120	14,290
8	7,450	10,530	14,880	18,220	21,080	29,740
10	13,600	19,220	27,150	33,250	38,430	54,270
12	21,830	30,840	43,570	53,370	61,690	87,100

Table A-41. STEAM PIPE CAPACITY AT 30 PSI.

Pipe Size In.	Pressure drop per 100 ft. of pipe length					
	⅛	¼	½	¾	1	2
½	7	10	14	17	19	28
¾	16	22	32	39	45	64
1	32	45	64	79	91	129
1¼	70	99	142	174	202	283
1½	110	156	220	270	312	440
2	223	316	446	546	630	892
2½	368	520	735	900	1,040	1,472
3	675	953	1,340	1,652	1,905	2,690
3½	990	1,405	2,010	2,470	2,850	4,020
4	1,420	2,020	2,850	3,490	4,025	5,700
5	2,625	3,720	5,260	6,450	7,450	10,550
6	4,315	6,100	8,650	10,600	12,200	17,300
8	9,000	12,700	18,000	22,000	25,420	36,000
10	16,400	23,200	33,300	40,250	46,500	65,750
12	26,350	37,250	52,500	64,500	74,500	105,500

Table B-41. STEAM PIPE CAPACITY AT 60 PSI.

Pipe Size In.	Pressure drop per 100 ft. of pipe length						
	⅛	¼	½	¾	1	2	5
½	8	12	17	21	25	35	55
¾	20	28	40	49	57	81	128
1	40	57	81	100	115	163	258
1¼	89	127	179	219	253	358	567
1½	139	197	279	342	395	558	882
2	282	400	565	691	800	1,130	1,790
2½	465	660	930	1,140	1,318	1,860	2,940
3	853	1,205	1,690	2,090	2,410	3,410	5,400
3½	1,275	1,800	2,550	3,120	3,605	5,090	8,060
4	1,800	2,550	3,610	4,462	6,100	7,220	11,400
5	3,320	4,710	6,660	8,150	9,440	13,300	21,100
6	5,475	7,725	10,950	13,420	15,450	21,900	34,600
8	11,360	16,100	22,800	27,900	32,200	45,550	72,100
10	20,800	29,400	41,500	51,000	58,900	83,250	131,200
12	33,300	47,100	66,700	81,750	94,500	133,200	210,600

Table C-41. STEAM PIPE CAPACITY AT 100 PSI.

Pipe Size In.	Pressure drop per 100 ft. of pipe length				
	½	¾	1	2	5
½	21	26	30	43	68
¾	50	61	70	99	160
1	100	120	140	200	320
1¼	220	270	310	440	690
1½	340	420	480	680	1,080
2	690	850	980	1,390	2,190
2½	1,140	1,400	1,620	2,280	3,610
3	2,090	2,560	2,960	4,180	6,610
3½	3,120	3,830	4,420	6,250	9,870
4	4,420	5,420	6,260	8,840	13,960
5	8,170	10,020	11,580	16,350	25,840
6	13,420	16,450	19,020	26,840	42,410
8	27,930	34,250	39,580	55,870	88,280
10	50,970	62,500	72,230	101,900	161,100
12	81,810	100,300	115,900	163,600	258,500

Table D-41. STEAM PIPE CAPACITY AT 125 PSI.

Pipe Size In.	Pressure drop per 100 ft. of pipe length				
	½	¾	1	2	5
½	23	29	33	47	75
¾	54	66	77	109	172
1	109	134	155	220	347
1¼	241	296	341	483	764
1½	375	460	532	751	1,185
2	760	930	1,075	1,520	2,410
2½	1,250	1,535	1,775	2,550	3,960
3	2,280	2,815	3,245	4,590	7,260
3½	3,430	4,200	4,850	6,850	10,880
4	4,850	5,930	6,850	9,700	15,350
5	8,950	11,000	12,700	17,950	28,400
6	14,710	18,070	20,800	29,500	46,500
8	30,650	37,550	43,400	61,400	97,100
10	56,000	68,500	79,100	112,000	177,000
12	89,900	110,200	127,100	179,600	284,100

Table E-41. STEAM PIPE CAPACITY AT 180 PSI.

Pipe Size In.	Pressure drop per 100 ft. of pipe length				
	½	¾	1	2	5
½	28	34	39	56	88
¾	64	78	90	128	202
1	129	158	182	258	407
1¼	283	347	400	566	895
1½	441	540	624	882	1,394
2	895	1,092	1,260	1,785	2,820
2½	1,470	1,800	2,080	2,940	4,650
3	2,675	3,300	3,805	5,390	8,550
3½	4,040	4,930	5,695	8,050	12,740
4	5,700	6,980	8,500	11,400	18,000
5	10,500	12,900	14,900	21,080	33,300
6	17,300	22,200	24,420	34,600	54,600
8	36,000	44,100	50,850	72,000	113,900
10	65,800	80,500	93,000	131,300	207,000

Table F-41. STEAM PIPE CAPACITY AT 250 PSI.

Pipe Size In.	Pressure drop per 100 ft. of pipe length				
	½	¾	1	2	5
½	32	39	45	64	102
¾	74	91	105	150	230
1	150	180	210	300	470
1¼	330	400	470	660	1,160
1½	510	620	720	1,020	1,620
2	1,040	1,270	1,470	2,070	3,280
2½	1,710	2,090	2,410	3,410	5,400
3	3,130	3,820	4,420	6,250	9,880
3½	4,670	5,710	6,610	9,340	14,770
4	6,600	8,080	9,340	13,210	20,890
5	12,220	14,950	17,290	24,440	38,650
6	20,060	24,540	28,380	40,100	63,400
8	41,750	51,100	59,100	83,500	132,000

Table G-41. CONDENSATE RETURN PIPE CAPACITY IN LBS. PER HR.

Pipe size, in.	Low pressure		High pressure return, steam pressure in psi					
	Gravity return	Vacuum return	25	50	100	150	200	250
¾			236	312	419	560	682	1,074
1	200	350	474	617	823	1,120	1,385	2,150
1¼	400	600	989	1,306	1,755	2,330	2,880	4,450
1½	700	950	1,610	2,126	2,850	3,800	4,710	7,350
2	1,200	2,000	3,280	4,325	5,785	7,700	9,550	14,875
2½	1,650	3,350	5,400	7,160	9,640	12,800	15,850	24,600
3	2,600	5,350	9,890	13,070	17,550	23,300	28,850	34,750
3½	3,800	8,000	14,700	19,400	25,900	34,500	42,700	51,350
4	6,500	11,000	20,800	27,360	36,550	49,200	60,900	73,350
5	10,400	19,400	38,850	52,925	70,000	91,500	114,500	127,600
6	18,000	31,000	61,200	83,700	112,700	150,000	185,500	223,100
Press. Drop*		⅛	½	⅝	¾	1	1¼	1½

*Pressure drop in psi per 100 ft. of equivalent length used in determining capacities given.

Table H-41. EQUIVALENT LENGTH OF PIPE TO BE ADDED FOR FITTINGS

Size of pipe, in.	Length in feet to be added to run				
	Standard elbow	Side outlet tee	Gate valve (*)	Globe valve (*)	Angle valve (*)
½	1.3	3	0.3	14	7
¾	1.8	4	0.4	18	10
1	2.2	5	0.5	23	12
1¼	3.0	6	0.6	29	15
1½	3.5	7	0.8	34	18
2	4.3	8	1.0	46	22
2½	5.0	11	1.1	54	27
3	6.5	13	1.4	66	34
3½	8.0	15	1.6	80	40
4	9.0	18	1.9	92	45
5	11.0	22	2.2	112	56
6	13.0	27	2.8	136	67
8	17.0	35	3.7	180	92
10	21.0	45	4.6	230	112
12	27.0	53	5.5	270	132

*Valve in full open position

INSTALLATION OF ARMSTRONG INVERTED BUCKET TRAPS

Before Installing
Run pipe to trap. *Before installing* the trap, clean the line by blowing down at full steam pressure. (Clean any strainer screens after this blow-down.)

Trap Location ABC's
*A*ccessible for inspection and repair
*B*elow drip point whenever possible
*C*lose to drip point

Trap Hook-Ups. For low and medium pressure service, see Figs. 42-1 through 42-8. Follow the Power Piping Code for Drips and Drains when installing high pressure traps.

Shut-Off Valves ahead of traps are needed when traps drain steam mains, large water heaters, etc., where system cannot be shut down for trap maintenance. They are not needed for small steam heated machines—a laundry press, for example. Shut-off valve in steam supply to machine is sufficient.

Shut-off valve in trap discharge line is needed when trap has a bypass. It is a good idea when there is high pressure in discharge header. See also Check Valves.

By-passes (Figs. 42-6 and 42-7). Use only when *continuous service is a must.* Keep by-passes above traps as shown.

Unions. If only one is used, it should be on discharge side of trap. With two unions, avoid horizontal or vertical in-line installations. The best practice is to install at right angles as in Figs. 42-1 and 42-6 or parallel as in Fig. 42-7.

Standard Connections. Servicing is simplified by keeping lengths of inlet and outlet nipples identical for traps of a given size and type. A spare trap with identical fittings and half unions can be kept in the storeroom. In the event a trap needs repair it is a simple matter to break the two unions slip out the ailing trap, put in the spare and tighten the unions. Repairs can then be made in the shop and the repaired trap, with fittings and half unions, put back in stock.

Test Valves (Fig. 42-1) provide best means of checking trap operation. Use a pet cock or a small globe valve. Provide a check valve or shut-off valve in the discharge line to isolate trap while testing.

Strainers. Install strainers ahead of small traps when dirt conditions are bad or where specified. They are seldom needed with larger size of traps.

Traps No. 880-883 have built-in strainers. When strainer blow down valve is used, shut off steam supply valve before opening strainer blow-down valve. Condensate in trap body will flash back through strainer screen for thorough cleaning. Open steam valve slowly to be sure trap regains its seal.

Dirt Pockets (Figs. 42-1 and 42-7) are excellent for stopping scale and core sand. Clean periodically.

Syphon Installations require a water seal and a check valve in the trap. Syphon pipe should be one size smaller than nominal size of trap used but not less than ½" pipe size.

Elevating Condensate. Do not oversize the vertical riser. In fact, one pipe size smaller than normal for the job will give excellent results.

Check Valves *are frequently needed.* They are a must if no discharge line shut-off valve is used. Fig. 42-9 shows three possible locations for external check valves —also an Armstrong Internal Check Valve (See page 4). Recommended locations given below.

Discharge Line Check Valves prevent back flow and isolate trap when test valve is opened. Normally installed at location B. When return line is elevated *and* trap is exposed to freezing conditions, install check valve at location A, Fig. 42-9.

Inlet Line Check Valves prevent loss of seal if pressure should drop suddenly or if trap is above drip point. Armstrong Stainless Steel Check Valve in trap body, location D, is recommended. If swing check is used, install at location C.

Protection Against Freezing. In general, a properly selected and installed Armstrong Trap will not freeze as long as steam is coming to the trap. If the steam supply should be shut off, the trap should be drained manually or automatically by means of a thermo drain or pop drain.

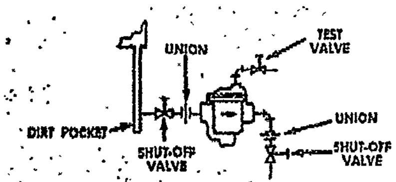


Fig. 42-1. Standard hookup No. 800-814, 880-883 traps, with shut-off valves to isolate trap during testing, inspection or repair. Unions should be at right angles—not in-line—to facilitate trap removal.

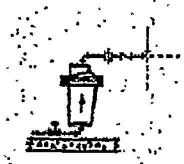


Fig. 42-2. Hookup No. 211-216 traps.

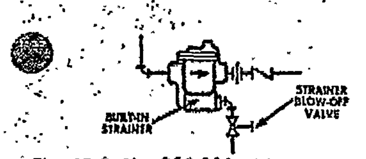


Fig. 42-3. No. 880-883 with strainer blow-down valve.

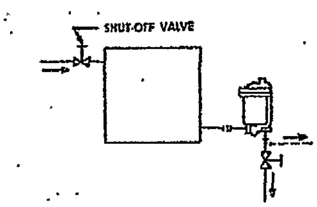


Fig. 42-4. Hookup No. 801 trap (shows how shut-off valve ahead of unit can serve as shut-off for a trap).

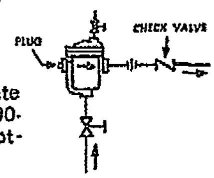


Fig. 42-5. Alternate hookup for No. 800-814 with inlet at bottom.

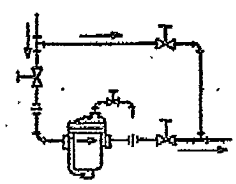


Fig. 42-6. Bypass hookups for No. 800-814 and 880-883 traps.

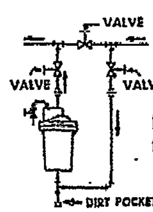


Fig. 42-7. Bypass hookup for No. 211-216 traps.

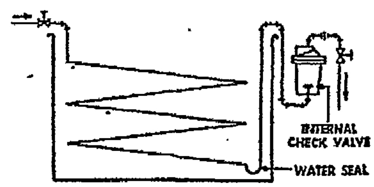


Fig. 42-8. Trap draining syphon.

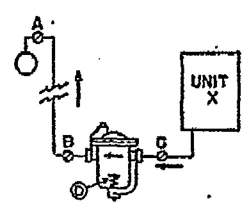


Fig. 42-9. Possible check valve locations.

TROUBLE SHOOTING INVERTED BUCKET STEAM TRAPS

The following summary will prove helpful in locating and correcting nearly all steam trap troubles. Many of these troubles are in reality system troubles rather than trap troubles.

Whenever a trap fails to operate and the reason is not readily apparent, the discharge from the trap should be observed. If the trap is installed with a test outlet, this will be a simple matter—otherwise, it will be necessary to break the discharge connection.

Cold Trap—No Discharge. If trap fails to discharge condensate, then:

A. Pressure may be too high.
1. Wrong pressure originally specified.
2. Pressure raised without installing new pressure change assembly.
3. P.R.V. out of order.
4. Pressure gage in boiler reads low.
5. Orifice enlarged by normal wear.

B. No water or steam coming to trap.
1. Stopped by plugged strainer ahead of trap—or plugged strainer in Nos. 880-883 and 983 traps.
2. Broken valve in line to trap.
3. Pipe line or elbows plugged.

C. Worn or defective mechanism. Repair or replace as required.

D. High Vacuum in return line. Increases pressure differential beyond which trap may operate. Install correct pressure change assembly for pressure *differential* encountered.

E. Trap body filled with dirt. Install strainer or remove dirt at source.

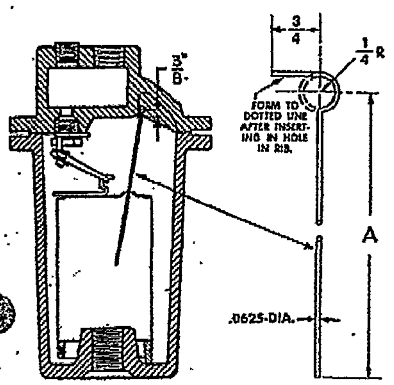


Fig. 44-1. Vent-scrubbing wire for use when oil plugs vent. Trap inlet tube must be removed.

F. Bucket vent filled with dirt.
Prevent by:
1. Installing strainer.
2. Enlarging vent slightly.
3. Using bucket vent scrubbing wire.

Vent Scrubber. If the bucket vent should be closed by an oil film, either enlarge the vent or install a scrubbing wire. For vent enlargement, first try a No. 46 drill. If this is not enough, then use a No. 42 drill. Make scrubbing wire as shown in Fig. 44-1 to the length shown in Table A-44. The hole in the center rib of the trap should be 5⁄32″. Enlarge vent with No. 37 drill.

Table A-44. SCRUBBING WIRE DIMENSION

Trap Number	Length "A"
800, 880, 801, 811, 881, 211	2¼″
812, 212, 882	3″
813, 213, 883, 814, 214, 215	5″
216	6½″

Hot Trap—No Discharge

A. No water coming to trap.
1. Trap installed above leaky by-pass valve.
2. Broken or damaged syphon pipe in syphon drained cylinder.
3. Vacuum in water heater coils may prevent drainage. Install a ¼″ check valve as vacuum breaker between steam admission valve and coil.

Steam Loss. If the trap blows live steam, trouble may be due to any of the following causes:

A. Valve may fail to seat.
1. Piece of scale lodged in orifice.
2. Worn valve parts.

B. Trap may lose its prime.
1. If the trap is blowing live steam, close the inlet valve for a few minutes. Then gradually open. If the trap catches its prime, the chances are that the trap is all right.
2. Prime loss is usually due to sudden or frequent drops in steam pressure. On such jobs, the installation of a check valve is called for—location D or C in Fig. 42-9. If possible locate trap well below drip point.

Continuous Flow. If the trap discharges continuously, check the following:

A. Trap too small.
1. A larger trap, or additional traps should be installed in parallel.
2. High pressure traps may have been used for a low pressure job. Install right size of pressure change assembly.

B. Abnormal water conditions.
1. Boiler may foam or prime, throwing large quantities of water into steam lines. A separator should be installed or else the feed water conditions remedied.

Sluggish Heating. When trap operates satisfactorily but units fail to heat properly:

A. One or more units may be short-circuiting and the remedy is to install a trap on each unit. See page 24.

B. Traps may be too small for job even though they may discharge intermittently. Try next-size-larger trap.

C. Trap may have insufficient air-handling capacity. Use of thermic buckets may help. See page 4. Where thermic bucket is not recommended, larger-than-standard bucket vents will speed up heating.

Mysterious Trouble. If trap operates satisfactorily when discharging to atmosphere, but trouble is encountered when connected with return line, check the following:

A. Back Pressure may reduce capacity of trap.
1. Return line too small (Trap hot).
2. Other traps may be blowing steam (Trap hot).
3. Atmospheric vent in condensate receiver may be plugged (Trap hot or cold).
4. Obstruction in return line (Trap hot or cold).
5. Excess vacuum in return line (Trap cold).

Imaginary Troubles. If it appears that steam escapes every time trap discharges, remember: Hot condensate forms flash steam when released to lower pressure, but flash steam usually condenses quickly in the return line.

How to Order Repair Parts. For all operating mechanism parts, specify trap size and maximum operating pressure or orifice size. For gaskets, specify trap size. For body and cap, specify trap size and pipe connections.

INSPECTION AND REPAIR OF INVERTED BUCKET TRAPS

Frequency. All traps should be opened at least once a year to check operating mechanism.

