

US EPA ARCHIVE DOCUMENT

BOILER MANUAL

LMCF00090



INSTRUCTIONS
FOR
OPERATION
AND MAINTENANCE



WHEELER CORPORATION

New York, N. Y.

LMCF00091

71. B.
42-3

S.S. SPARTAN, Hull 369

and

S.S. BADGER, Hull 370

Built For

CHESAPEAKE and OHIO RAILWAY CO.

By

CHRISTY CORP.

FOSTER WHEELER CONTRACT FWB 3370-3 & 3396-9

Instruction Book FWB 3370-3

FOSTER WHEELER CORPORATION

165 Broadway

New York, N.Y.

LMCF00092

TABLE OF CONTENTS

Part I - Description of Steam Generators

	<u>Section</u>
Design Data	1-1
General Description	1-2
Components	1-3
Drums	
Waterwalls	
Furnace	
Refractory	
Superheater	
Economizer	
Steam Drum Internals	1-4
Desuperheater	
Internal Feed Lines	
Dry Pipe	
Continuous Blow-Down	
Surface Blow-Down	
Plates and Baffles	
Auxiliary Equipment	1-5
Tube Data List	1-6
Performance Curve	1-7
Drawings	1-8

Part II - Operation

Putting Steam Generator in Operation	2-1
Lighting Off	
Raising Steam	
Cutting in Boiler	
Shutting Down	
Safety	2-2
Operating Precautions	2-3
Emergency Procedures	2-4
Low Water	
Tube Failure	
Loss of Fires	
Air Heater Fires	
Fuel Economy	2-5
Putting New Steam Generator in Service	2-6
Hydrostatic Test	
Boiling Out	
Boiling Out Pressure Parts by Steam Method	
Inspection	
Initial Starting	
Laying Up Boilers	2-7

LMCF00093

Section

Boiler Feed Water	2-8
Sea Water Distillate	
Shore Water	
Salt Water Contamination	
Condensate Leakage	
Effect of Condensate Carry-Over	
Source of Contamination	
Leaking Lines in Bilges	
Elimination of Oil and Grease	
Avoid Excessive Make-Up	
Boiler Water Hardness	
Securing Boiler Water Samples for Analysis	

Part III - Maintenance

Boiler and Waterwall	3-1
Water Washing	3-2
Methods	
Procedure	
Washing Economizers	
Washing Superheaters	
Washing Main Boiler Tubes	
Drying Out the Boiler	
Tube Removal and Replacement	3-3
Boiler Tubes	
Superheaters	
Economizer	
Expanding Tubes	3-4
Description of Expanders	
Operation	
Maintenance	
Installing and Removing Handhole Plugs	3-5
To Install the Lip Type Plug	
To Install the Taper Plug (no lip)	
Inspection	
To Install Oval Handhole Plugs	
2" Plugs	

LMCF00094

Section

Installing and Removing Handhole Plugs (Continued)	3-5
Emergency Repair of Taper-Lip Handhole Plugs	
Elliptical Handhole Seat Grinder	
Operating Instructions	
Five-Roll Hand Operated Rolling Tool for 2" Handhole Seats	
Instructions for Operation	
Precautions	
Caution	
Economizers - Welded Return Bend	3-6
Refractories	3-7
General Description	
Refractories for Sectional Header Type Steam Generators	
Refractory for "D" Type and "A" Type Steam Generators	
Causes of Refractory Failure	
Inspection of Refractory	
Repairs to Refractory	

Appendix

Crosby Safety Valves
Jerguson Gage Glasses
Vulcan Soot Blowers
Swartwout Feed Water Regulators
Yarway Remote Level Indicator

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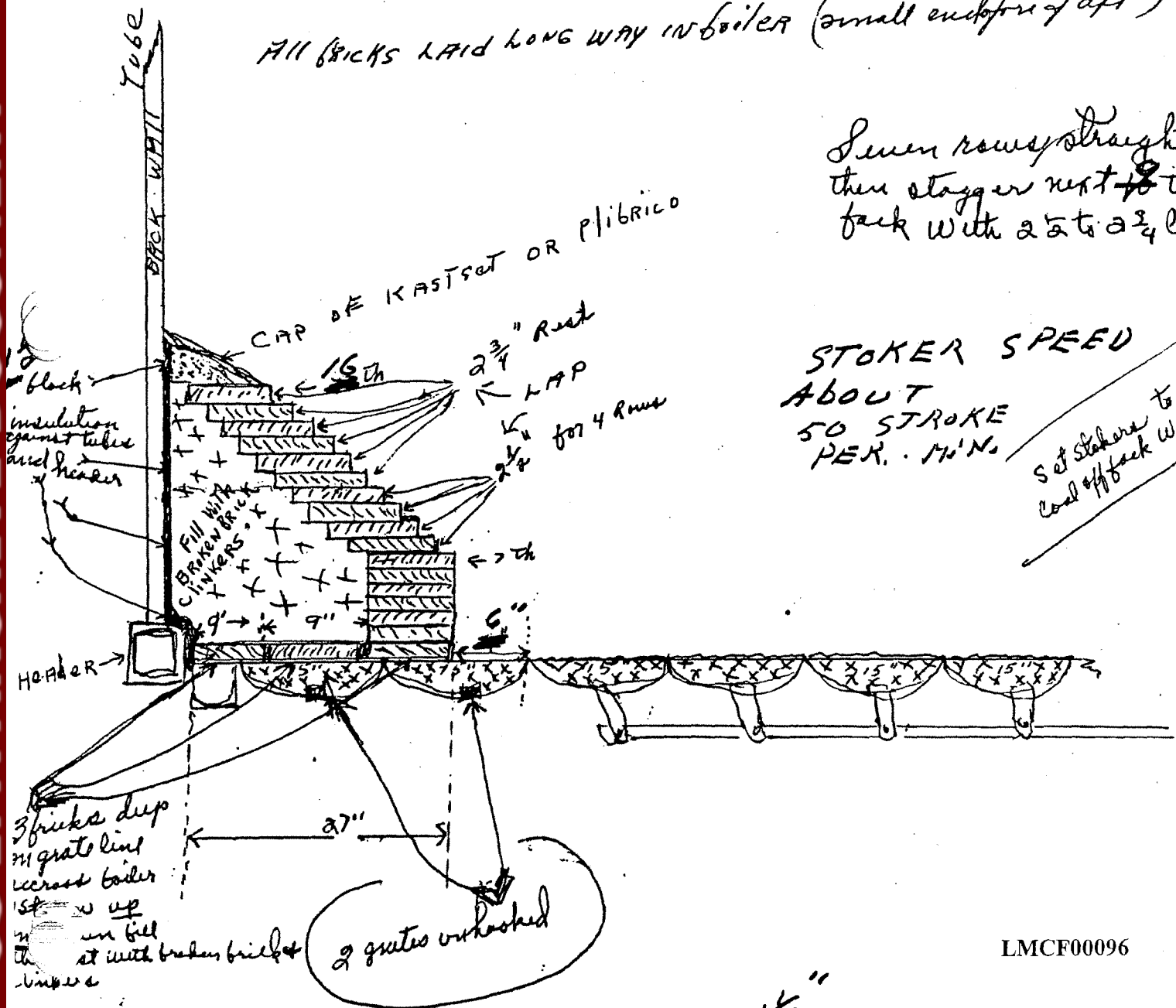
Block or plug
of air nozzles that wall
covers

All bricks laid long way in boiler (small end of aft)

Seven rows straight
then stagger next to
back with $2\frac{1}{2}$ to $3\frac{1}{4}$ in

STOKER SPEED
ABOUT
50 STROKE
PER MIN.

Set stokers to
load off back wa



3 bricks deep
in grate line
across boiler
1st w up
in full
at with broken brick
lines

INSULATE between tubes & wall both side & back use $1\frac{1}{2}$ " block insulation - insulate head also

LMCF00096

BOILERS - Steamers 42 and 43

4 boilers each ship - 2 right hand, 2 left hand
Foster-Wheeler Type D 2 drum FWB 3370-3 and 3396-9. Design
500#, operating pressure 450#, final temp. 740°, feed water
225°, year 1950. Heating surfaces. Boiler 4475 sq. ft.
Water Wall 340 sq. ft.
Economizer 2860 sq. ft.
Total 7675 sq. ft.

Superheater 720 sq. ft.
Furnace
volume 880 cu. ft.
Grate sur. 101 sq. ft.

Weight of water per boiler @ steam level 16,500 lb.

Performance	Normal	Maximum
Total evap. ea. boiler lbs/hr.	29,500	44,000
Superheater outlet temp. °F.	750	760
Total draft loss thru boiler		
inc. grates & econ. H ₂ O	1.7	3.7
Air temp. under grates	100°	100°
Radiant heat absorbing surface	325 sq. ft.	
BTU/sq.ft. RHA surface	126,000	
Liberation BTU/cu.ft.	49,350	
Total volume	830 cu. ft.	
Soot Blowers-Vulcan Model P-3 size 2"		
Feed regulators-Swarthout 2½" 600# Thermo hydraulic S.C. Type SM		

One forced draft fan for each boiler.
Belt driven by 20 H.P. electric motor 1800 RPM, fan speed 1080 RPM
Clarage Vortex Control Single Inlet Type W, size 3 Design 2
Capacity 20600 CFM @ 3½" w.g. @ 100° F.

One induced draft fan for each boiler Prat-Daniel #110 Type 1
SWBI. KWS design with Multi-Clone Collector #6HC-1-70. Belt
driven by Terry Turbine.

Performan - barometric 30" H.G.		fan design	
lbs steam	30,000	44,000	
lbs gas per hr.	52,400	72,000	86,400
R.P.M.	764	1,130	1300
temp.	340	390	410
draft	3.21	6.63	8.25
B.H.P.	28	39.	61.4

General Regulator Combustion Control Electronic relay type.

Completely independent stack duct for each boiler.

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PART I - DESCRIPTION OF STEAM GENERATORS

FOSTER WHEELER CONTRACT FWB 3370-3 & 3396-9

DESIGN DATA
(Section 1-1)

TYPE: Foster Wheeler "D" Type

THE STEAM GENERATOR INCLUDES:
Boiler, Waterwalls, Superheater,
Economizer, Soot Blowers, Valves
and Fittings, Feed Water Regulators

Four (4) Steam Generators are
Installed Per Vessel.

FUEL: Coal

PRESSURE: Lb. psi

Design..... 500
Hydrostatic test..... 750
Hydrostatic test for
desuperheaters..... 300
Superheater Outlet..... 450
Safety Valve Setting
steam drum..... 475
and..... 470
Safety Valve Setting
superheater outlet..... 450

TEMPERATURE: Normal Full
Power Deg. F.

Final temp. at super-
heater outlet.....750
Feed Water Temperature 225

HEATING SURFACES: SQ. FT.

Boiler..... 4475
Waterwall..... 340
Economizer..... 2860
Total Water Heating
surface..... 7675
Superheater 720

GRATE SURFACE: SQ. FT. 101

WEIGHT PER BOILER:

At steaming Temperature Lbs.
Boiler Dry.....146,970
Water Normal level.. 16,500
Total.....163,470

Weight of Water Full 20,390

BOILER PERFORMANCE

	<u>NORMAL</u>	<u>MAXIMUM</u>
Total Evaporation, ea. boiler lbs/hr	29,500	44,000
Superheater outlet temperature-Deg. F.	750	760
Feed Temperature - Deg. F.	225	225
Total draft loss through boiler including grates and economizers H ₂ O	1.7	3.7
Air temperature under grates - Deg. F.	100	100

GENERAL

(Section 1-2)

The steam generators on this contract are of the "D" type design, two left hand and two right hand, designed for coal firing. Each steam generator includes a two drum bent tube boiler section, side waterwalls, rear waterwalls, convection type superheater, and an extended surface economizer. A desuperheater which supplies low temperature steam to auxiliaries, is installed in the steam drum below the normal water level.

The superheater is located behind the first three rows of 2" boiler tubes and in front of the bank of 1 1/4" generating tubes. It consists of U-bend elements rolled into headers which are parallel to the boiler tubes. The superheater elements extend across the boiler, at right angles to the boiler tubes.

The economizer is located inboard and above the generating tube bank and arranged for three parallel water circuits through the unit.

The rear of each boiler is fitted with a double casing. Air leaving the blowers passes through this double casing, absorbs heat from the furnace inner casing, and enters the furnace below the grate area.

The products of combustion formed in the furnace make a single pass through the screen tubes, superheater, and large bank of generating tubes, then upward through the economizer to the uptake.

COMPONENTS

(Section 1-3)

Drums

The nominal inside diameter of the steam drum is 48" with a wrapper sheet 7/8" thick and a tube sheet 2 1/2" thick. The water drum has an inside diameter of 30" with a shell thickness of 1-9/16".

Waterwalls

The furnace is water cooled on the roof, side wall and rear wall with 2" tubes. These tubes form heat absorbing sur-

faces which protect refractory and at the same time provide additional boiler heating surface.

Circulating water for the rear waterwall is provided by means of three 4" O.D. feeder tubes which are expanded into the lower rearwall header. Two of these 4" tubes lead from the steam drum, below the water level, and one 4" tube leads from the water drum.

The side waterwall is supplied by means of five 4" O.D. feeder tubes which lead from the water drum to sidewall header. These side and rearwall feeders are shown in Part I, Section 1-8 of this manual on drawing NY 500-470.

A tube list in Part I, Section 1-6 of this manual gives size, number, and quantity of all tubes installed in these steam generators.

Furnace

The furnace is of ample size for burning the required quantity of fuel without excessive heat release. The side wall, rear wall, and roof of the furnace are lined with water tubes backed up by tile, high temperature insulating block, mineral wool blanket, and the outer casing. The front wall of the furnace is lined with refractory blocks backed up by high temperature insulating blocks, and the casing.

Refractory

Drawing No. NY 500-719 in Section 1-8 of this manual shows in detail the arrangement of brickwork and insulation furnished on this contract. Maintenance of refractory is completely described in Section 3-7.

Superheater

The superheater is located in the generating tube bank behind the screen tubes. It is a three-loop, four-pass type, consisting of 104 U-bend elements rolled into the superheater headers.

Each header is fitted with a 3/4" drain valve and the header diaphragms are perforated with a small drainage slot; to provide complete drainage.

The superheater elements are supported by alloy plates placed parallel to the gas flow and extending from the steam drum to the water drum. The support plates are secured to four 3" superheater support tubes. The superheater elements pass through holes in these support plates.

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Steam enters the outboard superheater header at the bottom, makes four passes through the loops, leaves at the top of the outboard header, and flows to the main steam line and desuperheater inlet.

The 2" superheater safety valve is installed in the piping between the superheater outlet and the stop valve.

Economizer

The economizer is of the counterflow, extended surface, three pass type. It consists of a series of "U"-bend horizontal elements, which have their longitudinal axis parallel to the boiler drum.

The ends of these economizer "U"-bend elements are connected by means of headers. The economizer ends are expanded into these headers, machined flush with the inside surface of the headers and seal welded. See Part III, Section 3-6, and drawings NY 500-439 and NY 500-440 in Part I, Section 1-8.

Each element is made by shrinking 5" O.D. cast iron rings on 2" O.D. x 9 BWG seamless steel tubes to form the extended heat absorbing surface. These elements are installed through the front tube sheet.

Each economizer is fitted with an inlet manifold header, an outlet manifold header, a 1/2" vent and a 3/4" drain.

Two steam soot blowers are provided for keeping the economizer elements clean.

STEAM DRUM INTERNALS (Section 1-4)

Desuperheater

A desuperheater is installed in the steam drum of each steam generator to supply low temperature steam required for auxiliary equipment, and to protect the superheater at low ratings by maintaining steam flow through the superheater. The desuperheating is accomplished by the cooling action of the water in the steam drum which absorbs heat from the superheated steam.

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The desuperheater consists of 2" pipe which makes four lengthwise passes below the normal water level in the drum. The ends are connected to inlet and outlet connections located at the rear of the drum.

Due to the higher pressure in the drum than in the superheater, which would permit moisture and solids in the drum to be entrained in the auxiliary steam line in the event of a leaking joint, the desuperheater should be tested independently of the steam generator at a pressure of 300 psig.

Internal Feed Line

The internal feed line extends horizontally the length of the drum, below the normal water level. It is made of 2½" seamless pipe closed at the ends. The internal feed line has slots which are cut horizontally in the top for introducing feed water into the drum evenly throughout its length. The feed water inlet connection is located in the top of the drum as shown in Drawing No. NY 500-564 in Part I, Section 1-8 of this manual.

Dry Pipe

The dry pipe is suspended along the top center line of the steam drum. It consists of an 8" pipe closed at each end and perforated along its upper surface with 3/8" holes. In the bottom of the pipe, at each end, are 3/4" drain holes. Steam enters the dry pipe through the upper perforated area, thus preventing carry-over of moisture. Steam leaves the dry pipe through the steam nozzle in the top of the drum.

Continuous Blow-Down

A continuous blow-down pipe is placed near the bottom of the steam drum. It consists of 3/4" pipe which enters through a fitting in the rear head of the drum and extends approximately one-half the length of the drum. The end of the pipe is open. The purpose of the blow-down is to provide a means of reducing the density of the boiler water.

Surface Blow-Down

A 1½" surface blow-down pipe is located in the steam drum at the normal water level. The surface blow is used for removing scum, oil or grease from the surface of the water and for reducing high water level when the steam generator is in operation.

Plates and Baffles

Swash Plates are 3/16" plates placed in the steam drum of the boiler. They keep surging of water to a minimum by dividing the lower half of the drum into three separate, approximately uniform spaces.

Steam Baffle Plates are perforated plates placed at the normal water level in the steam drum to prevent foaming. The plates are horizontal. They extend the width of the drum and run about 2/3 its length.

AUXILIARY EQUIPMENT

(Section 1-5)

The auxiliary equipment furnished on this installation by Foster Wheeler Corporation on this contract includes Crosby Safety Valves, Jerguson Gage Glasses, Vulcan Soot Blowers, Swartwout Feed Water Regulators, and Yarway Remote Level Indicators.

Manufacturer's instruction manuals covering description, operation, and maintenance of this equipment will be found at the end of this instruction manual under section entitled "Appendix". A complete listing of all valves and fittings furnished by Foster Wheeler is included in Part I, Section 1-8, Drawing No. NY 502-220, of this manual.

TUBE DATA - (FOR ONE STEAM GENERATOR)
(Section 1-6)

1 1/4" O.D. x 12 BWG GENERATING TUBES

<u>Row No.</u>	<u>No. Per Row</u>
5	69
6	73
7	75
8	74
9	75
10	74
11	75
12	74
13	75
14	74
15	75
16	74
17	74
18	75
19	74
20	75
21	74
Total	1259

2" O.D. x 10 BWG TUBES

<u>Row No.</u>	<u>Location</u>	<u>No. of Tubes</u>
1	Sidewall	30
1A	"	29
	Total Sidewall Tubes -	59
2	Screen	13
2A	"	2
3	"	30
4	"	29
	Total Screen Tubes -	74
22 to 47 incl.	Rearwall	26
48 to 63 incl.	Rearwall Risers	16

4" O.D. x 6 BWG

<u>Tube No.</u>	<u>Location</u>	<u>No. of Tubes</u>
F1	Sidewall Feeders	4
F2	Sidewall Feeder	1
F3	Rearwall Feeder	1
F4	Rearwall Feeder	1
F5	Rearwall Feeder	1
Total	- -	8

DC1	Downcomer Tubes	2
DC2	"	2
DC3	"	2
DC4	"	2
Total	- -	8

3" O.D. x 6 BWG TUBES

<u>Tube No.</u>	<u>Location</u>	<u>No. of Tubes</u>
SS1	Superheater Sup.	2
SS2	Superheater Sup.	2
	Total Superheater Support Tubes	4

PERFORMANCE CURVE
(Section 1-7)

DRAWINGS
(Section 1-8)

General Arrangement	NY-500-439
Auxiliary Sections	NY-500-440
Steam Drum Internals	NY-500-564
Brickwork and Field Insulation	NY-500-719
Feeders and Rear-Wall Risers	NY-500-470
Spares and Tools Per Ship	NY-501-585
Valves and Fittings Per Ship	NY-502-220

Part II — OPERATION

PUTTING STEAM GENERATOR IN OPERATION

(Section 2-1)

The following procedure is a brief, easily remembered outline of the necessary steps to be taken in putting a steam generator in service for normal operation. If the unit is new, has been laid up, or has undergone extensive repairs refer *first* to the section "Putting New Steam Generator in Service." Section 2—6.

Lighting Off

Valves —Closed: Steam stop valves, surface and bottom blow, economizer vent and drain, waterwall drains.

Open: Gage valves, gage glass valves, superheater vent, superheater and desuperheater drains, air cock and feed stops.

Feed —Fill boiler with best available feedwater, (preferably 0.3 grains total solids per gal. or less) through auxiliary feed line until water appears in the lower gage glass. Continue until water raises one inch. Change over to main feed line, closing auxiliary check valve only, and fill to 3" in lower glass. This procedure checks both feed lines.

Burners—Inspect furnace floor for oil. Ventilate boiler thoroughly using forced draft fan to remove inflammable gases. Recirculate fuel oil until oil at proper temperature is available at the burners. Install the smallest sprayer plates in the atomizers furnished for type of oil with which the burner is designed to operate and using torch, light off one burner. Make sure the torch doesn't go out. Make sure the burner stays lit. If it goes out, don't attempt to light the burner again without first ventilating the furnace. Flarebacks happen this way.

Raising Steam

To prevent damage to the refractory and excessive temperatures in the superheater, it is

recommended that at least 3 or 4 hours be taken to put the boiler in service. However, in cases of extreme necessity the unit may be put in service more rapidly.

Valves —Main steam stop valves should be eased slightly to prevent sticking due to expansion. When steam issues forcibly from the air cock (approx. 20 lb.) it may be closed. A flow of steam must be maintained through the superheater. The superheater vent valve should be wide open when lighting off but may be closed-in somewhat as pressure rises to reduce amount of steam wasted. The superheater header drain valves and the desuperheater drain valve (if installed) should be cracked slightly so as to prevent accumulation of condensate. Blow the pressure gage line to check operation of the steam gage. Allow condensate to build up in line so that steam will not come in contact with gage and cause damage to it.

Feed —Check the water level by blowing down the gage glasses. Blow both upper and lower connections. As the boiler warms up, the level in the gage glass will rise. Do not allow it to rise out of sight in the gage glass. The water level may be lowered by using the surface blow. If a surface blow is not provided *put out the fires* and use the bottom blow. As the steam pressure rises it may be necessary to add water to make up for the loss through the vents and drains. If steam should be formed in the economizer, as indicated by water hammer, feed to clear the economizer and blow-down boiler if level becomes too high.

Burners—When bringing up steam it is advisable to rotate the burners. Use first one burner then change to another, allowing the brickwork to heat evenly for approximately 3 hrs. before full pressure is reached on boiler. This will necessitate burner shut-off periodically. Use a torch for lighting burners.

Cutting in the Boiler

Valves —When the boiler pressure is within a few pounds of line pressure, warm up the steam lines slowly with the drains on the lines *open* using by-pass valves around the main stops if provided. On some boilers the pressure may be equalized through an auxiliary steam line. If not, ease the stop valves open slowly until first rush of steam subsides. *Do not close superheater vents or drains until boiler is on the line.*

Feed —The water level must not be too high when cutting in the boiler. If pressure in the line is lower than that in the boiler there is likelihood of carrying water over into the superheater. For this reason the superheater drains are left cracked open until boiler is on the line. Regulate feed supply or change to automatic regulator.

Burners—Change to proper size sprayer plates for steaming. Adjust air and oil supply and change to automatic combustion control if so equipped.

Shutting Down

If possible use the soot blowers just before shutting down.

Burners—Extinguish the fires and remove burners. Allow the forced draft fan to run a few moments to clear the furnace of all gases, then shut it off and close all air registers. Allowing cold air to blow through the furnace will damage the brickwork and may cause casings to crack. Remove the atomizers for cleaning.

Valves —Open the superheater vent and crack superheater drain valve $\frac{1}{4}$ turn. When the boiler pressure drops below line pressure the steam stop valves may be closed. When the steam pressure drops to approximately 20-25 lb. gage fully open the superheater drains (and de-superheater drains if fitted) and the air cock.

Feed —As the boiler cools down the water level will drop. Maintain the level at least

2 in. in the low glass. Unless absolutely necessary, do not use cold feedwater to cool down a boiler. When the boiler is cold close the feed stops. The steam stop valves can usually be tightened when the boiler has cooled but should be eased up when lighting off again.

SAFETY

(Section 2-2)

Safety should be the first consideration in boiler operation. Accidents are often costly, not only to boilers, but also by causing delays in sailing of the vessel. The most frequent and most serious accidents are caused by low water and flarebacks. The competent operator will avoid dangerous situations and eliminate careless practices that may lead to damage or injury. The best accident prevention is to be thoroughly informed with the construction and proper operation of the boiler and the auxiliary equipment. Also, in an emergency, knowing what to do may eliminate serious damage.

Good operation not only increases safety but pays dividends in reduced maintenance expense.

OPERATING PRECAUTIONS

(Section 2-3)

The outline in Section 2-1 is purposely brief as it is intended to serve as a guide for the proper sequence of steps performed in lighting off and raising steam. It is supplemented by the following additional precautions.

If the boiler is equipped with automatic combustion control, shift to manual operation before lighting off. When lighting off, it is difficult to completely eliminate smoke while the furnace is cold. Too much air, in an effort to stop the smoke, is likely to result in unburned oil vapor being deposited on the boiler, air heater and economizer surfaces. As the boiler heats up this vapor is driven off and secondary combustion may occur. The heat of this secondary combustion can cause warped casings, baffles and supports, and if severe, tube failure.

Too little air at any time will cause the boiler to "pant". Allowing this to continue will loosen the casings with resultant gas leaks and damage to the refractory. "Panting" can also occur under certain conditions of poor mixture of air and oil, or water in the fuel oil.

Never light a burner from the hot brickwork. This practice may result in serious damage and personal injury, due to explosion.

Keep the superheater vent open to assure steam flow through the superheater. It is just as important as water in the boiler. The superheater thermometer is not a reliable indicator of the temperatures in the superheater when raising steam.

Decrease the firing rate and increase the feed for a few moments if steaming, which causes water hammer, occurs in the economizer. Continued water hammer can cause leaks in the feed piping, economizer return headers and return bends.

Use the surface blow to reduce high water level. Do not use the bottom blow or open the water wall drains unless all the fires are extinguished. For most effective use of the bottom blow, first, open the valves in the blowdown line then open the boiler blowdown valve wide. When blowing operation is completed, close valves in reverse order. When operating either the surface or bottom blowdown valve, open valve wide and operate quickly while opening or closing.

The normal water level, unless otherwise specified, is at the centerline of the steam drum. Carry normal water level as the perforated baffles of drum internals are designed to function best at this level. Be suspicious of a water level that does not fluctuate. Check gage glasses frequently whether on manual or automatic operation. Check carefully gage glasses that appear completely full or completely empty as either may cause serious damage to equipment.

If there is an unaccountable drop in the steam pressure, check the water level in the boiler by blowing the gage glass before increasing firing rate. Steam pressure will drop when there is insufficient water in the boiler.

When maneuvering anticipate changes in the water level due to changes in steam demand. A sudden increase as from "stop" to "full" will result in a sharp rise in the water level. The feed should not be decreased but rather increased to keep up with the demand for steam. If the feed is decreased and the water level allowed to fall, the water may drop out of sight when the firing rate is suddenly decreased. Conversely, carrying the water level too high at low loads may result in the water going out of sight in the top of the glass. This

may cause a sudden drop in superheat temperature and leaking of the main steam line joints.

Carryover may also occur due to foaming, a condition caused by a high percentage of dissolved solids in the boiler water. Boiler feedwater must be pure, free of dissolved solids, oil and oxygen. Use distilled water only, if possible, for all makeup feed. Samples of boiler water should be tested twice daily. Proper alkalinity should be maintained to prevent corrosion. To prevent priming, blow down the steam generator if the total concentration of dissolved solids exceeds 500 parts per million (30 grains per gal.) or if the amount of scale forming salts is excessive.

To maintain low boiler water concentration, use continuous blow when installed or the surface blow. Otherwise shut off fires and use the bottom blow.

Do not permit oil, especially that containing vegetable fats, to enter the boiler as the insulating film formed on heating surfaces will result in blistering and eventual rupture of the affected tubes. Sludge, rolled into small, hard balls found in the waterwall headers, is an indication that oil is getting into the boilers.

Dissolved oxygen may cause pitting and corrosion at and above the waterline in the drum and also in the economizer. On vessels equipped with deaerators, the oxygen content of the feed should be tested periodically as a check on deaerator operation and should never be more than .03 cc per liter. To avoid oxygen pitting, maintain the design feedwater temperature, particularly in port. Feedwater below design temperature is very likely to contain oxygen. Vessels not equipped with a means of removing oxygen from the feedwater must chemically treat the boiler water.

Boiler treating chemicals are preferably introduced into the drum through a chemical feed line rather than through the economizer as the chemicals may possibly settle on the inner surface of the economizer tubes.

It is most important that the recommendations of a competent feedwater treatment concern are followed.

The soot blowers should be used twice daily or as often as necessary as indicated by changes in the stack temperature or in the draft loss. A temperature drop of more than 20 deg. F. after blowing tubes might indicate the desirability of

more frequent blowing. Drain the lines generously before blowing tubes. Wet steam in the soot blowers will cause the soot to cake and become difficult to remove. Use the soot blowers in the proper order; that is start by blowing the air heater and/or economizer, then the superheater, the generating bank and finally the economizer and/or air heater again. The order of blowing in the superheater and generating banks should follow the path of the gases. The gas path may be determined from the general arrangement drawing showing the position of baffles, if any.

Raise the air pressure when using the soot blowers. When using soot blowers in port or under low loads, be ready to relight the fires should they be blown out. To reduce corrosion leave the soot blower drains *open* when the soot blowers are not in use and see that air check valves are functioning. The scavenging air check valves admit air to the elements when not in use to prevent corrosive gases from backing up into the soot blower heads and piping.

Hard external deposits found on economizer surfaces are evidence that either wet steam is being used for soot blowing or the temperature of the stack gases has fallen below the dew point. When the stack temperature falls below the dew point, there is danger of certain components of the stack gases condensing on the elements. These condensed gases, particularly those from fuels with a high sulfur content, will cause hard caking of soot deposits and are highly corrosive.

These hard soot deposits may plug the economizers, and cause corrosion damage. These deposits may be removed by steam lancing. Steam lancing ports are installed on most boilers.

On boilers equipped with air heaters, the by-pass must be used under low load conditions when the stack temperature may fall below the dew point. Failure to use the by-pass may result in soot caking and corrosion damage to the heating surfaces and uptakes. The accumulated soot may also result in a soot fire, causing severe damage to air heater.

Remove atomizers from the boiler when they are not in use. Atomizers in a cold boiler could flood the furnace with oil due to leaky valves. Atomizers not in use but remaining in position in a steaming boiler will become choked with carbon and may be damaged by overheating.

Inspect the fires for flame impingement on the refractory throats or floor where deposits may be formed.

Safety valves should be occasionally lifted manually as a check on their operation.

EMERGENCY PROCEDURES

(Section 2-4)

Low Water

Low water, whether resulting from inattention, feed pump failure or any other cause, is the most serious condition encountered. If the loss is gradual and noticed by the operators:

- (a) Increase the rate of feed.
- (b) Check feed line for leaks or open valves.
- (c) Check blow valves for leaks or open valves.
- (d) Check auxiliaries for water in steam from auxiliary steam line which indicates leakage from boiler steam drum into desuperheater.
- (e) Start auxiliary feed system.

If, at any time, the water level falls out of sight in gage glass *secure all burners immediately*. *Caution.* Do not fill hot boiler with cold water, as relatively cold feedwater coming in contact with an overheated drum or tubes may cause severe distortion and leakage of rolled joints.

Tube Failure

In the event of tube failure, the boiler should be secured quickly except for the feed. Feedwater should be added in an effort to keep the water in sight until the boiler cools down. *Watch the water in the other boilers.* The sudden demand for feed may result in low water in the other boilers. If the failure is severe and the water cannot be kept in sight, shut off the feed to the effected boiler immediately. In extreme cases it may be necessary to keep the forced draft fan running to carry the steam up the stack. If escaping steam is a danger to life the boiler may be emptied through the bottom blow.

Loss of Fires

If the burners should go out from loss of oil pressure, stoppage of the pump, forced draft blower failure or water in the fuel, close all burner valves immediately, ventilate the furnace and relight burners one at a time using a torch. Restoring the oil supply with the burner valves open and

OPERATION

allowing the fires to relight from hot brickwork may result in an explosion.

Air Heater Fires

Air heater fires can be avoided by keeping the heating surfaces clean. In the event of fire, considerable damage is usually done by the time the fire is detected. The boiler should be secured, shutting down the forced draft fan quickly and using the steam soot blowers in the air heater as an aid in smothering the fire.

If the boiler is shut down for any reason, open the superheater vent to maintain a steam flow through the superheater. Crack superheat drains to prevent accumulation of water in the superheater elements.

FUEL ECONOMY

(Section 2-5)

To obtain high boiler efficiencies, the following conditions should be observed:

Maintain operating temperature and pressure

Adjust burners for proper combustion

Keep fire and water sides of boiler clean

Check casings and all pressure parts against leakage.

The most common cause of low efficiency is excess air. A certain amount is necessary but it should be kept to a minimum. To obtain the proper amount of air, without smoke, burners must be clean and properly adjusted with the jacket tube so that the flame just clears the refractory cone without impingement. The best position may vary slightly with different firing rates. To obtain best operating results the jacket tube may be moved in and out by loosening the thumb screw for proper mixture of air and oil. The jacket tube should also be the proper length so that the face of the sprayer plate nut is in correct relation to the face of the diffuser. This varies with different types of burners; with the Todd "Vee-Cee" burners the face of the sprayer plate nut should project $\frac{1}{2}$ " into the furnace beyond the point where the diffuser starts to flare. With Todd straight mechanical (Hex-Press) burners this distance is $\frac{1}{4}$ ". Using the Vee-Cee steam assisted atomizer the distance is $1\frac{1}{4}$ ". This length is altered by loosening the set screw and screwing the burner clamp on or off the jacket tube. These dimensions apply only with the Standard Hex-Press Register and Hex-Press diffuser.