Valves and Seats. If the valve seat has a sharp smooth edge, and if there is a narrow bright ring all the way around the ball valve, chances are that the valve is tight. Valves and seats which have become wire drawn or badly grooved from wear should be replaced. *Do not use a new seat with an old valve or vice-versa.* Valves and seats are factory-lapped together in matched sets for perfect fit.

Years of experience have proved that when valves and seats have worn enough to require renewal, a new lever and guide pin assembly should also be installed to get maximum mileage from the new valve parts.

Valve Seat Installation. When installing valve seats in Armstrong traps, do NOT use any pipe dope or lubricant of any kind on the seat threads. The joint is made, not by the threads, but rather by the contact between the ground end of the valve seat and the beveled seating area at the bottom of the tapped hole. See Fig. 45-1. Make sure that this seating area is perfectly clean.

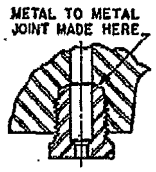


Fig. 45-1. ***Important!*** Valve seat seal is made at point of contact indicated, not by threads. Be sure to read paragraph above.

Replace Lever and Guide Pin Assembly. When new valve parts are used with an old lever, bucket travel, valve opening and trap capacity are reduced. With used and worn guide pins, the valve is not guided as closely to its seat. Poor guidance develops leaks quickly because valve can strike side of seat instead of center.

When you install a new mechanism less bucket or a pressure change assembly, you make the trap as good as new.

Guide Pin Assembly Installation. Install with hooks pointing away from adjoining gasket surfaces as shown in Fig. 45-7.

Alignment of Guide Pins. To check the alignment of the guide pins, hold the lever assembly against the valve seat with the valve contacting its seat, and the two fulcrum points resting on the face of the seat. When the lever is held in this position, the guide pins should be central in the guide pin holes. See Fig. 45-2. There should be equal side-to-side movement of lever as shown in Fig. 45-3 and Fig. 45-4. It is a very simple matter to bend the pins until they are centrally located. Care should be taken so that the pins will remain perpendicular to the guide pin plate so that the lever can drop until it rests on the guide pin hooks.

The Lever Assembly is hooked over the guide pins. In a few sizes of traps, particularly at low pressures, the valve lever assembly must be slipped on the guide pins before the guide pin assembly is fastened into position.

Buckets. Cracked or corroded buckets should be replaced.

Bucket Hooks. Since July 1, 1940, all free-floating lever Armstrong Traps have been furnished with stainless steel buckets. Normally wear is limited to the bucket hook. In the Nos. 212-812 and larger sizes, these hooks are now riveted to the bucket cap, so that the hooks can be renewed.

Thermic Buckets. Hold over steam jet or lighted match to see that disc seats properly when bi-metal strip is heated.

Dirt in Trap. Remove all sediment and other dirt from the trap body. The mechanism may require cleaning by immersing in gasoline or kerosene. If there is an exceptional amount of dirt, install a strainer ahead of the trap. The strainer will have to be blown down or cleaned at periodic intervals.

By-Pass Valve Inspection. If traps are installed with a by-pass, it is highly important that the by-pass valve be checked to make sure it is perfectly steam tight. If the trap can be operated without the by-pass by all means remove it. Avoid the practice of opening by-pass valves and leaving them open.

Internal Check Valve Installation. Since November, 1946, all Armstrong Trap bodies have been tapped on the inside to take Armstrong spring-loaded check valves. To install one of these check valves after a trap has been installed in the line, simply remove the trap cap and extended inlet tube from the body and screw the check valve in position, or replace tube with check valve, coupling and tube combination.

Check Valve Inspection. Make sure that check valves ahead of trap, in trap, or in return line, are tight and in good condition.

Pressure Changes. An Armstrong Trap will operate at any pressure lower than the maximum for which it is furnished. The maximum pressure depends upon the diameter of the discharge orifice used in each size of trap.

If it is necessary to change the working pressure of the trap to obtain greater capacity at lower pressures, or to enable the trap to work at higher pressures, a complete *pressure change assembly* is required. This comprises a valve seat, a valve, valve retainer, valve lever and guide pin assembly.

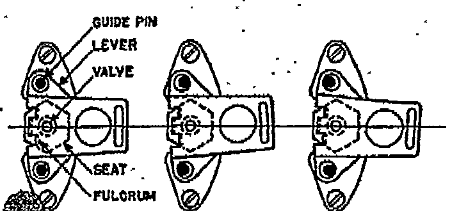


Fig. 45-2 Fig. 45-3 Fig. 45-4

Fig. 45-2 shows CORRECT ALIGNMENT of guide pins. When correctly aligned, lever can be moved sideways the same distance to the right (Fig. 45-3) as to the left (Fig. 45-4).

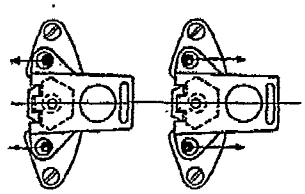
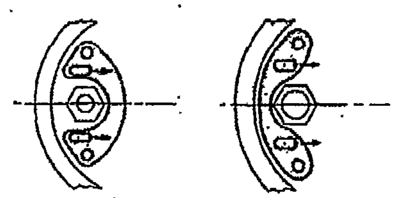


Fig. 45-5 Fig. 45-6

Two examples of INCORRECT ALIGNMENT. Guide pins should be bent in direction of arrows until they center in holes as shown in Fig. 45-2.



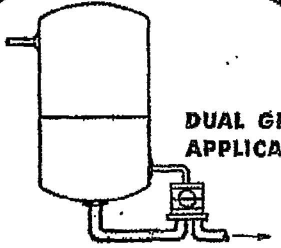
Nos. 211, 212, 213	Nos. 214, 215, 216
Nos. 310, 312, 313	Nos. 314, and larger
Nos. 800, 811, 812, 813	No. 814
Nos. 880, 881, 882, 883	No. 864T
Nos. 860T, 861T, 862T, 863T	

Fig. 45-7. Guide Pin Plate Locations. Pins always point away from adjoining Gasket Surfaces.

Clark FLOAT TRAPS

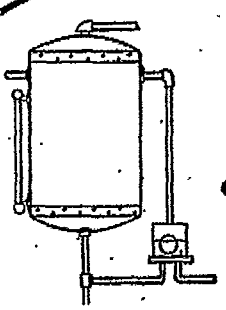
These traps, due to their large orifices, can be sized to handle unusual dirt conditions not possible with ordinary float traps but frequent blowdown or cleaning is advisable. Float traps may be damaged by surges of liquid which can cause float failure through collapsing of float. In cases of this type the trap fails in the closed position and the trap does not blow through.

Safety factor: A safety factor of 1½ to 2 times the maximum load is recommended for the normal operation. Greater safety factors may be desirable to get the benefits of oversized orifices. Oversizing float traps does not affect their operation as it does in other types of traps. See the capacity tables on the back of this folder.



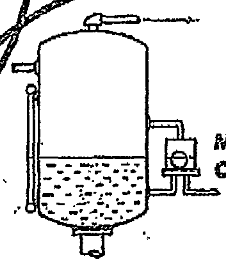
DUAL GRAVITY APPLICATIONS

The ball float in the Clark duo-gravity drainers is weighted to sink in the lighter of the two liquids and to float in the heavier liquid. When the heavy liquid enters the drainer, the float becomes buoyant and opens the discharge valve allowing the heavy liquid to be discharged from the unit. Typical installations include: removal of water from gasoline accumulators, settling tanks, evaporators and Pipe lines carrying light liquids with water present.



CONTINUOUS DRAINAGE

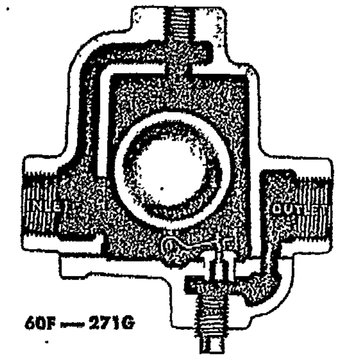
When the float trap is placed below the level of the tank or fluid line, the liquid flows continuously into the trap and the float will reach a point of equilibrium, holding the discharge valve open sufficiently to discharge the liquid at the same rate it enters.



MAINTAINING CONSTANT LEVELS

Clark Float Traps may be used to maintain constant levels in tanks and reservoirs. As liquid level rises, the float buoyancy increases. When the buoyancy is sufficient to overcome the force exerted by the gas pressure against the valve, the float mechanism will open the discharge valve. Pressure then forces the liquid out of the trap, lowering the liquid level. As the level drops the float loses buoyancy and sinks to close the discharge valve.

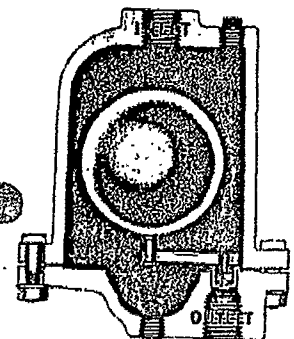
CLARK FLOAT TRAPS discharge as accumulated liquid flows by gravity into the trap body, causing the ball float to rise and open the discharge valve. There is always a liquid level present at discharge over the discharge orifice, which creates a liquid seal and permits drainage without loss of air or gas. The float tends to reach a point of equilibrium to discharge continuously at the same rate the liquid enters the trap. With these operating characteristics, the traps are used to advantage—



60F — 271G

. . . to drain accumulated liquids from air or gas lines..
. . . for systems where there are wide variations in condensate load. Extreme light loads or no-load conditions do not affect the efficiency of these traps.
. . . for superheated steam systems where no-load or even re-evaporation conditions exist to prevent any loss of steam.
. . . for maintaining constant levels.
. . . for discharging liquids of low or varying specific gravities.
. . . for dual-gravity service to maintain an interface by draining a heavy liquid from a lighter liquid.

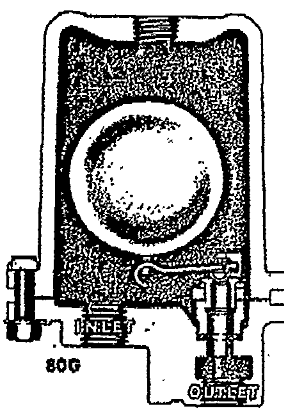
TRAPS No. 60F, 271G, 540, 542 are of high pressure cast iron (ASTM Class 35) for pressures to 250 psi — 450°F. or 300 psi — 150°F. Trap No. 701DF is of forged steel construction for pressures to 300 psi — 500°F. Working parts are of stainless steel with Clark-loy (heat-treated stainless steel) seats and discs. Floats are copper-plated steel or optional stainless steel.



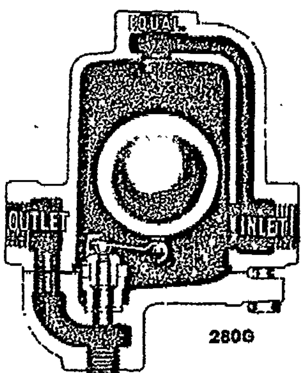
542

Trap No.	In and Out Conn.	Equal Conn.	Dimensions			Continuous discharge capacities in G.P.M. at indicated pressures. Orifice diameters are shown at the maximum operating pressure for each trap.										
			HT.	DIA.	WT.	15	30	50	75	80	100	125	150	200	250	300
60F	½"or ¾"	¼"	5¾"	*5⅛"	5	⅛ .9	⅛ 1.3	7/64 1.3	3/32 1.1	3/32 1.1	5/64 .9	5/64 1.0				
540	½"		6 7/16"	4⅞"	9	9/64 1.2	9/64 1.6	7/64 1.3	7/64 1.5	5/64 .8	5/64 .9	5/64 1.0	1/16 .6	1/16 .7		
542	½"or ¾"	¼"	6 11/16"	5⅝"	11	9/64 1.2	9/64 1.6	9/64 2.0	9/64 2.5	9/64 2.5	7/64 1.7	7/64 1.9	7/64 2.0	5/64 1.2	5/64 1.2	1/16 .9
271G	½"or ¾"	½"	8¾"	*5⅞"	12	7/32 2.9	7/32 4.0	5/32 2.7	5/32 3.1	5/32 3.1	7/64 1.7	7/64 1.9	3/32 1.4	5/64 1.2	5/64 1.2	5/64 1.3
701DF	½"or ¾"	½"or ¾"	6 5/16"	4⅞"	9	7/32 2.9	7/32 4.0	5/32 2.7	5/32 3.1	5/32 3.1	7/64 1.7	7/64 1.9	3/32 1.4	5/64 1.2	5/64 1.2	5/64 1.3

*Face to Face Dimension



80G



280G

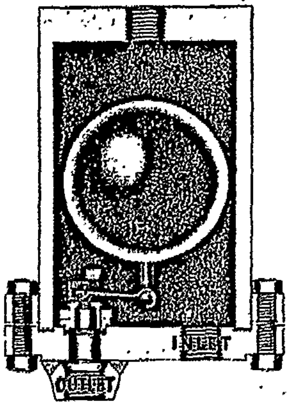
SERIES 80G — 280G CLARK TRAPS are of high-pressure cast iron (ASTM Class 35) construction for pressures to 250 psi — 450°F. or 300 psi — 150°F. Available for pipe sizes ½"—2" in 80G Series and ½"—1¼" in 280G series. Equipped with stainless steel working parts and Clark-loy (heat-treated stainless steel) seats and discs. Duo-Step Leverage standard for greater capacities at lower cost. Copper-plated steel floats for pressures to 200 psi or optional stainless steel floats for pressures to 300 psi.

	80-G	280-G	81-G	281-G	82-G	84-G
Pipe Size	½", ¾"	½", ¾", 1"	¾", 1"	¾", 1", 1¼"	1", 1¼"	1½", 2"
Equalizer Connection	½"	½"	¾"	½"	1"	1½"
Height	8⅜"	11½"	9½"	13"	11¼"	14½"
Diameter	6¼"	*7⅜"	7⅞"	*9⅛"	8¼"	11¼"
Weight	16	21½	28	40½	41	80

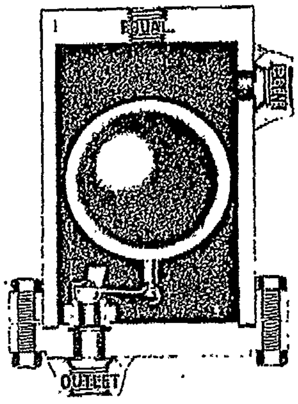
*Face to Face Dimension

See back of this folder for complete charts of continuous discharge capacities in G.P.M. at indicated pressures and various specific gravities. Orifice diameters shown on the chart are indicated at the maximum operating pressure for each trap. For sizing dual-gravity applications, forward requirements to your local representative or the factory.

SERIES 640, 740 AND 4200 CLARK FLOAT TRAPS



640

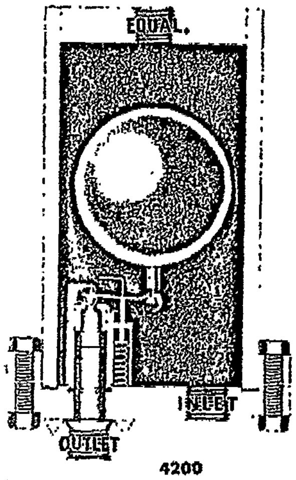


740

SERIES 640 and 740 CLARK FLOAT TRAPS are of fabricated steel for maximum pressure of 600 psi at 750°F. or 1000 psi at 150°F. Equipped with stainless steel working parts, Clark-loy (heat-treated stainless steel) seat and valve disc for long wear and low maintenance. Duo-Step Leverage for greater capacities at lower cost. Chrome-plated steel or optional stainless steel floats.

The 641 and 644 can also be furnished in all cast stainless steel construction.

4200 — CLARK FLOAT TRAPS are of fabricated steel for maximum pressure of 600 psi — 750°F. or 1000 psi at 150°F. Stainless steel working parts and Clark-loy seats and valve disc — chrome-plated or optional stainless steel floats. Operating mechanism includes spring assist for greater capacities at higher pressures and low specific gravities. The 4201 is the same as above but is equipped with a side inlet similar to the 740 series.



4200

	640 740	641 741	642 742	643 743	644 744	4200 4201
Pipe Size	1/2", 3/4", 1"	3/4", 1", 1 1/4"	1", 1 1/4" 1 1/2"	1 1/4", 1 1/2"	1 1/2", 2"	1", 1 1/4", 1 1/2"
Equalizer Connection	1/2"	1/2"	3/4"	1"	1"	3/4"
Height	8 5/8"	11 1/4"	12 11/16"	14"	15 11/16"	12 11/16"
Diameter	6 1/4"	7 3/4"	9 1/8"	10 1/8"	11 5/8"	9 1/8"
Weight	23	46	75	106	147	76

Note: Above traps can be furnished with sockerweld connection. 740 series and 4201 can be furnished with 600 lb. ASA flanged connection.

See back of this folder for complete charts on continuous discharge capacities in G.P.M. at indicated pressures and various specific gravities. Orifice diameters shown on the chart are indicated at the maximum operating pressure for each trap. For sizing dual-gravity applications, forward your requirements to your local representative or the factory.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-36

SUBJECT: INSTALLATION AND REPAIR OF PLUMBING

Installation of plumbing includes toilets, sinks, showers, hot water tanks, water coolers, septic tanks, sewer lines, water lines, etc. In this line of work extreme care must be used because of the type of material with which you are working. Toilets and sinks must be secured properly. Septic tanks and sewer lines must be laid one-eighth inch drop to two feet of pipe to get proper gravity flow and still float the material away.

Repair of plumbing consists of plugged sewer lines, valve gaskets and corrosion to water lines. To unplug a toilet, use a plunger or plumber's friend. If this doesn't clear the line, use a plumber's snake; this will unplug the line. To replace valve gaskets, remove valve bonnet and put in new gasket.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE DATE: JULY 1, 1970
CLASSIFICATION: PIPEFITTER (TRAINEE)

ITEM NO. B-37 SUBJECT: INSTALL TUBING

Tubing should be installed in tubing channel whenever possible. If not possible, it should be run on or in some type of hanger that runs the entire length of the job.

Tubing must be cut square and reamed out on the end after each cut. Care should be taken when making tubing connections that tubing is sufficiently in connection. When tightening connection, use backup wrench because tubing will twist or crimp. Also, it will do this when putting tubing in hangers, so handle very carefully.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-38

SUBJECT: STEAM RADIATORS

A. REMOVE

When removing a radiator, secure a scaffold and rigging before disconnecting. There is a flange at the top of the radiator, from which the bolts must be removed, and a union at the bottom of the radiator. There are two hanger bolts that hold radiators in place. After the rigging is in place, the hanger bolts may be removed and the radiator taken out.

B. INSTALL

When installing a radiator, clean flange and union surfaces, use the proper gasket and reverse the procedure above.

C. REPAIR

Radiators usually leak in the soldered fittings on the coil inside the radiator housing. If so, it will be necessary to completely take the raditor apart to repair the leak. Put a test on the radiator to locate the leak. Then clean the area thoroughly and resolder.

Sometimes radiator headers develop holes. If this happens, cut a patch to cover the hole and have it welded on.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-39

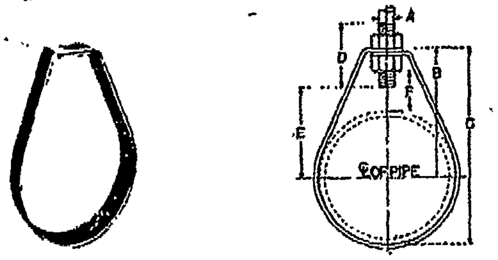
SUBJECT: INSTALL PIPE HANGERS AND SUPPORTS

Pipe hangers are installed to hold pipe securely in place. The majority of the pipe hangers are made by the pipefitter as he installs his fabrications to help hold the pipe as he proceeds. He makes the hangers out of whatever he feels necessary to do the job.

Attached is information and illustrated drawings of various pipe hangers and supports.

adjustable ring

fig. 269



size range: ½ through 8 inch.

material: Carbon steel.

finish: Black or galvanized; furnished black unless otherwise specified.

service: Recommended for suspension of non-insulated, stationary pipe lines or conduit.

maximum temperature: 650°F.

approvals: Underwriters' Laboratories listed and Factory Mutual approved for ¾ to 8 inch pipe only when galvanized. Complies with Federal Specification WW-H-171c (Type 7) and Manufacturers Standardization Society SP-69 (Type 7).

features: Provides for vertical adjustment, 1 to 2 inches.

ordering: Specify pipe size, figure number, name.

loads • weights • packaging

pipe size	max recom load, lb*	wgt (approx) lb per 100	carton
½	610	10	25
¾	610	14	25
1	610	15	25
1¼	610	17	25
1½	610	25	25
2	610	28	25
2½	970	37	25
3	970	43	25
3½	970	47	25
4	1250	90	10
5	1250	110	....
6	1600	154	....
8	1800	270	....

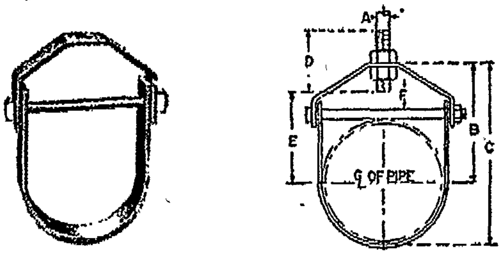
* With minimum safety factor of 5.

dimensions (inches)

pipe size	A	B	C	D	rod take-out E	adjustment F
½	⅜	1 11/16	2 5/16	2½	1⅛	1
¾	⅜	2 1/16	2⅝	2½	1 5/16	1
1	⅜	2 3/16	2⅞	2½	1 7/16	1
1¼	⅜	2 7/16	3 7/16	2½	1 13/16	1¼
1½	⅜	2¾	3 11/16	2½	1 15/16	1¼
2	⅜	3	4 3/16	2½	2 3/16	1¼
2½	½	3⅞	5 5/16	3½	3	1¾
3	½	4¼	6	3½	3 5/16	1¾
3½	½	4½	6½	3½	3 9/16	1¾
4	⅝	4⅞	7⅛	3½	3 13/16	1¾
5	⅝	5 11/16	8 7/16	4	4⅝	2
6	¾	6⅜	9 11/16	4½	5 3/16	2
8	⅞	7 5/16	11⅞	4½	6¾	2

adjustable clevis, light weight

fig. 65



size range: ⅜ through 4 inch.

material: Carbon steel.

finish: Black.

service: Recommended for suspension of light loads, pipe or conduit.

maximum temperature: 650°F.

approval: Complies with Federal Specification WW-H-171c (Type 12).

installation: Hanger load nut *above* the clevis must be tightened securely to assure proper hanger performance.

adjustment: Vertical adjustment is provided, varying with the size of clevis. Tighten upper nut after adjustment.

features: An economical attachment for light duty service.

ordering: Specify pipe size, figure number, name.

loads • weights • packaging

pipe size	maximum recommended load, lb*	weight (approx) lb per 100	pieces per carton
⅜	150	12	100
½	150	13	100
¾	250	27	100
1	250	28	100
1¼	250	32	100
1½	250	34	100
2	250	40	100
2½	350	81	50
3	350	80	50
3½	350	99	25
4	400	139	25

* With minimum safety factor of 5.

dimensions (inches)

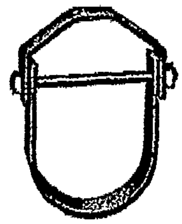
pipe size	size of steel: upper	size of steel: lower	A	B	C	D	E	adjustment F
⅜	1/16 x ¾	1/16 x ¾	⅜	1⅜	1¾	2½	¾	5/16
½	1/16 x ¾	1/16 x ¾	⅜	1⅝	2 1/16	2½	15/16	½
¾			⅜	2⅞	3⅜	2½	2 3/16	1 9/16
1	#13 U.S. Gauge x ⅞		⅜	3 1/16	3¾	2½	2⅜	1⅝
1¼			⅜	3¼	4 1/16	2½	2½	1 9/16
1½			⅜	3 7/16	4⅜	2½	2 11/16	1⅝
2			⅜	3⅝	4 13/16	2½	2 15/16	1 9/16
2½	⅛ x 1¼	⅛ x 1¼	½	4 7/16	6	3¼	3⅝	2⅛
3	⅛ x 1¼	⅛ x 1¼	½	4⅝	6⅜	3	3 11/16	1⅞
3½	⅛ x 1¼	⅛ x 1¼	½	4 13/16	6 13/16	2 15/16	4	1 13/16
4	3/16 x 1¼	⅛ x 1¼	½	5½	7¾	3¼	4⅝	2 1/16

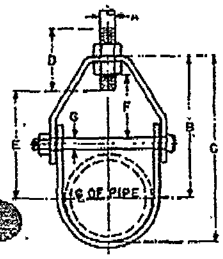
pipe hangers and supports

clevis

adjustable clevis

fig. 260





size range: 1/2 through 24 inch.

material: Carbon steel.

finish: Black or galvanized; furnished black unless otherwise ordered.

service: Recommended for the suspension of non-insulated, stationary pipe lines.

maximum temperature: 650°F.

approvals: Underwriters' Laboratories listed and Factory Mutual approved for 3/4 through 8 inch pipe. Complies with Federal Specification WW-H-171c (Type 1) and Manufacturers Standardization Society SP-69 (Type 1).

installation: Hanger load nut *above* clevis must be tightened securely to assure proper hanger performance. When an oversized clevis is used, a nipple should be placed over the clevis bolt as a spacer to assure that the lower U-strap will not move in on the bolt.

adjustment: Vertical adjustment without removing pipe may be made from 1 1/8 to 4 1/4 inches, varying with the size of clevis. Tighten upper nut after adjustment.

features:

- New design has yoke on outside of lower U-strap so yoke cannot slide toward center of bolt, thus bending of bolt is minimized.
- New design provides increased strength even with lighter stock size.
- Sizes 5-inch and up have rod and two nuts instead of bolt and nut; thread length on clevis rod is such that the thread locks the nuts in place.

ordering: Specify pipe size, figure number, name.

loads • weights • packaging • dimensions (inches)

pipe size	maximum recommended load, lb*	weight (approx) lb per 100	pieces per carton	size of steel upper	size of steel lower	A	B	C	D	E	adjustment F	G
1/2	610	34	100	1/8 x 1	1/8 x 1	3/8	2 7/16	2 7/8	2 1/2	1 3/4	1 1/8	1/4
3/4	610	39	100	1/8 x 1	1/8 x 1	3/8	2 15/16	3 7/16	2 1/2	2 3/16	1 1/2	1/4
1	610	44	100	1/8 x 1	1/8 x 1	3/8	3 1/8	3 13/16	2 1/2	2 7/16	1 5/8	1/4
1 1/4	610	45	100	1/8 x 1	1/8 x 1	3/8	3 5/16	4 3/16	2 1/2	2 5/8	1 5/8	1/4
1 1/2	610	55	100	#9 U.S. Ga. x 1	1/8 x 1	3/8	3 9/16	4 9/16	2 1/2	2 13/16	1 5/8	1/4
2	610	61	100	#9 U.S. Ga. x 1	1/8 x 1	3/8	3 11/16	4 7/8	2 1/2	2 15/16	1 5/8	1/4
2 1/2	1130	140	50	3/16 x 1 1/4	3/16 x 1 1/4	1/2	4 11/16	6 1/8	3	3 13/16	2	3/8
3	1130	152	50	3/16 x 1 1/4	3/16 x 1 1/4	1/2	4 3/4	6 9/16	3	3 7/8	1 3/4	3/8
3 1/2	1130	170	25	3/16 x 1 1/4	3/16 x 1 1/4	1/2	4 15/16	6 15/16	3	4 1/16	1 3/4	3/8
4	1430	213	25	1/4 x 1 1/4	3/16 x 1 1/4	5/8	5 5/16	7 13/16	3 1/2	4 1/2	1 15/16	3/8
5	1430	244	....	1/4 x 1 1/4	3/16 x 1 1/4	5/8	6 3/16	9	3 1/2	5 1/8	1 3/4	1/2
6	1940	357	....	1/4 x 1 1/2	3/16 x 1 1/2	3/4	6 13/16	10 1/8	4	5 5/8	1 7/8	1/2
8	2000	496	....	1/4 x 1 3/4	3/16 x 1 3/4	7/8	8 5/16	12 5/8	4 1/4	7	2 1/8	5/8
10	3600	878	....	3/8 x 1 3/4	1/4 x 1 3/4	7/8	9 7/8	15 1/4	4 1/2	8 3/8	2 1/4	3/4
12	3800	1140	....	3/8 x 2	1/4 x 2	7/8	11 1/16	17 9/16	4 3/4	9 3/4	2 5/8	3/4
14	4200	1481	....	1/2 x 2	1/4 x 2	1	12 7/16	19 7/16	5 1/4	10 13/16	2 15/16	7/8
16	4800	2100	....	1/2 x 2 1/2	1/4 x 2 1/2	1	15	23	6	12 7/16	2 5/8	1
18	4800	2437	....	1/2 x 2 1/2	1/4 x 2 1/2	1 1/8	15 3/4	24 3/4	6 1/2	13 15/16	3 3/4	1 1/8
20	4800	4256	....	5/8 x 3	3/8 x 3	1 1/4	17 3/8	27 3/8	7	14 7/16	4	1 1/4
24	4800	4843	....	5/8 x 3	3/8 x 3	1 1/4	19 3/8	31 5/8	7 1/2	17 1/2	4 1/4	1 1/4
30	6000	6950	....	3/4 x 3	3/8 x 3	1 1/4	24 1/8	39 1/8	8 1/4	21 7/8	5	1 1/4

* With minimum safety factor of 5

pipe hangers

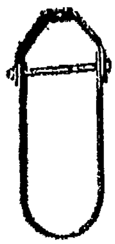
clevis

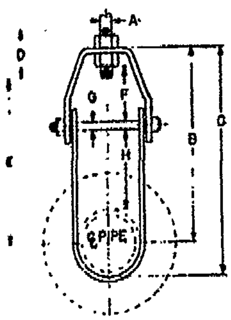
adjustable clevis for insulated lines

fig. 300

alloy:

fig. 300A





size range: ¾ through 12 inch.

material: fig. 300 — carbon steel.
fig. 300A — carbon steel yoke and clevis bolt; chrome molybdenum steel U-strap.

finish: Black.

service: Recommended for suspension of insulated, stationary pipe lines.

maximum temperature: fig. 300 — 650°F
fig. 300A — 1050°F

approvals: Complies with Federal Specification WW-H-171c (Type 1) and Manufacturers Standardization Society SP-69 (Type 1).

installation: Hanger load nut above clevis must be tightened securely to assure proper hanger performance.

adjustment: Vertical adjustment is provided, varying with the size of the clevis. Tighten upper nut after adjustment.

features:

- Designed for 2 inches of insulation on ¾ through 1½ inch pipe and 4 inches of insulation on 2 inch and larger pipe.
- When properly installed, clevis bolt is outside the insulation.

ordering: Specify pipe size, figure number, name.

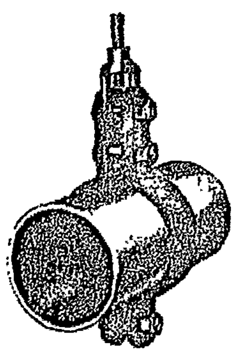
loads • weights • dimensions (inches)

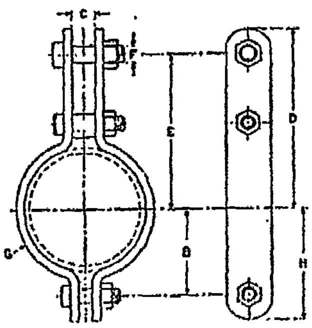
pipe size	maximum recommended load, lb*	weight (approx) lb per 100	size of steel upper	size of steel lower	A	B	C	D	E	adjustment F	G	H
¾	610	51	⅛ x 1	⅛ x 1	⅜	4¾	5⅜	2½	4	1½	¼	2
1	610	58	⅛ x 1	⅛ x 1	⅜	5	5$\frac{11}{16}$	2½	4¼	1⅝	¼	2
1¼	610	64	⅛ x 1	⅛ x 1	⅜	5$\frac{3}{16}$	6	2½	4$\frac{7}{16}$	1⅝	¼	2
1½	610	72	#9 U.S. Ga. x 1	⅛ x 1	⅜	5$\frac{5}{16}$	6$\frac{5}{16}$	2½	4$\frac{9}{16}$	1⅝	¼	2
2	610	85	#9 U.S. Ga. x 1	⅛ x 1	⅜	7$\frac{7}{16}$	8$\frac{11}{16}$	2½	6$\frac{11}{16}$	1⅝	¼	4
2½	1130	191	$\frac{3}{16}$ x 1¼	$\frac{3}{16}$ x 1¼	½	8$\frac{7}{16}$	9$\frac{15}{16}$	3	7½	2	⅜	4
3	1130	201	$\frac{3}{16}$ x 1¼	$\frac{3}{16}$ x 1¼	½	8½	10$\frac{5}{16}$	3	7$\frac{5}{16}$	1¾	⅜	4
3½	1130	210	$\frac{3}{16}$ x 1¼	$\frac{3}{16}$ x 1¼	½	8$\frac{11}{16}$	10¾	3	7¾	1¾	⅜	4
4	1430	247	¼ x 1¼	$\frac{3}{16}$ x 1¼	⅝	9$\frac{5}{16}$	11⅝	3½	8$\frac{3}{16}$	1$\frac{15}{16}$	⅜	4
5	1430	301	¼ x 1¼	$\frac{3}{16}$ x 1¼	⅝	9⅞	12¾	3½	8¾	1¾	½	4
6	1940	337	¼ x 1½	$\frac{3}{16}$ x 1½	¾	10⅝	14	4	9⅜	1⅞	½	4
8	2000	673	¼ x 1¾	$\frac{3}{16}$ x 1¾	⅞	12⅜	16¾	4	11	2	⅝	4
10	3600	1102	⅜ x 1¾	¼ x 1¾	⅞	13¾	19$\frac{3}{16}$	4½	12¼	2⅛	¾	4
12	3600	1382	⅜ x 2	¼ x 2	⅞	15⅛	21$\frac{3}{16}$	4½	13⅝	2$\frac{7}{16}$	¾	4

* With minimum safety factor of 5.

WA-TEX 001431

double bolt pipe clamp
fig. 295





size range: 3/4 through 24 inch.

material: Carbon steel.

finish: Black or galvanized; furnished black unless otherwise specified.

service: Recommended for suspension of pipe requiring up to 4 inches of insulation and where flexibility of the clamp is desirable — within the limitation of temperature and loads shown below.

maximum temperature: 750°F.

approvals: Complies with Federal Specification WW-H-171c (Type 3) and Manufacturers Standardization Society SP-69 (Type 3).

installation: Attachment to the clamp may be made with a weldless eye rod fig. 278, page ph-59, or the weldless eye nut fig. 290, page ph-63.

features:
- Load bolt and attachment will extend outside of 4-inch thick pipe covering.
- Load ratings meet USAS code requirements and are substantiated by laboratory test.
- Rounded corners on clamp ends provide greater safety for personnel.

ordering: Specify pipe size, figure number, name.

loads • weights • dimensions (inches)

pipe size	max recom load, lb* for service temp 650°F	750°F	wgt (approx) lb per 100	B	C	D	E	F	G	H
3/4	950	850	70	15/16	5/8	2 7/8	2 7/16	3/8	3/16 x 1	1 3/8
1	950	850	76	1 1/16	5/8	3	2 9/16	3/8	3/16 x 1	1 1/2
1 1/4	950	850	81	1 1/4	5/8	3 3/8	2 11/16	3/8	3/16 x 1	1 11/16
1 1/2	1545	1380	234	1 13/16	1 1/16	4 7/8	4 1/8	5/8	1/4 x 1 1/4	2 3/8
2	1545	1380	258	2 1/8	1 1/16	5 7/8	5 1/8	5/8	1/4 x 1 1/4	2 11/16
2 1/2	1545	1380	272	2 5/16	1 1/16	6 1/8	5 3/8	5/8	1/4 x 1 1/4	2 15/16
3	1545	1380	304	2 3/4	1 1/16	6 11/16	5 15/16	5/8	1/4 x 1 1/4	3 1/2
3 1/2	1545	1380	328	3	1 1/16	6 15/16	6 5/16	5/8	1/4 x 1 1/4	3 3/4
4	2500	2230	666	3 3/8	1 1/16	7 5/8	6 1/2	3/4	5/16 x 2	4 1/2
5	2500	2230	699	3 15/16	1 1/16	8 1/8	7	3/4	5/16 x 2	5
6	2865	2555	1145	4 3/4	1 7/16	9 15/16	8 9/16	7/8	3/8 x 2 1/2	6 1/8
8	2865	2555	1315	5 3/4	1 7/16	10 13/16	9 9/16	7/8	3/8 x 2 1/2	7 1/8
10	3240	2890	1991	6 7/8	1 7/16	12	10 5/8	1	1/2 x 2 1/2	8 1/4
12	3240	2890	2225	7 7/8	1 7/16	13	11 5/8	1	1/2 x 2 1/2	9 1/4
14	4300	3835	3768	9 1/16	2	14 5/16	12 11/16	1 1/4	5/8 x 3	10 11/16
16	4300	3835	4137	10 1/16	2	15 5/16	13 11/16	1 1/4	5/8 x 3	11 11/16
18	4300	3835	4487	11 1/16	2	16 3/4	14 11/16	1 1/4	5/8 x 3	12 11/16
20	5490	4900	5725	12 3/8	2	17 1/2	15 7/8	1 3/8	3/4 x 3	14
24	4500	4015	6590	14 3/8	2	19 1/2	17 7/8	1 3/8	3/4 x 3	16

... stresses shown in the USAS Code for Pressure Piping.