The refractory cone must be concentric and have the proper depth and angle. The air registers should be in good order, that is, working freely, not warped or choked with carbon deposits.

The fuel should be at the right pressure and temperature for best atomization. Oil that is too cold will not atomize properly and oil that is too hot will carbonize in the burner tips. The best atomization of the fuel oil is generally obtained when the viscosity is 150 Seconds Saybolt Universal. The temperature at which the fuel will be at this viscosity may be found by referring to the chart, Fig. 1. Use the proper size sprayer plates. Make sure the tips you are using have the proper spray angle. *Do not use more than one size burner tip in the steam generator at the same time.* Use all burners unless oil pressure becomes too low. The use of steel tools in cleaning sprayer plates may damage them, resulting in poor atomization, thereby requiring a large amount of excess air to eliminate smoke. Enlargement of the holes will result in each burner handling a different quantity of oil and adjustment of proper amount of air will be impossible.

Excess air in large quantities will be indicated by white smoke. In some cases white smoke may result from too high fuel oil temperature. If the flame is intensely white as observed through peepholes in boiler or burner, too much air is being supplied. If the flame is red there is insufficient air. The ideal flame is a bright golden color. Excess air will also be indicated by a rise in superheat temperature but for accuracy the use of an Orsat to analyze the flue gases is necessary. Smokeless combustion or a very light brown haze with high CO_2 (12.5% to 14%) and no CO are the ideal conditions.

Boiler casings must be tight as any air leaking into the boiler will sharply reduce efficiency.

Steady steaming with little fluctuation in air or oil pressures will be an advantage. Normal temperatures and pressures should be maintained. High stack temperatures may mean excess air or fouling of the heating surfaces. A rise in air pressure required for combustion may be caused by poor burner adjustment or partial plugging of the gas passages. Keep the firesides of the boiler clean, particularly the superheater and the economizer. Fouling of the heating surfaces not only reduces the heat transfer rate but in extreme

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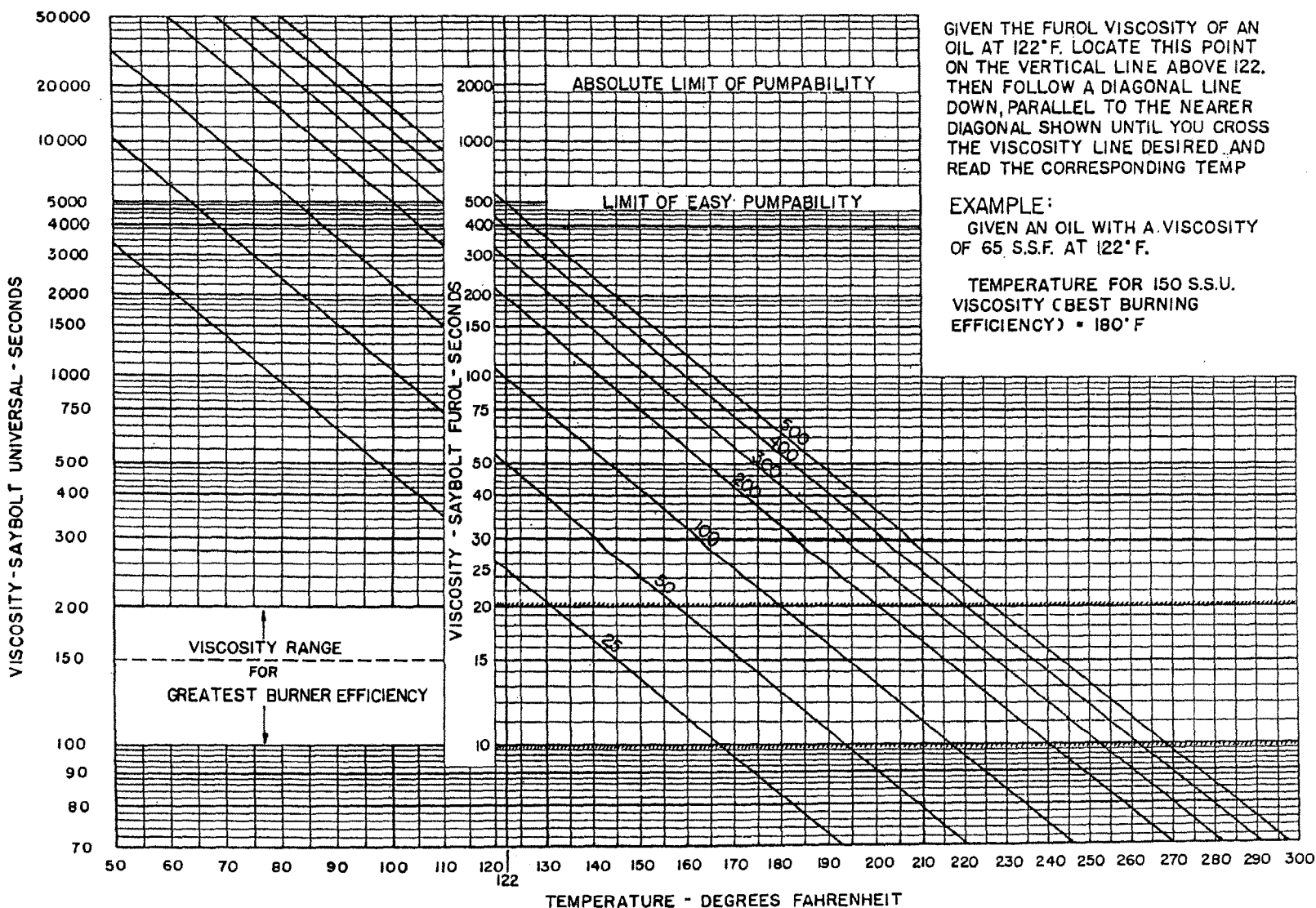


FIGURE 1. CHART FOR DETERMINING PROPER BURNER TEMPERATURE TO GIVE MOST EFFICIENT COMBUSTION.

cases "laneing" may result with high gas velocities and temperatures through small sections of the boiler. This causes severe damage to all parts adjacent to or within the lane. Frequency of use of the soot blowers should be governed by the changes in draft loss and stack temperatures before and after blowing tubes.

Maintain proper feedwater temperature. Lower feed temperature will result in higher superheat. Conversely a high feed temperature will cause superheat temperature to be below normal.

PUTTING NEW STEAM GENERATOR IN SERVICE

(Section 2-6)

Before a new boiler, one that has been laid up or one which has undergone extensive repairs, is put in service it should be subjected to a hydrostatic test, boiling out, drying out for the refractory and final inspection.

Hydrostatic Test

Prepare the boiler for hydrostatic test by removing all tools, rags, etc. from the drums, tubes and headers. Many tube failures are due to negligence in removing foreign materials. Close up all handholes and manholes. Remove all access doors including those for waterwall headers. A boiler that has been in service must be thoroughly cleaned on the fireside to facilitate inspection. Check operation of pressure gages. Close tightly all stop check, drain and blowdown valves. Install blanks where necessary. Do not allow a stop valve with steam on one side to be subjected to hydrostatic test on the other side of the valve. Install safety valve gags. Do not use a wrench on these gags. It is unnecessary and may result in bent valve stems.

The vents on the drum, superheater and economizer should be open while filling the boiler to let the air escape. These vents may be closed as water issues from them. Some boilers have check valves in the feed line between the economizer and the drum. If the test pressure is being applied through a connection to the air cock on the boiler drum, a separate test will be necessary on the economizer. The boiler should be at room temperature before testing. The water used for the test should be at the same temperature or above. It may be

as high as 180 F. but in no case less than room temperature or less than 70 F. whichever is higher. In high pressure boilers with thick drums, it is desirable that the temperature of the water used for filling be close to the boiler temperature. The use of cold water for testing a boiler which has not thoroughly cooled down will result in leaking of the rolled joints.

The pressure should be raised gradually, being careful not to exceed the test pressure.

A hydrostatic test to the working pressure will usually be sufficient for a boiler which has been repaired but for a new boiler or one undergoing annual inspection the test pressure is $1\frac{1}{2}$ times the design pressure.

When inspection of all pressure parts and rolled joints is complete the pressure may be lowered by cracking a drain valve. Open a vent valve before the pressure drops to zero and leave wide open while draining the water to avoid a vacuum on the boiler.

The desuperheater should be tested separately at a pressure not over 300 lb. A leaking desuperheater would allow water from the drum to pass into the desuperheater and be carried with the steam to the auxiliaries or superheater.

On completion of the test, drain all water from the superheater and desuperheater, remove safety valve gags, and remove any blanks.

Boiling Out

The boiler must be boiled out to remove any preservative on the tubes and the oil used in rolling the tubes. Oil is a good insulator and if any remains after erection or repairs, blistered and ruptured tubes may result.

Before proceeding with boiling out of boiler remove as much oil as possible by wiping out the ends of the tubes, the headers and drums using rags and by pulling rags through the tubes, using an approved solvent. Make sure no rags are left in the boiler as a tube may be plugged and the loss of circulation will result in tube failure. Air circulation should be provided for the protection of any men working inside the drum.

The boiling out solution consists of three pounds of caustic soda and three pounds of either soda ash or trisodium phosphate for each 1,000 pounds of water capacity of the boiler at normal water level

A boiling out solution using five pounds of Navy standard boiler compound for each 1,000 pounds of water capacity is also satisfactory. The chemicals should be mixed thoroughly in hot water and the solution poured into the drum. Close up the drum and fill the boiler until the water is just in sight in the gage glass. The superheater vents and drains and the air cock should be open.

Observe all normal safety precautions when the boiler is being fired for drying out or boiling out.

Using the smallest size sprayer plate, fire the boiler, closing the air cock when steam issues from it but leaving a superheater vent open sufficiently to maintain a good steam flow through the superheater. Allow the pressure to rise to 50 pounds and maintain this pressure during the boiling out. Raise the water level nearly to the top of the glass and blow down the level to $\frac{1}{4}$ glass using the bottom blow. Mix another ten pounds of boiling out solution and inject into the boiler using the chemical feed line. Every six hours again raise the water level and repeat the blowdown procedure. This should be continued for 36 hours or until examination of water samples from all blowdown lines shows that no oil is present. The sample, in a glass container, is best examined in a dark room by shining a small pen type flashlight through the water. Another simple test consists of dropping small shavings of camphor on the surface of a sample in a shallow container. If the camphor remains motionless, oil is present. If even the slightest trace of oil is present the boiling out process should be continued.

When boiling out is completed, the solution is preferably dumped overboard through the bottom blow. It is highly caustic and will cause damage to paint or protective coatings if dumped into the bilge. The compound may cause some damage to valve stem packings and some repacking may be necessary. Also, gage glass mica may require replacement because of contact with a caustic solution. After the boiler is emptied it should be opened up and all tubes and headers thoroughly washed out with a high pressure fresh water hose.

Boiling Out Pressure Parts by Steam Method

If steam is available and the pressure parts are to be boiled out but the furnace is not to be dried out, attach steam supply lines to the bottom blow

valve and the lowest openings in the superheater and economizer. If practicable, blank off the piping connection between the steam drum and the superheater and also the piping between the steam drum and the economizer. Close all other openings and provide independent blowdown lines from the steam drum, superheater vents and economizer vents.

Using just enough water to dissolve the compound and soda, make up separate boiling out solutions for the boiler, economizer and superheater, by dissolving three (3) pounds each of soda ash and caustic soda (or 5 lb. of Navy standard boiler compound) for each 1,000 lb. of water capacity of each of these sections.

Using a portable or hand pump, inject the boiling-out mixtures into the generating, superheater, and economizer sections of the boiler. The mixture for the generating sections should be divided between the water drums and headers. Add fresh water to the *generating section only* to bring the water level in sight at the lowest visible point in the boiler water-gage glass. The mixed compound should be admitted to superheaters and economizers without additional water.

Admit saturated steam to the boiler, superheater and economizer maintaining a pressure of 25 to 50 lb./sq. in. in the steam drum. To insure circulation, the steam supply should be under a pressure of about 25 lb./sq. in. higher than the pressure in the steam drum. Open the steam drum, superheater and economizer vents to permit a continuous slow overflow from each section. Boil out the pressure parts in this manner for 24 hours; then shut off the steam supply and drain the superheater, economizer and boiler. Flush the superheater, economizer and boiler either through the temporary blowdown lines or by filling the boiler and economizer and flooding the superheater.

Drain the boiler and wash out and inspect all pressure parts.

Drying Out Furnace

A drying out fire should be lit in the furnace within a few hours after installing new plastic refractory. A wood fire is generally considered to be the best for this purpose as it provides a more even heat for the entire furnace. The boiler should be prepared for lighting off in the usual manner as

OPERATION

if getting ready for steaming except that a wood fire is started in the center of the furnace floor. The fire should be kept burning at least 18 hours and longer if time allows. The longer the drying out period, the better. If the setting is heated too rapidly, the outer layer of refractory will dry first, shrink away from the remainder and cracks will result. Also, with rapid heating, steam formed in the refractory, especially in a thick wall, may not be able to seep out without developing pressure. Do not allow the steam pressure to exceed 100 lbs. during this period. Removal of an air register allows more wood to be added.

The furnace may also be dried out with an intermittent oil fire using the smallest size sprayer plate and rotating the fire from one burner to another every half hour. The pressure should not be allowed to exceed 100 lb. Drying out may be completed in a minimum of 12 hours, although 24 or 36 hours is more desirable. At the end of this time the pressure may be raised to working pressure and the boiler cut in on the line if necessary. The furnace will be dried out but 12 to 24 hours of steaming at normal capacity is required to cure the refractory. If the boiler is to be cooled down again, close all openings and allow to cool slowly. If possible, enter the furnace to check the drying out and look for cracks or excessive shrinkage.

Drying out may be accomplished simultaneously with the boiling out process if the initial firing rate is kept very low and increased slowly.

Inspection

Because of the possible presence of inflammable or noxious vapors in the steam generator, it is extremely important to ventilate the unit thoroughly before entering for inspection of pressure parts. It is also important to make sure, before entering the unit, that all valves which might permit the entrance of steam or water are tagged, closed and secured by a lock or wiring.

Make a thorough inspection of the internal surfaces and, if any scum or oil is present, repeat the boiling-out procedure. It is advisable to run a rag on a rod through various tubes to determine their condition. Black smudge may be found at the ends of a tube in a new steam generator even though the remainder of the tube may be clean. A slight trace of this black deposit is not harmful and it may be wiped out with a rag which has

been moistened with a non-oily, non-poisonous cleaning fluid; however, if the black smudge is greasy or if any other oil or grease is found, it will be necessary to boil out the pressure parts again.

Before closing up the drum, check the internals including baffles, chemical feed line and regulator damping chamber to see that they are secure and that holes are not clogged. On a boiler that has been in service examine for scale deposits and corrosion. Pitting of the drum at the waterline or above is usually a sign of oxygen in the feedwater. Also examine the desuperheater and the feed line applying hydrostatic test if necessary to check tightness. Check dry pipe making sure holes or slots are not plugged.

The internal surfaces of the superheater tubes should be inspected for scale deposits. Scale indicates carryover and will quickly result in a warped superheater and tube failures.

When examining the fireside, the soot blowers should be rotated from the outside. Check alignment of the holes so that steam will not impinge on the tubes, and also that the soot blower elements are straight and not chafing on the tubes. Elements may be straight but the boiler tubes warped so that chafing occurs.

On a boiler that has been in service, check for blistered or sagged tubes. Look for soot deposits in the air heater, economizer, economizer vestibules and the superheater bank. Examine the soot blower bearings, edges of the superheater support plates, access doors and openings for corrosion. See that baffles are secure and dampers operating. Inspect refractory to see that headers, drums, doors, doors frames, etc. are adequately protected. Measure the thickness of the brick wall to determine if erosion necessitates renewal. Determine the depth of the floor by measuring from the top of the floor to the centerline of the burner. If the floor is too high because of slag deposits it should be renewed as flame impingement will build up more carbon deposits.

Encrustations around handholes indicate leaks. Gaskets or ferrules should be replaced and encrustations removed as they are corrosive.

Examine the air casings under the burners for oil which may be a fire hazard.

Before closing up and filling the boiler, be sure the bottom blow valve is closed.

Initial Starting

Before starting a new boiler for the first time, make sure all gages, thermometers and test connections have been installed and are operating. Check all auxiliary equipment such as feedwater regulators and indicators, valves, combustion control system and soot blowers. Read carefully the sections under "Operation" and "Operating Precautions". Before cutting in the boiler it is imperative that the safety valves be blown and reset, if necessary, to lift at the proper pressures. The superheater safety valve *must* lift before the main safety valves to give adequate protection to the superheater.

It is desirable to limit the firing rate to low loads for a few days to thoroughly dry out and cure the refractory and also to ascertain that all auxiliary equipment functions properly.

LAYING UP BOILERS

(Section 2-7)

A boiler not in use should not be allowed to stand partially filled with water for long periods. If it is expected that the boiler will be out of service for more than a day, fill the boiler, economizer and superheater completely with water to give protection against corrosion. Care should be taken to see that the boiler is *completely* filled by building up 20 or 30 lb. pressure and venting at high points. Make sure that leaking valves do not allow the gradual entrance of steam or feedwater from other boilers, as serious corrosion will result.

To fill the boiler, deaerated feedwater should be used, adding chemicals to give a final boiler alkalinity of 20 to 30 gr. per gallon. This should be

checked occasionally as the alkalinity will gradually decrease. Either provide means for recirculating the feed water when filling or add sufficient soda ash or caustic soda before the boiler is filled. Adding these later with no circulation may result in spots of concentrated alkalinity. If possible, light a fire under the boiler before it is completely filled to circulate the chemicals and drive off any oxygen. The filling of the boiler and the superheater may then be completed. Do not use the wet lay-up method if danger of freezing exists. Be sure the superheater is drained before putting the boiler in service again.

If the boiler is to be laid up for a prolonged period it is best laid up using one of the commercial preservatives available to coat all internal surfaces or else it may be laid up dry. If laid up dry it is important that it be drained completely, using an air hose to blow water out of any pockets that are not self draining and mopping up water remaining in the drums. Check all valves for tightness. A number of shallow pans containing a dehydrating agent such as silica gel, quicklime or calcium chloride should be placed in each drum and the boiler closed up tightly. This dehydrating agent should be examined every 3 months and replaced whenever it has absorbed enough moisture to make it ineffective.

Before laying up a boiler it should be thoroughly cleaned on the fireside. Soot deposits, especially when damp, are highly corrosive and if allowed to remain may result in serious damage to the casings and pressure parts. All openings to the furnace should be tightly closed and the stack covered. Better protection may be had with special fireside preservatives sprayed on the tubes.

BOILER FEED WATER

BOILER FEED WATER

(Section 2-8)

Sea Water Distillate

Practically all waters used for boiler feed purposes contain some impurities which are undesirable. The distillate obtained from evaporation of sea water should not contain more than 0.5 grain per gal. of chloride. Even then small amounts of all the other salts found in sea water will be found in the distilled water and eventually will enter the boiler with the make-up feed water. The soap hardness of water distilled from sea water normally will show less than 0.3 grain per gal. of hardness when the chloride content is not over 0.5 grain per gal.

Shore Water

All shore waters contain varying amount of contaminating salts, depending on the character of the rocks, sand, and earth over which they have flowed and on the extent and nature of municipal treatment to which they have been subjected. The impurity content of shore water will always be higher and, more important, will be chemically and proportionately different from that of the evaporated water which water-treatment is designed to control. Water received from shore should not be used in the boilers (except in emergency) without first being evaporated in the ship's distilling plant. If necessary to use shore water without distillation, the water should be tested and only a neutral water, low in hardness, should be accepted for temporary use during the emergency. A neutral water is one which is colorless with phenolphthalein indicator and green with methyl-purple indicator. The evaporation of shore water, in order to obtain satisfactory feed water for the boilers, may result in depositing on the evaporator tubes an extremely hard scale different from that resulting from evaporation of sea water.

Salt-Water Contamination

Feed water shall be maintained as free from impurities as possible. This requirement involves careful attention to the entire plant through which the water passes, either in the form of steam or as water, for, even though water used as make-up feed be excellent at the time of its entry into the system, it may absorb impurities from the various parts of the installation.

The most common source of contamination of the water in boilers is salt-water leakage into the fresh-water system. The principal parts of the system where this leakage may occur are listed below:

- (1) Condensers: main, auxiliary, and dynamo.
- (2) Salt-water-cooled air-ejector condensers.
- (3) Distilling plants.
- (4) Salt-water-cooled gland-exhaust condensers.
- (5) Leaky bottom-blow valves on idle boilers.
- (6) Leaky feed suction and drain lines which run through bilges.
- (7) Leaky seams and rivets in reserve feed tanks.

Condensate Leakage

Condensers are the most common source of salt-water leakage into the feed water system. Particular attention should be given to establishing a routine to detect leakage of salt water into the fresh-water side of condensers. In most installations, the condensate consistently contains no more than 0.5 grain per gal. of chloride. Any consistent increase above this value is a definite indication of a leak. When a leak is detected, it should be corrected as soon as operating conditions will permit dismantling the unit affected.

Effect of Condensate Carry-Over

Whenever the condensate from any condenser shows the presence of chloride to be above the usual operating value, it is well to check the steam from the boilers by testing a sample of water from one of the steam drain lines. Such a steam-condensate sample should be tested for both alkalinity and chloride since a small amount of alkalinity may affect the chloride determination. The results of the steam-condensate analyses will indicate whether or not there is any carry-over of boiler water in sufficient quantity to give more than normal chloride readings in the condensate. Sudden large increases in ship speed may cause carry-over from the boilers. The effect of this carry-over on the chloride in the condensate will be more pronounced the higher the chloride content of the boiler water.

Source of Contamination

It is of the greatest importance that any unusual rise in the chloride content in the feed tanks, feed water, or boilers be investigated at once and the source of the leakage found and corrected. To locate these sources, test the fresh water from different units in the system, and where possible cut out the elements one at a time until the feed water freshens. A test for chloride in the feed water should be made each time one of the elements is cut out. Before making a test, the plant should be allowed to operate for several minutes without this element in commission so that the chloride concentration of the feed water due to that element may have time to be diluted with salt-free water.

Leaking Lines in Bilges

The system may be salted up by leaky feed-suction lines which run through the bilges. Such leaks will also be responsible for some loss of make-up feed water. Periodic tests of feed-suction lines should be made as very often leaks will exist which are responsible not only for a loss of fresh water but for loss of pumping efficiency when the lines are being used.

Elimination of Air in Feed Water

It is imperative that all possible precautions be taken to eliminate dissolved air from the boiler feed water in order to reduce corrosion of boilers and, particularly, of economizers. Elimination consists in correcting all possible sources of air leakage into the feed system and of maintaining the efficiency of the deaerating equipment. Where open hot wells are used, it is recommended to keep temperature as close to 212 deg. F. as possible, so as not to absorb air from the atmosphere. This can be accomplished by the installation of a small heating coil in the hot well. The hot well should be tightly covered, with a minimum opening for observation.

Elimination of Oil and Grease

The presence of oil and grease in the feed water and in the boilers is a frequent occurrence. The following precautions should be effective in preventing any oil from reaching the boilers:

(1) In general, it is not necessary to use oil for the internal lubrication of the steam cylinders or valve chests of any reciprocating machinery. Saturated steam provides enough water of condensation to give the necessary lubrication, and in superheated steam units the metals used are usually designed to operate satisfactorily without lubrication. The use of a pure mineral oil may be used in special cases. Only a light, smooth coating of petrolatum shall be applied to the inside of cylinders at specified inspections.

(2) Very little lubrication of rods is necessary and this lubrication shall be kept at a minimum by the use of small quantities of mineral oil at each application. With main reciprocating engines using forced lubrication, the oil from such parts as crossheads and guides should be prevented from splashing on the piston rods or valve stems.

(3) When filters or grease extractors are fitted, they always should be used and kept in efficient condition.

(4) Filtering material should be cleaned or renewed as often as found necessary. Special precautions and instructions when using diatomaceous-earth filter-aid should be observed.

(5) Drains from fuel oil heaters and from heating coils in lubricating oil tanks and fuel oil tanks always shall be passed through an inspection tank before discharging into the feed system. Frequent inspections of these tanks are necessary in order that the presence of oil will be discovered soon after its first appearance, in order that drains may be diverted to the bilge until the source of contamination is removed.

Avoid Excessive Make-Up

It is necessary to add to the system make-up feed water to replace water lost by leakage. All boilers, piping, glands, and valves should be kept tight and in efficient condition. The amount of make-up feed used per hour in port and per mile under way should be checked daily and every effort made to keep these amounts at a low and consistent level. The use of excessive quantities of make-up feed indicates lack of attention to one of the most important details connected with operating the engineering plant of a vessel. The amount of make-up feed water used by a ship is usually a fair indication of the overall engineering efficiency.

BOILER FEED WATER

Boiler-Water Hardness

The occurrence of boiler-water hardness usually is evidence either that the make-up feed water contains excessive hardness or that the boiler contains considerable scale, although false soap hardness may result from the presence of zinc supplied either by condenser corrosion or from galvanized storage tanks. The amount of compound which is added to maintain the proper alkalinity should simultaneously insure zero hardness of the boiler water if proper feed water is used. The source of any unusual hardness in the boiler or feed water should be searched for, found, and corrected. If the boiler water consistently shows hardness, and the measures taken fail to remedy this condition, competent feedwater treatment concern should be consulted.

Securing Boiler Water Samples For Analysis

When taking water samples for analyses, it is particularly important that the sampling connection first be thoroughly flushed to insure obtaining samples that are truly representative of the water in the boiler and to remove sediment which may be trapped in the connection. Coolers should be installed in the line from the connection with the Salinometer valve to cool the boiler-water samples to approximately 100° F. except that samples for dissolved oxygen test must be cooled below

70° F. Figure 2 shows a typical cooler. Samples of water for analysis should be taken in clean containers, should be free from suspended matter, and should be protected from contamination during the time between sampling and analysis. If the sample bottle is not stoppered tight, alkaline samples will absorb carbon dioxide from the atmosphere reconvert the hydroxide to carbonate, so that erroneously low results for alkalinity will be obtained with the phenolphthalein titration.

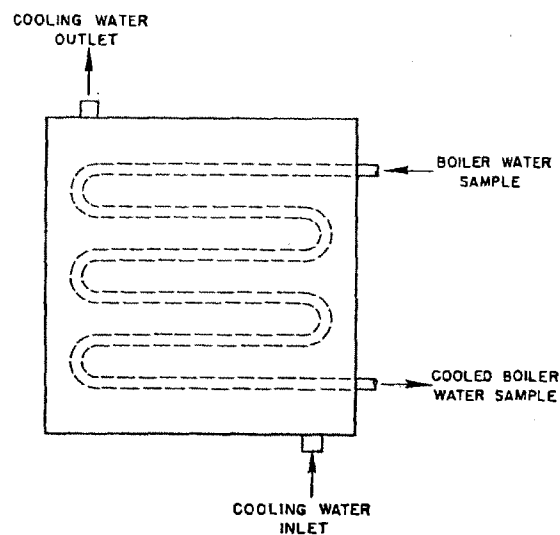


FIGURE 2. SUGGESTED METHOD OF COOLING BOILER WATER SAMPLES FROM SALINOMETER CONNECTION.

Part III — MAINTENANCE

BOILER AND WATERWALL

(Section 3-1)

The most important item in the care of boiler tubes is to keep them clean inside and out. The outside is kept clean by the use of soot blowers and the inside by careful attention to the water treatment. It is recommended the tubes be turbed throughout with soft wire brush as often as is found necessary. The tubes nearest the furnace will require the most cleaning as they are exposed to the highest gas temperatures, and consequently scale has the greatest tendency to form in them.

The firesides of a boiler present more of a problem. Soot accumulations are removed with the soot blowers and, periodically, by removing the access doors and hand lancing and scraping. For deposits of soot and slag that resist these methods the operator may resort to water washing.

WATER WASHING

(Section 3-2)

When gas passages have been clogged to such an extent that mechanical cleaning is ineffective, the firesides should be cleaned by hot-water washing. This procedure should not be used indiscriminately and is ordinarily necessary only for inaccessible superheaters and economizers. The following should be kept in mind when resorting to water washing:

- (1) Possibility of damage to brickwork
- (2) Possibility of acid corrosion of tubes and drums
- (3) Availability of sufficient fresh water
- (4) Protection of electrical equipment around or under the boiler. *Boilers shall be dried out carefully immediately after water washing.*
- (5) Because of damage caused by water washing, it should be resorted to only when all other methods have failed.

Methods

In general, there are two approved procedures for water washing:

- (1) Use of a water lance, see Fig. 1.
- (2) Use of soot blowers for distributing the water in the tube nests.

The first method requires less water and results in less wetting of the boiler and refractories but has the disadvantage that all parts of the tube nests cannot be reached. The second method requires more water and results in considerable wetting of the boiler but has the advantage of the washing action of a large quantity of water. When sufficient water is available, best results can be attained by employing a combination of the two methods. The procedure described below involves the use of both methods. When necessary to conserve water, use the lance method. The latter will ordinarily be found sufficient for economizers and (when necessary to wash) the generating, waterwall, and water screen tube banks.

Procedure

Open, remove, or loosen access doors and panels to provide access to the firesides and drainage from the furnace, and around drums and headers. It may be found desirable only to loosen certain panels to reduce splashing on adjacent machinery or personnel. Line up a fire and bilge pump for pumping the waste water overboard.

Install canvas shields or gutters where practicable to reduce wetting of the refractories or

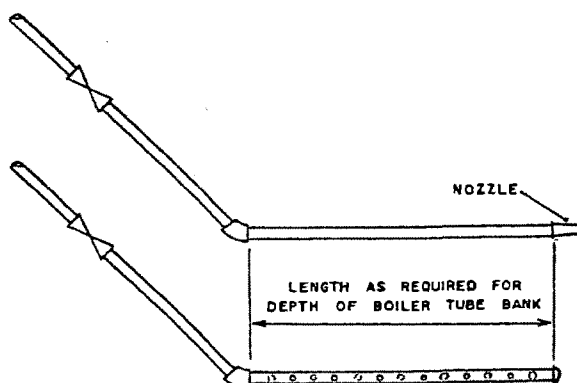


FIGURE 1. WATER LANCE FOR APPLYING WATER LOCALLY WHEN WATER WASHING.

TUBE REMOVAL & REPLACEMENT

TUBE REMOVAL AND REPLACEMENT

(Section 3-3)

Screen, waterwall, roof and floor tubes, or any tubes in or near the furnace and superheater tubes, may be plugged in case of failure, but should be replaced at the first opportunity.

When plugging tubes on the fire side of the furnace, the following factors should be taken into consideration:

(1) *Screen tubes*—plugging or removal of these tubes will tend to increase superheat temperature.

(2) *Wall tubes*—removal or plugging of adjacent side, rear or roof tubes endangers the refractories.

(3) *Floor tubes*—plugging or removal of floor tubes should be held at an absolute minimum, since loss of these tubes will effect the circulation in the furnace wall tubes.

(4) *Superheater*—plugging or removing superheater tubes will increase pressure drop through the superheater, therefore, the number of tubes out of use in any one pass should be held at a minimum.

Tubes in the main tube bank may be plugged in case of failure. Because of the large number of generating tubes in the main tube bank, the loss of several tubes will not effect the performance of the steam generator.

Boiler Tubes

If it should become necessary to renew a boiler tube, the defective tube is removed as follows:

1. Working from the inside of the drum (steam or water drum) use a round nose chisel and chip off flare (sometimes called the bell) of the tube to be removed, until the tube end becomes flush with the drum. *Extreme care must be exercised in this operation so as not to dig the chisel into the drum.*

2. Use an acetylene torch or any heating torch, heat the inside of the tube to a dull red. Allow tube to air cool.

3. Burn, chip, or hack saw both ends of the tube at furnace side approximately 1" to 2" from tube sheets, taking care not to harm tube sheets. After both ends of the tube have been cut from the drums, the tube is pulled out through the tube bank and removed from the furnace. Boiler tubes located in the front of the superheater are removed through the burner opening. Tubes lo-

cated in the main tube bank are removed through the access door placed at the bottom of the casing.

4. Insert driving tool (made up to correct size and gage of tube) into the tube and drive the tool with a small mallet. This will free the tube ends from the drums.

5. To remove tube ends without cutting flares off as above paragraph 1 describes, flush cut tubes next to drums on fire side and drive into drums.

When installing a new tube, first properly clean the tube seat to the bare metal using a fine emery cloth. Inspect the seat to check that no spirals or grooves remain in the tube seat.

The spare tubes may be protected with an internal coating which, if not removed, will act the same as scale in service. This should be thoroughly removed and the outside as well as inside of the tube at the ends must be free of burs and cleaned bright with fine emery cloth.

The tube is then placed in the drum holes and rolled with the proper expander for the tube size, gage and sheet thickness.

To remove waterwall tubes, follow instructions in paragraphs 2, 4 and 5, substituting the word "headers" for "drums".

The amount a tube should be expanded can only be determined from experience.

Tubes should be cleaned internally after expanding.

Superheaters

To cut out a superheater tube, first remove the handhole plugs from the header opposite the ends of the tube to be removed. Access to the superheater header is by means of panels or doors in the boiler casing.

Remove the adjacent plugs above or below this point to admit a light and to give better access for working. The tube should be cut at the U-bend end and one side taken out at a time. Use an acetylene torch and heat the tube end to be removed to a dull red. Allow the tube to air cool for shrinking. The bell end of the tube being removed is to be crimped in or cut off. Insert tube driver (made up to correct size and gage of tube) into the tube and drive the tool with a small mallet. Pull tube at the U-bend end with a turn buckle or small chain hoist, taking up slack on turn buckle

Step 1: Cut the superheater element at the U-bend end removing U-bend in order to take out one side at a time. Assemble cutter shank extensions and insert through tube from the U-bend end. Attach pilot from hand hole end that fits nearest ID of expanded tube and attach weld removing cutter. Assemble sleeve, feed nut and washer over driving shank and screw into extension. Insert spacer and additional pipe spacer as necessary between sleeve and end of tube. With the use of an air motor or electric drill to turn driving shank, feed cutter by backing feed nut until weld is removed (approximately 1/16").