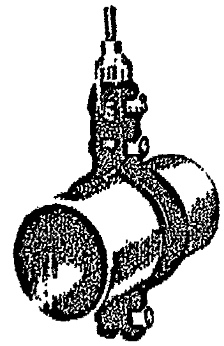
WA-TEX 001432

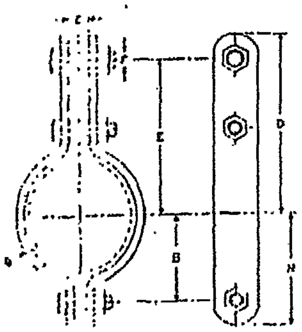
pipe hangers

steel clamps

heavy duty double bolt pipe clamp

fig. 295H





size range: 6 through 24 inch.

material: Carbon steel.

finish: Black.

service: Recommended for suspension of pipe requiring up to 4 inches of insulation and where flexibility of the clamp is desirable.

750°F.

approvals: Complies with Federal Specification WW-H-171c (Type 3) and Manufacturers Standardization Society SP-69 (Type 3).

features:

- Load bolt and attachment will extend outside of 4-inch thick pipe covering.
- Load ratings meet USAS code requirements and are substantiated by laboratory test.

ordering: Specify pipe size, figure number, name.

loads • weights • dimensions (inches)

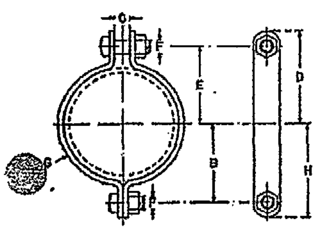
pipe size in.	maximum recommended load, lb* for service temperature		wgt (app'x) lb per 100	B	C	D	E	F	G	H
	650°F	750°F								
6	3500	3125	1200	4 3/4	1 3/4	10 3/16	8 15/16	1	3/8 x 2 1/2	6
8	4800	4285	1650	6	2	11 3/8	10 1/8	1 1/8	1/2 x 2 1/2	7 1/4
10	5500	4910	3025	7 1/4	2 1/4	13 1/8	11 3/8	1 1/4	1/2 x 3 1/2	9
12	7000	6250	4200	8 5/8	2 1/2	14 5/16	12 9/16	1 3/8	5/8 x 3 1/2	10 3/8
14	9500	8485	6000	9 5/8	2 1/2	15 1/2	13 1/2	1 1/2	3/4 x 4	11 5/8
16	10000	8930	8000	10 7/8	3	17 1/8	14 7/8	1 3/4	3/4 x 4 1/2	13 1/8
18	13800	12325	11500	12 1/2	3 1/2	18 1/4	16 1/4	2	1 x 4	14 1/2
20	15300	13665	14000	13 1/2	3 1/2	19 3/4	17 1/4	2	1 x 5	16
24	16300	14555	19000	15 1/2	3 1/2	22 5/16	19 5/16	2	1 x 6	18 1/2

* Based on the allowable stresses shown in the USAS Code for Pressure Piping.

pipe hangers and supports

steel pipe clamps

medium pipe clamp
fig. 212



size range: 1/2 through 24 inch.

material: Carbon steel.

finish: Black or galvanized; furnished black unless otherwise specified.

service: Recommended for suspension of cold pipe lines or hot lines where little or no insulation is required.

maximum temperature: 750°F.

approvals: Underwriters' Laboratories listed and Factory Mutual approved for 3/4 through 8-inch pipe. Complies with Federal Specification WW-H-171c (Type 4) and Manufacturers Standardization Society SP-69 (Type 4).

installation: Normally used with weldless eye nut fig. 290, page ph-63, or eye rod.

features:
- Load ratings meet USAS Code requirements and are substantiated by laboratory test.
- Clamps tightly to pipe.
- Wide range of sizes.
- Rounded corners provide greater safety for personnel.

ordering: Specify pipe size, figure number, name.

loads • weights • dimensions (inches)

pipe size	max recom load, lb* for service temperature 650°F	750°F	wgt (approx) lb per 100	B	C	D	E	F	G	H
1/2	500	445	29	1	7/16	1 17/32	1	5/16	1/8 x 1	1 17/32
3/4	500	445	33	1 1/8	7/16	1 21/32	1 1/8	5/16	1/8 x 1	1 21/32
1	500	445	35	1 1/4	7/16	1 25/32	1 1/4	5/16	1/8 x 1	1 25/32
1 1/4	500	445	38	1 7/16	7/16	1 31/32	1 7/16	5/16	1/8 x 1	1 31/32
1 1/2	800	715	89	1 9/16	1/2	2 1/8	1 5/8	5/16	1/8 x 1	2 1/16
2	1040	930	113	2 1/8	1/2	2 3/4	2 1/8	1/2	1/4 x 1	2 3/4
2 1/2	1040	930	124	2 1/2	5/8	3 1/4	2 5/8	1/2	1/4 x 1	3 1/8
3	1040	930	139	2 13/16	5/8	3 9/16	2 15/16	1/2	1/4 x 1	3 7/16
3 1/2	1040	930	153	3 1/8	5/8	3 13/16	3 3/16	1/2	1/4 x 1	3 3/4
4	1040	930	229	3 7/16	3/4	4 3/8	3 5/8	5/8	1/4 x 1 1/4	4 3/16
5	1040	930	260	4	3/4	4 15/16	4 3/16	5/8	1/4 x 1 1/4	4 3/4
6	1615	1440	542	4 7/8	7/8	5 7/8	5	3/4	3/8 x 1 1/2	5 3/4
8	1615	1440	654	6	1	7	6 1/8	3/4	3/8 x 1 1/2	6 7/8
10	2490	2220	1362	7 5/16	1	8 9/16	7 7/16	7/8	1/2 x 2	8 7/16
12	2490	2220	1518	8 1/4	1	9 5/16	8 7/16	7/8	1/2 x 2	9 3/8
14	2490	2220	2050	9	1 1/8	10 5/8	9 1/4	7/8	1/2 x 2 1/2	10 3/8
16	2490	2220	2225	10	1 1/8	11 5/8	10 1/4	7/8	1/2 x 2 1/2	11 3/8
18	3060	2730	3156	11 1/2	1 1/4	13	11 5/8	1	5/8 x 2 1/2	12 7/8
20	3060	2730	3581	12 1/2	1 3/8	14 1/8	12 3/4	1 1/8	5/8 x 2 1/2	13 7/8
24	3060	2730	5312	15	1 5/8	16 7/8	15 1/4	1 1/4	5/8 x 3	16 5/8

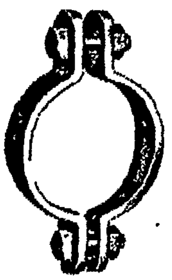
* Based on the allowable stresses shown in the USAS Code for Pressure Piping.

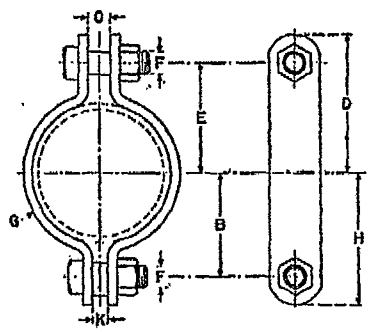
pipe hangers

pipe clamps

heavy pipe clamp

fig. 216





size range: 3 through 16 inch.

material: Carbon steel.

finish: Black.

service: Recommended for suspension of heavy loads where little or no insulation is required.

maximum temperature: 750°F.

approvals: Complies with Federal Specification WW-H-171c (Type 4) and Manufacturers Standardization Society SP-69 (Type 4).

installation: Normally used with eye rod or with weldless eye nut fig. 290, page ph-63.

features:

- Additional line can be suspended below clamp by attachment to bottom bolt.
- Load ratings meet USAS Code requirements and are substantiated by laboratory test.
- Designed for heavy loads in temperature up to 750°F.
- Rounded corners provide greater safety for personnel.

ordering: Specify pipe size, figure number, name.

loads • weights • dimensions (inches)

pipe size	max recom load, lb* for service temperature		wgt (approx) lb per 100	B	C	D	E	F	G	H	K
	650°F	750°F									
3	3370	3005	417	2 15/16	1	4	3 1/8	3/4	5/16 x 2	3 13/16	5/8
3 1/2	3370	3005	458	3 3/16	1	4 5/16	3 5/16	3/4	5/16 x 2	4 1/16	5/8
4	3515	3135	604	3 9/16	1	4 7/8	3 3/4	7/8	3/8 x 2	4 11/16	5/8
5	3515	3135	700	4 1/8	1	5 1/2	4 3/8	7/8	3/8 x 2	5 1/4	5/8
6	4865	4340	1340	5	1 1/8	6 5/8	5 1/4	1	1/2 x 2 1/2	6 3/8	7/8
8	4865	4340	1570	6 1/8	1 1/8	7 5/8	6 1/4	1	1/2 x 2 1/2	7 1/2	7/8
10	6010	5360	2450	7 5/16	1 1/4	9 1/16	7 11/16	1 1/4	5/8 x 2 1/2	8 15/16	7/8
12	8675	7740	4250	9	1 5/8	10 7/8	9 1/4	1 1/2	3/4 x 3	10 5/8	7/8
14	9120	8135	5197	9 3/4	1 5/8	11 7/8	10	1 1/2	3/4 x 3 1/2	11 5/8	7/8
16	9120	8135	5687	10 3/4	1 5/8	12 7/8	11	1 1/2	3/4 x 3 1/2	12 5/8	7/8

* Based on the allowable stresses shown in the USAS Code for Pressure Piping.

WA-TEX 001435

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE DATE: JULY 1, 1970
CLASSIFICATION: PIPEFITTER (TRAINEE)

ITEM NO. B-40 SUBJECT: PACK VALVES

When you are packing valves you must be sure to have the right size packing for the size valve you are packing. Also, there are special types of packing for steam, gas, etc., service.

When packing valves be sure to have sufficient packing under packing ring to stop product leak and still let valve open and close.

It helps to lubricate the packing while installing.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-41

SUBJECT: INSTALL AND REMOVE OHMART LEVEL CONTROLLER

A. REMOVE

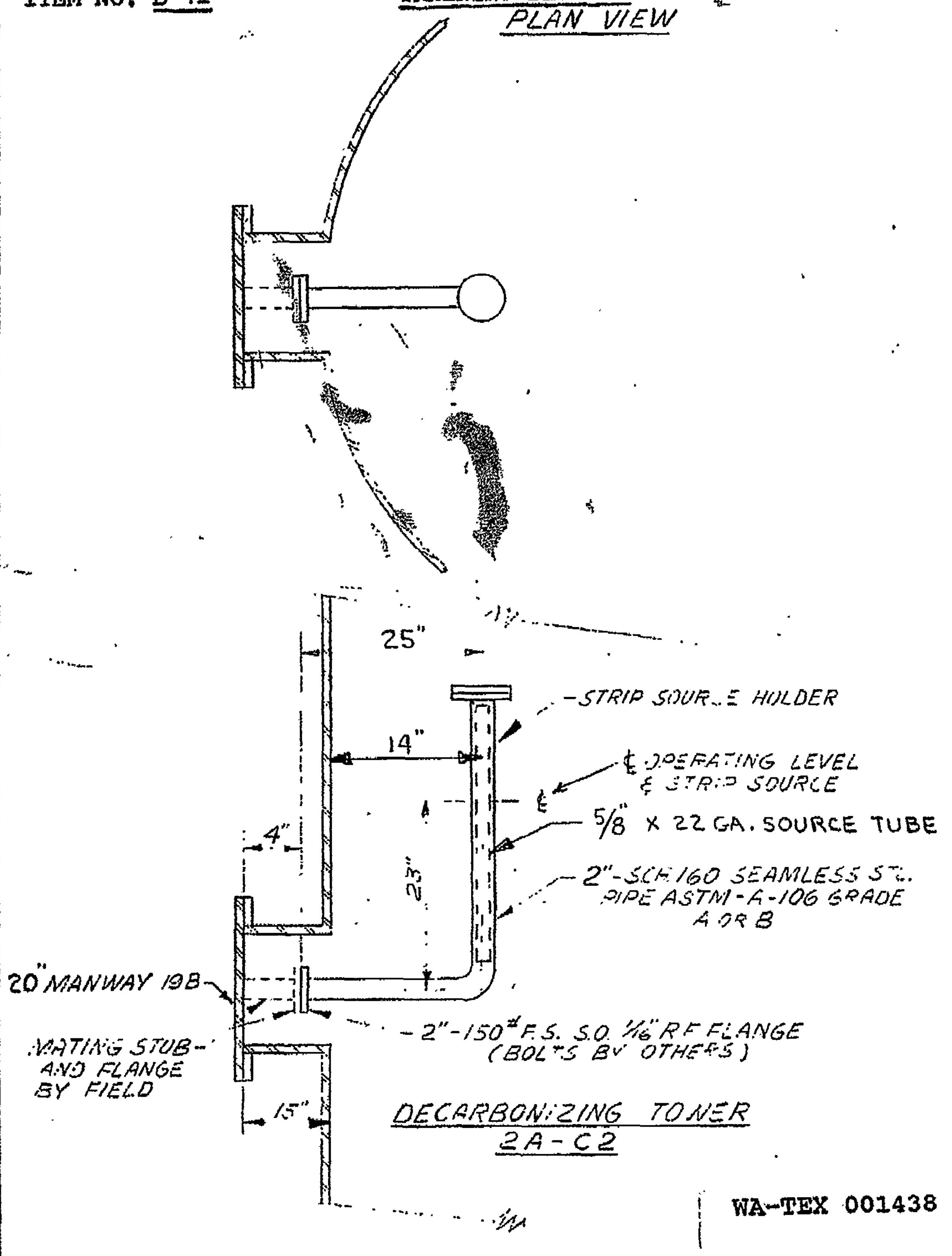
The removal of Ohmart level controller is done right after crude unit is brought down for test and inspection.

There are two bolts left in the manway, remove them and open manway as far as possible. The Ohmart level controller is bolted to the manway by a two-inch flange. This requires two men. One man loosens bolts while the other holds the controller, which has handles. Be careful not to touch upper part of controller. Take the controller out and let it down to the slab by rope. Keep it at arms length. Put controller in container and take it to storage room.

B. INSTALL

Installation is done after the decarbonizing tower is ready to be put back in operation. Be sure gasket surface is clean and put a new gasket and bolts in. Then reverse procedure above.

It is important that you read and understand Standing Instruction No. 8.



WA-TEX 001438

△							
△							
△	12-28-57	REVISED PER OHMART SKETCH 11/27/57					
△	DATE 11-13-57	ISSUED FOR CONSTRUCTION PER TL-1646-A	DR.	CH'K.	DR SUP	ENG.	CHIEF ENG.

BECHTEL CORPORATION	INSTALLATION DETAIL FOR LRC-447-A STRIP SOURCE HOLDER	DR. N.M.	DATE	JOB No. 2525
		CH'K.	DR. SUP.	DRAWING No. 50-EJ-166
		ENG.	CHIEF ENG.	REV 1

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)
DATE: JULY 1, 1970

ITEM NO. B-42
SUBJECT: REPAIR HYDRANTS

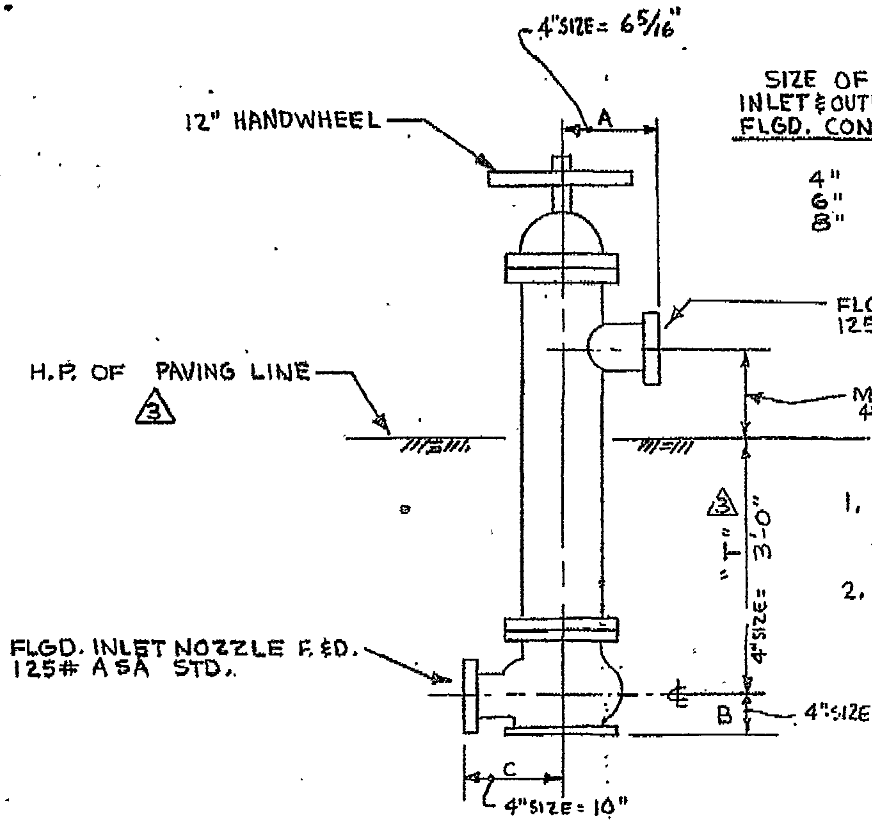
A. SERVICE WATER

Disconnect piping to hydrant, turn hydrant to open position, then take the top of the hydrant head off, with it will come hydrant shaft and hydrant disc, which is made of rubber. Put new rubber disc on shaft and it is ready to put back together. Before putting together, clean out bottom of hydrant and be sure all hydrant parts operate properly.

B. FIRE WATER

To repair this type of hydrant you must have the hydrant dug out and completely removed. These hydrants have a rubber disc in them which can be replaced. Before installing, clean hydrant and make sure all parts work properly.

Special 150# W.P. Self draining hydrant type valve, modified from manufacturer's standard fire hydrant to provide one 125# flanged outlet nozzle on the barrel. Valve to open against line pressure, working parts to be removable from grade. Balance of parts to be manufacturer's standard fire hydrant construction with suitable corrosion resistant materials, seals and gaskets. Valve to be provided with handwheel which is to turn counterclockwise to open.



SIZE OF INLET & OUTLET FLGD. CONN.	NOM. DIA. OF HYDRANT VALVE SEAT OPENING.
4"	4"
6"	6"
8"	6"

NOTES

1. "T" DIMENSION TO BE SPECIFIED WHEN ORDERING VALVE.
2. DIM'S A, B & C TO BE FURNISHED BY VALVE SUPPLIER.

WA-TEX 001440

VALVE ITEM Nº = L-1068

THIS DWG. HAS BEEN ADAPTED FROM TEXAS CO. VALVE Nº V-850B1

THE TEXAS COMPANY
PUGET SOUND WORKS

6400 L
APPROVED BY THE TEXAS CO.
TL# 350-L 4-1-57

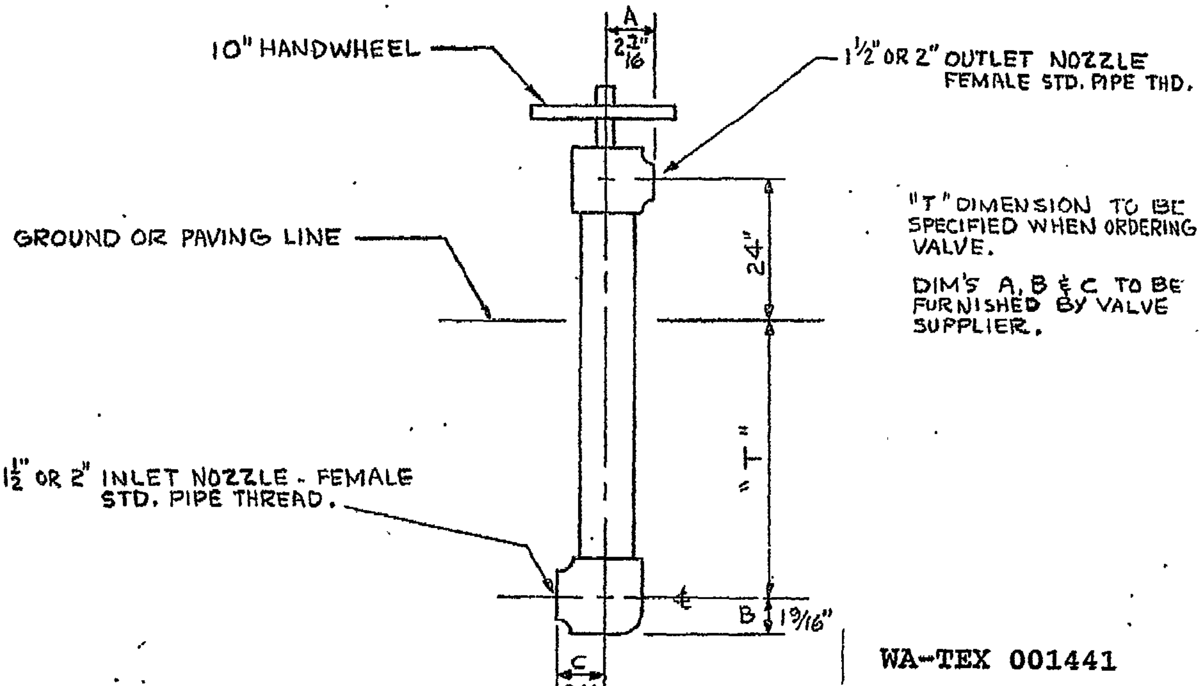
Rev.	Date	Description						
3	11-11-57	REVISED AS NOTED	E.J.H.	ME.				
2	10/23/57	ADDED DIM'S. A, B, C, T & MFG. STD. PER VENDOR DWG. F.P.# 2525-48-6-39	H.G.					
1	4/12/57	ISSUED FOR CONSTRUCTION	H.G.					
0	DATE 3-22-57	ISSUED FOR APPROVAL	DR. H.G.	CH'K.	DR. SUP.	ENG.	CHIEF ENG.	

HYDRANT TYPE VALVE FOR WATER SERVICE

DR. H-D | DATE 3-19-57 | JOB No. 2525
CH'K. | DR. SUP. | DRAWING No. | REV.
ENG. | CHIEF | 50-F1-128 | 3

BECHTEL CORPORATION

Special Self draining valve, hydrant type, 2" valve seat opening, [illegible] p.s.i. working pressure, bronze seat, leather or rubber faced pi[illegible], suitable corrosion resistant materials, suitable seals, 10" handwheel, turn counterclockwise to open, working parts to be removable from grade, valve to open against line pressure. Darling Valve & Mftrg. Co. drawing number [illegible] or equal.



VALVE ITEM NO. L-1067

NOTE: THIS DRAWING HAS BEEN ADAPTED FROM TEXAS CO. VALVE DWG. NO. V-85181

THE TEXAS COMPANY
PUGET SOUND WORKS

6400 L
APPROVED BY THE TEXAS CO.
TL# 350-L 4-1-57

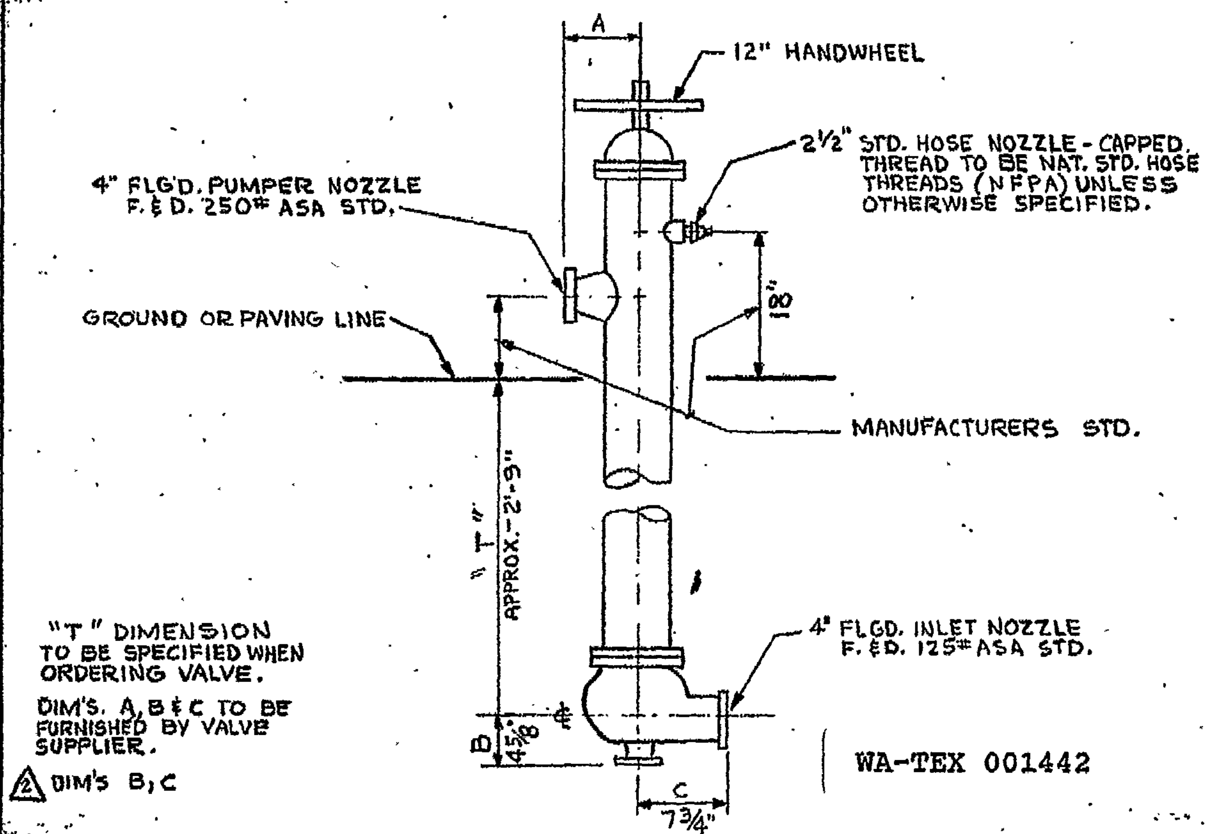
3	10/2/57	ADDED DIM'S A, B & C FR. VENDOR DWG. F.P. #2525-48-528-1-D	H.G.	SOB	wolf	SH	
2	4/12/57	ISSUED FOR CONSTRUCTION	H.G.		wolf	SH	
1	DATE 3-22-57	ISSUED FOR APPROVAL	DR H.G.	CH'K.	DR. SUP. wolf	ENG. SH	CHIEF ENG.

HYDRANT TYPE VALVE FOR WATER SERVICE

BECHTEL CORPORATION

DR. LEE H.	DATE 3-19-57	JOB No. 2525	
CH'K.	DR SUP	DRAWING No.	REV
ENG.	CHIEF ENG	50-EL-140	2

Special 150# W.P. Self draining hydrant type valve, modified from manufacturer's standard 4" nominal valve opening fire hydrant, to provide one 4" 250# ASA Std. flanged pumper nozzle and one 2-1/2" hose nozzle on the barrel. Valve to open against line pressure, working parts to be removable from grade. Balance of parts to be manufacturer's standard fire hydrant construction with suitable corrosion resistant materials, seals and gaskets. Valve to be provided with handwheel which is to turn counterclockwise to open. Similar to Darling Mfg. Co. Dwg. No. D-[illegible] or equal.



WA-TEX 001442

VALVE ITEM No = L-1069

NOTE: THIS DRAWING HAS BEEN ADAPTED FROM TEXAS CO. VALVE DWG. NO V-85082

THE TEXAS COMPANY
PUGET SOUND WORKS

6400 L
APPROVED BY THE TEXAS CO.
TL# 350-L 4-1-57

3							
2	10/23/57	ADDED MISC. DIM'S. PER VENDOR DWG. F.P. # 2525-48-S-28-7-1	H.G.				
1	4/12/57	ISSUED FOR CONSTRUCTION	H.G.				
0	DATE 3-22-57	ISSUED FOR APPROVAL	DR. H.G.	CH'K.	DR. SUP.	ENG.	CHIEF ENG.

FIRE WATER MONITOR VALVE HYDRANT TYPE

DR. LEE H.	DATE 3-19-57	JOB No. 2525
CH'K.	DR. SUP.	DRAWING No. 50-EL-139
ENG.	CHIEF ENG.	REV. 2

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-43

SUBJECT: INSTALL EXPANSION JOINTS

To install expansion joints, be sure flanges are lined up properly and to have the right gasket for the job; tighten bolts up evenly.

Expansion joints are used to prevent the transmission of vibration and to absorb the movement of piping due to thermal temperature changes. They are used on boilers, condensers, turbines, reactors and pumps.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-44

SUBJECT: FLANGE AND UNFLANGE EQUIPMENT

To flange and unflange equipment, have the right tools for the job, know the right size bolts and nuts, have the right size gaskets for the flange and be sure that the surface of the flanges are clean and properly lined up.

When working on flanged equipment, there are safety precautions to be taken. First, obtain a Safety Work Permit, Form R-241-A. The permit will state the precautions that must be taken to disconnect the flanged equipment. When loosening the bolts on the flange, loosen the bolts on the opposite side of the flange from the one you are working; if there is product in the line, it will spray away from you.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-45

SUBJECT: INSTALL EDUCTORS

A. INSTALL

When installing eductors, be sure all flange and union surfaces are clean, proper gaskets are used and that flanges are lined up properly.

The above points are important because a leak may cause loss of suction.

See the following examples of commonly used ejectors.

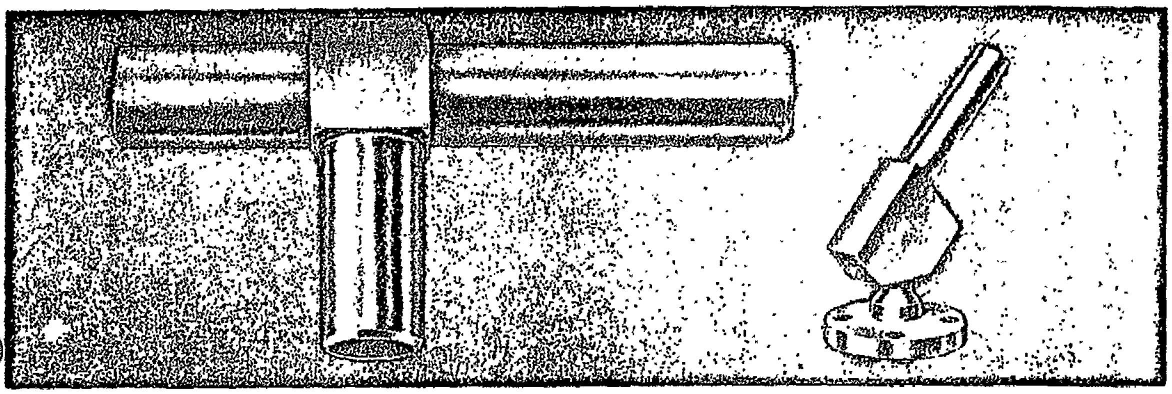
Penberthy SPECIAL EJECTORS

Bulletin SP-E

In almost every industry where liquid transfer, air or vapor removal, blending or agitating are a function of the production process, Penberthy Jet Pumps are a popular choice. Their acceptance is based on the efficient, maintenance-free, quiet operation, minimum space requirements and ease of installation.

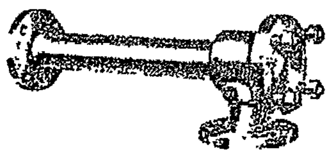
In addition to the complete line of standard model jet pumps, Penberthy maintains design and production facilities to produce special jet pumps to meet customer requirements and material specifications. Illustrated below are new bar stock ejector models and representative variety of special design and special jet products built to customer needs.

SPECIAL JET PUMPS

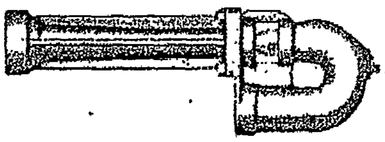


This bar stock stainless steel ejector has butt-welding connections and is used where special corrosion resistance is desired.

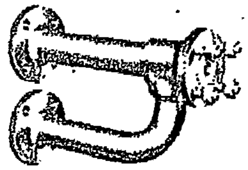
This special bar stock ejector is constructed with an angled and flanged suction connection required for a unique installation.



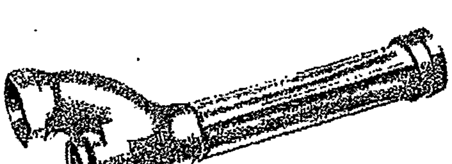
Special stainless steel jet pump with flanged connections for handling corrosive chemicals. Available in Hastelloy and carbon steel.



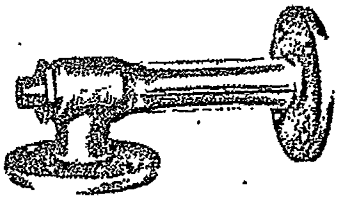
Submerged type (open suction) carbon steel ejector with screwed connections for use in tanks and having minimum resistance to flow.



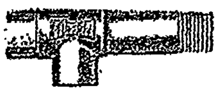
Special stainless steel all-flanged connections ejector with suction parallel to discharge to meet installation limitations.



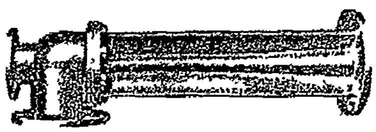
Parallel flow design carbon steel ejector for use in liquid transfer. Suction connection is shown above inlet.



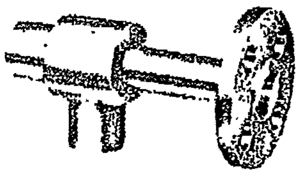
Special water-operated jet pump with flanged suction and discharge connections and screwed inlet.



This small (1/4" x 3/8" N.P.T. connections) bronze ejector has male discharge and female suction on inlet connections.

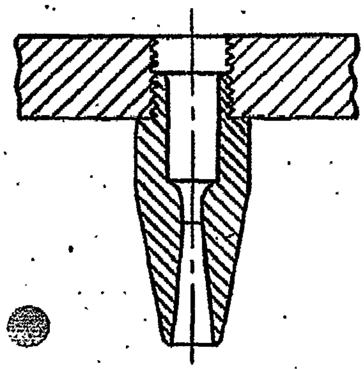


Large cast bronze hydraulic ejector with flanged connections for bilge water removal.

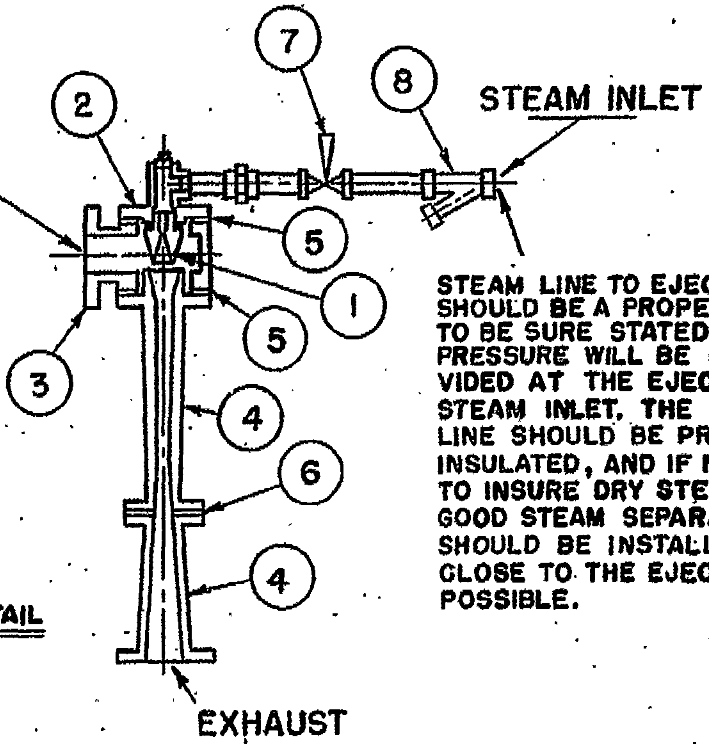


Special stainless steel ejector with flanged discharge and screwed inlet and suction connections for pumping corrosive chemicals.

GRAHAM SINGLE STAGE NON CONDENSING AIR EJECTOR



TYPICAL STEAM NOZZLE DETAIL



STEAM LINE TO EJECTOR SHOULD BE A PROPER SIZE TO BE SURE STATED STEAM PRESSURE WILL BE PROVIDED AT THE EJECTOR STEAM INLET. THE STEAM LINE SHOULD BE PROPERLY INSULATED, AND IF NECESSARY TO INSURE DRY STEAM, A GOOD STEAM SEPARATOR SHOULD BE INSTALLED AS CLOSE TO THE EJECTOR AS POSSIBLE.