Step 2: Remove spacer. Back entire mechanism into header, replace cutter with tube removing reamer and proceed as in Step 1, until tube is entirely free from header. When reamer has penetrated tube for above 1/2", remove the pilot and continue reaming. Clean tube seat thoroughly of any particles of tube, paying special attention to the grooves.

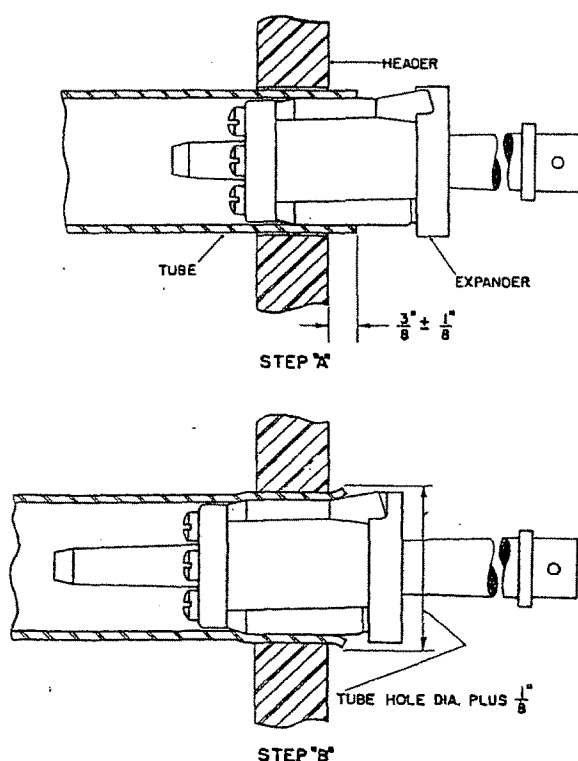


FIGURE 4. EXPANDER FOR ROLLING TUBES IN MAIN BOILER TUBE BANK AND THE SUPERHEATER ELEMENTS.

Step 3: Insert new tube to within 1/16" from inside face of header. Expand tube in seat by using expander with mandrels, universal joint and extension.

Step 4: Seal weld tubes as per instructions on arrangement drawing of superheater.

Step 5: Remove any weld splatter projecting over inside edge of tube or inside of tube.

EXPANDING TUBES

(Section 3-4)

The proper use of expanders is of utmost importance in the installation of tubes. The process of expanding is a most severe application of power and unless care is used, tubes and tube seats can be badly damaged.

Tubes should be expanded just enough to secure tightness so that ample "life" may be left in the metal for future expanding should it be found necessary. The judgment of the operator must govern the proper amount of rolling.

Description of Expanders

An expander consists of three or five expanding rolls and one or two belling rolls, held in place by a cage. A tapered mandrel fits thru a hole in the center of the cage. The rolls are set at an angle to the longitudinal axis of the body so that when the mandrel is rotated in a clockwise direction, it provides the pull or feed necessary to move the mandrel forward. As the mandrel moves forward, the rolls are forced outward expanding the tube to its seat.

The rolls are tapered to match the taper on the mandrel, so that they will expand the tube parallel to the seat. Selection of the proper expander to be used is important. Factors governing the selection include size and gage of the tube and the thickness of the seat in the drum or header. Composition of the tube, wall thickness and diameter may also affect the selection of the proper taper. Less

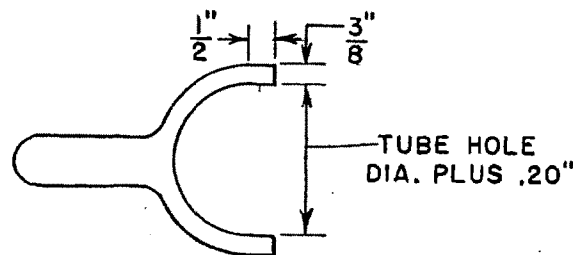


FIGURE 5. SNAP GAGE.

off the end of a tube from the expanding operation, it cannot get into a tube seat into which a tube has not been expanded.

When starting to expand a tube, the expander should be set into the tube, with approximate one-half of the straight rolls in the tube so that the expander will move into the tube as the mandrel is rotated. The proper setting can only be determined by experience as it is necessary to set the expander back farther from the end of the tube when expanding into a thick tube sheet than when expanding into a thin tube sheet. The expanding operation should be stopped when the small end of the belling roll is in line with the inside edge of the seat. If the tube has not been sufficiently expanded when the small end of the belling roll reaches the inside edge of the seat, the expander should be removed and the rolling operation repeated as outlined above. Do not let the small end of the belling roll pass the end of the seat as it will cut the tube, round the seat or pull the tube into the drum.

For starting to expand economizer tubes, the thrust collar should be set so that the distance from its seating surface to the front end of the

belling roll is the same as the distance from the handhole surface to the face of the tube sheet. When the expander is in place, it should be set so that the thrust collar is approximately $\frac{1}{2}$ " to $\frac{3}{4}$ " from the seating, that is $\frac{1}{2}$ " to $\frac{3}{4}$ " of travel left.

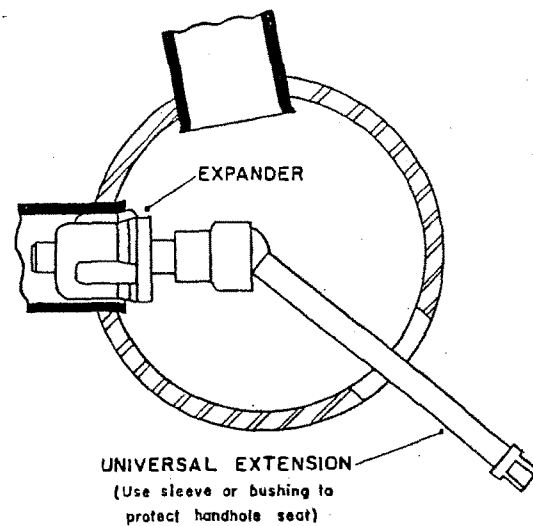


FIGURE 9. EXPANDER WITH UNIVERSAL JOINTED MANDREL FOR WATER WALL ROUND HEADERS.

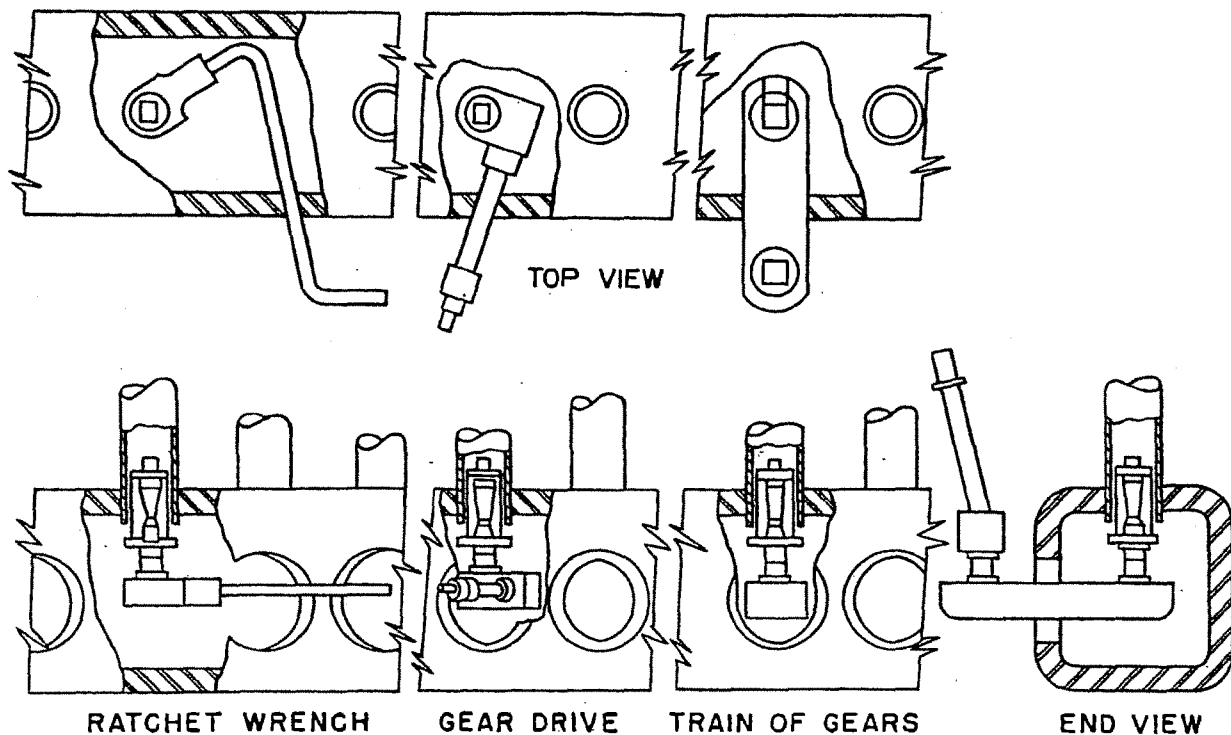


FIGURE 8. EXPANDING TUBES IN WATER HEADERS WITH HAND HOLES 90 DEG. FROM THE TUBE HOLES.

INSTALLING AND REMOVING HANDHOLE PLUGS

(Section 3-5)

Check Drawing for types of handholes used on this installation.

Before installing handhole plugs, all plug seats, plugs and gaskets or ferrules should be carefully cleaned. Powdered graphite and water should be used on the threads of all plugs, to prevent the nuts from freezing after the equipment has been in service.

Particular care must be taken when reinstalling old plugs to see that all rust and scale is removed.

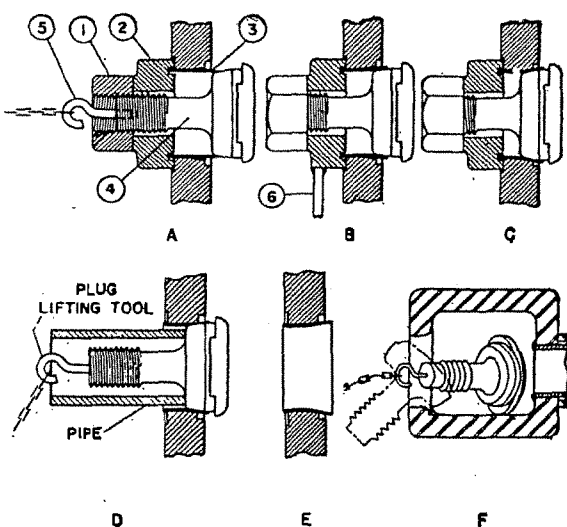


FIGURE 10. LIP TYPE HANDHOLE PLUG DETAILS.

REFERENCE LIST

- | | |
|----------------------|------------------|
| 1. Nut | 4. Handhole Plug |
| 2. Handhole Plate | 5. Lifting Tool |
| 3. Ferrule or Gasket | 6. Make-up Plate |

To Install the Lip Type Plug

Screw the lifting tool into the end of the stud, pass the plug through the handhole and draw it squarely in against the header wall (see Fig. 10 above). Wipe both sides of the ferrule with light, clean machine oil and insert in hole. Keep the square edge of the ferrule outside and the beveled end against the plug.

Slip the make-up plate over the stud, making sure that the ferrule is entered in the grooved plate and is true and squarely seated on the plug.

Install nut hand tight as shown in "A" of Fig. 10. Hold make-up plate firmly against header and tighten nut with wrench, tapping the plate back against the header after each small increment of tightening. The plug must not be allowed to bind unless the plate is fully in contact with the header.

Draw the plug in as far as possible with the wrench, then remove make-up plate, coat stud with a water and graphite mixture and install the standard handhole plate and tighten nut securely. Note that the plug must be drawn in hard in order to compress the ferrule properly and make a sealed joint as shown in "C" of Fig. 10.

To Install the Taper Plug (no lip)

Assemble the plug complete using make-up plate. Coat the threads on the handhole plug with a mixture of graphite and water and lightly coat both sides of the ferrule with clean, light machine oil. Keep the square edge of the ferrule outside and the bevel end against the plug.

Insert the plug into the seat and bring the make-up plate firmly against the header, similar to sketch "B" of Fig. 10. Slowly draw up the plug, using a wrench and tap the plate lightly to facilitate tightening and proper seating of the plug and ferrule.

When completely tightened and properly seated, remove make-up plate and replace with permanent handhole plate.

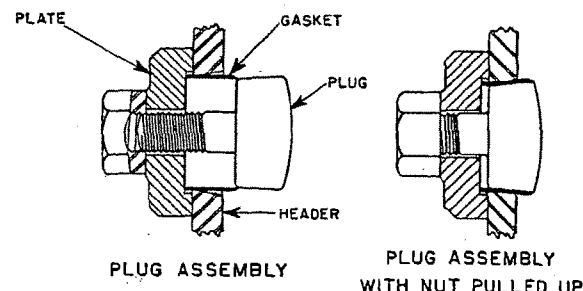


FIGURE 11. 2" STANDARD (STRAIGHT TAPER) HANDHOLE PLUG.

Inspection

To remove plug for inspection, remove nut and plate and lightly crimp the projecting end of the gasket at two points to hold gasket in place. Next screw lifting tool into stud or fasten a wire around the stem of the plug, thread pipe nipple over

ELLIPTICAL HANDHOLE SEAT GRINDER

For repairing minor defects in elliptical handholes, an Elliott Handhold Seat Grinder is suggested. This unit is designed to hold a grinding wheel in one plane while permitting its free movement in that plane. It is driven by either an air or electric motor, the drives being interchangeable.

The unit is set up for use by threading a face plate to a handhole plate stud of an adjacent handhole. An adjusting plate is screwed to the face plate on a ball joint, and adjusted by four leveling screws. This plate rigidly controls the alignment of the grinding wheel relative to the seat face. The grinder can be set up to work at any angle.

The width of the seat to be ground is controlled by a guide roller on the spindle housing, which bears against the side of the handhole. Guide rollers can be supplied in four diameters and four different diameters of grinding wheels are available. Adapters for $\frac{3}{4}$ " and 1" handhold studs are furnished. A convenient spacer on the grinding spindle is used to adjust the level of the grinding wheel for various thickness of headers.

Handholes of any shape can be ground. Any handhole within range of the unit can be faced with a single setting. In case the reach is greater than $11\frac{1}{2}$ ", an extension link can be furnished.

Operating Instructions

The handhole grinder is assembled with the grinding wheel ahead of the spindle collar for use in grinding heavy headers. For thin headers it will be necessary to assemble the spindle collar in front of the grinding wheel. Before setting up the grinder, measure the distance between the top of the header and the top of the yoke. This should be approximately 2 in. If it is less, use washers between the leveling plate and the top of the yoke. A good job of leveling the grinder reduces the grinding time and results in a smoother seat.

1. Remove the leveling plate from the grinder assemble by unthreading the ball nut.
2. In a handhole within reach of the grinder, assemble a handhole plate and yoke, then thread the leveling plate on the stud (plate has a 1" U. S. thread) and set up tight.

For other thread sizes of studs an adapter is used between the stud and leveling plate.

3. Insert the grinding wheel in the handhole to be refaced. Turn the adjusting lock nut clockwise to the limit of travel.
4. Assemble the grinder onto the leveling plate, adjust the grinder to the best working position and tighten the ball nut by hand.

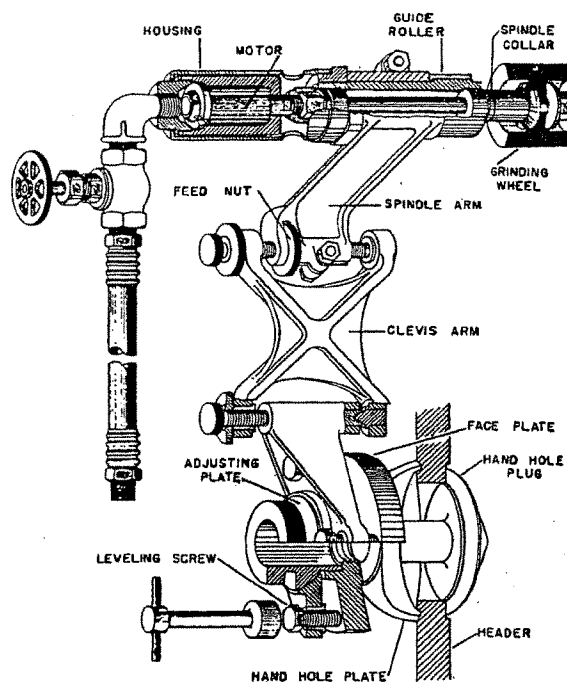


FIGURE 14. ASSEMBLY OF AIR-DRIVEN HANDHOLE SEAT GRINDER.

5. While turning the drive nut with the fingers, turn the adjusting lock nut counter-clockwise until the grinding wheel contacts the gasket face lightly.
6. Turn the adjusting screws, with the T-handle wrench, while twirling the drive nut, until the wheel contact is uniform around the entire seat.
7. Turn the adjusting lock nut clockwise to remove the grinding wheel from contact with the gasket seat.
8. Attach the motor drive unit by threading the motor onto the housing lock nut.

HANDHOLE PLUGS

the handhole is out of round, it is advisable to true it up with a 5-roll expander.

For operation of the tool proceed as follows:

1. Measure the thickness of the header material in the handhole.
2. Measure the same distance on the handhole reseating tool, making adjustments by adding or subtracting some of the thrust washers, see Fig. 15 until the distance from the bottom spacer collar to the center of the rolls is such that when the tool is inserted in the header handhole, the bearing surface will fall approximately in the middle of the rolls.
3. Lubricate the rolls and the washers slightly.
4. Screw back the feed nut until the rolls fall back in the roller head.
5. Insert the reseating tool in the header handhole.
6. Tighten feed nut hand tight.
7. Place ratchet wrench on the end of the mandrel.
8. Drop latch so that it engages with the feed nut.

9. Rotate to the right approximately 45 deg.
10. Remove latch so as to stop feed.
11. Roll until tension is relieved.
12. Repeat steps No. 8 to 11 until a handhole seat of the required width is obtained, or until the marred surface of the header seat is refinished.

Precautions

1. The header surface where the spacer collar seats should be examined and must be perfectly true and at 90 deg. with the handhole opening.
2. Dimension for tapered seat as shown in Fig. 16 of handhole seat should be kept accurate, too wide a seat would make it difficult to make a tight joint.

Caution

3. Do not feed too rapidly and check continuously that latch feed does not slip into place, when rolling is commencing.
4. *This tool must be used with discretion; as over rolling or improper use may result in serious damage.*

ECONOMIZERS

Welded Return Bend Design

(Section 3-6)

Access Doors

Insulated access doors are installed at each end of the economizer. The doors at the rear of the economizer must be removed for access to the handhole plugs in the headers. These doors must be removed to examine welded joints for tightness. Doors at the front of the economizer, in addition to the above, are removed for tube removal and cleaning.

Internal Inspection

For internal inspection of the elements the handhole plate must be removed. Refer to Fig. 2.

- (1) Screw plug lifting tool into stud.
- (2) Remove nut, piece No. 7.
- (3) Remove plate, No. 6.
- (4) Slip pipe over lifting tool.
- (5) Drive plug into the header by tapping pipe as shown in view D of Figure 10 Section 3-5 Handhole Plugs (pg. 9).
- (6) Crimp ferrule (or gasket) part No. 8 Fig. 2 using crimping tool (Fig. 3) and remove from header.
- (7) Remove plug (5) by means of lifting tool.

Taking Economizer Element Out of Service

To take any element out of service, plug off the entire stream which is affected by it. Place tube plugs in the inlet (top) and outlet (bottom) headers of the elements of the lane in which the leak occurs—thereby blocking off the entire pass.

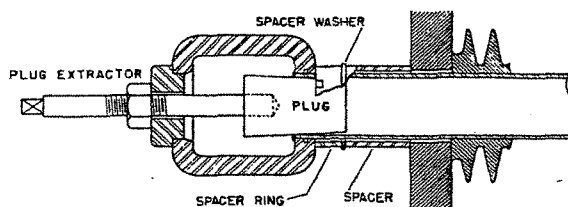


FIGURE 1. SECTION THROUGH FORGED STEEL HEADER SHOWING METHOD OF REMOVING THE PLUG FROM AN ECONOMIZER TUBE THAT HAS BEEN PLUGGED TO PERMIT OPERATION WITHOUT WAITING FOR REPAIRS.

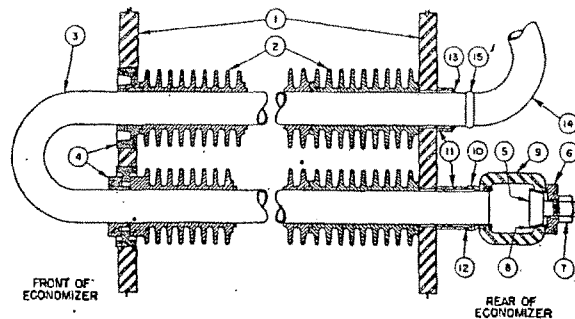


FIGURE 2. STANDARD U-BEND ECONOMIZER ELEMENT CONNECTED TO HEADERS WITH WELDED RETURN BENDS.

REFERENCE LIST

- | | |
|---------------------------|------------------------------|
| 1. Tube Sheets | 9. Headers Inlet or Outlet |
| 2. Extended Surface Rings | 10. Spacer Ring |
| 3. Economizer Tubes | 11. Spacers |
| 4. Sealing Rings | 12. Spacer Washer |
| 5. Hand Hole Plug | 13. Tube Tack Weld to Spacer |
| 6. Hand Hole Plate | 14. Return Bend |
| 7. Nut | 15. Return Bend Weld |
| 8. Ferrule or Gasket | |

The flow of water through the individual passes of the economizer is shown by the drawing in Section 1—under “Description of Economizer” in the first section of this book. This drawing must be followed to determine the passes of water through the economizer. Carefully check the drawing to determine the pass in which leak occurs so that the elements at both the inlet and outlet header of this pass can be plugged.

The tube plug for this purpose should have a taper of $\frac{1}{8}$ " in $3\frac{1}{4}$ " length or $15/32$ " per 12". The tube plug and plug extractor are shown in Figure 1.

Removing Economizer Elements

Burn, or preferably cut off (using hack saw) both return bends (14) Fig. 2 from effected element at four places where the return bends are welded. This cut should be made through the weld (15). This is necessary for accessibility in installing and aligning new element. Chip the tack weld (13) to spacer on effected element only. If one

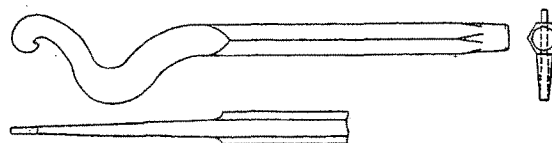


FIGURE 3. CRIMPING TOOL FOR REMOVING HANDHOLE GASKET.

1. Thoroughly clean split chill ring and install it in the return bend. See Fig. 7.
2. Fit bend to tube and tack weld the tube in place.
3. Apply first weld head using $\frac{1}{8}$ " Fleetweld #5 or #85 electrode.
4. Thoroughly clean the weld with a rotating wire brush or peen weld if more practicable.
5. Apply a sufficient number of welding passes

to build weld up flush with tube and bend. Clean each pass thoroughly as described above.

6. Apply a final weaving pass covering the weld.

After return bend is welded in place, tack weld tube to spacer in four places (Fig. 2, #13).

Replace handhole plugs and test the welded joints under pressure. If tight, replace economizer doors.

REFRACTORIES

(Section 3-7)

General Description

Why refractories and insulation?

The primary reasons for the use of materials of this nature are to confine the temperatures resultant from the combustion process in the desired areas, maintain uniform furnace temperature, to aid in supporting combustion and to protect vital parts of the steam generator from direct flame impingement or excessive heat.

For simplicity these materials can be divided into three groups according to their general characteristics and uses:

- A. Dense Fire Clay Refractories.
(Super duty, special super duty or high heat duty.)
- B. Insulating Refractories.
- C. Industrial Insulating Materials
(Block, Blankets, etc.)

(A) Dense Fire Clay Refractories may be subdivided into many types. This description covers only those materials common to Marine Steam Generator furnaces. Fundamentally the function of the dense fire clay refractories is to take the abuse or wear resulting from high furnace temperatures and direct exposure to gases of combustion.

Materials in this group are furnished in many different forms and shapes. Those common to marine boilers and generators are kiln fired fire brick, such as Empire, Mex-Ko and KX-99, the plastic and castable refractories such as Super Plastic, Super Hybond, Kast-Set and KS-4. The latter are of such nature that they can be molded or cast into desired shapes on the job. The KS-4 is a type of high temperature castable made especially for gun application.

Kiln fired fire brick are provided in standard and special shapes. The standard are referred to as series brick. These are designed to eliminate, to a great extent, undesirable cutting. Special shapes such as anchor brick, roof tiles, etc. are made for specific uses and locations.

(B) The Insulating refractories are refractories having outstanding insulating qualities. These

materials possess the property of insulating value at elevated temperatures. Their use will be covered later. Similar to the dense refractory group, these are provided in several forms and shapes, among which are standard shapes and castable types. An example of the latter is Kast-O-Lite, a lightweight refractory castable.

(C) Such items as block and blanket insulation, loose rock wool and insulating cement are identified as Industrial Insulating materials. Generally these materials are designed for high insulating efficiencies in a specific temperature range usually 1200° to 1900° F. These materials do not possess refractory properties and are therefore used as backing up and in areas where insulating efficiency more than refractory properties are desired. This group has in addition to pre-formed shapes such castable materials as castable #20, SK-7 and castable block mix which are used where it is necessary to form special shapes or fill hard-to-get-at areas. The SK-7 as in the case of KS-4 is made for gun application.

The materials described above are common to all Marine Steam Generators in part or as a whole.

Refractories for Sectional Header Type Steam Generators

The materials used in the furnace and boiler sections of the sectional header boiler are largely of standard shapes and sizes. The walls are constructed with standard 9" straights and series brick of Mex-Ko super duty fire brick backed by insulating brick and/or block insulation.

Anchor brick secured by anchor bolts located on specified centers are provided to hold the wall back against the casings. All bricks are bonded together by a good grade of bonding mortar of the same characteristics as the clay used to manufacture the brick. In furnaces having water walls, i.e.: the Victory Ship boilers and the C2SAJ1 class vessels these tubes are backed up by a high heat duty fire brick such as Empire, backed by block insulation.

An illustration of typical side wall construction can be seen in figure 1. The application of materials in the floor and corbell in this type of unit is also illustrated in this figure. The materials used in the front wall and burner sections are shown in figure 2.

Corbell construction in these units serve a dual purpose. They are installed using Kast-Set or Super Plastic (as specified on boiler refractory drawing) to seal the floor expansion joints and to protect the wall headers from exposure to direct furnace heat.

The lower drum in these units is protected by a refractory wall, referred to as a bridgewall. This is constructed of either Super Plastic or Kast Set as specified. It is the practice to anchor these materials to the drum using special anchors made for this purpose. The top of this drum is protected by a covering of Kast Set.

Coal fired units of this type equipped with grates have a higher bridgewall than is common in oil fired units. This bridgewall is generally constructed of a slag resisting KX-99 fire brick to the height above the grate line as specified on brick work drawing. Either Super Plastic or Kast Set is then carried up from this point and over the top of the drum.

Furnace water walls in the "A" or "D" type units are backed with first quality or super duty refractories, i.e. Empire or if the latter Mex-Ko. Dependent upon the unit, these are either 9" straights and series or square edge tile. This is then backed with block and blanket insulation. The same construction is followed for the furnace roof.

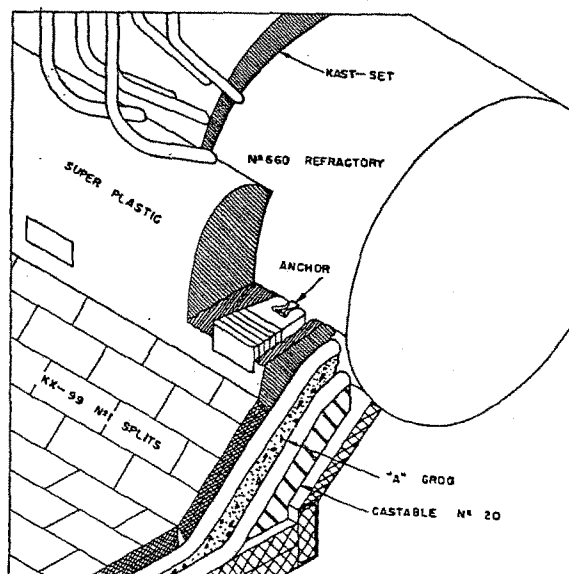


FIG. 3—REFRACTORY INSTALLED ON LOWER DRUM AND FLOOR TUBES OF "D" TYPE STEAM GENERATOR.

The economizer vestibule and boiler side and end walls are insulated in the same manner as described for the same area in the sectional header boiler. There are some exceptions to this, however. Some units have walls cast of Castable #20 insulation and others were equipped with special anchored square edge tiles. The vestibule floors are insulated with two layers of block insulation, the topmost covered with insulation coating to prevent penetration of water or soot into the block.

The superheater header is protected by a panel of Kast Set poured in place. This serves as protection from the hotter furnace gases that would cause damage to these headers and tubes. The casing on the loop end of the superheater is provided with removable access doors. These doors are protected with Kast-O-Lite backed with block insulation.

The refractory and insulating materials used in these units are designed to withstand the conditions normally expected to be found therein. With proper operation and maintenance, few if any, difficulties should arise.

Causes of Refractory Failure

Some common refractory failures encountered in marine furnaces are spalling (mechanical, structural and thermal), slagging and abrasion. These are considered the major causes. Briefly the costliest refractory failures can be considered to be spalling and slagging. There are many factors that can be related to the causes of spalling for our purpose.

Spalling

Three basic types of spalling are:

1. Mechanical, sometimes referred to as pinching, is not frequently found to occur in furnace walls. This type of failure is generally caused by improper location or lack of proper expansion joints. Fireclay brick expand approximately 0.06 percent at 1800° F. It is therefore important that expansion joints be properly located, as shown on drawings.

2. Structural spalling is the type most frequently encountered in marine boiler furnaces. This condition is accelerated by slagging and flame impingement. Present day oils usually contain chemicals which act as a flux when deposited on incandescent fire brick. These fluxes have a

should be consulted. Discuss any problems that may arise with your service engineer.

After all old refractory, insulating materials and debris have been removed all casings and the floor pan should be examined for defects and distortions. It is important that these be repaired before replacing any brickwork or insulation.

In making renewals or repairs, emphasis should be placed on strict adherence to the boiler refractory drawing and any latest revisions suggested by your service engineer.

When laying fire brick care should be exercised to get thin even joints. This is accomplished by using mortar of a consistency suitable for dipping the brick. The best side of the brick should be selected for the furnace interior and after being dipped on two sides in the mortar, are then fitted snugly against the next by rubbing until a tight fit is assured. All joints should be staggered by placing a soap at the end of the course, or by the use of a large 9" straight. When placing the anchor bolts and anchor brick it is important that the fit be loose enough to permit movement due to expansion. During the construction of the wall all excessive mortar should be removed using a wire brush.

Whenever Super Plastic is to be installed, the manufacturers' recommendations should be followed closely. The plastic should be rammed in place using a three pound maul or an air rammer made for that purpose. Proper expansion joints should be provided and the plastic areas should be divided into sections with contraction cuts. These cuts are made by scoring the plastic approximately 3" deep with a sharp thin instrument such as a trowel. After completion of the Super Plastic work, the surface should be scratched to permit venting. When using Hybond, it is necessary to vent the surface by punching holes using a thin rod.

All castable should be dry mixed in a clean container before adding the water as prescribed by the manufacturer. Where metal tubes penetrate into or through the castable or whenever the castable is anchored with metal anchors, provision should be made for expansion of the metal within the castable. Wrapping with friction tape or some other combustible material will serve this purpose.

Firebrick used in the floor should be laid with staggered joints around the floor. Placing soft block insulation of 1" thickness in the expansion joints will provide a 1/2" joint free from debris.

If the boilers are to be water washed it is important not to substitute your insulating products with some which are soluble in water, as there is a danger of washing away the backing up insulating materials. Wherever possible, water should be diverted away from the furnace and boiler linings.

On repairs where Plastic refractories are to be used, these materials should be applied last. It is desirable to light off as soon as possible after this work is completed. Where castables have been used the opposite will apply as the castables become stronger if permitted to fully air set before the application of heat.

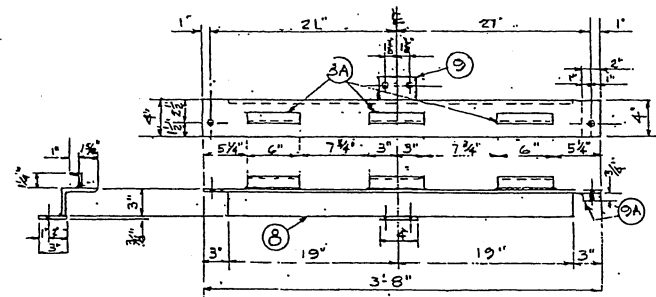
When all work has been completed, and all safety precautions have been complied with, a slow fire (wood if possible) should be started. If the unit is oil fired the smallest tip possible should be used. This drying out or baking period will permit the moisture to escape without building up captive steam in pockets throughout the lining. It is advantageous to maintain this fire for 18 to 24 hours if possible. The temperature may be gradually increased until steam is raised.

Patching or minor repairs to the furnace or boiler linings should be made as soon as discovered. This procedure will prevent serious damage to refractories and boiler.

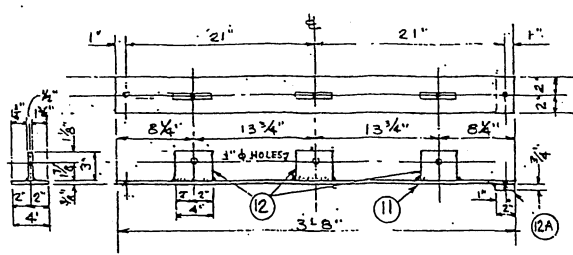
Before any patches can be made to brick surfaces all slag and loose particles must be removed. If the patch is to be shallow such as replacing spalled material, an application of Green Cote as described before can be made by spraying, brushing or troweling. If the extent of the repair is greater than this, the defective area should be removed back to solid brick or plastic.

The sides of the hole should be dove tailed to provide anchorage and Super Plastic rammed into the patch.

Inspection and necessary repair to the furnace lining will help to provide long and trouble free refractory life.