VAPOR OUTLET SHOULD BE PIPED WITHOUT RESTRICTION TO CARRY THE VENTED GASES TO A POINT WHERE THESE GASES WILL NOT BE OBJECTIONABLE. ALL EJECTORS ARE SENSITIVE TO BACK PRESSURE, SO CARE SHOULD BE EXERCISED TO SEE THAT IT DOES NOT EXCEED THAT FOR WHICH THE EJECTOR IS DESIGNED.

NO	NAME
1	STEAM NOZZLE
2	STEAM CHEST
3	AIR CHAMBER
4	DIFFUSER
5	AIR CHAMBER GASKET
6	DIFFUSER GASKET
7	STEAM VALVE
8	STEAM STRAINER

GMC-194

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE DATE: JULY 1, 1970
CLASSIFICATION: PIPEFITTER (TRAINEE)

ITEM NO. B-46 SUBJECT: INSTALL TEMPORARY FIELD PUMPS

When installing field pumps, get the right pump for the job and the right equipment to haul the pump to the job site. You can get piping and fittings for suction, discharge and steam supply from pipe storage area south of the airstrip.

It is best to hook up suction piping first and then the discharge. The steam supply to operate the pump is the biggest job because it is necessary to run from 50 to 500 feet of piping to get to a steam supply sufficient to run the field pump. When running the steam supply, run a large enough pipe to steam whatever you are hooking the pump to. A two-inch pipe is usually sufficient.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-47

SUBJECT: INSTALL STEAM TRACING ON PIPE AND FITTINGS

Steam tracing is installed on piping or vessels to keep product in a liquid form. It is important that tracing is fit properly to pipe so there will be no added heat loss. Steam tracing should be trapped sufficiently to get maximum heat from steam tracing.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-48

SUBJECT: MAKE PRESSURE TAPS

A. REQUIREMENTS

(1) WHEN PERMITTED - Where practical, operating lines or equipment shall be emptied and freed of combustible gases and liquids before performing hot work. However, pressure tapping may be performed in order to avoid loss of valuable operating time or expense for gas-freeing lines and equipment when all of the conditions for the operation have been met.

(2) WHERE NOT PERMITTED

(a) In vapor space of atmospheric tankage.
(b) On alloys requiring stress relieving of welds.
(c) In hydrogen or hydrogen rich service (because of tendency to leak through the packing glands).
(d) In systems with flanges rated over 300 # ASA.
(e) No pressure tapping shall be authorized on wall thickness of less than 3/16".

(3) HOT WORK PERMIT FORM R-241 must be obtained from the operating department. The permit must be countersigned by the PLANT MANAGER or ASST. PLANT MANAGER
Material to be pressure tapped must be hammer tested by Inspection Department. Inspector on job must sign permit and results of hammer test. Asst. Plant Manager should be notified one day in advance of pressure tap. Chief Engineer must initial permit indicating no alloy is involved and meets engineering standards.

(4) SPECIAL PRECAUTIONS:

(a) Close operating supervision shall be maintained during the entire operation.

(b) A check of surrounding area for possible gas accumulation shall be made. Sewers shall be covered and surrounding area wet down.

(c) A fire watch with adequate fire fighting facilities shall always be maintained.

(d) The actual wall thickness shall be determined by the Test and Inspection Department before starting work.

(e) The pressure rating of the pressure tapping equipment shall be at least as great as the system being tapped.

(f) Welders shall be instructed to apply a light bead of weld to start with, gradually building up to required weld to prevent excessive heat.

B. LINE TAPPING

(1) A continuous flow of product must be maintained at all times during the operation to carry off heat.

C. PRESSURE TAPPING ON TANKS

(1) Liquid in the tank shall be at least two feet above the upper limit of the welding and tapping. No pumping shall be permitted in or out of the tank.

D. VESSEL TAPPING

(1) Liquid in the vessel shall be at least two feet above the upper limit of the welding and tapping. No pumping shall be permitted in or out of the vessel. In some cases when unit is down for T&I, a steam flow may be used in place of product.

E. WILLIAMS DRILLING MACHINES

(1) These pressure tap machines drill holes from 1" to 2" and 3" to 14" in any size or type of line or vessel. The drilling operation may be done under pressure by using a valve between the machine and the line. The valve is not required when there is no pressure. Line or vessel must be steamed and gas freed to drill without valve. This machine is hand operated and tool must be fed by hand.

F. WORKING PRESSURE AND TEMPERATURES

(1) 1200 P.S.I. maximum working pressure at 100°F.

(2) 500°F maximum temperature at 1000 P.S.I. The working pressure or temperature rating is reduced accordingly if any attachment, valve or fitting, subjected to pressure or temperature when using the machine, has a maximum working pressure or temperature rating less than that specified above.

G. OPERATING INSTRUCTIONS

(1) Select the correct drill for the size tap to be made.

CAUTION: When drilling through schedule 120 or above nipples, a smaller size drill must be used. Example: When drilling through a 1" schedule 160 nipple a 3/4" drill should be used. Test drill to make sure the drill adapter end will go through adapter nipple.

(2) Travel of boring bar is 1' - 2".

) Assemble drill to holder, making certain that parts are tightly assembled. Drill has flats for tightening with crescent wrench.

(4) Be sure that length of nipple plus tapping valve is short enough to permit completion of tap in boring bar travel.

(5) Attach combined drill and holder to boring bar, then attach machine adapter and gasket to drilling machine body. Tools are attached directly to boring bar by means of screw threads and butt against the square shoulder of the boring bar.

(6) After tools are attached, use the torque rod to retract the boring bar into the body of the machine. Make sure drill is retracted far enough to attach machine adapter to closed valve on line to be tapped. (Screwed or flanged).

(7) Using special grease,* lubricate drill bit and then attach drilling machine and adapter to closed gate valve (screwed or flanged, whichever the case may be). Make sure all connections are tight and bleeder valve is closed.

(8) Open gate valve, after determining pipe thickness, advance tool to the surface of metal to be cut. This can be done with ratchet handle. Set indicator rod to show travel required to complete cut.

H. TAPPING OPERATION

(1) Hand operation - automatic feed of tools when hand operating the machine is accomplished by positioning the torque rod into the gear case socket and also into the torque rod socket. This prevents rotation of the feed gear case. Rotation of boring bar automatically feeds tools at a rate of 1/80th of an inch advance for each revolution of the ratchet handle or boring bar.

(2) If a packing leakage should occur around boring bar after drill has penetrated the metal surface, operator can complete drilling operation if leak is slight, or completely retract boring bar and tighten packing.

(3) To tighten the packing nut, position the feed tube to almost its upper limit. This permits alignment of the 3/8" hole to the feed tube with the corresponding holes in the packing nut. Insert wrench (found on end of feed indicator rod) and place it in packing nut hole. This permits packing nut to rotate clockwise for tightening by turning the feed tube.

(4) If it is necessary to retract boring bar completely, mark location of feed indicator rod on feed tube before retracting. Leave indicator rod location stationary which will locate position of tool in cut after packing is tightened and drilling resumed.

* Use "MARFAX" No. 2

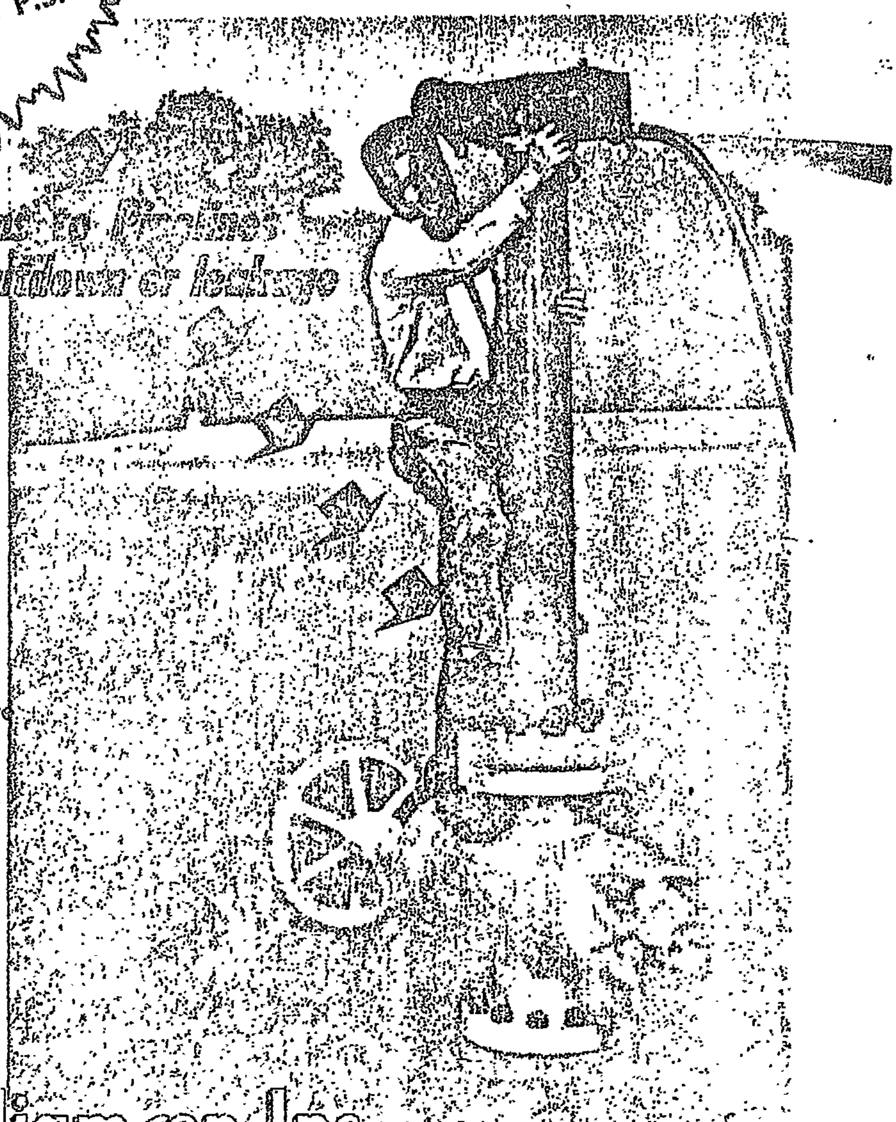
(5) RETRACTING BORING BAR WHEN CUT IS COMPLETED - when feed indicator rod is aligned with feed tube groove, the cut should be completed and boring bar may be retracted by using ratchet handle in counter-clockwise direction.

(6) After boring bar is retracted into feed tube, close gate valve. Use bleeder valve to bleed pressure from the machine before removing it from gate valve.

HIGH PRESSURE-HIGH TEMPERATURE TAPS made quickly & safely with the...

ASA 600-LB. RING JOINT FLANGE PERMITS PRESSURES TO 1,440 P.S.I. @ 100°F. TEMPERATURES TO 700°F. @ 700 P.S.I.

WmSON-HILLCO MODEL 660 TAPPING MACHINE



for making connections to Pipelines and Tanks without shutdown or leakage

★ **42" TRAVEL LENGTH OF BORING BAR**

permits . . .

PIPE TAPS TO 14" SIZE
TANK TAPS TO 16" SIZE

★ **CHOICE OF POWER:**
compact air motor or complete hydraulic drive (including engine driven pump) provides dependable lower cost power.

*Patent Nos. 2,679,178 - 2,097,398

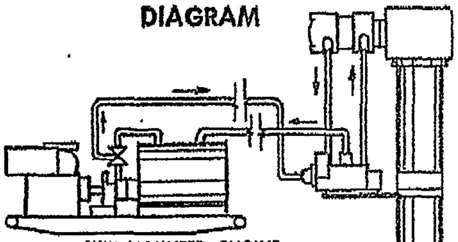
T. D. Williamson, Inc.
P. O. BOX 4038 TULSA 9, OKLAHOMA

THE WmSON-HILLCO MODEL 660 TAPPING

Choice of Power

HYDRAULIC POWER UNIT

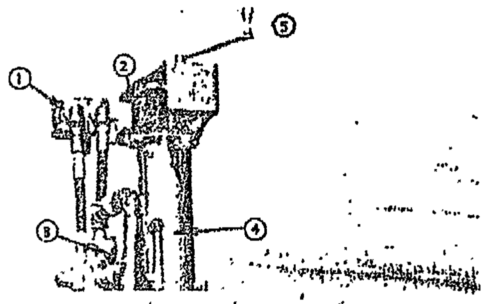
DIAGRAM

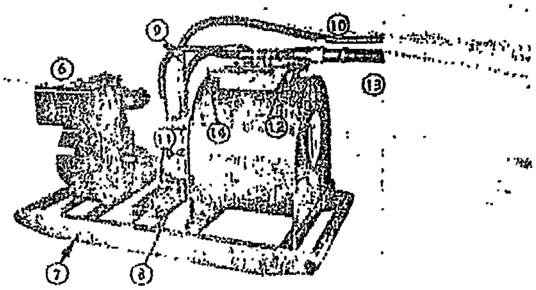


SKID MOUNTED, ENGINE DRIVEN HYDRAULIC PUMP WITH OIL RESERVOIR TANK

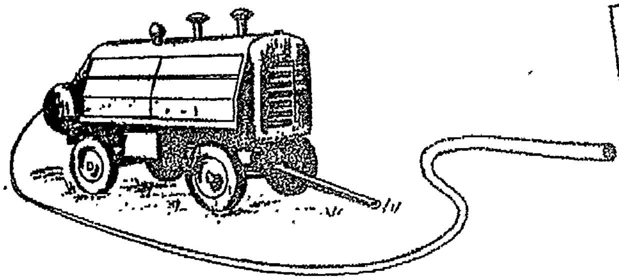
- **Relief valve protects system thru separate circuit.**
- **Extra large reservoir provides ample cooling.**
- **Mercury clutch between engine & pump with flexible coupling assures easy starting and long engine life (engine and pump mounted on specially designed neoprene shock mounts).**
- **Hydraulic components assure constant torque regardless of speed.**

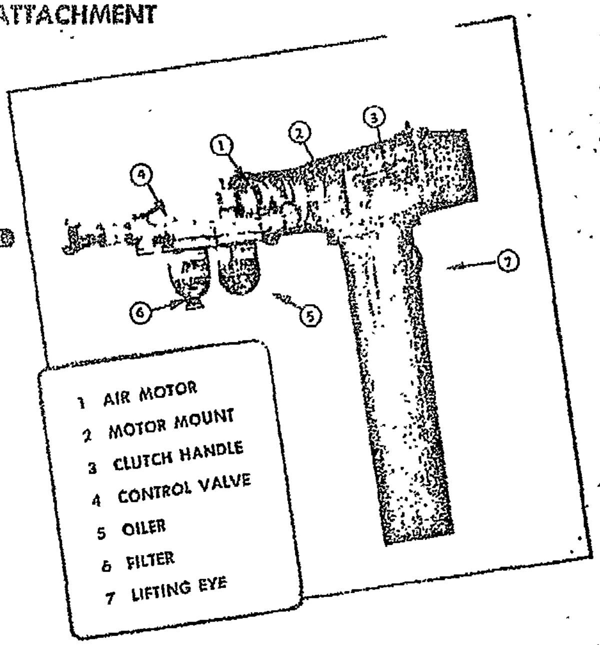
1. HYDRAULIC MOTOR MOUNTED DIRECT INTO WORMSHAFT
2. MOTOR MOUNT
3. PRESSURE GAUGE
4. CONTROL-VALVE HANDLE
5. LOWER-IN CRANK
6. 8 H.P. GASOLINE ENGINE
7. WELDED STEEL SKID
8. HYDRAULIC PUMP
9. RETURN TO TANK FROM RELIEF VALVE
10. DISCHARGE LINE TO TAPPING MACHINE
11. RELIEF VALVE
12. FILLER CAP
13. RETURN LINE FROM TAPPING MACHINE
14. SUCTION LINE





AIR MOTOR ATTACHMENT



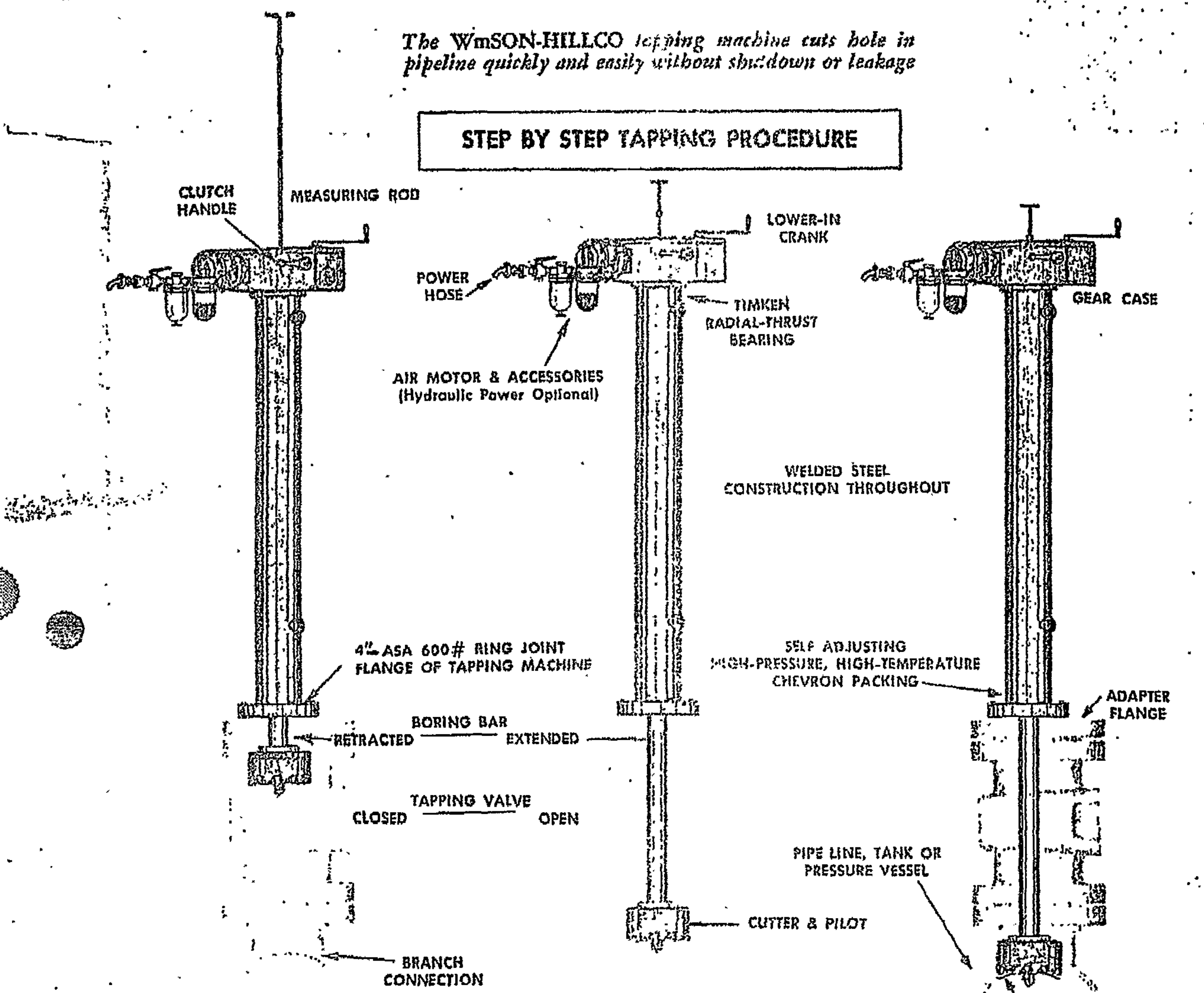


Sketch showing flow of compressed air from air compressor to receiver to air motor through 50 ft. or less of suitable air hose. Min. Compressor size: 105 CFM @ 90 PSI. (Furnished by Customer).

WITH NEW GEAR RATIO AND HIGH-SPEED POWER UNITS, (AIR OR HYDRAULIC MOTOR) TAPPING TIME IS REDUCED

MACHINE IS RUGGED AND DEPENDABLE

The WmSON-HILLCO tapping machine cuts hole in pipeline quickly and easily without shutdown or leakage



TAPPING MACHINE MOUNTED ON ADAPTER FLANGE

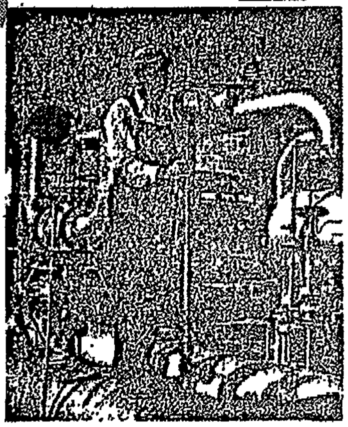
VALVE OPEN, BORING BAR EXTENDED

TAP COMPLETED, COUPON RETAINED ON PILOT DRILL

1. Weld side outlet to pipe line. Side outlet may be Pipe Nipple or Weldolet with or without reinforcement; or welded or bolted split tee.
2. Mount tapping valve on side opening. Round opening gate valves generally used. Plug valves may be used with special cutters.
3. Mount adapter flange on tapping machine, then install proper cutter. Attach tapping machine with adapter flange to tapping valve.
4. Valve open, lower-in crank is rotated to extend boring bar until pilot drill touches pipe.
5. Tapping under pressure through the wall without leakage. Coupon is retained on pilot drill by spring loaded balls.
6. Retract cutter with coupon, close valve and remove machine.

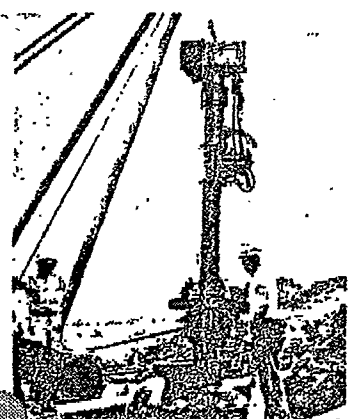
THE NEW LONGER BORING-BAR TRAVEL (42" USABLE TRAVEL) RESULTS IN A WIDER RANGE OF PIPE AND TANK TAPS . . .

3 Other Sizes of WmSON-HILLCO tapping machines to choose from . . .



MODEL 100
TAPS TO 2"
Hand Operated
800°F. @ 600 PSI
or 1200 PSI @ 100°F.

MODEL 300
TAPS TO 4"
Hand or Power Operated
400°F. @ 200 PSI
or 1000 PSI @ 100°F.

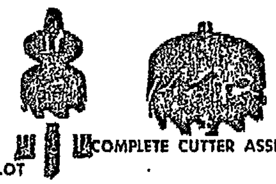


MODEL 1200
PIPE TAPS TO 24"
TANK TAPS TO 30"
Power Operated
500°F. @ 500 PSI
or 1200 PSI @ 100°F.

TYPICAL DRILLS & CUTTERS NEEDED TO COMPLETE VARIOUS SIZE TAPS (Model 660 Machine)

WmSon Insertooth cutters for Model 660 tapping machine range in sizes 3" to 14" for pipe taps and up to 16" for tank taps. All cutters have tool steel cutting edges.

Insertip pilots are equipped with spring loaded steel balls to hold coupon in cutter.



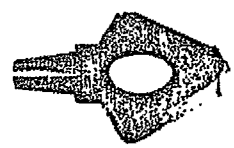
Broader application of tapping machines with PV drills *Designed for tapping holes through* PLUG VALVES

The PV drill is a spade type drill that passes through the rectangular opening in a plug valve, threaded or flanged, and drills a round hole in pipe.

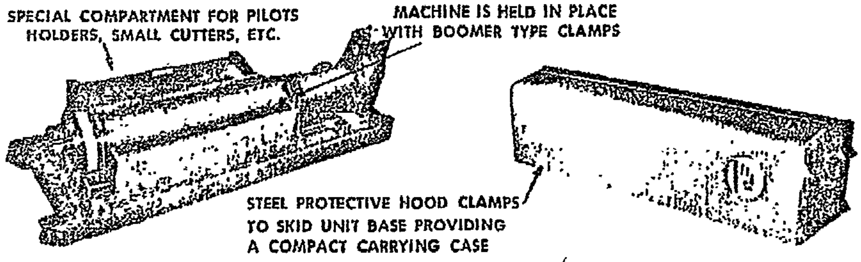
Other cutter shapes and sizes are available for use with special valves having restricted openings.

STANDARD PV DRILL SIZES FOR MODEL 660 TAPPING MACHINE

3" 4" 6" 8"

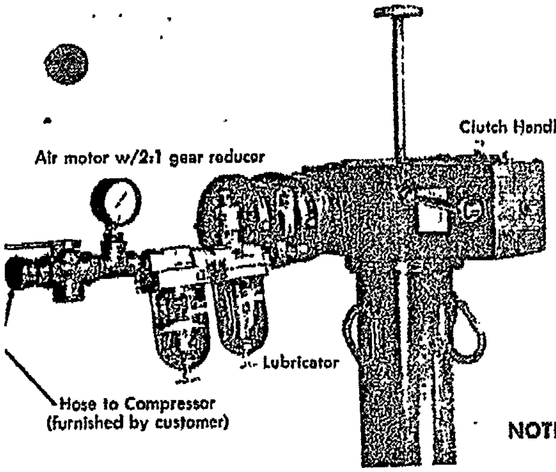


CARRYING CASE FOR TAPPING MACHINE



WA-TEX 001457

T. D. Williamson, Inc.
P. O. BOX 4038 TULSA 9 OKLAHOMA



AIR MOTOR

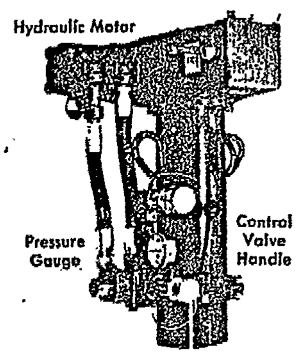
Minimum compressor requirements: 105 CFM @ 90 psi. (Furnished by customer)

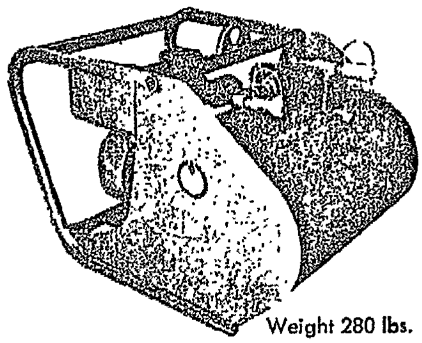
NOTE: Hydraulic power is recommended for taps over 12"

CHOICE OF POWER

HYDRAULIC POWER

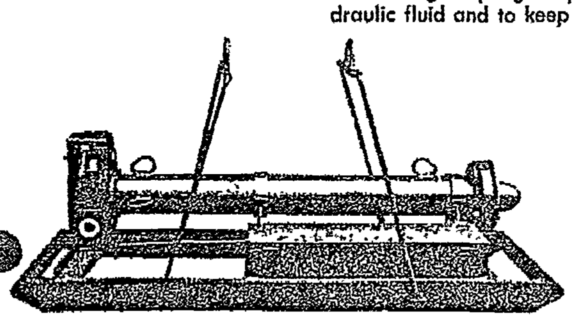
Complete self-contained power unit.
No other source of power required.





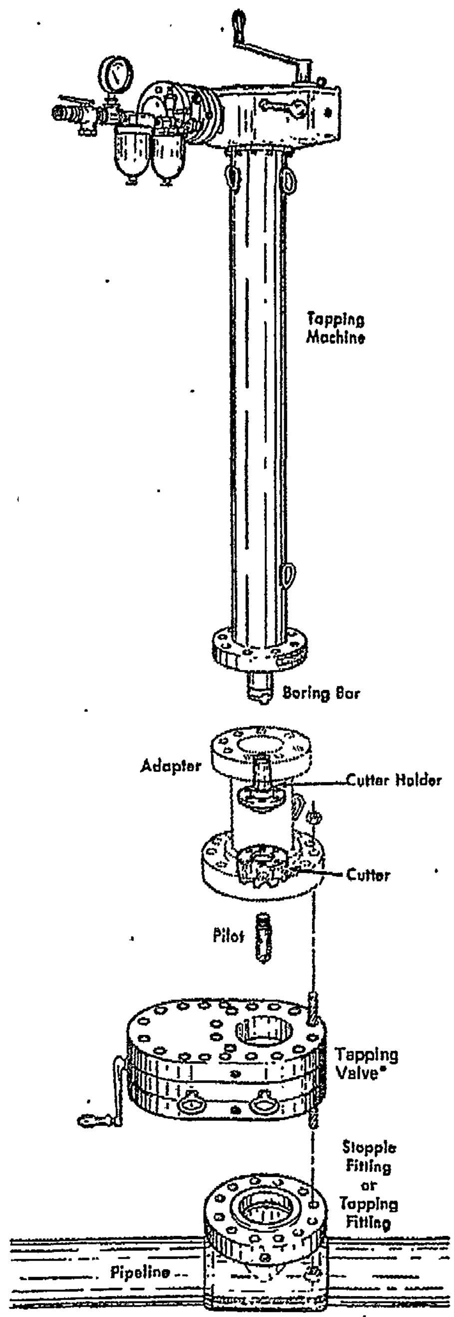
Hydraulic Power Unit

- 9 H.P. air cooled gasoline engine
- 20 gal. hydraulic fluid reservoir (SAE 10 W oil normally used for fluid.) Not furnished.
- Hydraulic hose — 50 ft.
  Diameter: ⅝" for pressure line
  ¾" for return line
- Hose connections equipped with best quality self sealing couplings to prevent loss of hydraulic fluid and to keep system clean.



Tapping Machine Mounted on Skid.

TYPICAL TAPPING SET-UP



* WmSon Sandwich tapping valve. Conventional gate valve may be used.

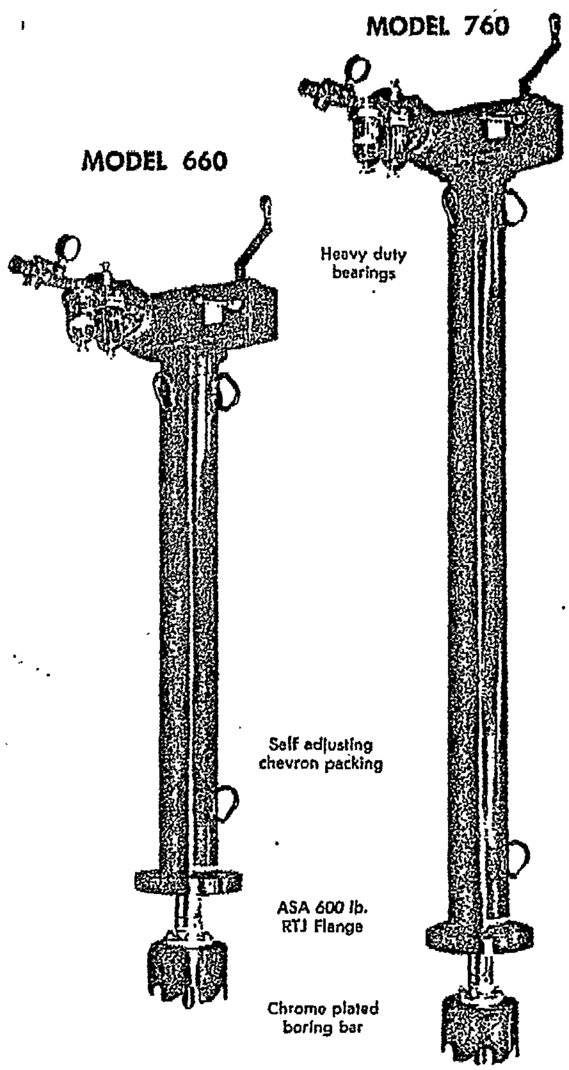
W<u>m</u>Son-Hillco Tapping Machines

Models 660 & 760

404.0
April 1, 1969
Supersedes
Jan. 1, 1967

For making connections to pipelines and plant piping safely and without shut-down.

Models 660 and 760 Tapping Machines are identical with the exception of length and tapping capacity.



Specifications

Model 660: Boring bar travel 42"; taps 3" thru 12"

Model 760: Boring bar travel 66"; taps 3" thru 16"

Maximum operating pressure, both models:
1,440 psi @ 100° F.

Maximum operating temp., both models:
700° F. @ 700 psi

Each machine factory tested to 2,175 psi

Power: Hydraulic or air

Feed: 660 – standard .005 per rev.
optional .003 per rev.
760 – standard .003 per rev.

Lower-in crank: Approx. 4½ turns per in.

Approximate Weights:
660 w/air motor 600 lbs.
760 w/air motor 625 lbs.
660 w/hydraulic 535 lbs.
760 w/hydraulic 660 lbs.

Lengths: 660, 64½" without measuring rod
110½" with rod
760, 88½" without measuring rod
158½" with rod

Cutters are available for standard pipe taps, Stopple Plugging Machine taps and Shortstopp® Plugging Machine taps. Special cutters can be furnished for tanks and flat plate taps.

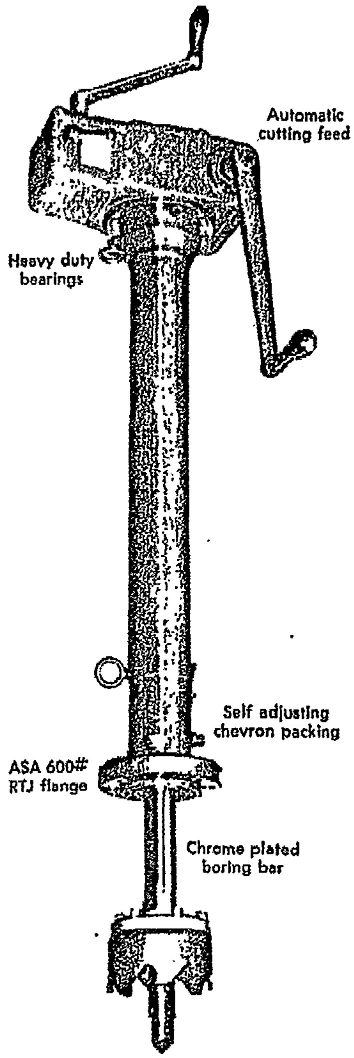
U. S. PATS. 2,679,173 – 2,097,398

WmSon-Hillco Tapping Machine
Model 360

403.0
Jan. 1, 1965
Supersedes

For making connections to pipelines and plant piping safely and without shut-down.

☆ Hand operated or air motor drive.



Specifications:

Boring bar travel: 24"

Tank taps to 4", pipe taps to 6"

Maximum operating pressure:
1,440 psi @ 100° F.

Maximum operating temperature:
700° F. @ 700 psi

Each machine factory tested to 2,175 psi

Power: Manual or air motor
Feed: .005 per revolution
Lower-in crank: 12 turns per inch

Weights: Hand powered, 125 lbs.
Air powered, 163½ lbs.

Length: 42¾" without measuring rod
70" with rod

- Cutters are available for standard pipe taps, Stopple Plugging Machine taps and Shortstopp® Plugging Machine taps.

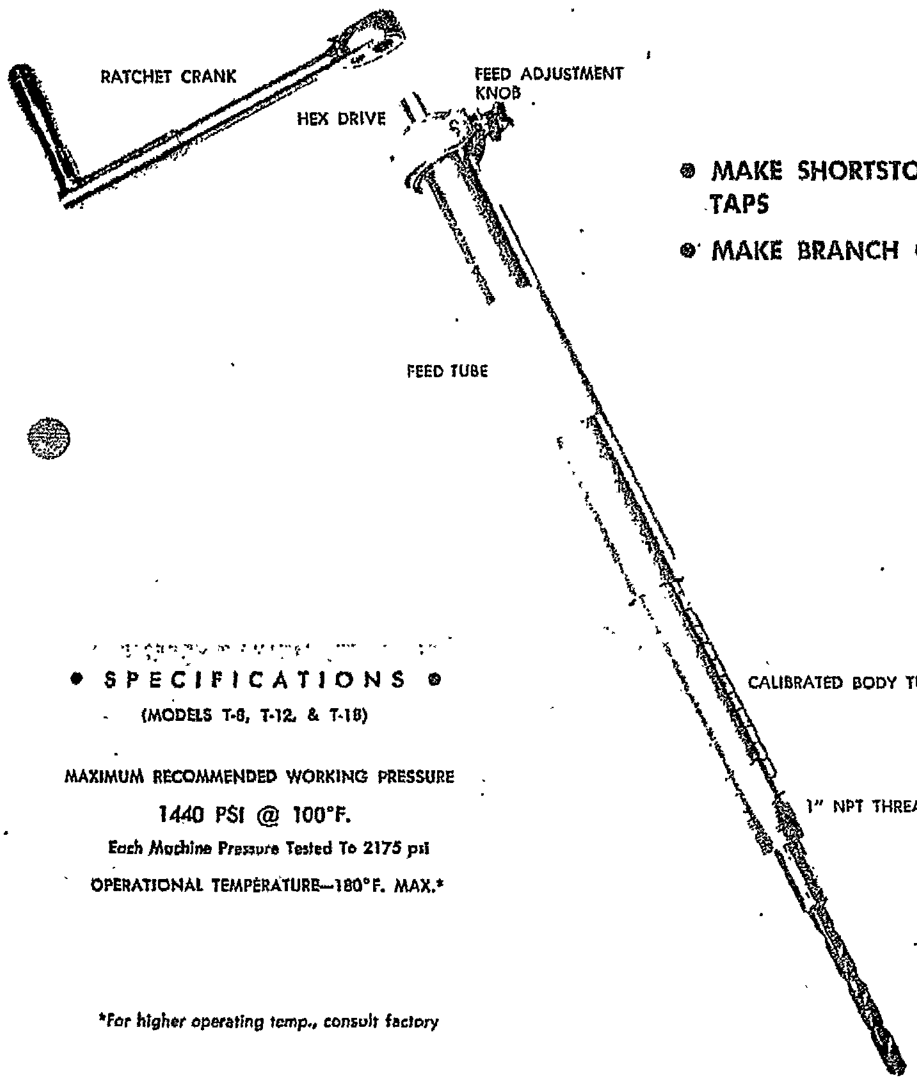
Special cutters can be furnished for tanks and flat plate taps.