SUPPORT ANGLE 7L



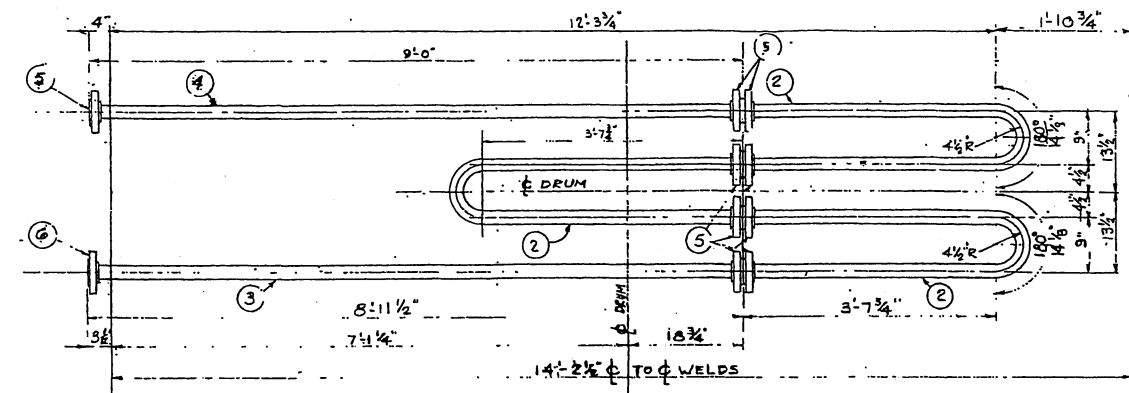
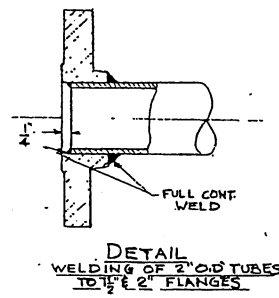
CENTER SUPPORT 10

MK.	SIZE	R	L	T	DEV	EQ.
UB-1	1/2"	3/16"	1 1/8"	1/8"	5 3/4"	8
UB-2	3/8"	1 1/2"	3"	1 1/4"	14 1/2"	21
UB-3	5/8"	1 1/4"	2 1/4"	1"	8 3/8"	28

U-BOLTS SEE DWG. D-291-256

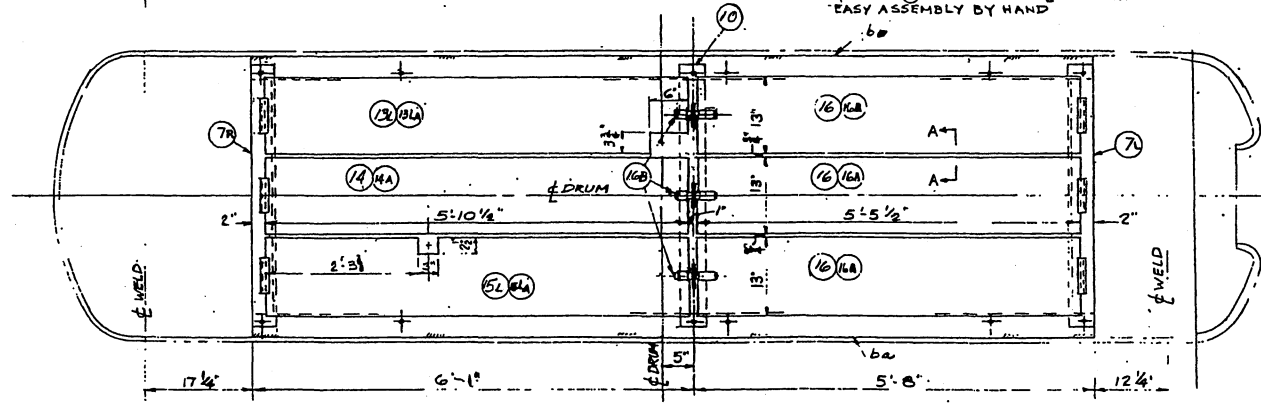
MK.	DESCRIPTION	REQ.
B514	5/8" HEX. NUTS	60
B512	"	15
B512	"	27
	5/8" HEX. NUTS	160
	1/2" "	12
	1" "	8

MISC. NUTS & BOLTS

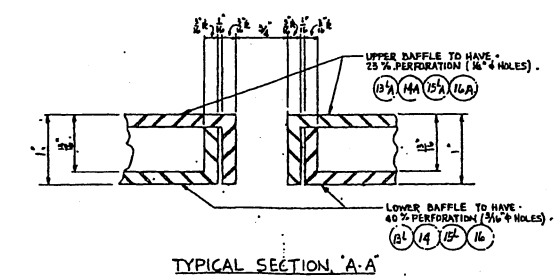


DESUPERHEATER PIPING 1

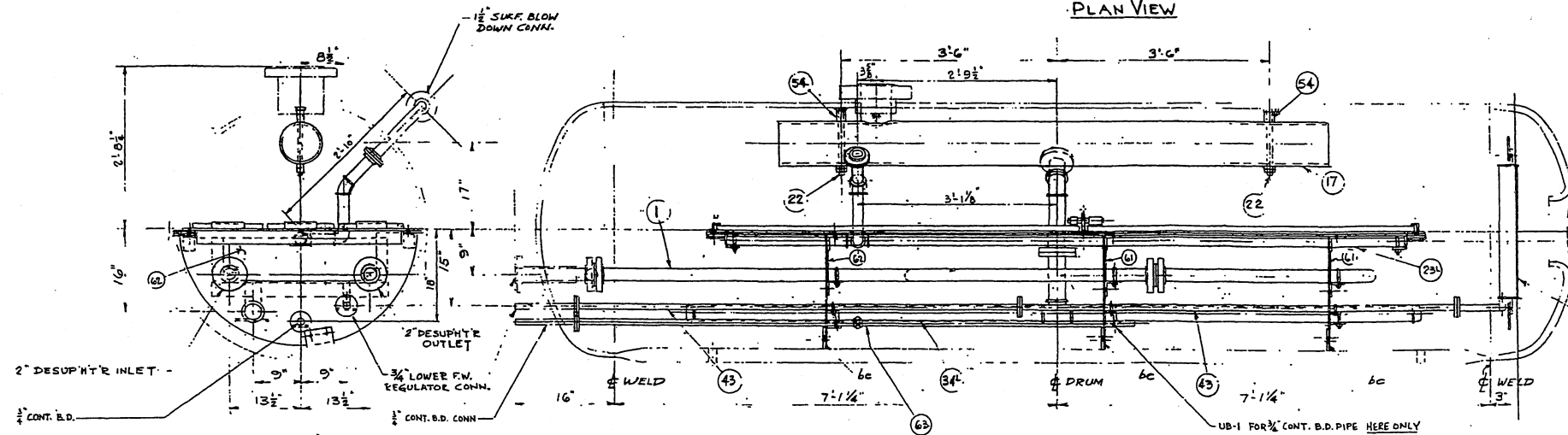
NOTE: WELDING OF BASES OF GRATING LATCH & CATCH (10) TO GRATING PL. MUST ASSURE EASY ASSEMBLY BY HAND.



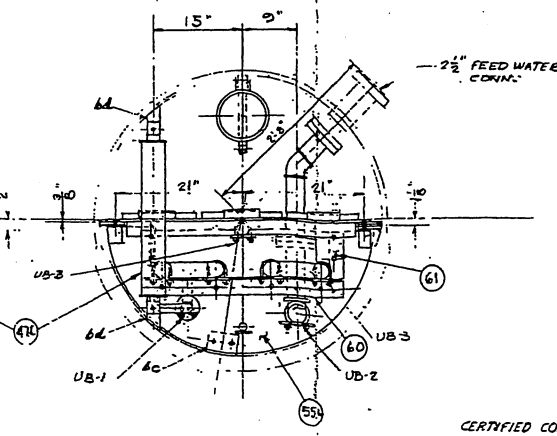
PLAN VIEW



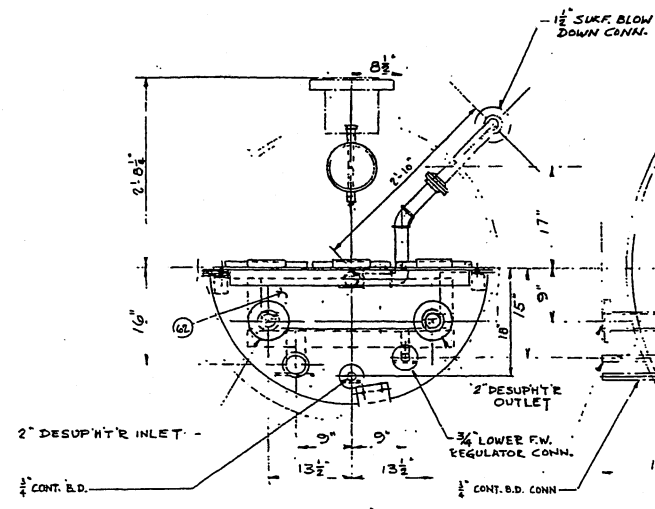
TYPICAL SECTION A-A



SIDE ELEVATION



FRONT VIEW



REAR VIEW

AS SHOWN FOR B-4628 AND B-4630
OPP HAND FOR B-4629 AND B-4631

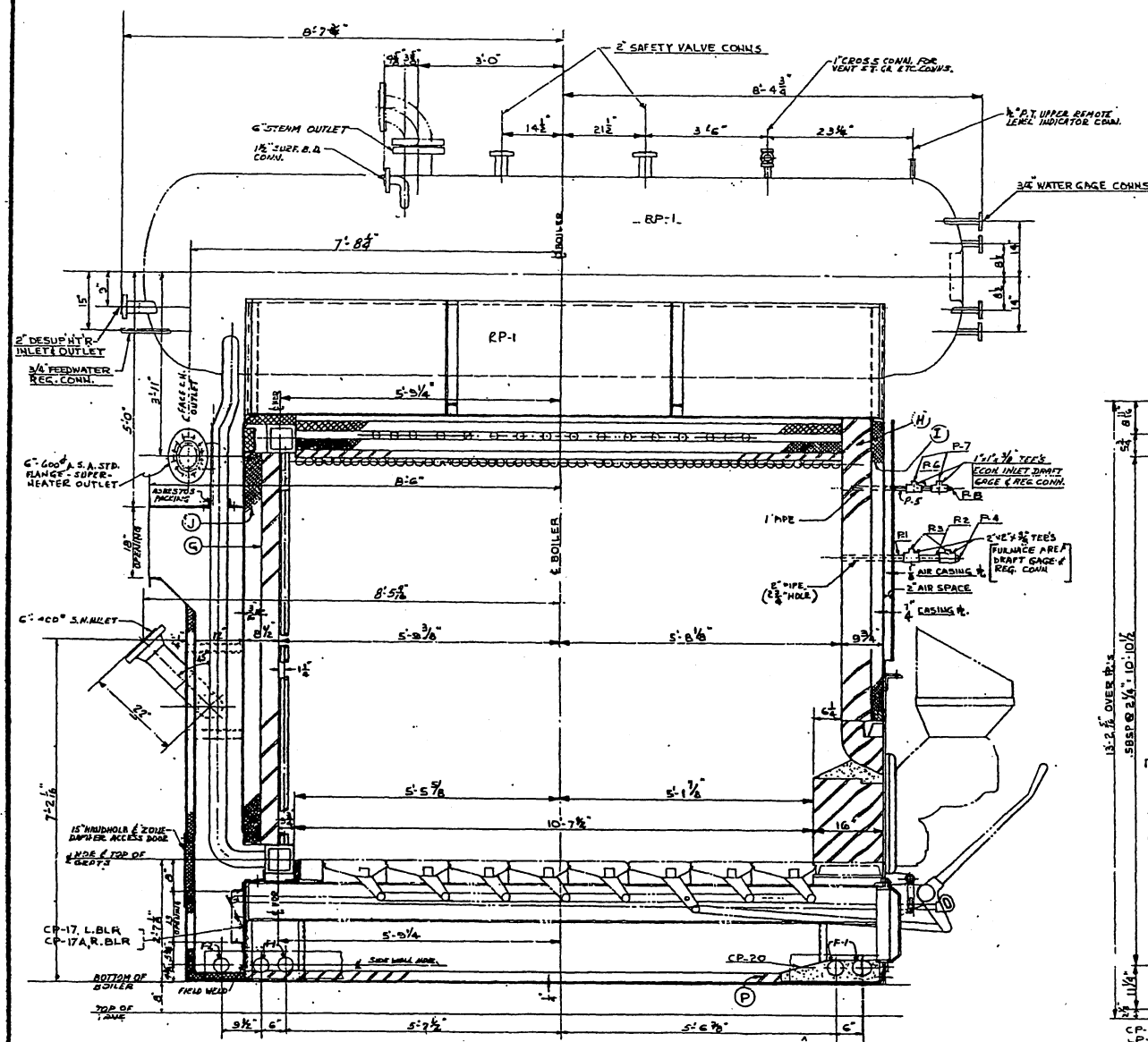
CERTIFIED CORRECT
JANUARY 21, 1951
H. Knackstedt
H. KNACKSTEDT

REFERENCE DWGS.
STEAM DRUM NY-500-453
EXT. & INTERNAL ATTACHMENTS
ON STEAM DRUM NY-501-518
DETAILS OF DRUM INTERNALS
& MATERIAL LIST NY-501-538

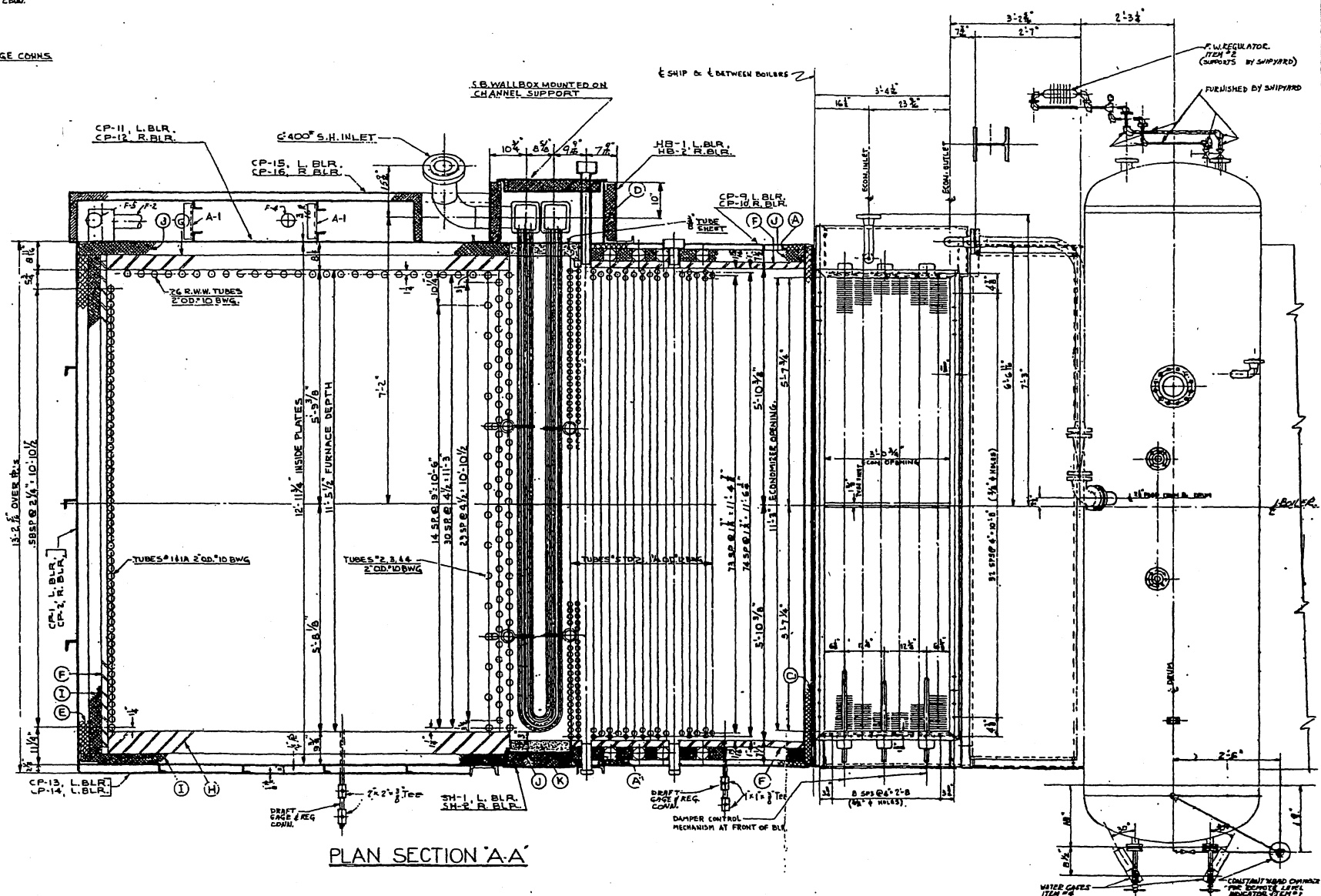
NOTES
1. ALL HOLES 3/4" UNLESS OTHERWISE SPECIFIED
2. ALL QUANTITIES FOR TWO BOILERS

1		CHANGED 2-BARS TO L-BAR ON SUPPORT ANGLE 7L		E.S.
DATE	DATE	DATE	DATE	DATE
REVISIONS				
ARRANGEMENT OF DRUM INTERNALS				
This Drawing is the Property of the FOSTER WHEELER CORPORATION THE BROADWAY, NEW YORK				
AND IS LOANED WITHOUT ANY OTHER RIGHTS BY THE BORROWER TO THE BORROWER'S PROJECT. IT IS TO BE RETURNED TO THE FOSTER WHEELER CORPORATION WHEN THE PROJECT IS COMPLETED. IT IS NOT TO BE REPRODUCED OR COPIED IN ANY MANNER WITHOUT THE WRITTEN PERMISSION OF THE FOSTER WHEELER CORPORATION.				
B-4701-4 (FWB-339L-4)				
DRAWN BY	SK	CHECKED BY	SK	APPROVED BY
NY-500-504-A				

LMCF00131



SECTIONAL ELEVATION 'B-B'



PLAN SECTION 'A-A'

CERTIFIED CORRECT
JANUARY 11, 1951
H. K. KRASTETZ

REVISION	DATE	DESCRIPTION
K	1-16-51	REVISIONS TO CORRECT LENGTH OF TUBES
J	1-16-51	REVISIONS TO CORRECT LENGTH OF TUBES
H	1-16-51	REVISIONS TO CORRECT LENGTH OF TUBES
G	1-10-51	ADDED DIMENSION FROM E DRAIN TO CONSTANT HEAD CHAMBER
F	1-4-51	LOCATED DRAFT GAGE COUPLER, REVISED DRAFT GAGE COUPLER LOCATION
E	12-25-50	RELOCATED R.W. REGULATOR
D	12-25-50	RELOCATED R.W. REGULATOR
C	12-25-50	RELOCATED R.W. REGULATOR

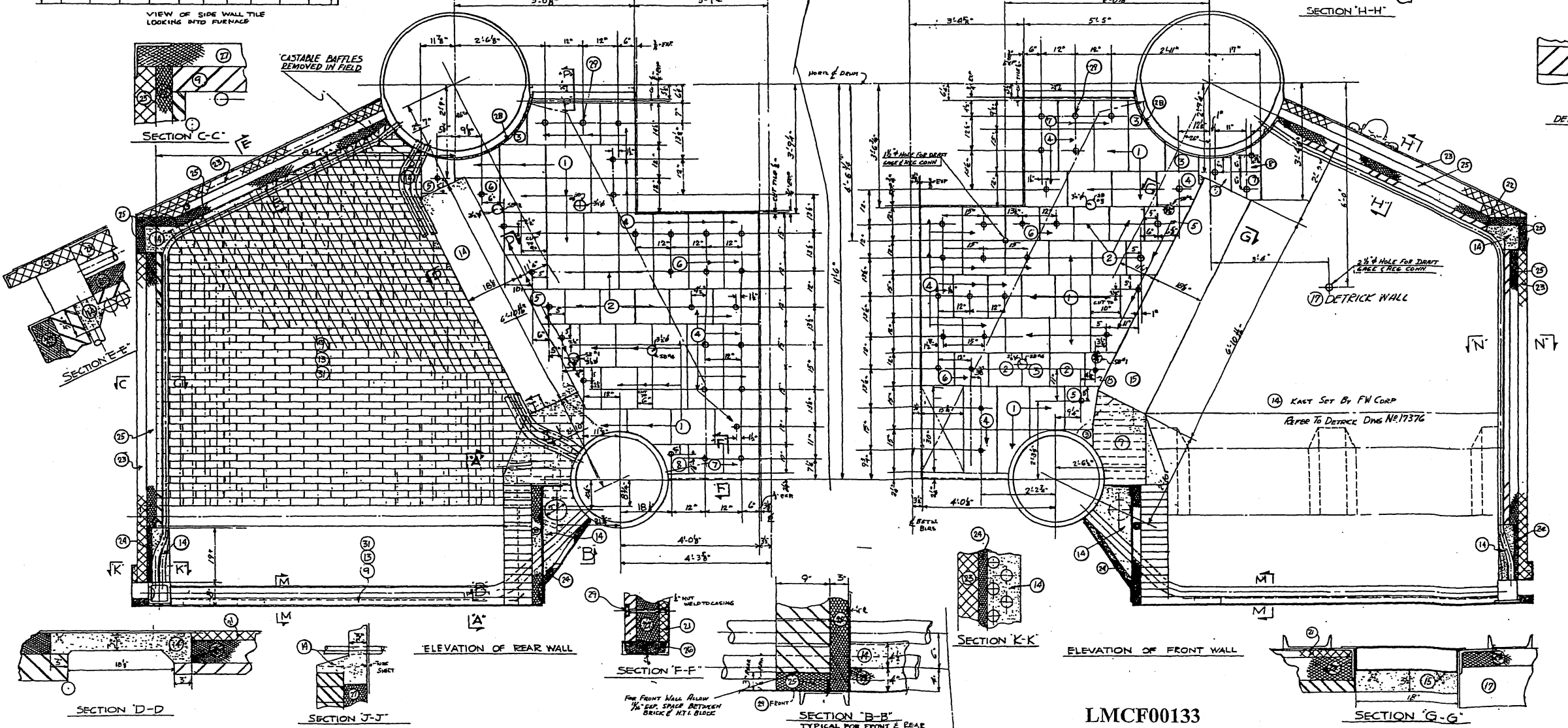
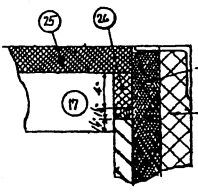
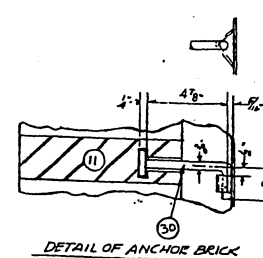
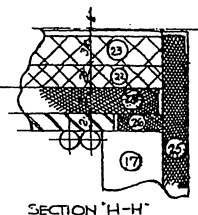
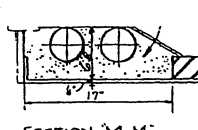
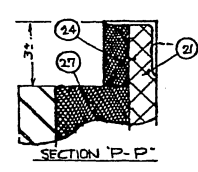
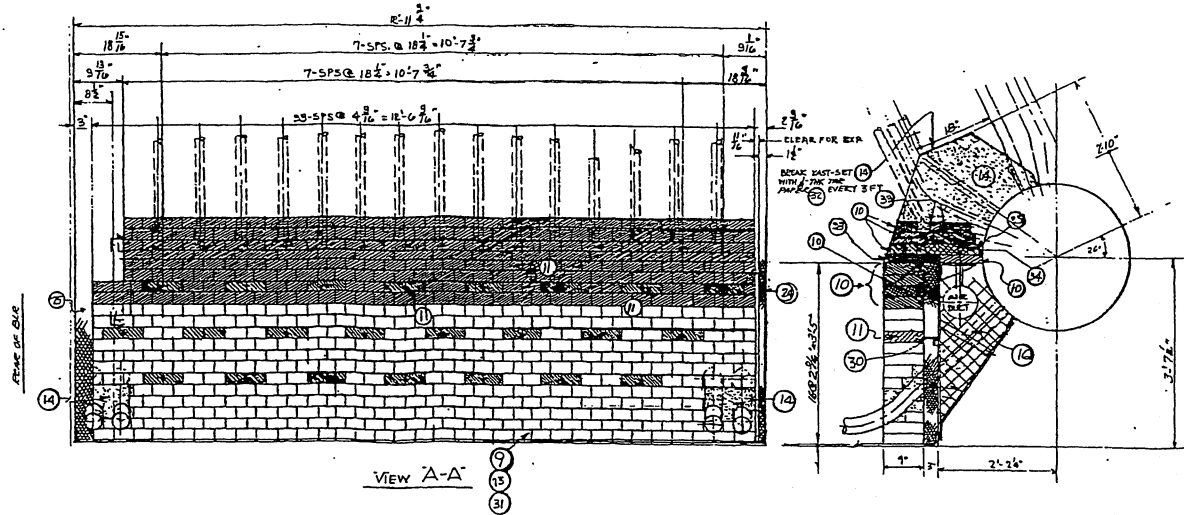
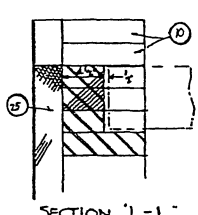
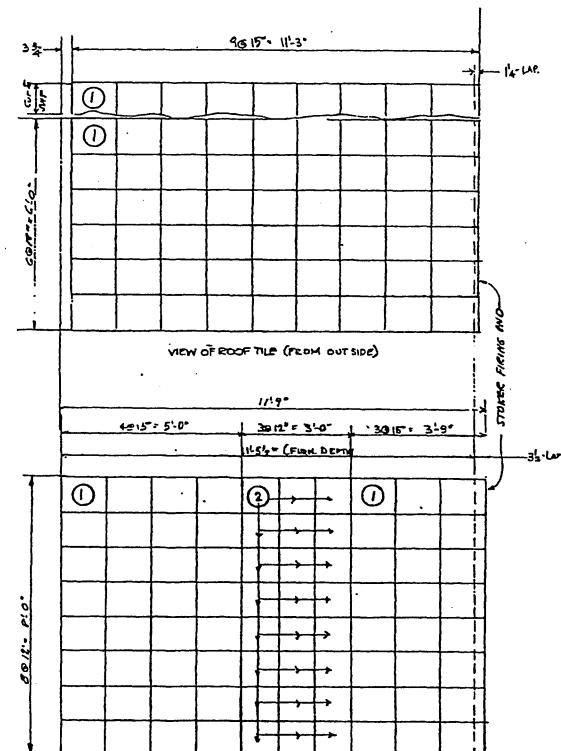
REVISION	DATE	DESCRIPTION
B	11-11-50	ADDED PARTIAL OUTSIDE PLAN
A	11-9-50	ADDED PARTIAL OUTSIDE PLAN

GENERAL ARRANGEMENT
AUXILIARY SECTIONS
FW STEAM GENERATOR

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DD-451 (FEB-33) 4
NY 500-440-K

LMCF00132



BILL OF MATERIAL									
QUANTITIES FOR FOUR (4) BLRS EQUALS ONE (1) SHIP									
NO	DESCRIPTION	PART NO	DWG NO	FRONT WALL	REAR WALL	2 ROOF	2 SIDE	5% EXTRA	TOTAL
1	15" x 12" x 2" TILE	STD	570	52	68	476		34	630
2	12" x 12" x 2" TILE	STD	570	20	24	96		7	147
3	10" x 12" x 2" TILE	STD	570	16	4			1	21
4	15" x 12" x 2" SPECIAL TILE	T-3431	NY-344-10	64	64			7	135
5	15" x 12" x 2" "	T-3440	NY-344-10	24	24			3	51
6	12" x 12" x 2" "	T-3430	NY-344-10	16	16			1	33
7	10" x 12" x 2" "	T-364	NY-344-10	16	8			1	25
8	10" x 12" x 2" "	T-363	NY-344-10	8	4				
9	9" x 12" x 2" FIRE BRICK	1ST QUALITY		70	2372	1360		262	5480
10	9" x 12" x 2" "	SURF-DUTY QUALITY				1150		50	1200
11	9" x 12" x 2" FIRE BRICK	F-1059	NY-404-262			184		10	194
12	9" x 12" x 2" SOAPS	SURF-DUTY QUALITY				16		1	17
13	9" x 12" x 2" SOAPS	1ST QUAL				40		430	520
14	KAST SET 100/LWT	5300	4100	3800	6000	16300		4300	50000
15	KAST-O-LITE 70/LWT	1000							1000
16	LOOSE ROCKWOOL EAGLE OR EQUAL 15" LIFT DENSITY					90		10	102
17	DETROCK WALL								
18	HIGH TEMP BONDING CEMENT								1500
19	FIBROUS ADHESIVE (FOR HIGH-TEMP BRICKS)								4480
20	ASPHALTUM PAINT (HEAVY)								4800
21	15" ROCKWOOL BLANKET (EAGLE OR EQUAL) 15"			15	15				30
22	2 1/2" "					5			5
23	3 1/2" "					58			58
24	4" HIGH-TEMP INSUL BRICK	CARRY-ON OR EQUAL (6" x 8")		10					94
25	3" "			262	17	553			832
26	2" "					28			28
27	4" "			167	440				607
28	1" ALBESTON POPP	AT UPPER DRUM							100
29	THE ANCHOR STUD 1/2"	NY-502-99		128	124				252
30	BRICK ANCHOR TA-3	NY-502-18					92		92
31	9" x 4 1/2" x 1 1/2" S&P	1ST QUAL							520
32	1/2" DETROCK								100
33	FURNACE FLOOR	* 10% EXTRA ON THESE QUANTITIES							
34	GOING THRU KAST-SET TO BE PAINTED WITH HEAVY ASPHALTUM PAINT OR TARP								
35	WIND PROTECTION TARP THRUOUT SURFACE PASSING THRU KAST-SET								
36	2" x 4" x 1/2" FIRE BRICK	SURF-DUTY QUALITY				1200		10	210
37	3" x 4" x 1/2" FIRE BRICK	NY-344-10				30		2	32
38	BRICK ANCHOR	AB-1	NY-344-10						32

CERTIFIED CORRECT
JANUARY 12, 1951
H. K. KNAACKSTEDT
H. K. KNAACKSTEDT

F	6-30-51	CHANGED TOTAL QUANTITY OF ITEM 18
E	7-1-51	IN B.M. CORRECTED QUANTITY
D	1-12-51	ADDED TO BILL OF MATERIAL - INCREASED QUANTITY ITEM 18
C	1-12-51	ADDED TO BILL OF MATERIAL - INCREASED QUANTITY ITEM 18
B	1-6-51	ADDED BAFFLES FOR SMOKELOWERS AND DETROCK WALLS & REEL CORNER. REVERSE CONTOUR OF KAST-SET AT LOWER DRUM.
A	12-18-50	COMPLETED & CHECKED

LETTER DATE DESCRIPTION

REVISIONS

ARRANGEMENT OF
BRICKWORK & FIELD INSULATION

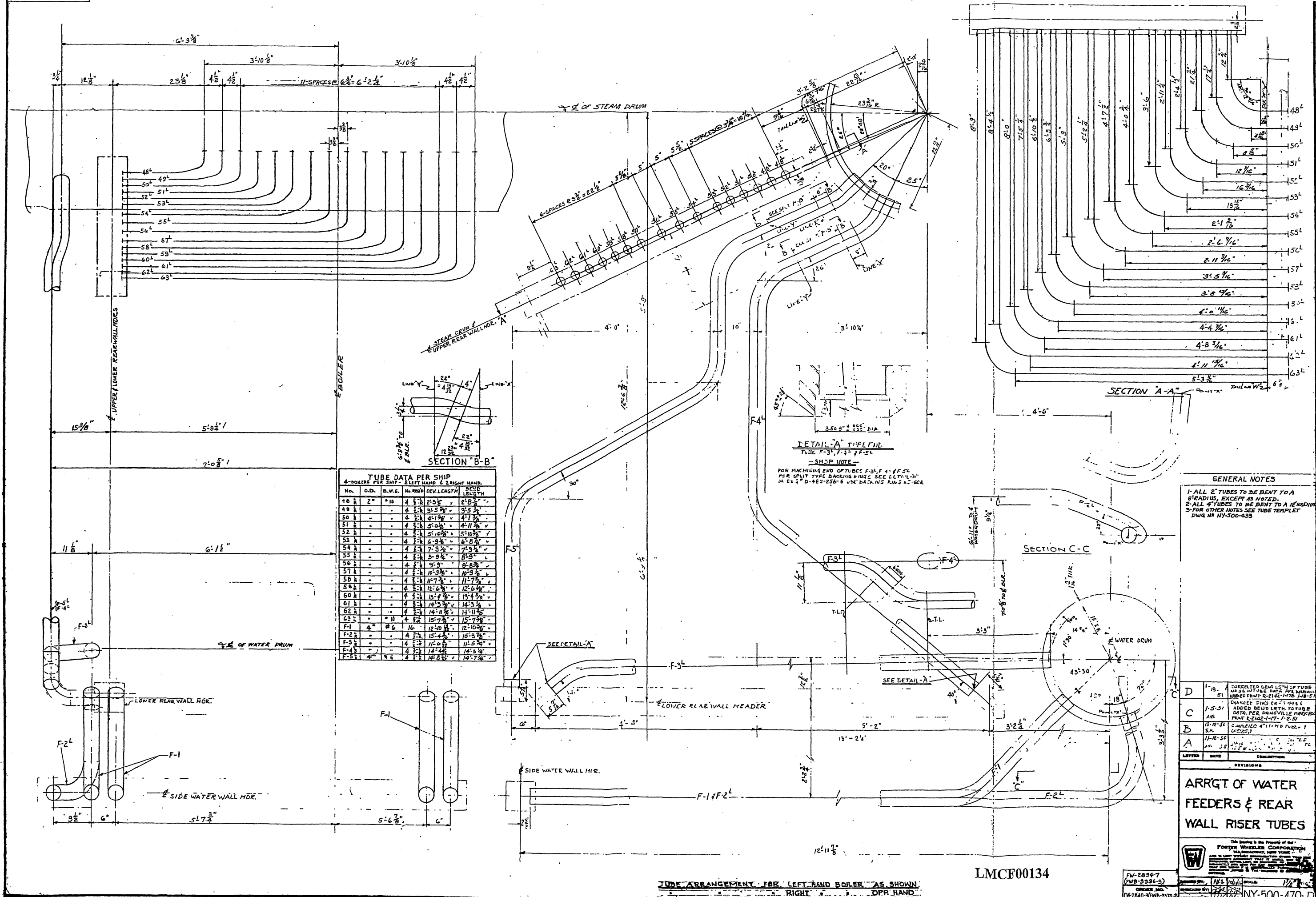
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100 BROADWAY, NEW YORK

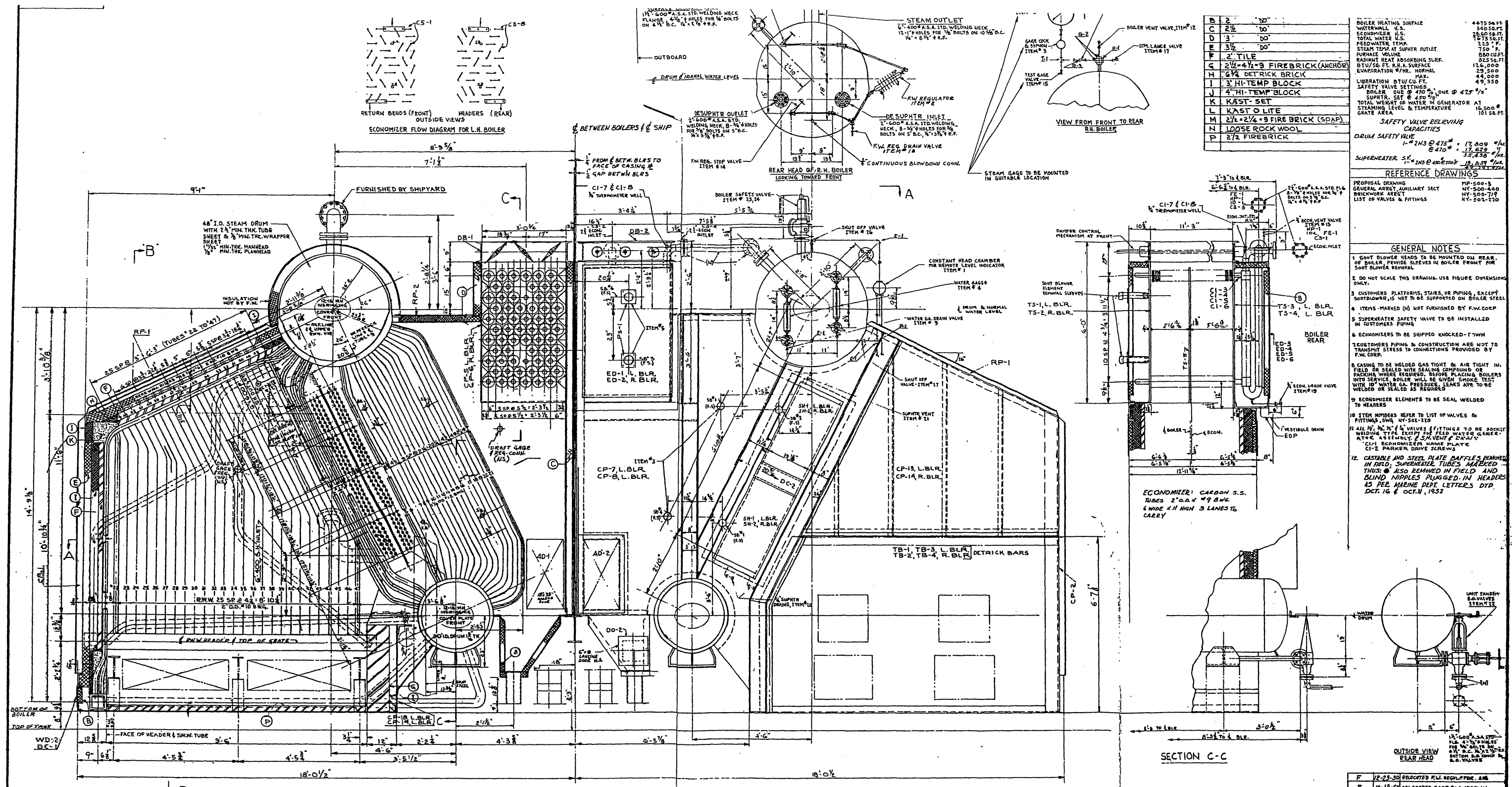
DO NOT SCALE
DO NOT SCALE
DO NOT SCALE

DD-457 (REV 3-51)
ORDER NO.
DD-407: FWD 3370-3

DRAWN BY: J. K. KNAACKSTEDT
CHECKED BY: J. K. KNAACKSTEDT
APPROVED BY: J. K. KNAACKSTEDT

SCALE: 3/8" = 1'-0"
NY 500-719-G





B	2	10"
C	2 1/2	10"
D	3	10"
E	3 1/2	10"
F	2	10"
G	2 1/2	10"
H	2 1/2	10"
I	2 1/2	10"
J	2 1/2	10"
K	2 1/2	10"
L	2 1/2	10"
M	2 1/2	10"
N	2 1/2	10"
P	2 1/2	10"

BOILER HEATING SURFACE	4475.54 SQ. FT.
WATERWALL, H.S.	2465.50 SQ. FT.
ECONOMIZER, H.S.	2500.00 SQ. FT.
TOTAL WATER W.S.	1755.50 SQ. FT.
FEEDWATER TEMP.	215° F.
STEAM TEMP. AT SUPPLY OUTLET	750° F.
FURNACE VOLUME	880 CU. FT.
RADIANT HEAT ABSORBING SURF.	126,000 BTU/SQ. FT. H.S. SURFACE
EVAPORATION PER HOUR	29,500 LBS.
LIBERATION BTU/CU. FT.	49,350
SAFETY VALVE SETTINGS	ONE @ 470 LBS., ONE @ 475 LBS.
SUPPLY SET @ 450 LBS.	
TOTAL WEIGHT OF WATER IN GENERATOR AT STEAMING LEVEL & TEMPERATURE	16,500 LBS.
GRATE AREA	101.56 SQ. FT.

SAFETY VALVE RELIEF CAPACITIES	
DRUM SAFETY VALVE	1" @ 475 LBS. = 17,000 LBS./HR.
1" @ 470 LBS. = 17,000 LBS./HR.	
SUPERHEATER SAFETY VALVE	1" @ 475 LBS. = 35,430 LBS./HR.
1" @ 470 LBS. = 35,430 LBS./HR.	

REFERENCE DRAWINGS	
PROPOSAL DRAWING	MP-500-3
GENERAL ARRANG. AUXILIARY SECT	NY-500-440
BRICKWORK DETAIL	NY-500-719
LIST OF VALVES & FITTINGS	NY-502-220

GENERAL NOTES	
F	12-29-50 RELOCATED P.L. REQUIREMENT, ARE
E	12-13-50 RELOCATED SOOT BLOWERS IN
D	12-7-50
C	11-17-50
B	11-9-50
A	11-1-50

GENERAL ARRANGEMENT MAIN SECTION & OUTSIDE VIEWS F.W. STEAM GENERATOR	
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DRAWN BY	JTH
CHECKED BY	WJA
APPROVED BY	WJA
DATE	12/6
SCALE	3/4"
NY-500-439M	

LMCF00135

MARK NO.	NO. OF SHEETS	DESCRIPTION	SHIPPED FROM	DRAWING NO.	CONTRACT NO.	MARK NO.	NO. OF SHEETS	DESCRIPTION	SHIPPED FROM	DRAWING NO.	CONTRACT NO.	MARK NO.	NO. OF SHEETS	DESCRIPTION	SHIPPED FROM	DRAWING NO.	CONTRACT NO.	MARK NO.	NO. OF SHEETS	DESCRIPTION	SHIPPED FROM	DRAWING NO.	CONTRACT NO.	MARK NO.	NO. OF SHEETS	DESCRIPTION	SHIPPED FROM	DRAWING NO.	CONTRACT NO.
		2" O.D. #10 BNG SIDE						TUBE PLUGS						AIR TOOL TUBE CLEANERS						EXPANDERS - CONTINUED							EXPANDERS - CONTINUED		
S1	1	TUBE No. 1 - 17' 5 1/4" LG	DF	NY-500-433	FW	S34	24	PLUGS FOR 2" O.D. #10 BNG TUBES	D	D-351-93-E	FW	T20	1	CLEANER FOR 3" O.D. #10 & DN		GA	T26	1	EXPANDER FOR ROLLING AND DN		GA	T34	1	EXPANDER FOR STRAIGHT ROLL- DN			EXPANDER FOR STRAIGHT ROLL- DN		
S2	1	" 1A - 17' 7" LG				S35	24	" 1 1/4" O.D. #12 BNG	D	D-421-314-A	B			#9 BNG BENT, BOILER WATERWALL					BELLING 1 1/4" O.D. X 109" MIN.							INS. WITHOUT BELLING 2" O.D.			
		2" O.D. #10 BNG SCREEN				S36	6	" 3" O.D. #6 BNG	D	D-431-91	B			4 ECON. TUBES, PART NO. X-66, CONSISTING OF:					WALL TUBES INTO A 4 1/2" I.D. X 1 5/8" THK. DRUM, 1 1/2" SQ. ON							X 150" MIN. WALL TUBES INTO A 4 1/2" SQUARE X 1 1/2" WALL			
		TUBES				S37	6	" 4" O.D. #6 BNG	D	D-511-21	B			AIR MOTOR - X-66					END OF MANOREL.								HEADER. THE 2" DIA. HAND- HOLES ARE LOCATED DIRECTLY		
S3	1	TUBE No. 2 - 11' 9" LG	DF	NY-500-433	B	S38	16	2 3/4" X 3 1/4" OVAL H.H. PLUGS	D	MS2-461 G	FW			SHAFT WRENCH					EXPANDER FOR ROLLING AND DN		GA						OPPOSITE THE TUBE HOLES. 3/4"		
S4	1	" 2A - 11' 9 3/8" LG				S39	16	2 3/4" X 3 1/4" H.H. PLATES	D	MS2-372-G				SET SPARE BLADES X-6606					BELLING 4" O.D. X 203" MIN.								SQUARE ON END OF MANOREL.		
S5	1	" 3 - 11' 1 1/8" LG				S40	48	2 3/4" X 3 1/4" H.H. GASKETS	D	MS2-451-E				SINGLE UNIT CUTTER HEAD - X-6630					WALL TUBES INTO A 30" I.D. X 1 5/8" THK. DRUM, 1" SQ. ON END							ALSO FURNISHED WILL BE A			
S6	1	" 4 - 10' 7 1/2" LG						SUPERHEATER FITTINGS						4 EXTRA SETS OF CUTTERS - 797					OF MANOREL.								THREADED SLEEVE AND AD-		
		1 1/4" O.D. #12 BNG BOILER				S41	16	2 3/4" X 3 1/4" OVAL H.H. PLUGS	D	D-422-13H	S			1 EXTRA FLEX. GUNN - X-6661					EXPANDER FOR ROLLING & BELLING DN		GA						JUSTABLE BALL BEARING		
		TUBES				S42	16	2 3/4" X 3 1/4" OVAL H.H. PLATES	D	D-461-97				1 EXPANDING BRUSH - 6620-N					3" O.D. X 220" MIN. WALL TUBES								FRICION COLLAR TO FIT THE		
S7	8	TUBE No. 5 - 9' 4 3/8" LG	DF	NY-500-433	B	S43	48	2 3/4" X 3 1/4" H.H. GASKETS	D	MS2-451-E				1 SET OF REFILLS - 6622-N					INTO A 30" I.D. X 1 5/8" THK.								HANDHOLE & LIMIT TRAVEL		
S8	7	" 6 - 9' 3 3/8" LG						ECONOMIZER FITTINGS						2 TYPE B FLEXIBLE HOLDERS					DRUM, 3/4" SQ. ON END OF								OF EXPANDER. EXPANDER		
S9	6	" 7 - 9' 3 1/4" LG												35' 3/4" OPER. HOSE					MANOREL.								WILL THROUGH THE 2" DIA.		
S10	5	" 8 - 9' 4" LG				S44	16	2" H.H. PLUGS	D	MSY-38-J	C			SET OF HEAVY COUPLINGS					EXPANDER FOR ROLLING & BELLING DN		GA						HANDHOLE.		
S11	4	" 9 - 9' 4 3/8" LG				S45	16	2" H.H. PLATES	D	D-501-191-B				INSTRUCTION & PART SHEET					2" O.D. X 134" MIN. WALL								3/4" UNIVERSAL JOINT & DN		
S12	4	" 10 - 9' 6 1/4" LG				S46	48	ECON. H.H. GASKETS A= 3/4"	D	SB-03-02				METAL BOX					TUBES INTO A 30" I.D. X 1 5/8" THK. DRUM, 3/4" SQ. ON								ON ANGLE ROLLING IN THE		
S13	4	" 11 - 9' 8 1/8" LG				S47	12	CAP NUTS 7/8" SPEC. ACCORD	D	D-501-190				CLEANER FOR 1 1/4" O.D. #12 DN		GA			END OF MANOREL.								7 1/2" SQ. HEADER.		
S14	3	" 12 - 9' 10 3/8" LG				S48	16	2 3/4" O.D. X 2 1/2" I.D. X 1 1/2" THK. SHEET	D					BNG BENT BOILER & SUPHT'R					EXPANDER FOR ROLLING AND DN		GA						1/2" UNIVERSAL JOINT AND EX- DN		
S15	3	" 13 - 10' 1 1/8" LG				S49	16	1 1/2" O.D. X 1 1/2" I.D. X 1 1/2" THK. SHEET	D					TUBES, PART X-61, CONS. OF:					BELLING 1 1/4" O.D. X 109" MIN.								TENSION FOR USE WITH T-33		
S16	3	" 14 - 10' 4 3/8" LG						MANHOLE GASKET SPARES						AIR MOTOR - X-61					WALL TUBES INTO A 30" I.D. X 1 5/8" THK. DRUM, 1/2" SQ. ON								ON ANGLE ROLLING IN THE 9 1/4"		
S17	3	" 15 - 10' 7 3/8" LG						MANHOLE GASKETS.	DC		B			SHAFT WRENCH					END OF MANOREL.								HEADER.		
S18	3	" 16 - 10' 11 3/8" LG						MANHOLE GASKET SPARES						SET SPARE BLADES					EXPANDER FOR ROLLING AND DN		GA						RIGHT ANGLE GEAR DRIVE FOR DN		
S19	2	" 17 - 11' 5 3/8" LG				S50	8	12" X 16" TYPE "M" FLEX- MANHOLE GASKETS.	DC		B			SINGLE UNIT CUTTER HEAD - X-6130					BELLING 2" O.D. X 135" MIN.								USE WITH T31 ON ANGLE		
S20	2	" 18 - 11' 10 3/4" LG						MISCELLANEOUS TOOLS						4 EXTRA SETS OF CUTTERS - 337					WALL TUBES INTO A 7 1/4" SQ.								ROLLING IN THE 7 1/4" SQ. HDR.		
S21	2	" 19 - 12' 4 1/4" LG												2 EXTRA CUTTER PINS - 2644					X 1 1/2" THK. HEADER. ALSO A								THE DRIVEN END OF GEAR DRIVE		
S22	2	" 20 - 12' 10 1/2" LG												1 EXTRA FLEX. GUNN - X-6161					SET OF SMART MANORELS FOR								WILL HAVE A 3/4" FEMALE SQUARE		
S23	2	" 21 - 13' 5 1/8" LG												1 EXPANDING BRUSH - 6120-N					ANGLE ROLLING WITH 3/4" SQ. ON								THE GEAR DRIVE WILL PASS		
		2" O.D. #10 BNG REAR				T1	1	PLUG EXTRACTOR COMPLETE FOR 1 1/4" O.D. #2 O.D. TUBES	D	NY-322-172-D	GA			1 SET REFILLS - 6122-N					LARGE END OF MANOREL & PIN								THROUGH A 2 3/4" X 3 3/8" OVAL		
		WATERWALL TUBES				T2	1	OUSTER KNIFE - 1 1/4" TUBES	D	NY-354-41-B				2 TYPE B FLEX. HOLDERS					OR NUT & WASHER ON SMALL								HANDHOLE.		
S24	1	TUBE No. 45 - 11' 4 3/4" LG	DF	NY-500-679	FW	T3	1	" 2" "	D	NY-354-55A				35' 1/4" DPR. HOSE					END. A DIMPLE WILL BE								FURNISHED ON THE SOURCE		
S25	1	" 46 - 11' 6 1/2" LG				T4	1	PULL UP PLATE	D	D-421-360				SET HEAVY COUPLINGS					TO FIT SET SCREW OF ITEM								T-35. ALSO A SET OF		
S26	1	" 47 - 11' 8 1/8" LG				T5	1	PLUG LIFTING TOOL	D	NY-384-181-A				INSTRUCTION & PART SHEET					VERY SHORT MANORELS WITHOUT								PINS AND WASHERS FOR ROLLING		
		1 1/4" O.D. #105" MILLWALL ALLOY				T6	1	ROUND ANGLE CHISEL, 1 1/4" #2 TUBES	D	NY-484-84				METAL BOX					AT RIGHT ANGLES INSIDE								HEADER WITH A RIGHT ANGLE		
		SUPERHEATER TUBES				T7	1	TUBE DRIVER, 1 1/4" #2 TUBES	D	NY-484-85																			

SHIPPING KEY

DF - FURNISHED, FABRICATED & CONSOLIDATED BY DANVILLE.
DNF - FURNISHED BY N.Y. & SHIPPED TO DANVILLE FOR FABRICATION & CONSOLIDATION.
D - FURNISHED BY DANVILLE.
DC - FURNISHED BY CARTERET & SHIPPED TO DANVILLE FOR CONSOLIDATION.
- SHIPPED DIRECT.
DN - FURNISHED BY N.Y. & SHIPPED TO DANVILLE FOR CONSOLIDATION.

CERTIFIED CORRECT
JANUARY 27, 1951
H. Knickstedt
H. KNICKSTEDT

LMCF00136

NOTE
1. MATERIAL LISTE REQUIREMENTS OF & GENERAL RULE BUREAU OF SHIP
2. HULL #369 FOR

ITEM No.	QUAN PER SHIP	DESCRIPTION	ITEM No.	QUAN PER SHIP	DESCRIPTION
1	4	YARWAY REMOTE LEVEL INDICATORS FOR FLUSH MOUNTING, EQUIPPED WITH CONSTANT HEAD CHAMBER & SHUTOFF VALVES, RANGE 0-28", GOOD FOR PRESSURES UP TO 600 #/SQ. IN. ALSO SUFFICIENT 3/8" COPPER TUBING INCLUDING ADAPTERS & FITTINGS.	11	4	1/2" EDWARD FIG. #444Y, GLOBE VALVES WITH SOCKET WELDING ENDS (SALINOMETER)
2	4	SWARTWOUT - 2 1/2" 600# STD. THERMOHYDRAULIC "SC" TYPE "SM" FEED WATER REGULATORS FOR INSTALLATION ON 2 1/2" PIPE LINE. GENERATOR TO BE OF THE SCREWED TYPE & TO BE COMPLETE WITH SOCKET WELDING STOP & DRAIN VALVES. GENERATOR TO BE SUITABLE FOR 30" DRUM CONNECTIONS.	12	4	1/2" EDWARD FIG. #444Y, GLOBE VALVES WITH SOCKET WELDING ENDS (BLR. VENT)
3	4	10" CROSBY STEAM GAGES, TYPE "AAO", FLUSH MOUNTED, BACK CONNECTED, WITH SUITABLE SYPHONS & COCKS, GRADUATED 0-1000#. GAGES TO BE FURNISHED WITH RED HAND.	13	4	1/2" EDWARD FIG. #444Y, GLOBE VALVES WITH SOCKET WELDING ENDS (ECON. VENT)
4	8	JERGUSON No. 7 #P BOILER WATER GAGES, COMPLETE ON 2 1/2" CENTERS, 10" VISIBLE GLASS, #76 VALVES AND ILLUMINATORS. GAGE WILL BE FURNISHED WITH SUFFICIENT CHAIN & METAL PULLS FOR OPERATION FROM FLOOR & WILL ALSO BE FURNISHED WITH A DRAIN CONNECTION SUITABLE FOR SOCKET WELDING.	14	8	1/2" EDWARD FIG. #444Y, GLOBE VALVES WITH SOCKET WELDING ENDS. (FEED WATER REGULATOR STOP)
5	24	VULCAN SOOT BLOWERS ALL FITTED WITH MODEL P3 HEADS, AS FOLLOWS:- 8- 2" HYVULCOY ELEMENTS WITH HYVULCOY BEARINGS. (SUPERHEATER) 8- 2" VULCROM ELEMENTS WITH VULITE BEARINGS. (BOILER BANK) 8- 2" PLAIN STEEL ELEMENTS WITH PLAIN STEEL BEARINGS. (ECONOMIZER).	15	4	1/4" EDWARD FIG. #444Y, GLOBE VALVES WITH SOCKET WELDING ENDS (TEST GAGE)
6	8	2 1/2" 600# ASA STD. FLANGED GLOBE VALVES, EDWARD FIG #2818 (FEED STOP)	16	4	1/2" EDWARD FIG. #444Y-J, GLOBE VALVES WITH SOCKET WELDING ENDS, MODIFIED WITH LOCKING DEVICE. (LOCK OPEN)
7	8	2 1/2" EDWARD FIG. #2846 H 600# ASA STD., FLANGED GLOBE CHECK VALVES, GEAR OPERATED & WITH EXTENSION STEM'S 12'-0" LONG (FEED CHECK)	17	4	3/4" EDWARD FIG. #444Y, GLOBE VALVES WITH SOCKET WELDING ENDS (CLEANING HOSE VALVES)
8	4	1 1/2" EDWARD FIG. #6841, 600# ASA STD., FLANGED STRAIGHT-WAY VALVES (SURFACE BLOW)	18	8	3/4" EDWARD FIG. #444Y, GLOBE VALVES WITH SOCKET WELDING ENDS (WATERWALL DRAIN)
9	8	3/8" EDWARD FIG. #444Y, GLOBE VALVES WITH SOCKET WELDING ENDS. (GAGE GLASS DRAIN)	19	4	3/4" EDWARD FIG. #444Y, GLOBE VALVES WITH SOCKET WELDING ENDS. (ECON. DRAIN)
10	4	3/8" EDWARD FIG. #444Y, GLOBE VALVES WITH SOCKET WELDING ENDS. (FEED WATER REG. DRAIN)	20	8	3/4" 600# ASA STD. FLANGED GLOBE VALVES, EDWARD FIG. #4828 (SUPHTR DRAIN)
			21	4	1/2" 600# ASA STD. FLANGED GLOBE VALVES, EDWARD FIG. #4828 (SUPHTR VENT)
			22	4	1 1/2" 600# ASA STD. UNIT-TANDEM, FLANGED YARWAY FIG. #3978-3954 VALVES. TWO R.H. ASSEMBLIES & TWO L.H. ASSEMBLIES. (BOTTOM BLOW)
			23	4	2" H 3" CROSBY FIG. #HS-MS-35 DRUM SAFETY VALVES SET AT 470 #/SQ. IN.
			24	4	2" H 3" CROSBY FIG. #HS-MS-35 DRUM SAFETY VALVES SET AT 475 #/SQ. IN.
			25	4	2" H 3" CROSBY FIG. #HSA-MS-36 SUPERHEATER SAFETY VALVES SET AT 450 #/SQ. IN.
			26	4	1/2" EDWARD FIG. #445Y, ANGLE VALVES WITH SOCKET WELDING ENDS. (STOP VALVES FOR DATUM CHAMBER)
			27	4	1/2" EDWARD FIG. #444Y, GLOBE VALVES WITH SOCKET WELDING ENDS (STOP VALVES FOR DATUM CHAMBER)

CERTIFIED CORRECT
JANUARY 27, 1951
H. Knackstedt
H. KNACKSTEDT

LMCF00137

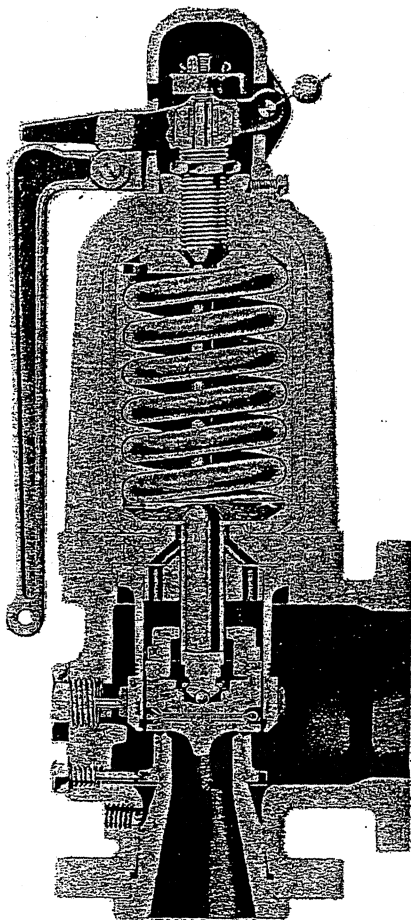
FWB-3396-9
FWB-3370-3

- NOTES
1. QUANTITIES ARE LISTED ON A PER SHIP BASIS (4 BOILERS)
 2. MATERIAL MEETS REQUIREMENTS OF U.S. COAST GUARD & GENERAL RULES OF AMERICAN BUREAU OF SHIPPING.
 3. REFERENCE DRAWINGS:-
NY-500-439 GENERAL ARRGT. & OUTSIDE VIEWS
NY-500-440 - GENERAL ARRGT. PLAN SECTIONS.

F	2/17/52 JN	CHGD PRESS SETTINGS ON DRUM SAFETY VALVES OF ITEMS #23, #24, & #25 FROM (495, 500 & 465) PSI TO (470, 475 & 450) PSI RESPECTIVELY AS PER CUST LTR 2-4-53
E	12/18/50	PER CUSTOMERS REQUEST CHANGED FIG. NO. OF VALVES FOR ITEMS 9 & 19 INCL. & ITEMS 26 & 27.
D	12/1/50	ADDED ITEM #27
C	4/29/50	REVISED DESIGNATION OF ITEM #14 & ADDED ITEM #26
B	1/25/50	DRAWING REMADE DUE TO CUSTOMER'S CHANGES & REVISIONS REQUEST BY MR. KENT DURING VISIT ON 11-20-50.
A	10/2/50	REVISED PER MR. R. A. STERN'S LETTER OF SEPT. 25, 1950.
LIST OF VALVES & FITTINGS PER SHIP (4 BOILERS) CHESAPEAKE & OHIO RAILWAY CO.		
This Drawing is the Property of the FOSTER WHEELER CORPORATION 165 BROADWAY, NEW YORK AND IS LENT WITHOUT CONSIDERATION OTHER THAN THE BORROWER'S AGREEMENT THAT IT SHALL NOT BE RE- PRODUCED, COPIED, LENT, OR DISPOSED OF DIRECTLY OR INDIRECTLY NOR USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS SPECIFICALLY FURNISHED. THE APPARATUS SHOWN IN THE DRAWING IS COVERED BY PATENTS.		
DRAWN BY:	WJM	11/25/50 SCALE: ——— = 1" = 0'
CHECKED BY:		
APPROVED BY:	<i>H. Knackstedt</i>	NY-502-220-E

Instructions for the
Operation and Maintenance
of

CROSBY SAFETY VALVES



THESE instructions are compiled to assist operating engineers in the servicing of their safety valves. By following these recommendations it will be found easy to keep the valves in good condition so that they will

- Stay tight
- Pop at their set pressures
- Open sharply without any simmer or warn
- Blow down not more than 4% of the set pressure
- Close tight without chatter

CROSBY
STEAM GAGE & VALVE COMPANY
WRENTHAM, - MASS.
BOSTON - NEW YORK - CHICAGO - DALLAS - LOS ANGELES
LONDON - PARIS

LMCF00138



CROSBY NOZZLE SAFETY VALVES

DESIGN

Many thousands of Crosby Nozzle Safety Valves are now in use, giving uniformly successful performance on all classes of service. They are handling the highest temperatures and pressures encountered in modern central stations and in marine power plants, providing the same trouble-free performance they give at more modest temperatures and pressures.

Crosby Nozzle Safety Valves have been chosen for these modern installations because:—Of their freedom from the performance faults of other safety valves; they have high discharge capacities, stay tight over long periods of time, operate accurately and surely, have minimum blowdown, and low maintenance costs. Designs particularly adapted to meet the various existing codes are regularly furnished. Crosby valves for "marine service" meet the latest rules of The Department of Commerce, Bureau of Marine Inspection and Navigation, American Bureau of Shipping and Lloyds Register.

Crosby Nozzle Valves employ the reaction principle (see Figure 1) to obtain the great capacity, precise control, low blowdown, smooth operation and other features of Crosby valves.

The valve opens to—and closes from—a moderate lift. The high capacity of the Crosby Nozzle Safety Valve, is produced by a secondary, progressively increasing lift which is distinct from the initial opening. After the valve has popped to a moderate lift, a slight accumulation of pressure lifts the disc higher. This movement progressively exposes an upper adjusting ring which deflects the steam flow in a downward direction through an angle of approximately 180°. The reactionary force resulting from this deflection is transmitted to the face of the disc lifting it to a higher position. The higher lift in turn increases the rate of flow which subsequently increases the lifting force until "full bore" lift is attained, this lift being readily attained at 3 percent accumulation (overpressure) above the set pressure.

Thermal and mechanical distortion of the valve body is undesirable and often results in leakage. Crosby valves are designed to minimize the effect of body distortion on the operation of the valves by the use

of "full nozzle" construction, and by the use of "synchro-discs." "Full nozzles" are screwed into the body from the flanged (lower) end until the **top** of the nozzle flange makes up against the recessed face of the body. As the **bottom** of the nozzle flange is in contact with the face of the boiler-nozzle flange it is evident that tightening of the inlet flange bolts will result in positive clamping of the nozzle flange with a minimum tendency to distort the alignment of the nozzle in the body. The synchro-disc design, due to its two-piece construction, is free to tilt slightly thereby automatically correcting any slight tendencies of misalignment.

The full nozzle construction eliminates threaded joints under pressure. Nozzles and synchro-discs (made from the same material) are so designed with respect to their mass distribution, that they expand and contract together thereby eliminating the galling of the seating surfaces which would be caused by unequal mass distribution. Seating surfaces are flat and of equal width thereby preventing indentation of one another and are easy to maintain.

A frequent cause of faulty operation is eliminated by the use of top guided discs. There are no feather guides below the disc to obstruct flow or stick as a result of expansion or scale formation.

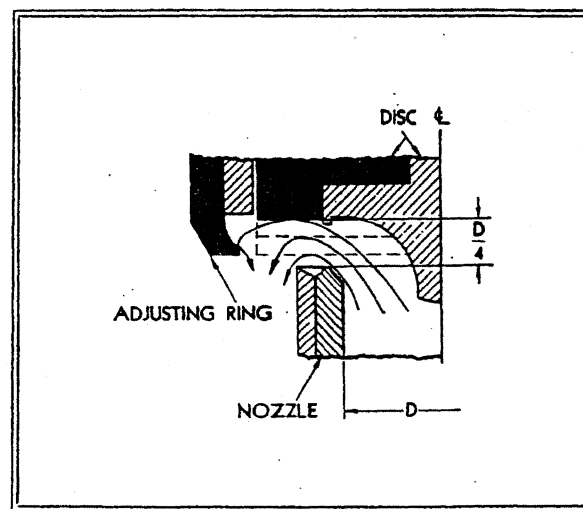


Fig. 1.



lates above the set pressure, the lift will increase until the maximum lift and rated valve capacity are obtained at a pressure 3 percent above the set pressure. When the pressure drops below the set pressure, the lift gradually diminishes until the valve closes sharply, with a blowdown of not more than 4 percent of the set pressure and with no simmering or leakage after closing.

Unless a safety valve is allowed a proper blowdown, its operation will be uncertain. The disc moves up or down when the force of the steam under it becomes greater or less than the force of the spring. The greater the blowdown the greater the operating forces and the more positive the valve operation. 3 percent should be considered a safe minimum blowdown. If the valve is set for less blowdown it may not develop its rated capacity within 3 percent accumulation of pressure. A valve is not defective if it will not operate properly on 2 percent blowdown.

The normal working pressure must always be below the pressure at which the lowest set valve closes. At the set, or popping pressure of a valve, the steam load under the disc balances the spring load on top. Therefore the closer the boiler pressure is to the popping pressure of the valve, the smaller the load holding the disc down and the more possibility there is of leakage, with the consequent damage to seats.

Springs are designed to cover definite ranges of pressure. If used outside these ranges, the proper adjustment of the valve becomes difficult or impossible.

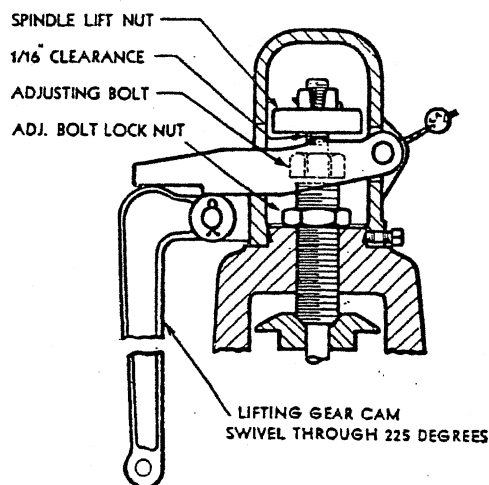


Fig. 3.

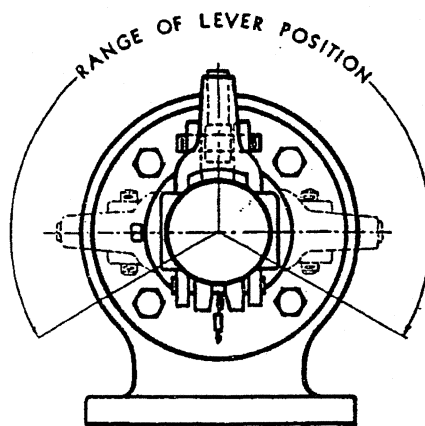


Fig. 4.