U. S. PATS. 2,679,173 — 2,097,398

4010
Jan. 1, 1965
Supersedes

WmSON SHORTCUTT DRILLING MACHINES

T-8, T-12 & T-18



- MAKE SHORTSTOPP® PLUGGING MACHINE TAPS
- MAKE BRANCH CONNECTIONS

• SPECIFICATIONS •

(MODELS T-8, T-12, & T-18)

MAXIMUM RECOMMENDED WORKING PRESSURE

1440 PSI @ 100°F.

Each Machine Pressure Tested To 2175 psi

OPERATIONAL TEMPERATURE—180°F. MAX.*

**For higher operating temp., consult factory*

U.S. PATENT NO'S 3068725, 3068726 & PATENTS PENDING IN OTHER COUNTRIES

WA-TEX 001461

Installation of Pig-Sig Scraper Passage Indicator

Shown below is the proper cutter and drill, either of which may be used for drilling a hole for Pig-Sig installation. The proper valve adapter is also shown.

Cutter Holder—Pilot

1¼" Cutter

Cutter holder — Pilot 5-206
Cutter Stock No. 5-181-01

1¼" Drill

Drill Stock No.
5-193-01

Valve Adapter for Cutter or Drill
706-16 For use on 2" threaded valve.

Notes: Cutter designed for wall thicknesses up to and including ⅜".
(For thicker wall pipe use drill.)
Valve requirements: *Min. thru bore 2".*

2" Thread-O-Ring* Plug Holder

A plug holder is used for setting Pig-Sig assembly with the T-101. This holder is also used for setting T-O-R plugs which may hold gauge adapters, thermometer wells, corrosion test coupons and other instrument probes.

Stock No.
5-185-01

*Thread-O-Ring is a T. D. Williamson, Inc. trademark for an externally, internally threaded pipe nipple.

Hole Saws and Valve Adapters

Hole saws are used with the T-101 for size on size taps.

Hole Saws

Hole Saw Diameter		Hole Saw Holder-Pilot	Hole Saw
Nom. size	Cutter O.D.	Stock No.	Stock No.
2"	1⅞"	5-204	5-179-02
3"	2⅞"	5-204	5-179-03
4"	3⅞"	5-205	5-179-04

Valve Dimensions*

Valve Size	Min. Thru Bore	Max. Face to Face Dimension
2"	2-1/16"	14½"
3"	3-1/16"	14¾"
4"	4-1/32"	12"

Valve Adapters (flanged)

Size	Series	Stock No.
2"	150#	6-1305-15
3"	150#	6-1318-15
4"	150#	6-1302-15
2"	300#	6-1305-30
3"	300#	6-1318-30
4"	300#	6-1302-30
2"	600#	
3"	600#	
4"	600#	

Valve Adapters (threaded)

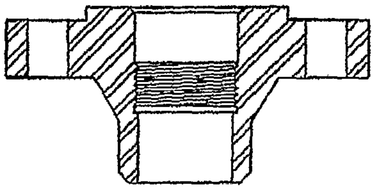
Size	Stock No.
2"	706-15

Size	Stock No.
3"	6-1303-01

**Minimum thru bore diameters and maximum face to face dimensions for making 2", 3", & 4" taps thru Shortstopp*

CHOICE OF FITTINGS

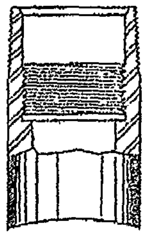
THREAD-O-RING FLANGE



CAN BE SUPPLIED WELDED TO SCARFED NIPPLE OR WELDOLET FITTING.

MADE FROM STANDARD WELDING FLANGE OF SPECIFIED SERIES AND FACING.

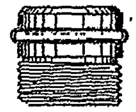
THREAD-O-RING NIPPLE



SCARFED TO FIT SPECIFIED PIPE SIZE.

MADE FROM SEAMLESS STEEL TUBING.

THREAD-O-RING PLUG

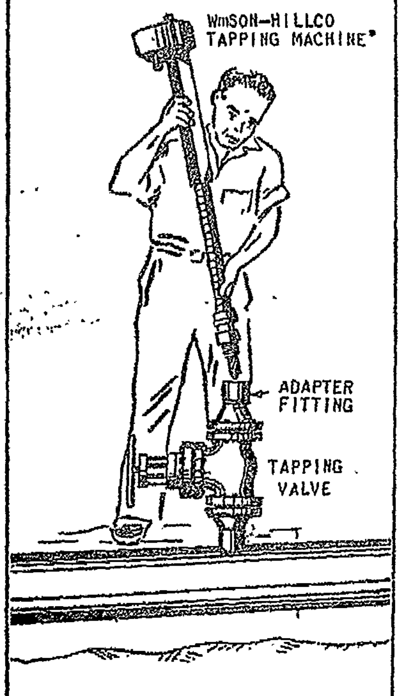


PRESSURE RATING:

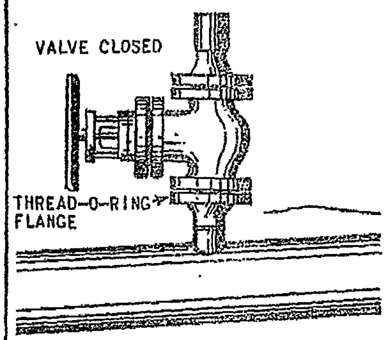
Plugs are installed against line pressure up to 1,000 PSI using WmSON-HILLCO Tapping Machines*

MADE FROM NAVAL BRASS WITH NEOPRENE O-RING

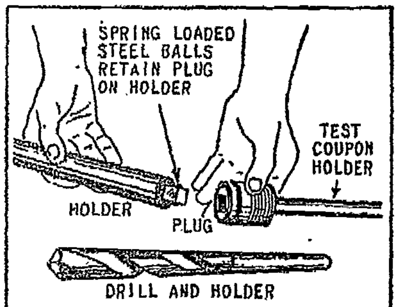
INSTALLING TEST COUPON IN PIPELINE WITHOUT SHUTDOWN



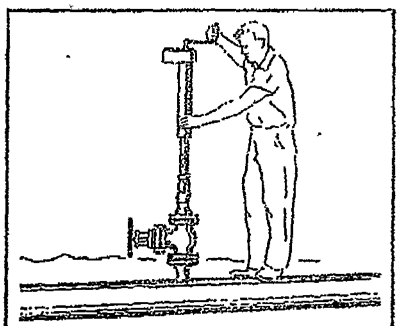
1. TAPPING MACHINE BEING MOUNTED ON FITTING IN PREPARATION FOR "HOT TAP".



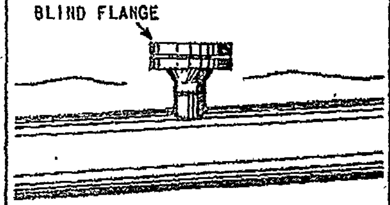
2. TAP COMPLETED, TAPPING MACHINE REMOVED.



3. DRILL IS REPLACED BY PLUG HOLDER AND THREAD-O-RING PLUG.



4. THREAD-O-RING PLUG WITH TEST COUPON IS LOWERED THROUGH THE VALVE AND THREADED INTO FLANGE.



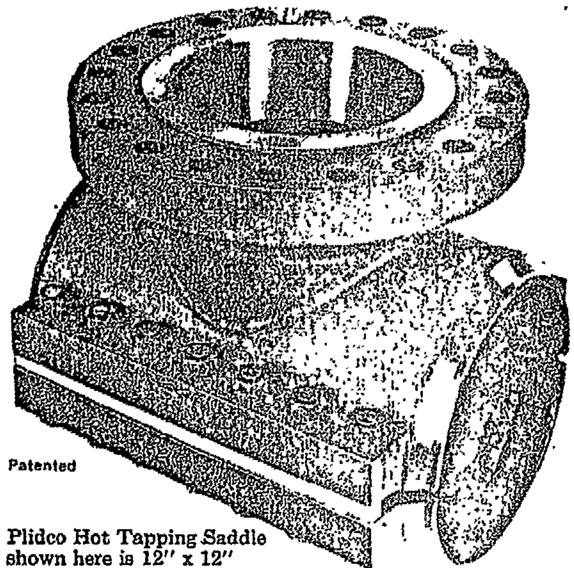
5. TAPPING MACHINE REMOVED, VALVE RECOVERED AND BLIND FLANGE IN PLACE.

NOTE: COUPON IS RECOVERED BY ABOVE PROCEDURE IN REVERSE.

** Threaded plugs are installed and removed with the following WmSON-HILLCO Tapping Machines only: Models 100, 100B, 100C, 300 and 360.

T.D. Williamson, Inc.
P. O. BOX 40 • TULSA 2, OKLAHOMA

PLIDCO HOT TAPPING SADDLE



Patented

Plidco Hot Tapping Saddle shown here is 12" x 12" with 600# ASA flanged outlet

The Plidco Hot Tapping Saddle is an adaptation of the Plidco Split-Sleeve. It is used for hot taps where surrounding conditions do not permit the immediate installation of a welded branch (including underwater tie-in to existing pipe line.)

With full branch connections, Plidco Hot Tapping Saddle can be utilized for tapping a hole large enough to permit plugging-off the main pipeline. A line break can thus be isolated and bypassed, using two plugging taps and maintaining service through a bypass.

Available with full-size branches and in any range of sizes and pressures with threaded, welding or flanged outlets. Buna-N packing standard. Silicone, Viton* and asbestos available, as well as neoprene.

After repairs are completed and oil-soaked earth is cleaned up, Hot Tapping Saddles may be permanently welded to pipeline if desired.

*DuPont Reg. T. M.

Write for Bulletin HT-700

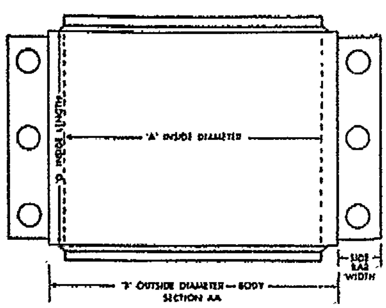


FIG NO 1

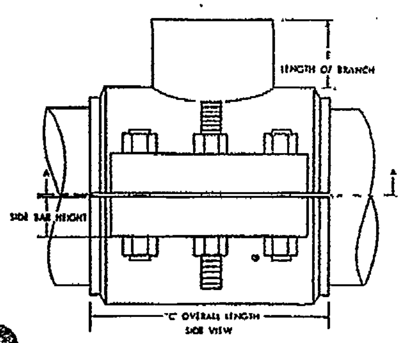


FIG NO 2

PLIDCO HOT TAPPING SADDLE SPECIFICATIONS

Main Pipe (Run) Nominal Size Inches	Branch Pipe Nominal Size Inches	Body Dimensions I.D. 'A' Inches	Body Dimensions O.D. 'B' Inches	Body Dimensions Overall Length 'C' Inches	Length Between End Packing 'D' Inches	Diam. of Studs Inches	Length of Branch 'E' Inches	Side Bars Inches	Approx. Shipping Weight Pounds
1½	1 thru 1½	2⅛	3¼	8½	5¼	⅝	2½	1 x 1	18
2	1 thru 2	2⅞	3¾	8½	5¼	⅝	2½	1 x 1½	20
3	1 thru 3	4	5	8½	5¼	⅝	2½	1 x 1½	28
4	1 thru 4	5	6	8½	5¼	⅝	3	1½ x 1½	35
6	1 thru 4	7⅛	8¼	9	5¼	¾	3	1½ x 1½	48
6	5 and 6	7⅛	8¼	18	12	¾	3	1½ x 1½	120
8	1 thru 4	9⅛	10¼	10	5¼	⅞	3½	2 x 1½	114
8	5 thru 8	9⅛	10¼	18	12	⅞	3½	2 x 1½	180
10	1 thru 4	11¼	12¾	10½	5½	1	4	2½ x 2	143
10	5 thru 10	11¼	12¾	18	12	1	4	2½ x 2	225
12	1 thru 4	13¼	14¾	10½	5½	1	4	2½ x 2	163
12	5 thru 10	13¼	14¾	18	12	1	4	2½ x 2	270
*12	12	13¼	14¾	24	18	1	4	2½ x 2	360
14	1 thru 6	14½	16½	14	8	1⅛	4	3 x 2½	264
14	8 and 10	14½	16½	18	12	1⅛	4	3 x 2½	340
*14	12 and 14	14½	16½	24	18	1⅛	4	3 x 2½	454
16	1 thru 6	16½	18½	14	8	1¼	4	3 x 2½	295
16	8 and 10	16½	18½	18	12	1¼	4	3 x 2½	380
*16	12 thru 16	16½	18½	24	18	1¼	4	3 x 2½	505
18	1 thru 6	18½	21	14	8	1¼	4	4 x 2½	360
18	8 and 10	18½	21	18	12	1¼	4	4 x 2½	465
*18	12 thru 18	18½	21	26	20	1¼	4	4 x 2½	670
20	1 thru 6	20½	23	14	8	1⅜	4	4 x 2½	400
20	8 and 10	20½	23	16	12	1⅜	4	4 x 2½	515
*20	12 thru 20	20½	23	28	22	1⅜	4	4 x 2½	800
22	1 thru 6	22½	25	14	8	1⅜	4	4 x 3	485
22	8 and 10	22½	25	18	12	1⅜	4	4 x 3	625
*22	12 thru 22	22½	25	30	24	1⅜	4	4 x 3	1038
24	1 thru 6	24½	27	14	8	1⅜	4	4 x 3	520
24	8 and 10	24½	27	18	12	1⅜	4	4 x 3	670
*24	12 thru 24	24½	27	32	26	1⅜	4	4 x 3	1885
26	1 thru 6	26½	30	14	8	1½	4	5 x 3	618
26	8 and 10	26½	30	18	12	1½	4	5 x 3	795
*26	12 thru 26	26½	30	34	28	1½	4	5 x 3	1500
30	1 thru 6	30½	34½	14	8	1½	4	5 x 3	940
30	8 and 10	30½	34½	18	12	1½	4	5 x 3	1218
*30	12 thru 30	30½	34½	38	32	1½	4	5 x 3	2550

*Not available from stock

Larger sizes on application

THE PIPE LINE DEVELOPMENT COMPANY
5350 West 130th Street • Cleveland, Ohio 44142 • Telephone: (Area Code 216) 267-1640
Export Department: 17 Battery Place, New York, New York 10004 Cable: WELDENDS-New York

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-49

SUBJECT: DISMANTLE, REPAIR AND REASSEMBLE OXYGEN LINES AND EQUIPMENT

a. SAFETY: To avoid fire and explosion hazards due to presence of oil or other combustible materials in the oxygen piping system, the following procedure shall be applied to the fabrication and installation of the oxygen piping system:

b. ASSEMBLE: The system should be assembled without the use of any greased joint compound. Gasket paste is not to be used on gaskets, bolts or flanges. Spool pieces installed at connections to equipment such as pumps, vessels and exchangers should be blinded with clean grease free blinds, gaskets and bolts. Control valves, regulators and instruments are purchased pre-cleaned and certified compatible for oxygen service; these elements are not to be installed until final equipment assembly. Valves should be installed, but without seats, gates, discs and other removeable parts.

c. HYDROSTATIC TESTING: Each section of the line should be subjected to a hydrostatic test, using clean, oil free water. The test pressure should be 1.5 times maximum operating pressure. The system should be filled with city water or other oil free water, then pumped up to test pressure. This should keep pump grease from entering the system.

After test is completed, the system should be degreased by washing with trichlorethylene.

d. NITROGEN TESTING: Nitrogen should be used in place of water, if available. The test pressure shall be 1.1 times maximum operating pressure. When testing with nitrogen, make sure proper fittings and gauges are checked out from main tool room. A ball check valve shall be placed in line between nitrogen supply and equipment being tested.

e. DEGREASING OXYGEN LINES: The system should be degreased by washing with trichlorethylene solvent followed by oil free hot water, then blown dry using warm dry nitrogen.

The valve parts which were removed should be individually degreased with trichlorethylene solvent. The valve parts should be thoroughly dried, reassembled without the use of oil, grease, or any lubricant, and valves repacked with dry oil-free asbestos packing.

Screwed connections at control valves and solenoid valves should be made up with a thin paste of freshly mixed litharge and glycerine dag dispersion #217, made by Acheson Colloids Company of Port Huron, Michigan, or equal applied to male threads only.

(1) Valve stem packing shall be suitable for oxygen service at 500°F (Johns-Manville Chempac 2024.)

(2) Low pressure nitrogen (app. 75 lbs.) available at H-2 Complex may be transferred through air hose. (Use pipe if long distance from test).

(3) High pressure nitrogen bottle connections available in main tool room.

(4) Box pump or field pressure pump may be used on hydrostatic test. Use high pressure test hoses or pipe if available.

f. REASSEMBLE: When reassembling existing oxygen lines and equipment after repairs are made, wash all parts with Trichlorethylene before replacing. Be sure no grease or pipe dopes of any kind get into these lines, nor should they be used as lubricant on gaskets, bolts or flanges.

CAUTION: Most oxygen fittings are Stainless Steel or Brass so be sure when dismantling and reassembling that nuts, bolts, flanges or other parts or fittings do not come in contact with oil or grease. It is recommended when disassembling that all fittings and parts be stored in a clean bucket.

TEXACO INC.
PUGET SOUND PLANT

TRAINING DETAILS

DEPARTMENT: PIPE
CLASSIFICATION: PIPEFITTER (TRAINEE)

DATE: JULY 1, 1970

ITEM NO. B-50

SUBJECT: INSTALL PIPE CLAMPS

A pipe clamp is used to repair a leak when the pipe line can't be blocked off or welding can't be done in the area. The pipe to be clamped must be cleaned as well as possible before putting the clamp over the hole. It is important that the clamp is centered over the hole and tightened evenly.