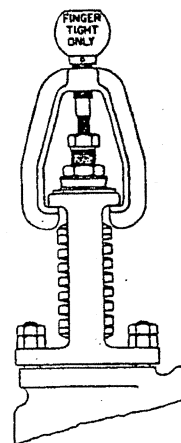


Fig. 5.

VALVE TROUBLES

Troubles occurring in the safety valve may be grouped under three general headings (a) Leakage (b) Incorrect Popping Pressure, (c) Faulty Operation.

Leakage at normal working pressure is usually caused by damaged seats or by lodged scale. It is sometimes possible to blow out lodged scale by giving several quick pulls on the lifting gear. If this does not stop the leakage, the seats are probably damaged and they should be repaired as soon as possible.

Strains set up in the valve body, either by pipe expansion or by weight of unsupported discharge piping also cause leakage. Such leakage can be stopped by relieving these strains.

Under normal operating conditions, a safety valve should pop consistently within the tolerances allowed by the Code. However, if under these same conditions the valve should fail to pop within the allowable tolerances, dirt or scale wedged between the disc holder and the guide or a deposit of hardened boiler compound on the nozzle under the seat may be causing it to stick. The valve should therefore be dismantled for cleaning.

If the valve pops too low, the seats may have become damaged. Low popping pressure is seldom caused by spring set, although this is considered a common cause.

Excessive warn, failure to close sharply, or too long blowdown, indicate improper adjustment, damaged seats or sticking. If adjustment does not remedy the trouble, the valve should be dismantled and examined.



necessary to break the joint between bonnet and cooling spool.

A special wrench is necessary to remove nozzle. If the nozzle should stick due to accumulation of deposit in the threads, soak in penetrating oil or heat the body adjacent to the threads.

CONDITIONING SEATS

The tightness of the valve and its proper operation depend directly on the condition of the seats. Many safety valve troubles are due to worn or damaged seats.

The nozzle seat is on the top of the nozzle being $1/16$ " wide. The disc seat is of the same diameter and width. Both seats are flat and it is important that both surfaces be true, without irregularities or scratches. See Figures 7 and 8.

Unless the seats have been damaged by dirt or scale, lapping the surfaces occasionally should keep the valve in good condition. Lapping must be very carefully done—the seats must be kept perfectly true.

Never lap the disc against its seat. Lap each part separately using a cast iron lapping block. After the rough lapping, polish the seating surfaces by using a small amount of fine compound spread evenly on the truest side of the block. This produces a very smooth matted finish. In lapping use a semi-rotary motion, turning the block occasionally to another position.

The lapping block should be checked frequently on a surface plate. Do not use a lapping block which is not perfectly true.

The nozzle seat can be lapped in position after the top structure of the valve has been disassembled. Boiler compound, or any other deposit, should be scraped off lightly before lapping.

The conical discs must be removed from the disc holder before lapping. Upon reassembly, the conical

disc should be free to tilt slightly in any direction and must project slightly beyond the recess in the disc holder. Do not attempt to machine the conical disc or the disc holder. Carry spare conical discs.

REMANCHING

If remachining or other major repairs are necessary, it is strongly recommended that the valve be returned to the factory, because all parts must be accurately centered and the work carefully done. No safety valve will be tight or will operate properly unless all parts line up exactly.

The simplest and most satisfactory way to remachine the nozzle seat is by means of the reseating machine, illustrated in Figure 9, and cutters specially designed for this purpose. This method eliminates breaking the connections or removing the valve from the boiler.

If a Crosby reseating machine is not available the nozzles can be removed from the body or the body (with the nozzle in place) may be mounted in a lathe to effect the necessary machining. It is vitally important that the part to be machined must run absolutely true before machining is done and that the proper seat contours be machined. Remachining templates are available for this purpose and are highly recommended.

Some types of Crosby valves, for lower pressures and temperatures, use what is termed a "solid one-piece" disc instead of the "disc-holder and conical disc." These discs may be machined to their proper contours, using the same template gage (opposite end) as used for machining the nozzle seat contours.

The machining is best accomplished by the use of a tool having a pointed nose like a threading tool with a downward rake of 15 degrees and a back rake 15 degrees. Take very light cuts using white lead and lard oil as lubricants.

REASSEMBLING

Before reassembling check the following points:—

(1) See that nozzle ring is below the seating surface of the nozzle. Leave the nozzle ring set screw out until valve is completely assembled.

(2) Check the height from the seat to the top of the valve body with a combination square and see that the distance from the underside of the guide flange to the bottom of the adjusting ring is the same. This "LEVEL" setting of ring is illustrated in Figure 11.

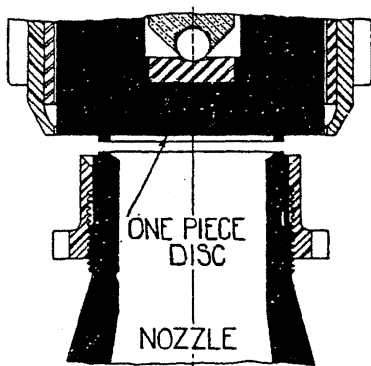


Fig. 7.

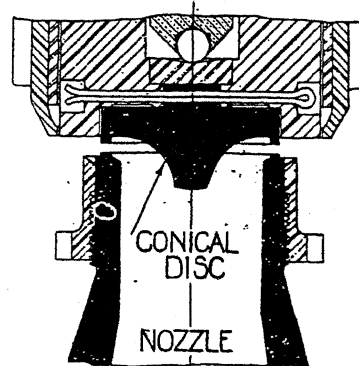


Fig. 8.

Subject: MAINTENANCE INSTRUCTIONS
FOR JERGUSON FLAT GLASS GAGES



Index:
Date: 7-16-48
Page: 1

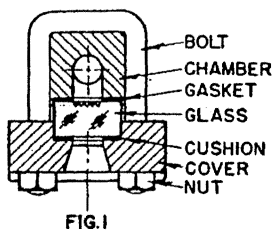


FIG. 1

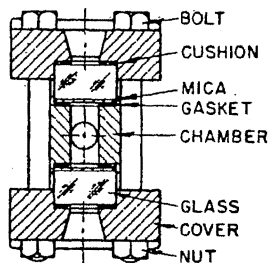


FIG. 2

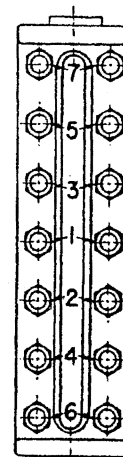


FIG. 3

DISASSEMBLY

Loosen end bolts first, working from alternate ends of the cover toward the center.

ASSEMBLY

Assemble gage in accordance with the applicable sectional view, Fig. 1 or Fig. 2, using gaskets as recommended below. Tighten all nuts finger tight, beginning with the center pair and working toward alternate ends as indicated by the consecutive numbers shown in Fig. 3. Repeat this procedure increasing the bolt torques in increments of about 5 foot-pounds until the recommended torque as indicated in Table 1 has been reached. This procedure is necessary to prevent excessive compression of gaskets at one end which would create a bending strain in the glass and cause breakage. A torque wrench is recommended to insure that a uniform and correct torque is obtained.

PROCESS	Gage Series	Recommended Torque	Gage Series	Recommended Torque
GAGES	R-5	30 ft.-lbs.	T-5	25 ft.-lbs.
	R-10	40 ft.-lbs.	T-10	35 ft.-lbs.
	R-20	50 ft.-lbs.	T-20	45 ft.-lbs.
	R-30	60 ft.-lbs.	T-30	55 ft.-lbs.
			T-50	25 ft.-lbs.
STEAM GAGES	All models up to 600 W.S.P.			40 ft.-lbs.
	All models over 600 W.S.P.			50 ft.-lbs.

NOTE: After new gaskets have been in service for a short time, they assume a somewhat permanent compression, especially if the gage is subject to heat. This effect may be noticed as a slight gasket leak or an apparent loosening of the bolts. Shortly after replacing gaskets, therefore, the bolts should again be tightened to the original torque by setting up the middle bolts first, and working towards the ends as described above.

GASKETS AND MICA

Series 50 gages employ O-ring gaskets. All other gages use 1/16" thick sheet. Gasket material must be suitable for the temperature and liquid conditions under which the gage will operate. Glasses in transparent gages to be used in steam service should be protected from steam erosion by a sheet of mica placed between the glass and its gasket on the liquid side. Special gaskets, glasses, O-rings, and replacement parts for Jerguson gages are obtainable.

VULCAN SOOT BLOWER CORPORATION, ENGINEERING DEPT. DUBOIS, PA.

Date Jan. 11, 1951 Dr. No. W-20059 Job No. 21487

FOR: Chesapeake & Ohio Railway Co.

Ferry

up to Instructions to follow MARK: FWB-3396-7 - GA-553

At

How Ship D.L. & W. Groveland-N.Y.D. & Mt.M.R. Dely. Shipping Date 3-15-51

Mark All Packages and Shipping Tags Order No. W-89101, Reqn. NE-616-16

Hand of Installation

FOUR Boilers.	Type FOSTER WHEELER	T. H.	T. W. Boilers No.
THEY furnish	THE Erector.	ALL	Labor to be furnished by CUSTOMER
THEY run steam connection and	THEY furnish material for running connection.		

This list covers SPECIAL PARTS for FOUR boilers and NO OUTSIDE MATERIAL

IMPORTANT—Check up ALL material with this list, and if there is any shortage report to the Home Office at DuBois immediately.

1. 4 - 2" Hyvuloy elements as per Sk. 21383. Mark #1.
2. 4 - 2" Hyvuloy elements as per Sk. 21383. Mark #2.
3. 4 - 2" Vulcrom elements as per Sk. 21383-1. Mark #3.
4. 4 - 2" Vulcrom elements as per Sk. 21383-1. Mark #4.
5. 8 - 2" Blower elements as per Sk. 21383-2. Mark FOUR #5, FOUR #6.
6. 8 - sleeves 19901, A-2-5/16", B - 32-5/8" and C - 29-3/4" each complete with FOUR 1/2" x 2" studs 19878 and FOUR 1/2" hex jam nuts V-1894. Mark for Els. #1 and #2.
7. 8 - sleeves 19901, A-2", B-6-9/16" and C-4" each complete with FOUR 1/2" x 2" studs 19878 and FOUR 1/2" hex jam nuts V-1894. Mark for Els. #3 and #4.
8. 8 - Sleeves as per Sk. A-0-21383 each complete with FOUR 1/2" x 2" studs 19878 and FOUR 1/2" hex jam nuts V-1894. Mark for Els. #5 and #6.
9. 24 - Sleeve stuffing boxes V-5010 each complete with the following:
 - 5 - Rings packing V-2851-2
 - 2 - 3/8" x 1-7/8" studs V-4319
 - 1 - Gland V-5011
 - 2 - 3/8" hex nuts V-4319-N
 Mark for all elements.
10. 24 - 6-13/16" O.D. x 4-13/16" I.D. x 1/8" thick gaskets V-4575. Tie together and tag for all elements.
11. 96 - Steel washers V-3030. Tie together and tag for all elements.
12. 24 - Support bars 18913, A-16".
13. 24 - Support arm carriages V-2809 each complete with ONE set screw V-1966.

OFFICE OF
Vulcan Soot Blower Corporation
DuBois, Pa.

Date Jan. 11, 1951 Page 2 Job No. 21487 19

Shipping date: 3-15-51

14. 24 - Vertical support screws 19011 each complete with the following:
2 - 1/2" hex jam nuts V-1894
2 - Washers V-1895
1 - Support spring 19815
15. 88 - Hyvuloy bearings V-2758 each complete with TWO Hyvuloy bolts (strap) V-2760 and FOUR 1/2" Hyvuloy nuts V-1985.
16. 64 - Vulite bearings V-2759-V each complete with TWO Hyvuloy strap bolts V-2917 and FOUR 1/2" Hyvuloy nuts V-1985. Mark with YELLOW.
17. 24 - 2" x 6-1/2" 600# F.S. companion flanges V-2361. Stamp flanges as follows: "V.S.B. - 600 P.S.I. - 2" - A-105-46 GR.1".
18. 24 - 2" 600# type "CG" flexitallio gaskets 15830.
19. 192 - 5/8" x 4-1/4" studs V-2480-S each complete with TWO nuts V-2480-W.
20. 480 ft. - Chain V-2504.

HEADS AND WRENCHES ON PAGE 3.

COPES - VULCAN DIVISION
CONTINENTAL FOUNDRY & MACHINE COMPANY
ROBERT H. WAGER
MARINE DEPT.
TELEPHONE S. O. 2.4228
423 VALLEY STREET
SOUTH ORANGE
NEW JERSEY

LMCF00144

OFFICE OF
Vulcan-Soot Blower Corporation
DuBois, Pa.

Date Jan. 23, 1951 Page 2-A Job No. 21487 19

Please add the following to the above job:

Item No.

24. 32 - Support plates as per Sk. A-0-21487.

US EPA ARCHIVE DOCUMENT

OFFICE OF
Vulcan Soot Blower Corporation
DuBois, Pa.

Date Jan. 11, 1951 Page 3 Job No. 21487 19

Shipping date: 3-15-51

HEADS:

350# Pressure 750° T.T.

Test all heads to a hydrostatic pressure THREE times operating pressure and stamp each head "600#" and "MS"

21. 24 - Series 2" 600 cast steel valve operating heads, Model PM-3, sheave wheel operation.
OUTLETS 2".
22. 1 - Set screw wrench V-2764.
23. 1 - Set screw wrench V-2765.

INSTRUCTIONS:

The elements are to be installed in the locations and as shown on Dr. W-20059. The nozzles are to be centered in the spaces between the boiler tubes in the locations shown on Dr. W-20059.

Elements #1 & #2 are each to be supported by ELEVEN Hyvuloy bearings V-2758 clamped to the boiler tubes in the locations shown on Dr. W-20059 with Hyvuloy strap bolts V-2760 using Hyvuloy nuts. See Dr. W-20059.

Elements #3 & #4 are each to be supported by EIGHT Vulite bearings V-2759-V clamped to the boiler tubes in the locations shown on Dr. W-20059 with Vulite strap belts V-2917 using Hyvuloy nuts. See Dr. W-20059.

Elements #5 & #6 are each to be supported by ONE end bearing by F.W.Corp.

Standard installing instructions for installing the heads and setting the sweeps are attached to this order.

RBM:bk

LMCF00146

VULCAN**PARTS LIST and SERVICE MANUAL
SOOT BLOWERS and DESLAGGERS**

Serial No. _____

This book contains information on various types of VULCAN Soot Blowers and Deslaggers. Listed below is information applying specifically to your installation.

By referring to this list before using this book, it will be much easier for you to locate the desired information.

The contents of this book are indexed on the following page.

Customer Chesapeake & Ohio Railway Co.
Vulcan Job No. 21487 General Arrangement Drawing No. W-20059
Associated Drawing Nos. _____

BOILER

Type Marine Make L.V. Nos. 4

SOOT BLOWER EQUIPMENT

<u>24</u>	<u>2" 600"</u>	<u>PM-3</u>	<u>C.S.</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

VULCAN SOOT BLOWER DIVISION**Continental Foundry & Machine Company****DUBOIS, PENNSYLVANIA****PRICE \$2.00**

LMCF00147

ARC WELDING INSTRUCTIONS

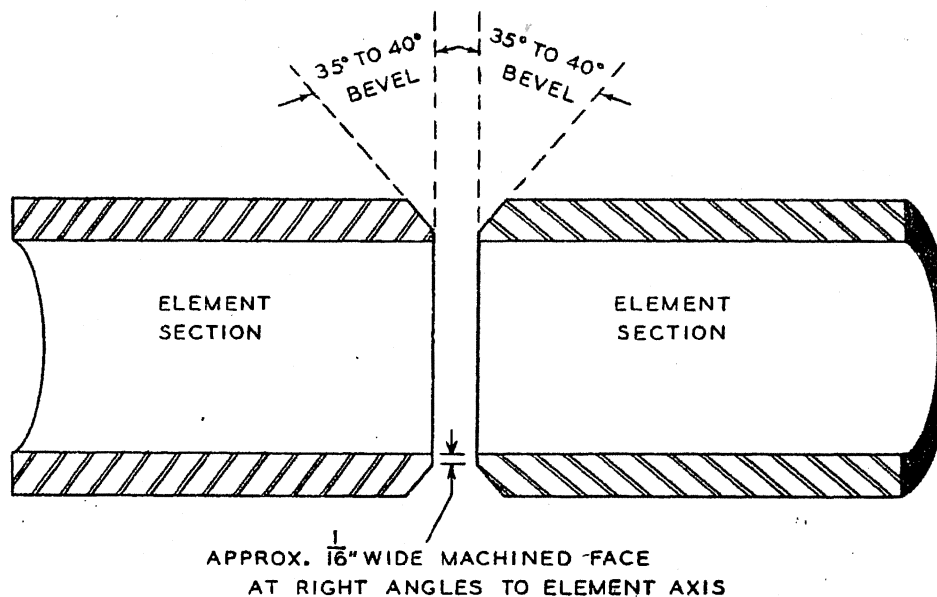
FOR HYVULOY, VULCROM, PLAIN STEEL SOOT BLOWER

ELEMENTS

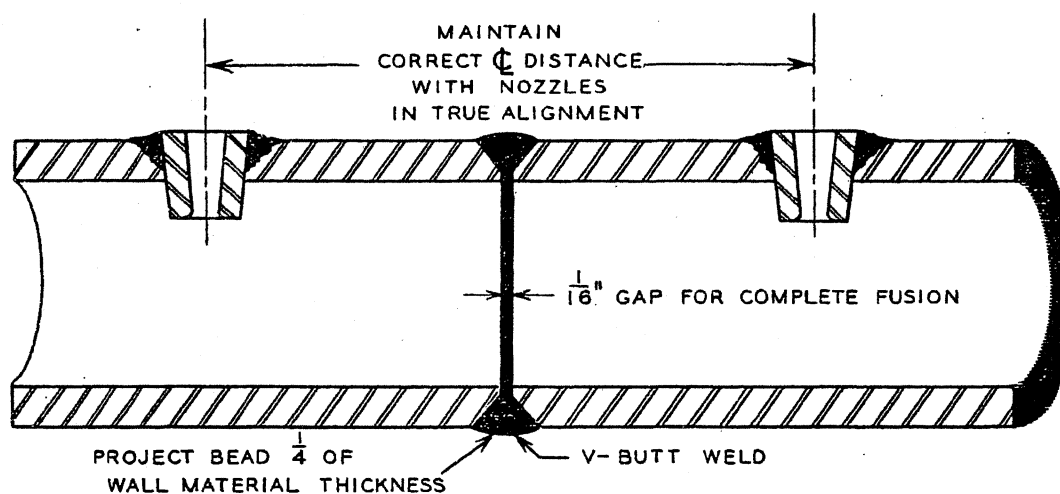
ELEMENT BEARINGS

SWIVEL TUBE AND LANCE NOZZLES

ELEMENT WELDING



PREPARATION OF ELEMENT JOINT FACES FOR V-BUTT WELD.
(Element Wall Thickness Exaggerated)



WELDED ELEMENT.
(Element Wall Thickness Exaggerated)

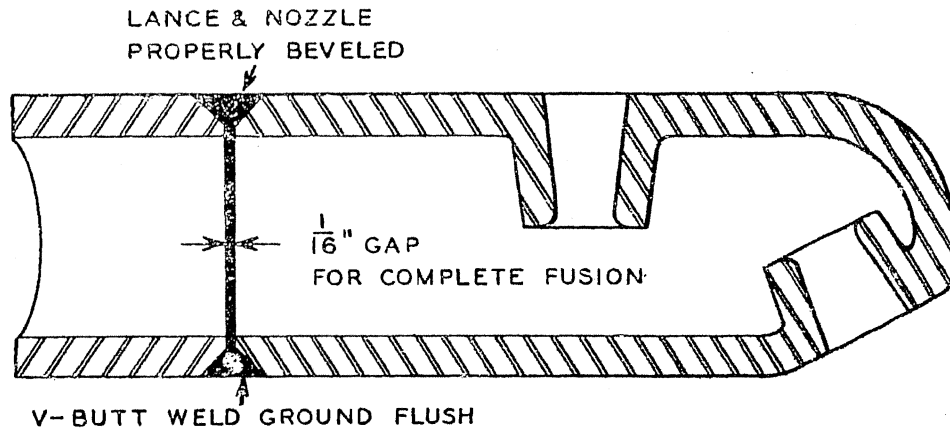
When joining elements by electric arc welding, best results are obtained by using a V-Butt Weld. Grind or machine a 35° to 40° bevel on the joining faces of the element sections with the bevel starting approximately $\frac{1}{16}$ " from element bore as shown in the above illustration. The faces or shoulders,

machined at right angles to the element axis, should be approximately $\frac{1}{16}$ " wide.

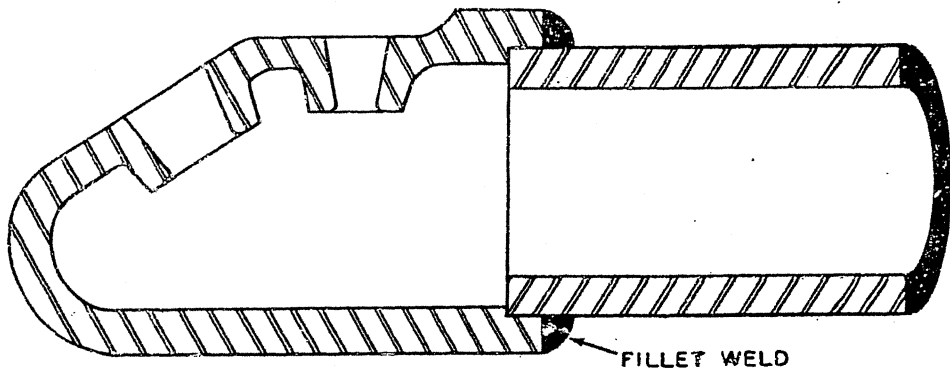
It is very important that the element sections be in correct alignment on their axes. Nozzles must be spaced the correct distance from each other and in true alignment.

LMCF00148

SWIVEL TUBE AND LANCE NOZZLE WELDING



WELDED RETRACT AND WALL BLOWER NOZZLE.



WELDED GUN BLOWER NOZZLE.

Retract and wall blower nozzles should be V-Butt welded to their respective lances or swivel tubes after beveling joining faces as described in Element Welding. Extra care must be exercised to obtain proper penetration at joint because the weld head must be ground flush and polished to permit passing of lance or tube through scraper plates and packing glands.

Gun blowers should be attached with fillet weld as illustrated above.

CAST NOZZLE WELDING DATA

The same nozzle welding data applies to stainless steel or monel swivel tubes or lances.

1. Use $\frac{1}{8}$ " diameter monel electrodes - Vul-

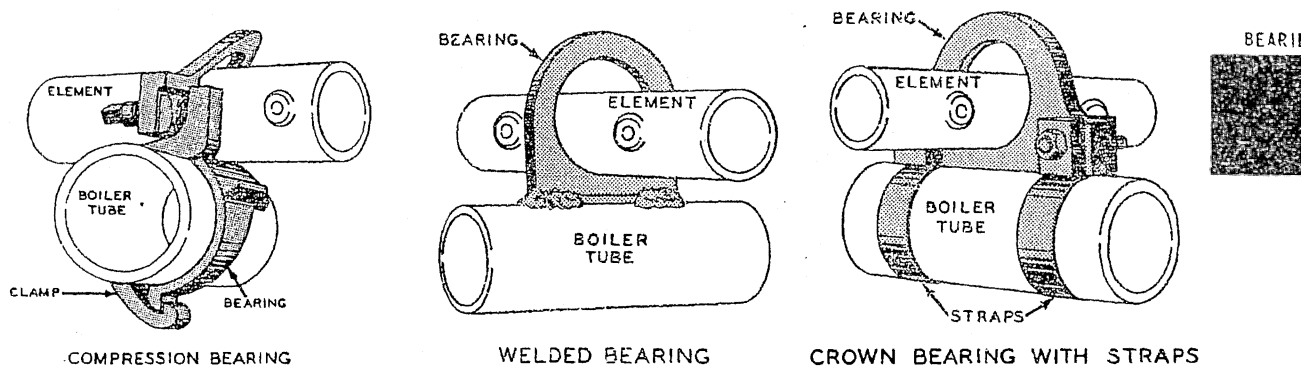
can Part No. V-4823. Specifications for this rod are: $\frac{1}{8}$ " diameter coated monel electrode. Its equivalent is International Nickel Company's Monel Metal Rod 130X. It is recommended for welding monel to monel or monel to steel.

If this rod is not available, good results may be obtained with electrodes furnished under Vulcan Part No. V-4711. Specifications for this second choice may be found under Hyvuloy and Alvuloy bearings.

2. Polarity of welder should be reversed - electrode positive.
3. Use 130 to 190 amperes.
4. Electric arc should be as short as possible to obtain deep penetration and avoid splashing.

NOTE: Special applications not covered in these instructions may be obtained from DuBois on request.

ELEMENT BEARINGS AND HANGERS



Illustrations of Typical Bearings

Bearings and hangers, fastened to the boiler tubes, support the element throughout its entire length within the boiler. Bearing materials, like element materials, are selected according to the temperature zone where they are installed. Each type of bearing has its own specific application which is governed by the type of boiler and method of construction.

As a general rule Cast Iron and Steel bearings are used on Plain Steel elements in low temperature zones. VULITE and ALVULOY bearings are used on VULCROM elements in medium temperature zones. HYVULOY bearings are used on HYVULOY elements in higher temperature zones.

All bearings and hangers are furnished complete with bolts, clamps, and nuts unless otherwise specified. Descriptions of the common types of bearings are listed below.

COMPRESSION BEARING - Made of HYVULOY, being used chiefly in higher temperature zones. Consists of one bearing, clamp, stud and nut. In this type of bearing the stud is placed in compression, so that as it becomes heated and expands, the clamping action on the tube is increased.

INTIMATE CONTACT BEARING - Made of Cast Iron or VULITE (a chrome cast iron alloy). Used in positions not requiring HYVULOY or special designs. Consists of one bearing, clamp, bolt and nut. Bolts are either plain carbon steel or alloy. This bearing is easy to install and has a long life. It may or may not be machined to fit the tubes, depending on actual requirements. The "nut cracker" action of the clamp grips the tube tightly, thus preventing slippage.

WELDED BEARING - Made of HYVULOY, ALVULOY or Plain Steel. This is the simplest type of bearing, used where a clamp type bearing is not practical. Welding rods of proper material are furnished to

insure that the bearing remains secure once it has been welded to the tube.

CROWN BEARING - Made of HYVULOY, ALVULOY, VULITE, Steel or Cast Iron. Consists of one bearing, two clamps, four washers, four bolts and four nuts. Washers are welded to the clamp for easier installation. This type of bearing is used where difficulty in installation might be encountered because of the tube spacing or other interferences. The clamps are very effective in maintaining the bearing in its correct position.

DISTAL END BEARING - Made of Cast Iron or Steel. Used to support the distal or plugged end of the element. Held in place against the boiler end by bolts or cap screws.

COMPRESSION HANGERS - Made of HYVULOY. Consists of one hanger, clamp, stud and nut. Clamping action is the same as on compression bearings, except that hangers support the element below the boiler tubes.

STATIONARY ELEMENT BEARING - Made of HYVULOY, VULITE or Cast Iron. Consists of one bearing, clamp, two washers, one bolt and one nut. The bearing itself is a block of metal held in place between the two ends of the clamp. It is not designed to support the element, but instead butts against the side of the element to keep it from moving sideways on the boiler tube.

If exact duplicate bearings are required for maintenance, repair or replacement, give the position at which the bearings are used, and the job number. Job numbers are on all General Arrangement Drawings and Bills of Materials. Vulcan engineering files contain all information on original equipment by job number.

IMPORTANT

No soot blower system will operate satisfactorily unless given proper maintenance attention.

Under the heading Maintenance and Lubrication will be found detailed instructions which, if followed, will assure long life and trouble-free operation of your Vulcan equipment.

INSTRUCTIONS FOR INSTALLING

VULCAN VALVE OPERATING HEAD, MODEL PM-3

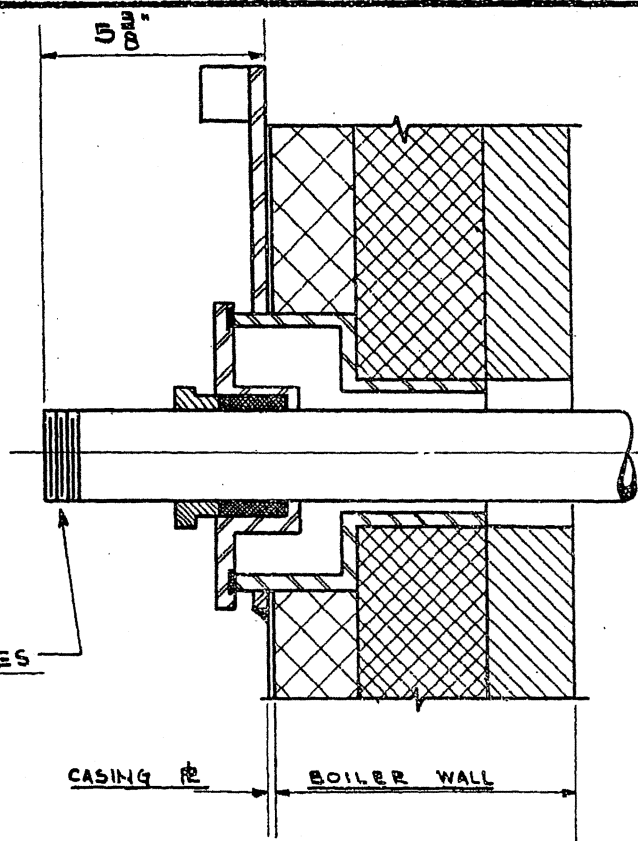
1. SLEEVE FOR BRICK SET BOILERS: Place the back of flange of SLEEVE SQUARE and flush with side wall of boiler, locating the centerline of SLEEVE on the centerline of ELEMENT both vertically or horizontally. Place SLEEVE so the word "Top" is on upper side installation shown on Drawing 20061. Refer to note on Page 2. When the boiler is bricked up and it is desired to cut holes, these holes should be approximately 9 by 10 inches. If it is desired to leave openings when setting new boiler, a 9 by 10 inch opening should be left. If the blower is not ready for installation these openings can be filled with loose brick and fire clay which can be removed. It is a good practice not to try to get along with a small hole or opening, as a large hole will allow work to be readily and conveniently accomplished, and it will be easier for the brick mason to fill up.
2. SLEEVE FOR STEEL CASED BOILERS: Cut a hole in the steel casing as shown on drawing, centered on the centerline of ELEMENT. Remove steel casing panel if necessary, and set SLEEVE into brickwork or if there is room to work from inside of the boiler setting, it may be unnecessary to remove panel to set the SLEEVE. Place finished face of SLEEVE with the side wall of boiler and 1/16" behind outer face of steel casing, locating centerline of SLEEVE on centerline of ELEMENT, both vertically and horizontally. The SLEEVE should be placed so the word "Top" is on the upper side. Fasten SLEEVE PLATE to SLEEVE by means of FOUR CAP SCREWS which are screwed into four tapped holes in the SLEEVE. Installation of SLEEVE AND SLEEVE PLATE are as shown on Drawing 20061. Refer to note on Page 2. The same size hole as specified above for brick set boilers should be cut through the brick wall behind the steel casing. This can be done from outside by removing a section of the steel casing or in some cases the hole may be cut from inside of boiler.
3. NIPPLES FOR SCREWED OUTLET HEADS: Place ELEMENT in correct position in boiler, being particularly careful to see that the nozzles register with the space between boiler tubes, according to special instructions in regard to location of the NOZZLES with reference to the boiler tubes. The NIPPLE on the end of ELEMENT will extend thru the SLEEVE (some ELEMENTS are made in one piece without a nipple and coupling, the ELEMENT itself taking the place of the NIPPLE.) Cut off end of NIPPLE, as shown on DRAWING 20061. Refer to note on Page 2. Thread the end of ELEMENT with standard Pipe thread. Place SEAL PLATE over NIPPLE or ELEMENT and into its position with reference to the SLEEVE or SLEEVE PLATE as shown on Dr. . Remove ELEMENT FLANGE from the HEAD. After placing SLEEVE CUP SPRING against the SEAL PLATE, screw ELEMENT FLANGE tightly onto end of NIPPLE or ELEMENT. Distance from hub of ELEMENT FLANGE to face of SLEEVE OR SLEEVE PLATE should be approximately 4 1/16" when the NOZZLES register properly with the spaces between the boiler tubes. The two 3/8" SET SCREW should be tightened down on the ELEMENT.

- (4) ASSEMBLY OR UPPER ARM SUPPORT AND HEAD: - The upper arm support is composed of the following pieces: a 7/8" square steel bar- "The Support Bar", and a steel stud- "THE SUPPORT SCREW". The SUPPORT BAR is to be placed in the square opening in the SUPPORT BUTTON and the 3/8" set screw tightened securely. Remove the JAM NUTS from the SUPPORT SCREW, place the support arm carriage and SUPPORT SPRING over the SUPPORT SCREW and replace the JAM NUTS. Lift the HEAD into position and slide the SUPPORT ARM CARRIAGE over the SUPPORT BAR. The four studs in the Gear should be lined up with the holes in the ELEMENT FLANGE, then assemble the HEAD to the ELEMENT FLANGE and screw the nuts onto the studs-final tightening with a wrench-being sure the GASKET is assembled in ELEMENT FLANGE. (The GASKET may be made to stick in the ELEMENT FLANGE by striking the outside gently to make it slightly oval shaped.) Complete assembly of the HEAD is shown on Dr. _____).
- (5) SETTING THE UPPER ARM SUPPORT: - After assembly has been completed, the HEAD should be leveled up by adjusting the JAM NUTS against the SUPPORT ARM CARRIAGE or SUPPORT SPRING. The HEAD should then be placed in the proper longitudinal position. This is done by moving the ELEMENT in or out from the side of the boiler (being sure the 3/8" x 3/8" SET SCREW in the SUPPORT ARM CARRIAGE HAS BEEN LOOSENED) until the NOZZLES REGISTER with the spaces between the boiler tubes as outlined in the special instructions. The 3/8" x 3/8" SET SCREW holding the SUPPORT ARM CARRIAGE in position on the SUPPORT BAR should then be tightened securely completing the assembly. After the outside piping has been erected, it is advisable to go over each HEAD and adjust the JAM NUTS against the SUPPORT ARM CARRIAGE or SUPPORT SPRING until the HEAD IS IN THE PROPER POSITION.
- (6) CHAIN: The Chain should be in one continuous piece. Splicing of the chain should be carefully done as shown on Dr. 8841.

NOTE: When the HEAD is to be installed farther from the side wall than standard either the SLEEVE will be moved out from the wall, or else a special SLEEVE PLATE or EXTENSION SUPPORT will be furnished. This will be explained in the special instructions for the job.

LMCF00154

NOTE:
ELEMENT CUT & THREAD IN FIELD.
DO NOT CUT TO DIMN. SHOWN UNTIL
AFTER CHECKING ACTUAL POSITION
OF NOZZLES WITH RESPECT TO TUBES



VIEW SHOWING DIMN. FOR CUTTING ELEMENT

CHANGES

NO.	WAS	DATE	BY
1			
2			
3			
4			
5			
6			

DO NOT SCALE DRAWING
 USE DIMENSIONS ONLY

ALL FRACTIONAL DIMENSIONS PLUS
 OR MINUS 1/64"

ALL DECIMAL DIMENSIONS AS
 SPECIFIED:

MATERIAL:

FOR:

P.M.-3 MARINE HEAD

SUPERSEDES:

SUPERSEDED BY:

FIRST USED ON JOB NO.

DRAWN BY- CLARR

FILE IN FOLIO: DV

COPES-VULCAN DIVISION
ERIE, PENNA.

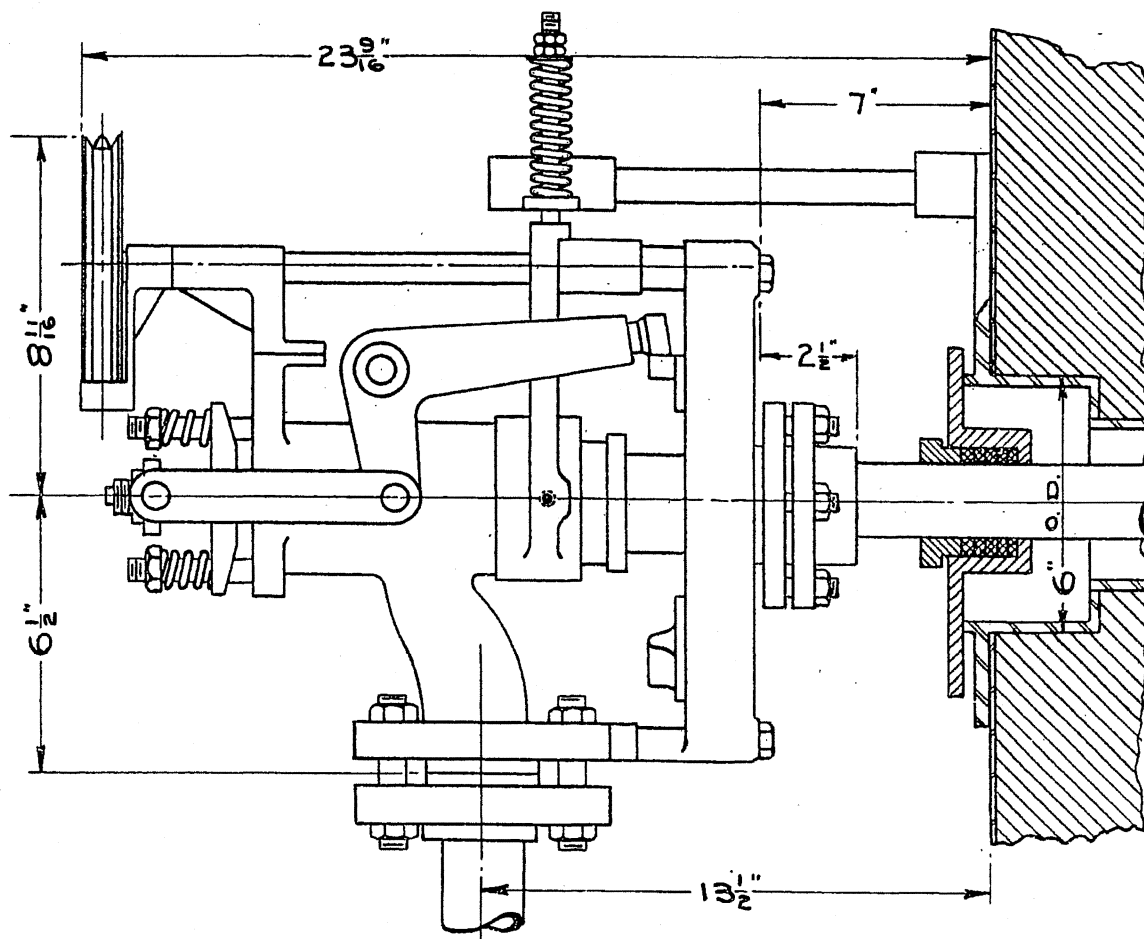
DATE 11-13-50

DR.
NO.

T-20061

SCALE 3 1/2"=1'-0"

LMCF00155



CHANGI

NO.	WAS	DATE	BY
1			
2			
3			
4			
5			
6			

DO NOT SCALE DRAWING
USE DIMENSIONS ONLY.

ALL FRACTIONAL DIMENSIONS PLUS
OR MINUS $1/64$

ALL DECIMAL DIMENSIONS AS
SPECIFIED:

MATERIAL:

FOR:

PM-3 HEAD

SUPERSEDES:

SUPERSEDED BY:

FIRST USED ON JOB NO.

DRAWN BY- *Robell*

FILE IN FOLIO: DV

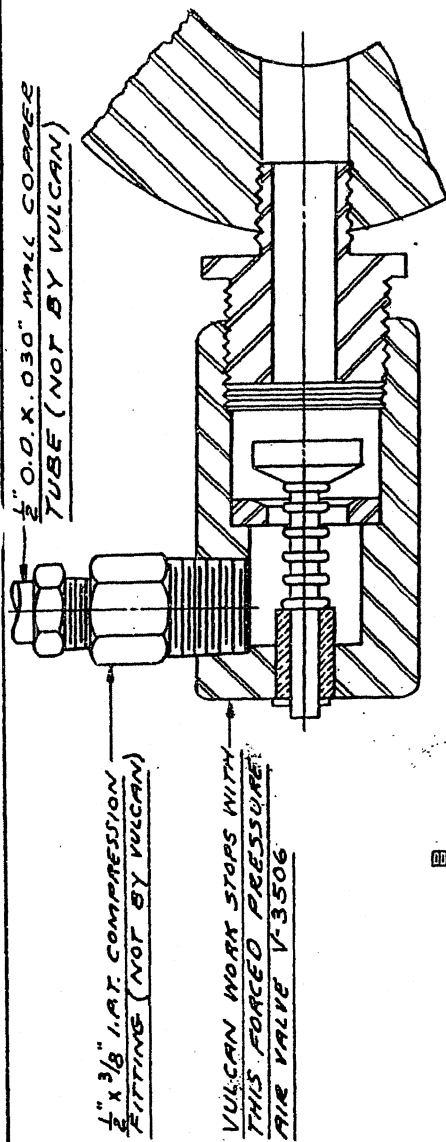
COPES-VULCAN DIVISION
ERIE, PENNA.

DATE 1-17-51

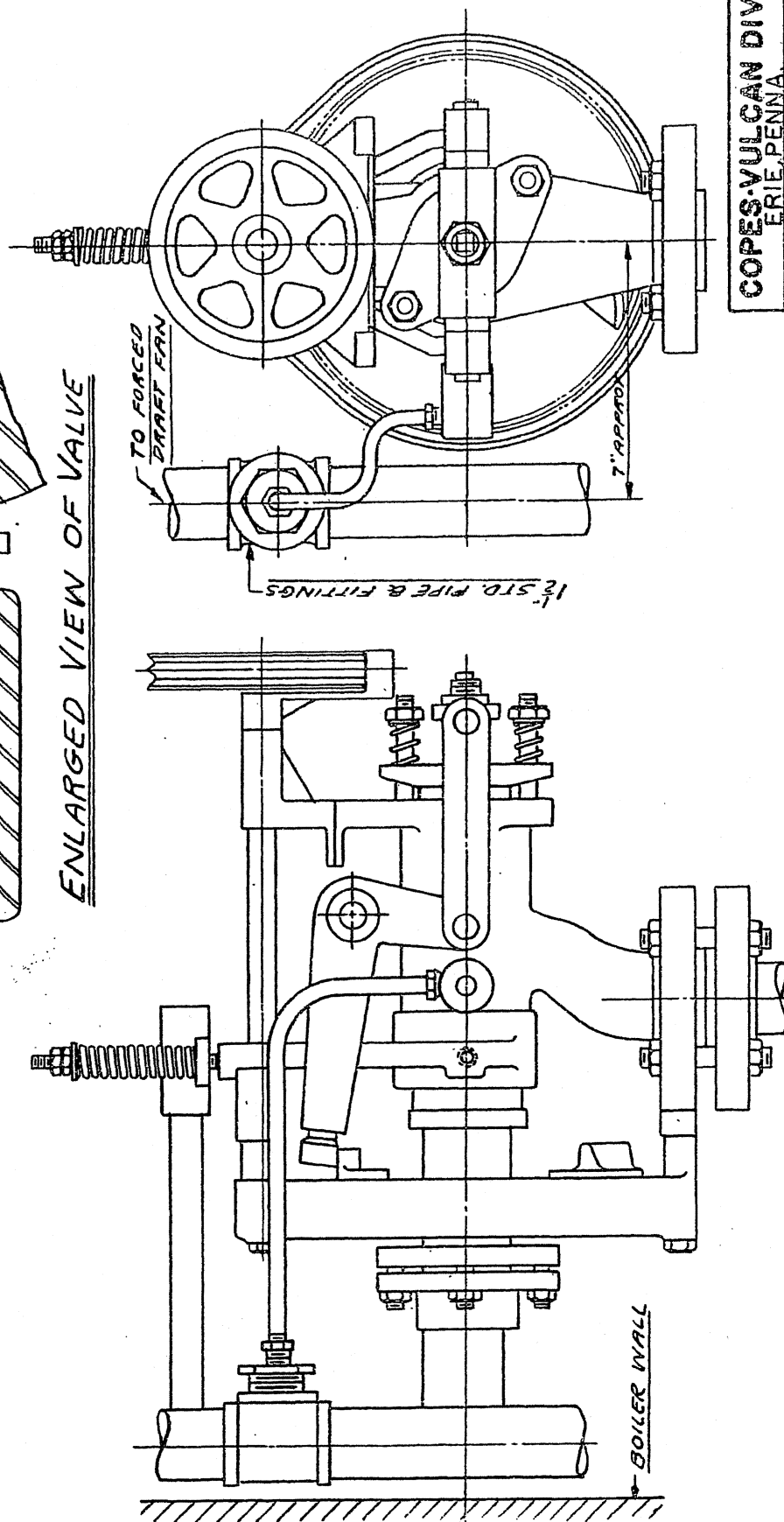
DR.
NO.

SCALE 3"=1'-0"

T-20203



ENLARGED VIEW OF VALVE



COPE'S-VULCAN DIV. ERIE, PENNA.	
DATE - 11-13-59	DR No
SCALE - 3/4" = 1'-0"	7-20058

DV

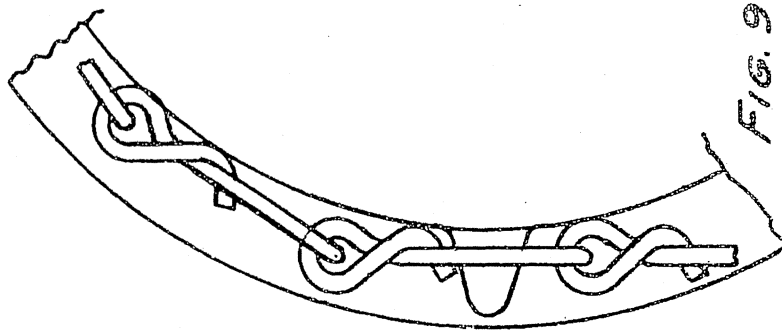


FIG. 9

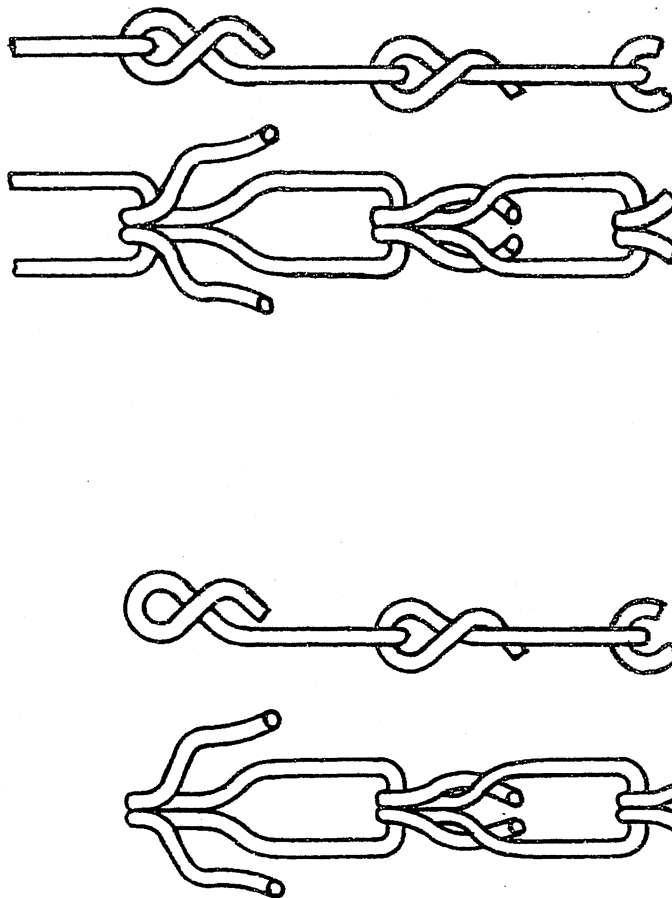


FIG. 8

FIG. 7

METHOD OF CONNECTING
ENDS OF #10 LOCK LINK CHAIN
1ST - OPEN END OF CHAIN AS SHOWN
BY FIG. 7
2ND - INSERT LINK ON OPPOSITE END OF
CHAIN IN OPENED LINK AS SHOWN
BY FIG. 8
3RD - CLOSE LINK
4TH - CHAIN MUST BE INSTALLED WITH
AROUND END NEXT TO SHERVE WHEEL
AS SHOWN BY FIG. 9

LMCF00157

DR. NO. 8841-1

REV. 41 - 5-1-49
REDEBRAWN & ADDED
FIG. 9

OPERATING INSTRUCTIONS

MODEL PM-3

Operate soot blowers every 6 to 12 hours, depending on requirements of boiler operating conditions. It may be necessary to increase cleaning under extreme load conditions.

Procedure:

1. Open boiler drafts before operating soot blowers.
2. Open drain valve and slowly open main steam supply valve.
3. Operate soot blowers in sequence as shown on General Arrangement Drawing, starting with the number one soot blower unit.

NOTE: Model PM-3 Soot Blower is designed for Sheave Wheel or Crank counter-clockwise rotation which in turn rotates the element in a clockwise direction. Do not force sheave wheel in a clockwise direction or soot blower mechanism will be damaged.

Cams are available for counter-clockwise rotation if such rotation is required.

4. Rotate sheave wheel counter-clockwise by pulling slowly and steadily on the chain or crank. Cams mounted on drive gear will automatically open and close the blower steam valve at the proper time.
5. The blower may be operated through as many cleaning cycles as desired to clean the tubes at each position. After each blower is operated, position element so that blower steam valve is closed.
6. After all heads have been operated, close the main supply valve and open drain valve.
7. Keep drain valve open at all times except when blower is in actual operation.

Operating Suggestions and Precautions

Open boiler drafts wide when operating soot blowers.
Close all steam supply valves when blowers are not in operation.
Open drain valves when blowers are not in operation.
Never use wet steam.

Never permit a soot blower unit to remain open or blowing unless it is properly rotated.

Clean tubes increase draft -- adjust damper accordingly.

SOOT BLOWING -- OIL & PULVERIZED FUEL FIRED BOILERS

Oil and pulverized fuel fired boilers should be operated between half load and full load to prevent loss of ignition or an explosion when blowing soot. Due to colder furnaces, lower gas velocities and higher oxygen content of flue gases at low boiler ratings, unburned combustible may accumulate in certain areas. This combustible may explode if the soot blowers are operated under these conditions. An exception may have to be made if a boiler has to be operated at a low rating for a long period, but whenever possible, the burner firing rate should be increased for the soot blowing cycle.

If the soot blowers must be used when the burners are not operating the refractory must be cool and no smoldering soot should be present at any place in the boiler setting. An inspection should be made for soot fires since combustible greases or unburned solid combustible material may be ignited by hot refractory or smoldering material when the soot blowers are operated.

SOOT BLOWING -- STOKER FIRED BOILERS

When taking a stoker fired boiler off the line, it is advisable to use the soot blower after drawing the fire or just before the non-return valve is closed so that boiler tubes will be clean for inspection.

ADJUST BLOWER STEAM VALVE

MODEL PM-3

Do not adjust blower steam if blowers operate satisfactorily and valve does not leak.

To adjust valve, rotate sheave wheel or crank counter-clockwise until the closing cam contacts cam follower to close valve. Loosen lock nut and tighten adjusting screw until valve is firmly seated, then secure lock nut. A leaky valve is indicated by the whistle blowing when the element is in non-blowing position of its sweep.

MAINTENANCE AND LUBRICATION

MODEL PM-3

Soot blowers, bearings and elements are continuously subjected to high furnace temperatures. The Vulcan Engineers take this point into consideration and use the highest possible engineering standards in design and construction of Vulcan Soot Blowers. As a result, the blower equipment, when properly installed and cared for, is as trouble-free as it can be. To keep the blowers operating efficiently and to assure long life, all that is required is your attention to items below.

The following items should be checked periodically:

1. Lubrication (weekly).

CAM FOLLOWER: Lubricate through the angle Alemite fitting at inside of blower yoke. Use a high temperature, non-fibrous, gun-type lubricant (Vulcan Part No. V-3008).

BALL BEARING: Lubricate through the Alemite fitting at the right hand side of the reaction plate. Use high temperature, non-fibrous gun type lubricant (Vulcan Part No V-3008).

GENERAL: Clean and lubricate gears and all other external moving parts with a good grade of motor oil.

2. MOUNTING: Make sure soot blowers units are securely mounted. Loose mountings could cause jets of steam to be improperly directed inside the boiler, resulting in a poor job of cleaning and possibility of damage to the tubes.
3. LINES AND OUTSIDE PIPING: Check for leaks. Tighten fittings to stop leaks or replace faulty fittings and connections.
4. PACKING: Check for leaks. Keep packing glands just tight enough to prevent leakage--do not overtighten. Replace a packing that leaks excessively.
5. PARTS INSIDE BOILER: Check bearings and elements to see that they are in good condition and are properly alined to permit the element to rotate freely. Check spacing of nozzles to see that they register properly between boiler tubes. Improper registration of nozzles, caused by wall movement or other changes, will cause jets of steam to be mis-directed with possibility of the tube cutting and damage to the other parts within the boiler.
6. KEEP SOOT BLOWERS CLEAN: To secure long life and top performance from your soot blower, the out surface should be cleaned occasionally. Dirt and rust accumulating over a period of time will enter the operating mechanism and will not permit the blowers to function properly. Dirt also acts as an abrasive causing moving parts to wear.

ADJUST BLOWING SWEEP

MODEL PM-3

The element on Model PM-3 Soot Blower rotates in one direction only (clockwise) for a complete 360 degree circle. The opening and closing of the blower medium is adjustable, thereby, establishing the blowing sweep on the general arrangement Drawing.

It is quite important that the sweep be adjusted as close as possible to specifications on the General arrangement Drawing. It is not economical to blow steam into a part of the boiler where no cleaning is required and under certain conditions, if the nozzles are pointed directly against the baffles, the baffles will be damaged.

Determine nozzle location by internal inspection, if the location was not previously determined and identified. Mark nozzle location on the element flange.

NOTE: There are two cams mounted on the drive gear; one opens the blower steam valve and the other closes the valve at the proper time during the 360 degree cycle of the blower. Refer to the assembly in the Parts List Section of this manual for identification of these cams.

To adjust blowing sweep, remove both cams. Rotate sheave wheel or crank counter-clockwise to position element nozzles at beginning of the blowing arc. Install opening cam so that it contacts the cam follower at this point. Again rotate sheave wheel or crank counter-clockwise until element is at the end of the blowing sweep and install closing cam so that it contacts cam follower at the end of the sweep.

After sweeps have been adjusted, the blower should be operated through its actual sweep and inspected for correct setting from the nozzle identification marks which have been previously placed on the element flange and nipple.

VALVE ADJUSTMENT

PM-3

Field Service has disclosed that it is possible to break pinions or destroy either opening or closing cams if the valve throw is not properly adjusted for opening and closing.

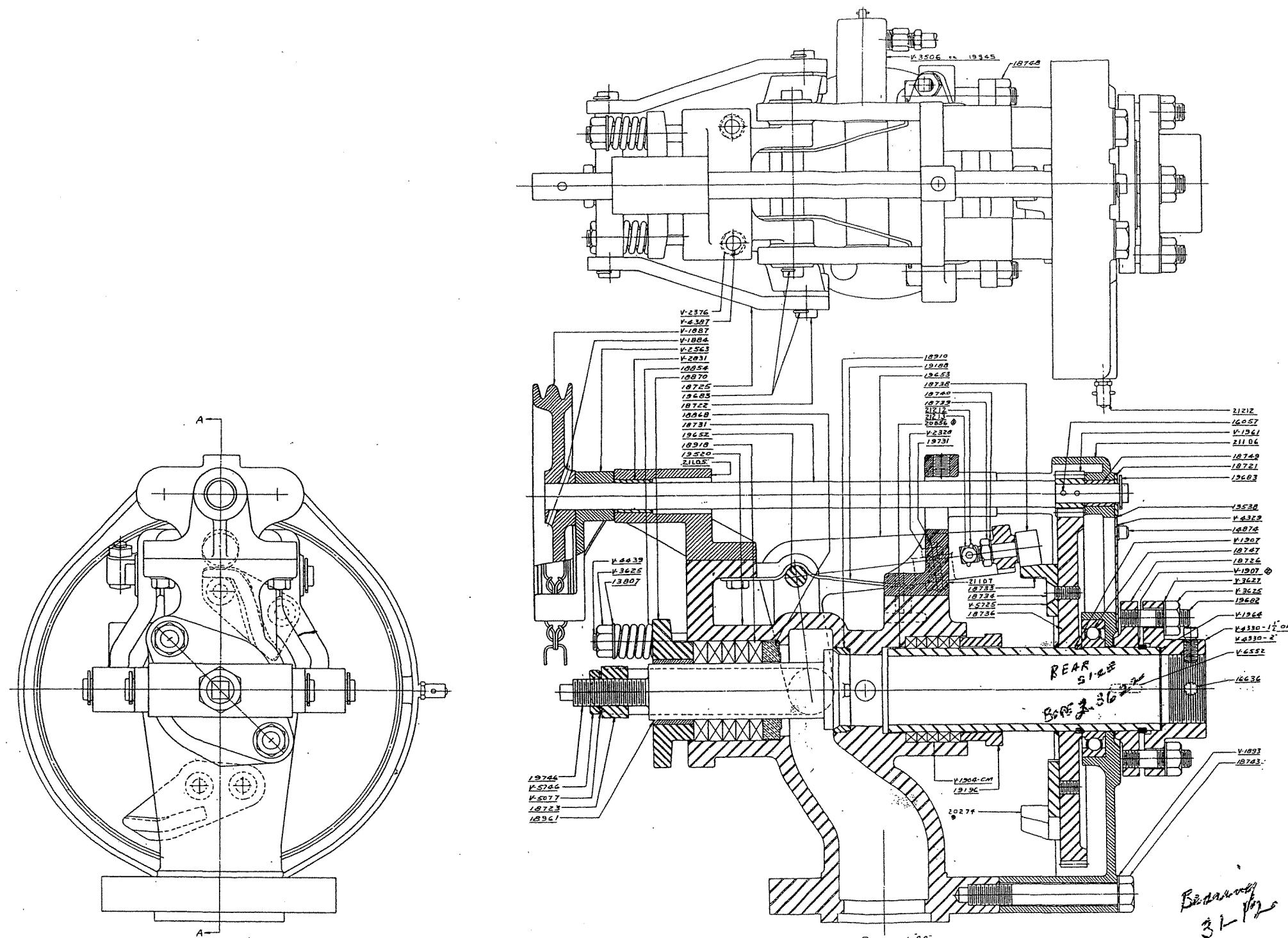
Proper procedure for adjustment is to loosen 3/4" Jam Nut, Part No. V-5746. The Valve proper can then be turned and adjusted thru the valve Nut, Part No. 18723, which is carried between and actuated by the two links, Part No. 18725, on either side of the head. A square end is milled on the valve to permit adjustment with a wrench.

With the unit in a closed position, that is, with Cam Follower, Part No. 18738, on the top of the closing Cam. Part No. 18733, the valve should be turned in only until it engages the seat snugly. The adjustment is then locked and maintained by use of the Box Jam Nut.

After this adjustment is complete, the unit should be rotated slowly by hand. On the PM-3 Units this is possible by using the Sheave Wheel or Crank. A Complete cycle of rotation should be made by hand to see that no undue strain is placed on the Cam Follower of either of the Opening or Closing Cams.

If too much pressure is exerted by the Valve on the Seat in closing, the Closing Cam may be broken or stripped from the Gear. If the Valve is not properly seated it will not only leak but may also strike the Packing Washer in its rear-ward movement and destroy the opening Cam.

Mal-adjustment in either direction can destroy the Pinion Gear because of undue power strain. If the error of adjustment is great enough, the Yoke Assembly can also be smashed. Proper adjustment and check of same should be made at the time the sweeps are set or checked. Hand operated PM-3 Units are just hard to turn.



LIST OF MATERIAL			
PIECE NUMBER	DESCRIPTION	NO. REQD	MATERIAL DWG NO.
V-1087	W/2"X16" GRAMPHIN	1	STEEL G-37
V-1088	3"X6"X12" WHEEL	1	MANGNESE IRON G-38
V-1089	5/8" X 1/2" X 1/2" WHEEL	1	STEEL G-40
V-1090	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-41
V-1091	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-42
V-1092	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-43
V-1093	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-44
V-1094	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-45
V-1095	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-46
V-1096	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-47
V-1097	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-48
V-1098	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-49
V-1099	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-50
V-1100	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-51
V-1101	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-52
V-1102	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-53
V-1103	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-54
V-1104	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-55
V-1105	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-56
V-1106	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-57
V-1107	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-58
V-1108	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-59
V-1109	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-60
V-1110	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-61
V-1111	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-62
V-1112	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-63
V-1113	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-64
V-1114	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-65
V-1115	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-66
V-1116	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-67
V-1117	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-68
V-1118	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-69
V-1119	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-70
V-1120	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-71
V-1121	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-72
V-1122	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-73
V-1123	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-74
V-1124	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-75
V-1125	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-76
V-1126	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-77
V-1127	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-78
V-1128	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-79
V-1129	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-80
V-1130	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-81
V-1131	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-82
V-1132	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-83
V-1133	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-84
V-1134	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-85
V-1135	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-86
V-1136	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-87
V-1137	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-88
V-1138	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-89
V-1139	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-90
V-1140	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-91
V-1141	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-92
V-1142	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-93
V-1143	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-94
V-1144	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-95
V-1145	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-96
V-1146	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-97
V-1147	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-98
V-1148	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-99
V-1149	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-100
V-1150	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-101
V-1151	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-102
V-1152	1/2" X 1/2" X 1/2" WHEEL	1	STEEL G-103

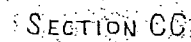
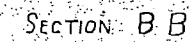
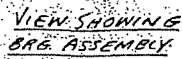
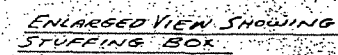
REVISION			
1	20345 WAS 1814	6-4-61	W.S.
2	20345 WAS 18339	V-1007 WAS 18726	W.S.
3	ADDED SUPPORT BRACKET 2107		
3	2108 WAS 18846	8-22-61	W.F.
3	2108 WAS 18931		
	CHANGED FLANGE FITTING TO PH TYPE		
4	20270 WAS 10735	1-8-62	R.S.M.

PATENTS ALLOWED AND AFFICE FOR	
VULCAN SOOT BLOWER CORP.	
SU 804, DENVA.	

FOR-
2" - PM-3 HEAD

DRAWN: <i>ALL</i>	TRACED:
CHECKED: <i>SEB</i>	APPROVED:
DATE: 11-26-58	SCALE: 1" = 1"00"
ASSEMBLY NO.	WORKING DRAWING
	X-19825

FILE IN DRAWING



NOTES
CAST STEEL MODEL PM-3 2 HEADS
600# A.S.A. STD.

1. PIPE VALVES & FITTINGS NOT BY VULCAN EXCEPT 500P. BLOWER HEAD CONNECTIONS FLANGES, BOLTS, NUTS & GASKETS. VALVES ARE 2" X 6 1/2" 600P A.S.A. FORGED STEEL. SOCKET WELDED.
2. DIMENS. ARE TAKEN FROM E. OF EL. TO E. OF TUBE TO WHICH BEARINGS ARE ATTACHED
3. HAND OF INSTALLATION- REAR OF BOILER

FOSTER WHEELER CORP. DWGS.
NY-500-439
NY-500-440

VULCAN DWGS.
SK-A-0-21383- BLOWING & TEARAWING AIR PIP

REVISIONS:

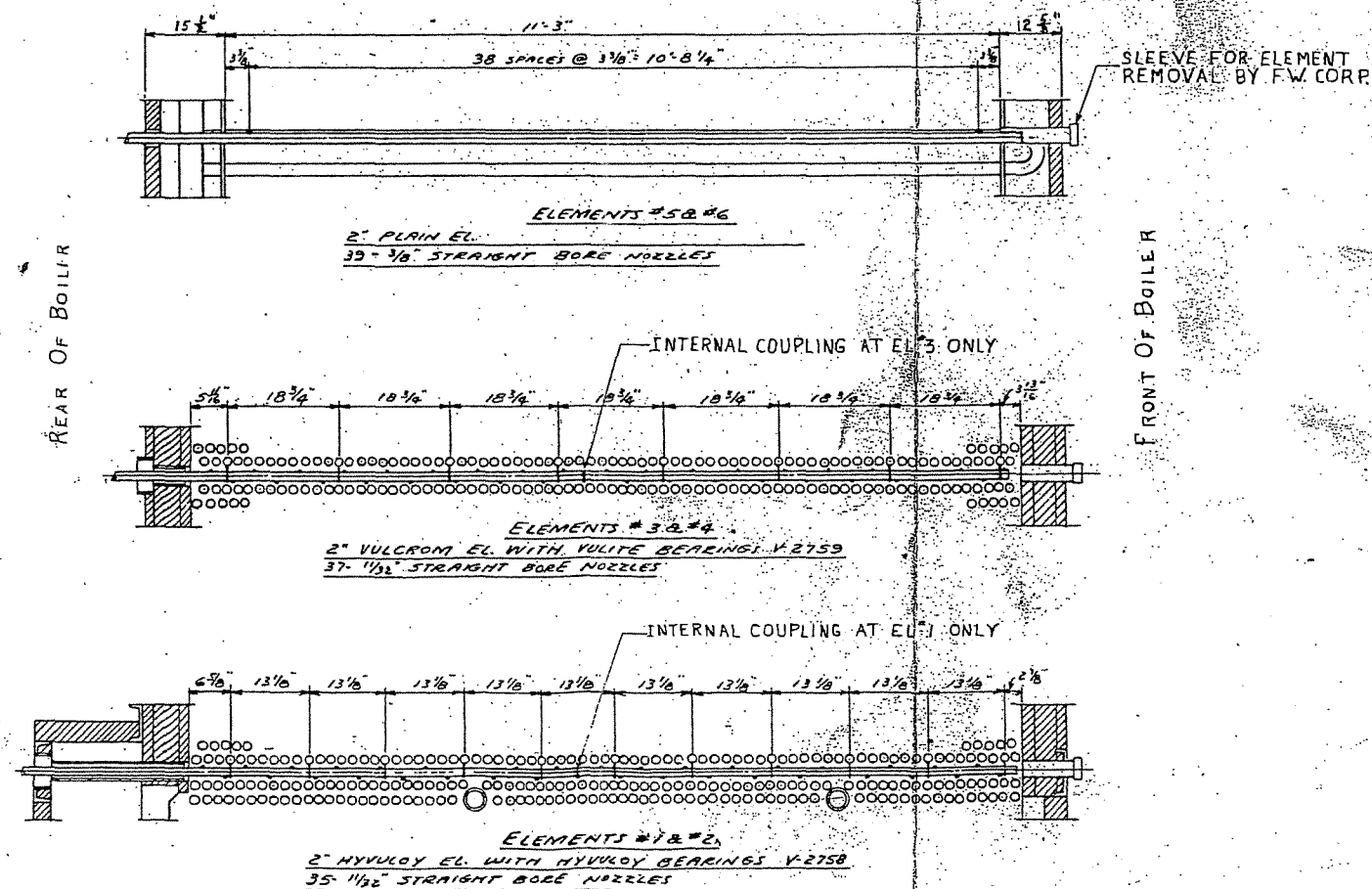
CHESAPEAKE & OHIO RAILWAY CO.
VULCAN JOB NO. 21383
FOSTER WHEELER CORR. REG. NO. NE-579-15-6

VULCAN JOB NO. 21487
FOSTER WHEELER CORR. REG. NO. NE-616-7

DRAWN BY: *A.L.*
TRACED BY:
CHECKED BY:
APPROVED BY:

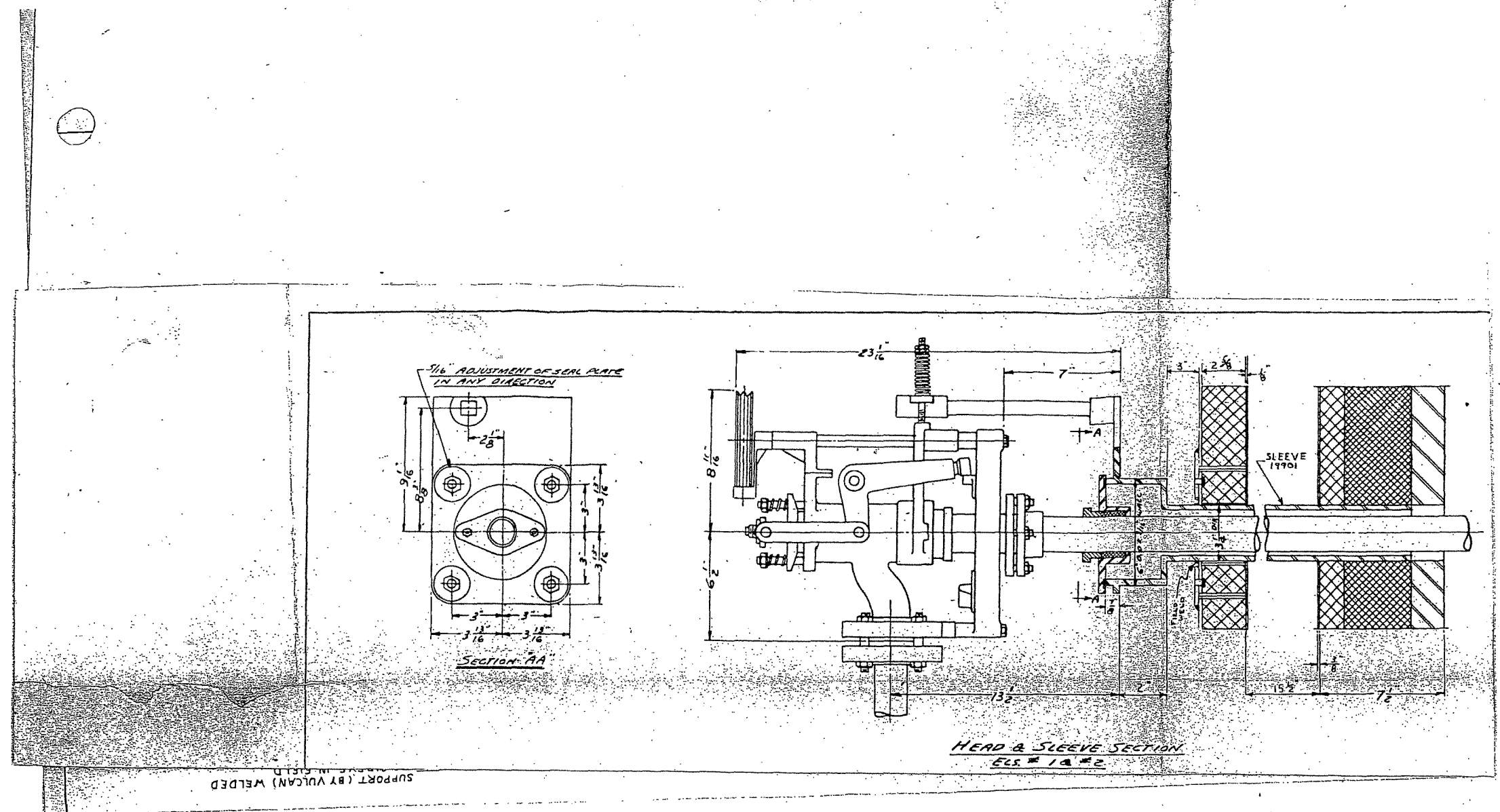
JOB NO: *21385-2198*
PRESSURE: *450"*
DATE: *11-10-50*
SCALE: *1/4" = 3'-10"*

DR. NO.-W-20059

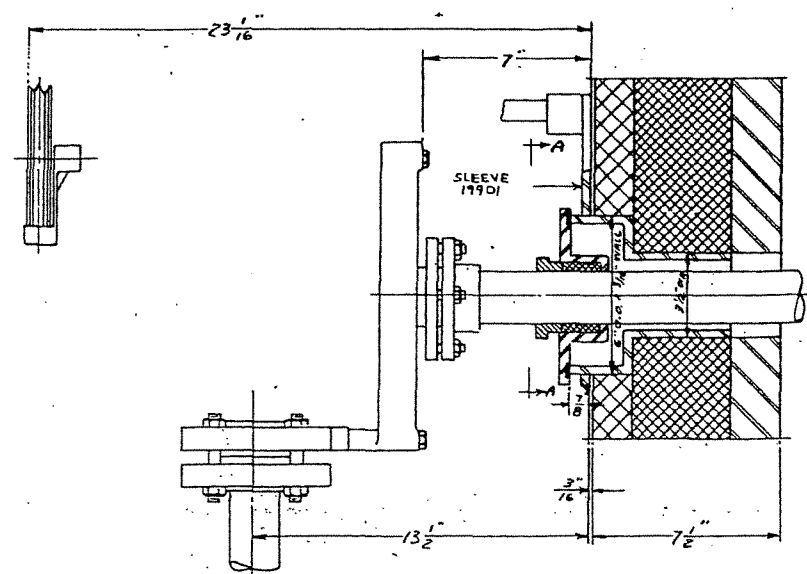


Pg. 1

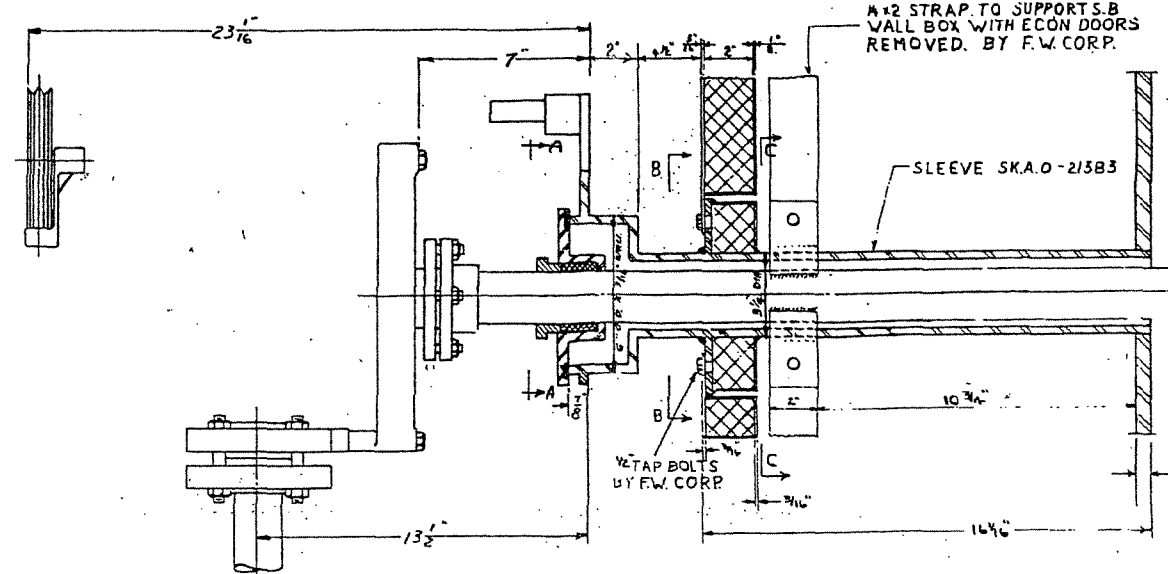
LMCF00164



Pg. 2



HEAD & SLEEVE SECTION
ELS. #3 & #4



HEAD & SLEEVE SECTION
ELS. #5 & #6

Pg. 3

INSTALLATION AND OPERATION OF SWARTWOUT TYPE "FW 1" THERMO-HYDRAULIC FEED WATER REGULATORS

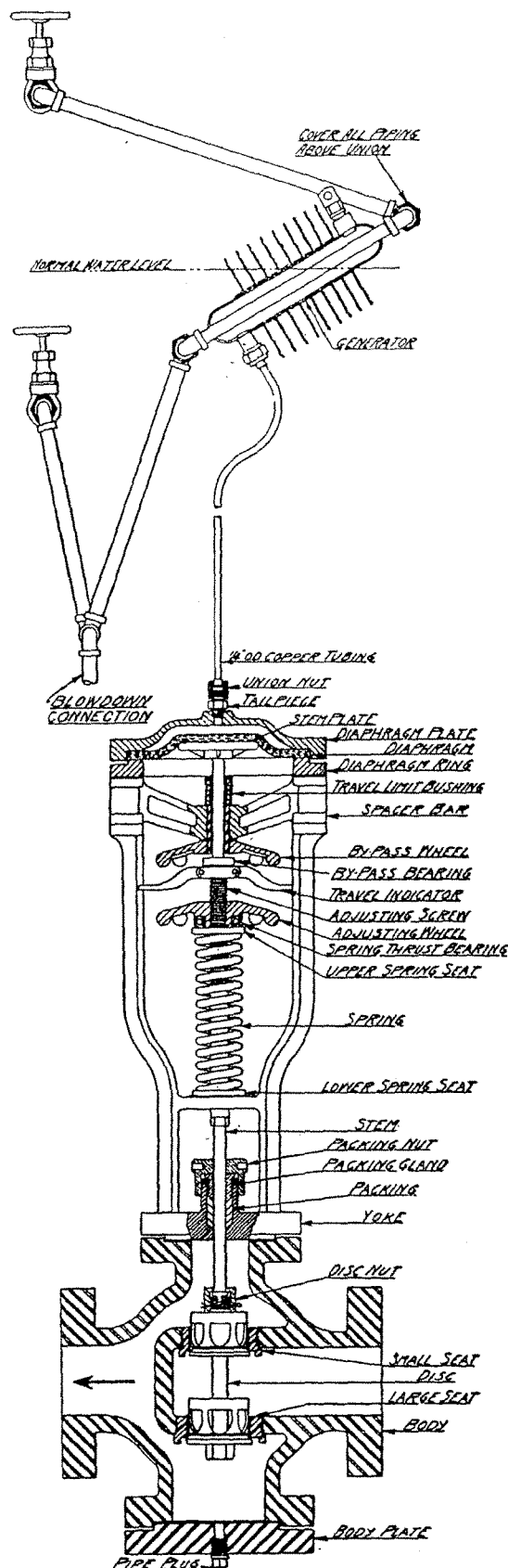


Fig. 332

Installation of Equipment

1. The regulating valve should preferably be mounted in an upright position as shown, although operation will be satisfactory if it is mounted horizontally. Inverted installation is undesirable because dirt will collect on the diaphragm and interfere with the regulation.
2. Install the valve so the flow is in the direction of the arrow shown in Fig. 332.
3. Install the generator as shown on the connection drawing sent with this equipment. Be sure to set the generator at the correct angle and height. Inaccurate location of the generator will result in improper operation of the regulator.
4. Cover all piping above the generator as shown in Fig. 332. Do not cover or paint the generator or any of the lower generator piping.
5. Connect the generator to the regulator by means of the special $\frac{1}{4}$ " O.D. connecting tubing furnished by the Swartwout Co. The tubing fittings are special ground joints to insure a leak proof system and ordinary pipe or tubing fittings should not be used.

Starting Instructions

1. Fill the generator system as follows:
 - a. Screw bypass wheel tightly against the spacer bar so that regulating valve is closed.
 - b. Close upper and lower hand valves on generator piping. Open blowdown valve.
 - c. Remove filling plug at top of generator and fill generator with clean HOT water.
 - d. Replace plug and crack upper generator shutoff valve to allow steam to circulate through the generator and escape at blowdown.
 - e. While keeping generator hot, crack open connecting tubing union nut on top of diaphragm plate of the regulating valve, and allow air to escape. When water appears, tighten nut.
 - f. Close upper generator shutoff valve and cool generator by pouring water over it.
 - g. After generator is *entirely* cool, remove filling plug and refill the generator.
 - h. It is important that *all* air be removed from the generator system. The best way to accomplish this with regulators mounted in any position except upright is to remove the diaphragm assembly from the rest of the regulator and hold it horizontally while cracking the connecting tubing union nut and allowing the air to escape. The diaphragm assembly can be

removed by removing the four large nuts that hold this assembly to the rest of the regulator.

2. Cut in the regulator by closing the blowdown valve and opening the upper and lower generator shutoff valves. The regulator will now pick up the load.

Adjustments

1. The characteristics of this type of feed water regulator are such that it will carry a high level at a low load and a low level at a high load. Allow the regulator to operate for at least 30 minutes and carefully observe the level being held before making any adjustments.
2. Spring Compression has practically no effect on water level and should not require adjustment. In general, increasing the spring compression will cause the regulator to be somewhat faster in closing off.
3. Generator location.
 - a. If it is necessary to raise or lower the water level being maintained, the unions in the generator hookup should be loosened and the generator raised or lowered the desired amount. Sometimes there is a false level within the generator if the drum connections are different from the water column connections and the generator must be raised or lowered accordingly.
 - b. The generator angle will affect the difference between the levels being maintained at high loads and low loads. The normal recommended generator angle is shown on the installation drawing (usually 30° with the horizontal). If the level variation with load changes is too great, the generator can be made more horizontal. This will increase the sensitivity of the system, however, and may start a hunting cycle. With boilers that are quite sensitive to changes in steam flow or water flow, it may be necessary to set the generator more nearly vertical.
4. The regulator can be manually held in an open position by screwing the bypass wheel out of the spacer bar.
5. If boiler operates at 25 psi or less, the generator should be filled with a good grade of denatured or wood alcohol instead of water.

Causes of Improper Operation

1. Low Water Level
 - a. Low pump pressure or low excess pressure across valve.
 - b. Partially filled generator system. Slow loss of water will result in slowly lowering water level. Refill the generator and tighten all tubing fittings and diaphragm

bolts. Slight leaks are hard to locate, but if a teaspoonful of borax is dissolved in the filling water, the leak will be easily discernible.

- c. Air in generator system.
- d. Generator located too low.
- e. A hand valve in feed line partially closed.
- f. Air binding in generator piping to drum. Blow down regulator.

2. High Water Level

- a. Too high an excess pressure across regulator.
- b. Valve held open by foreign substance lodged between seat and disc.
- c. Generator overfilled. (May have been filled with cold water or with regulator jacked partway open.) Crack tubing union at diaphragm to allow some water to escape. Make sure that regulator will still go open far enough to handle maximum load.
- d. Generator located too high.
- e. Hand bypass valve around regulator partially open.
- f. If upper generator piping is not covered it may cause high level at low loads.

3. Hunting

- a. Sensitivity is too great. Set the generator more nearly vertical.
- b. Hunting of the feed water regulator can also be caused by hunting of pump governors, combustion control, etc., so make sure that the feed water regulator is the cause of the hunting before making any adjustments.

4. Too wide a variation of level with load changes

- a. Sensitivity is too low. Set the generator more nearly horizontal.
- b. Wide variation in level can also be caused by wide variations in excess pressure.

Maintenance

1. Refill generator and tighten diaphragm bolts whenever a gradual lowering of drum level indicates leakage in the generator system.
2. If feed water conditions are bad blow down the generator for 3 to 5 seconds each day. Under normal conditions blowing down generator is seldom necessary except when starting up after a boiler shutdown.
3. In ordering repair parts, refer to the parts by name as shown in Fig. 332. *Be sure to mention size and serial number of the regulator.*

The Swartwout Company 18511 Euclid Avenue, Cleveland 12, Ohio

INSTALLATION AND OPERATION OF SWARTWOUT TYPE "FW 1" THERMO-HYDRAULIC FEED WATER REGULATORS

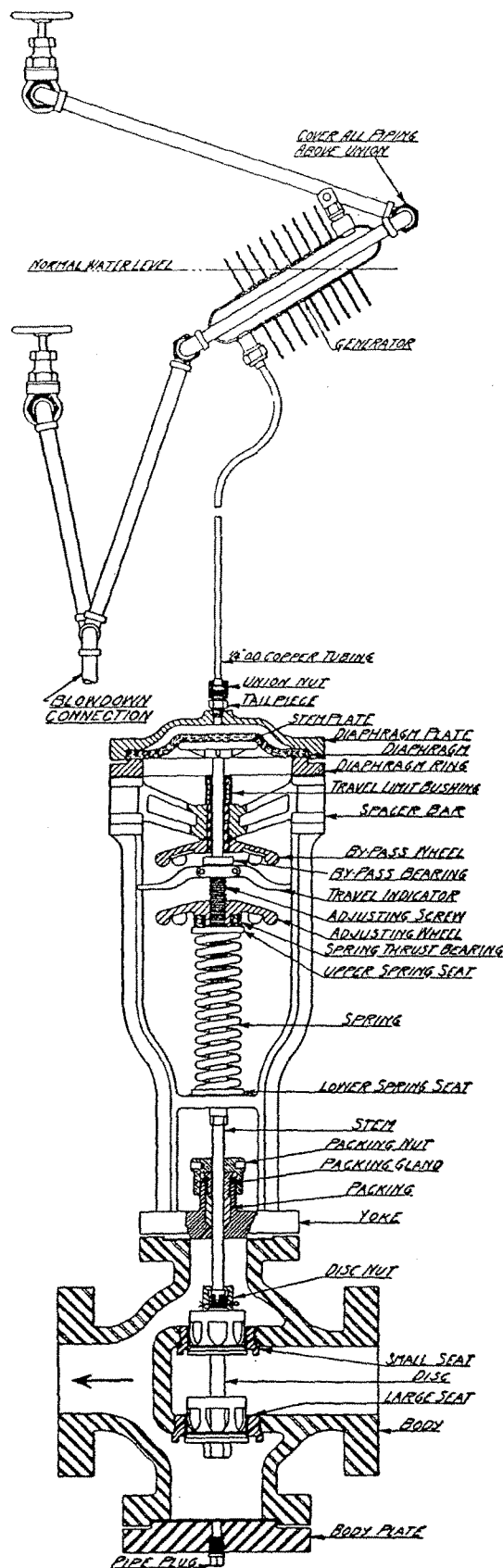


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The Swartwout Company 18511 Euclid Avenue, Cleveland 12, Ohio

INSTALLATION INSTRUCTIONS

- YARWAY -

Remote Water Level Indicator

Serial Numbers 5257-60

CONTENTS

- (1) How It Works
- (2) Assembly and Calibration Instructions
- (3) Installation Drawing
- (4) Type of Mounting
- (5) Parts List Drawing
- (6) Maintenance

Manufactured by
The Yarnall-Waring Company
Chestnut Hill
Philadelphia 18, Pa.

LMCF00171

YARWAY REMOTE WATER LEVEL INDICATOR - HOW IT WORKS

The YARWAY Remote Water Level Indicator registers the difference in head between a column of water which varies with the water level to be indicated and a constant head of water slightly above the highest variable head. In practice, the variable head connection is made at a point on the vessel below lowest water level to be indicated, and the constant head is obtained by connecting at a point above highest water level a small constant head chamber in which a constant overflow water level is established by condensation. This method permits remote indication since it merely requires two connecting tubes between the water level location and the indicator.

At the indicator, the variable and constant heads of water are connected to opposed sides of a diaphragm (#24 Parts List Drawing). The diaphragm in turn is connected by pin point frictionless linkage (11) to a beryllium copper deflection plate (4), which deflects in sensitive response to changes in differential pressure acting on diaphragm. Attached to the free end of deflection plate is a special permanent horseshoe type magnet (7) whose poles straddle a thin-walled tubular well (8), which extends horizontally into pressure-tight housing (2).

Inside the tubular well is a spiral strip armature (17) mounted on jeweled bearings and carrying on its outer end a counter-balanced pointer. Slight movement of magnet along outside well in response to variation in water level causes greatly amplified rotary movement of armature and attached pointer. Pointer swings over a brightly illuminated vertical scale clearly graduated and contrasted in color at high and low level pointer positions.

Calibration to give full scale indication for water level changes is obtained by adjustment of movable knife edge fulcrum (15), which controls the deflection characteristics of the deflection plate (4). Adjustment of pointer for close calibration of indication to actual water level is also provided. These adjustments are accurately set at the factory to meet individual requirements. Only minor adjustments, if any, are necessary on installation. Both adjustments are external and both can be made with full pressure on indicator.

Dirt pockets with blow-down valves should be provided at the side of the indicator and drain cocks are provided at indicator to permit occasional cleaning out of suspended matter which may accumulate. Shut-off valves are provided ahead of indicator. Additional valves may be inserted at water level connections, if desired by customer.

REMOTE WATER LEVEL INDICATOR INSTRUCTIONS (600# MAX. W.S.P.)
INSTALLATION

The detailed construction of indicator connections will vary with different installations. The installation drawing (EL) accompanying these instructions must be closely followed. This is particularly true of the location of the constant head chamber and related piping. The centerline of the constant head chamber must be located the required distance above the high water line as indicated on the installation drawing. The centerline of constant head chamber is marked on nameplate fastened to side thereof. Also refer to Parts List Drawing EL-903-690.

On panel mounted jobs, remove the casing cover and turn hinged flange on casing up. Insert the instrument (bottom fixed hinge first) into panel opening. (See print EL-906-721 attached). Fasten instrument to panel with four 10-24 machine screws and then replace casing cover.

Care should be taken that the tubes (13) are properly connected. The tube from the constant head chamber (2), painted red, connecting with the right-hand connection of the indicator (11), also painted red, when facing front of indicator. The tube from the variable head fitting (10) joining connection on the left-hand side of the indicator (11) when facing front of indicator.

The tubing should be run and the instrument mounted so that they will both be removed from hot equipment, particularly exposed hot piping.

Where connecting tubes run horizontally, they should slope 1" per foot continuously down toward the indicator (11) and both tubes should run close together to insure temperature uniformity. Bends should all be long radius.

Provide 6" clearance for removing side cover plate of indicator (11) on left-hand side when facing front of indicator.

Dirt, scale and chips must be blown out of the constant head chamber piping and the indicator connecting tubing before placing unit into operation.

PLACING UNIT IN OPERATION WITH BOILER DOWN

All valves should be opened and the indicator (11) and connecting tubes (13) should be filled with water by means of the priming connection (17) at the boiler connection. Air should be removed by periodically opening the drain valves (18) while filling with water from above. After all air has been removed and indicating system is filled with water, replace plug (17) and bring the boiler up to pressure. This is the method of putting indicator into service.

Air binding is the chief cause of faulty indication, and all air must be expelled from the system for satisfactory operation.

PLACING UNIT IN OPERATION WITH BOILER IN SERVICE

Close valves (15) above indicator and then slowly open shut-off valves (5) at boiler connections, checking tube connections for leakage. Two valves are provided at (15). Allow tubing to come down near room temperature, then open the left-hand valve first and then open the right-hand valve.

Blow down the drain valves (18) lightly, alternating between valves until all trapped air has been expelled. Do not permit hot boiler water to reach indicator (11) at any time. Allow sufficient time for condensate to refill the constant head chamber (2) before reading the instrument.

LMCF00173

INSTRUCTIONS CONTINUEDCALIBRATING INDICATOR FOR POINTER POSITION

The indicator is factory adjusted to meet your particular requirements as indicated on installation drawing attached. No further adjustment should be necessary. Sealing plugs (19), which must be removed to make any adjustments, are furnished with a lead seal, making removal of plugs impossible without breaking the seal. Preferably this seal should be broken only at the direction of the YARWAY sales engineer, but under no condition should this be done until all factors are checked to make certain that installation and priming are correct and in accordance with instructions. If pointer then does not agree with water level, proceed as follows:

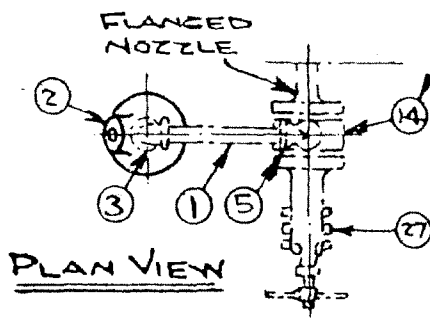
Shut-off valves (15) at indicator and open side cover plate of instrument case. Referring to Parts List Drawing, remove sealing plug (19) on side of indicator body. Turn the exposed adjusting screw (16) clock-wise to raise pointer hand (21) and counterclockwise to lower pointer position. Under no condition should this screw be turned clockwise more than 1/8 of a turn from the position it is in when received.

CARE OF INSTRUMENT WITH EQUIPMENT DOWN

Before draining the tank, heater or boiler drum, close main shut-off valves or root valves tightly to prevent draining of indicator connecting piping. When equipment is put back into service, open shut-off valves. Indicator will function properly without repriming.

NOTE :-

SPECIAL FITTING (P.14)
INSERTED BETWEEN FLANGED
NOZZLES OF BOILER DRUM AND
THE FLANGES OF THE WATER GAGE



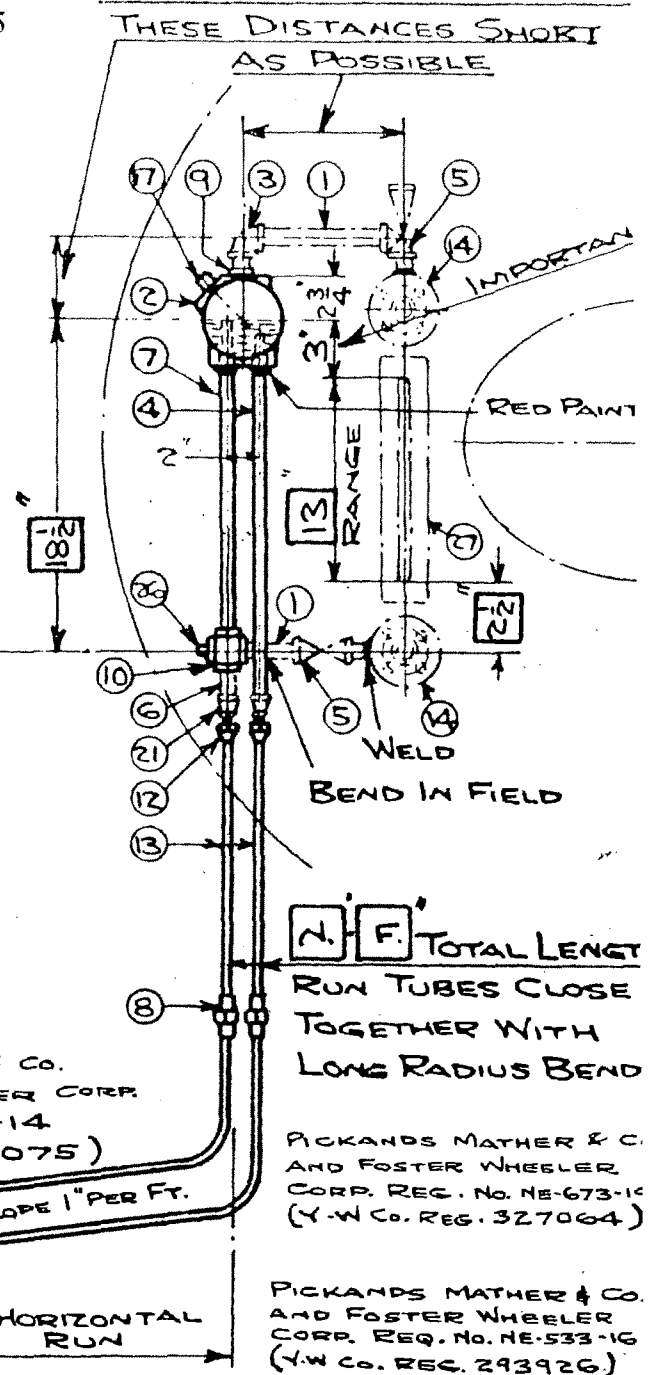
(N.F.) = Not FURNISHED BY Y-W Co.

NO.	NAME
1	PIPE $\frac{1}{2}$ " (N.F.)
2	CONSTANT HEAD CHAMBER
3	ELBOW $\frac{1}{2}$ " (N.F.)
4	NIPPLE $\frac{1}{2}$ " \times 36"
5	VALVES $\frac{1}{2}$ " GATE (N.F.)
6	NIPPLE $\frac{1}{2}$ " \times 6" (N.F.)
7	NIPPLE $\frac{1}{2}$ " \times 17 $\frac{5}{8}$ "
8	TUBE COUPLINGS (N.F.)
9	RED. BUSH. $\frac{1}{4}$ " \times $\frac{1}{2}$ " (N.F.)
10	CROSS $\frac{1}{2}$ "
11	INDICATOR UNIT
12	TUBE ADAPTERS (N.F.)
13	TUBES $\frac{3}{8}$ " OD. COPPER (N.F.)
14	SPECIAL FITTINGS (N.F.)
15	VALVES $\frac{1}{4}$ " VOLT
16	NIPPLES $\frac{1}{4}$ " \times $1\frac{1}{2}$ "
17	PIPE PLUG $\frac{1}{2}$ "
18	DRAIN VALVES
19	UNION $\frac{1}{4}$ "
20	CONNECTING NIPPLES
21	REDUCERS $\frac{1}{2}$ " \times $\frac{1}{4}$ " (N.F.)
22	RED. BUSH. $\frac{1}{2}$ " TO $\frac{1}{4}$ " (N.F.)
23	
24	(N.F.)
25	
26	
27	WATER GAGE (N.F.)
28	
29	TEE $\frac{1}{4}$ " (N.F.)
30	NIPPLE $\frac{1}{4}$ " (N.F.)
31	TEE $\frac{1}{2}$ " \times $\frac{1}{2}$ " \times $\frac{1}{4}$ " (N.F.)
32	NIPPLE $\frac{1}{2}$ " \times 6" (N.F.)
33	REDUCER $\frac{1}{2}$ " \times $\frac{1}{4}$ " (N.F.)
34	VALVES $\frac{1}{4}$ " (N.F.)

C	PREVIOUSLY USED ON REG. 267064
B	PREVIOUSLY USED ON REG. 263875
A	PREVIOUSLY USED ON REG. 263875

ALTERATIONS

YARWAY REMOTE WATER LEVEL INDICATOR
MARINE TYPE
600 * MAX. W.S.P. FIG. #4314
YARNALL - WARING CO.
FOR VICTORY SHIPS PHILADELPHIA, PA.



THIS DRAWING APPROVED BY
CUSTOMER G-10-47
INDICATOR IS CALIBRATED FOR
A TOTAL RANGE OF 13 INCHES

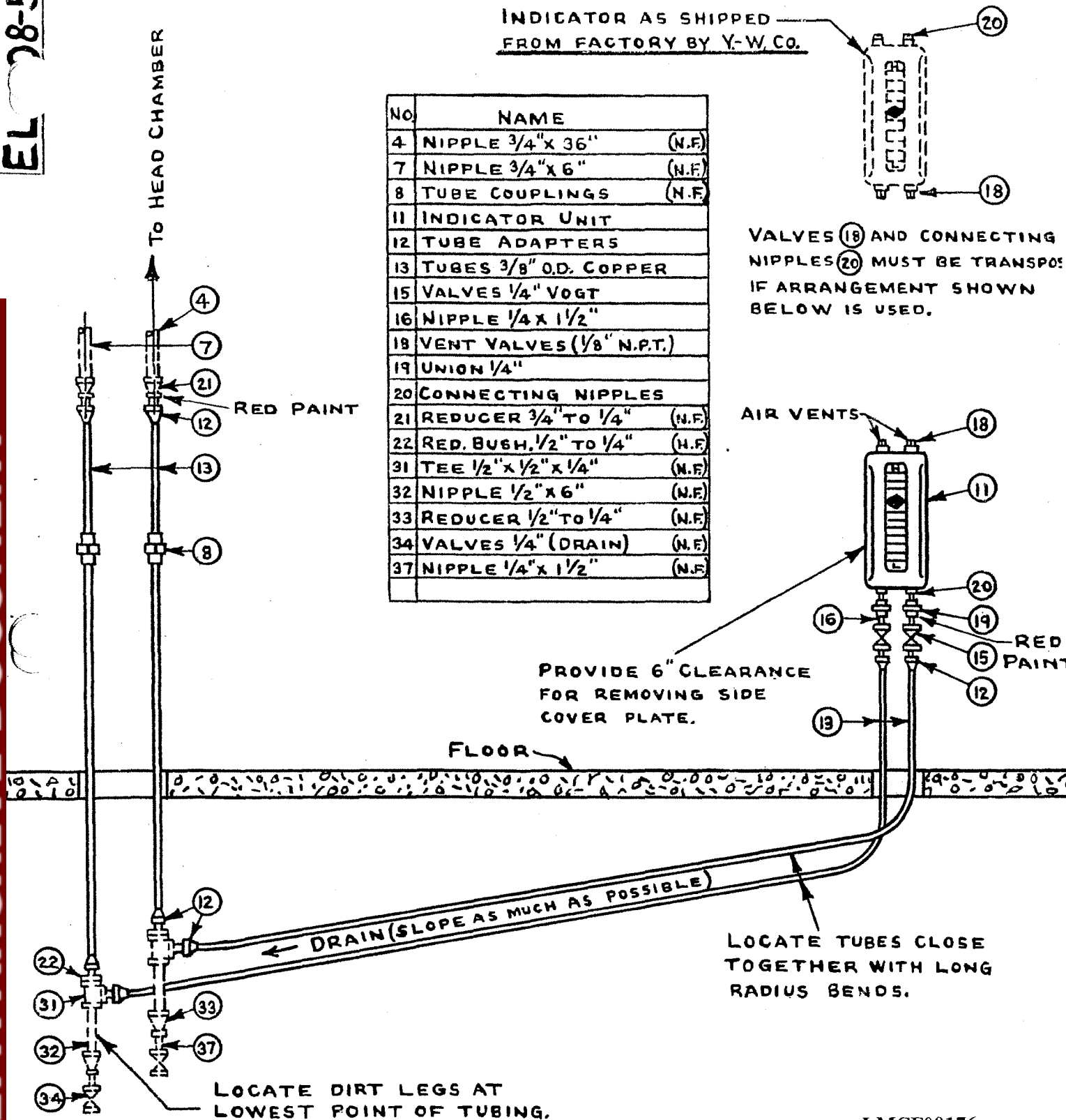
PROVIDE 6" CLEARANCE FOR REMOVING
SIDE COVER PLATE
INDICATOR FURNISHED FOR PANEL MOUNTIN
NO ADDITIONAL VALVES REQUIRED

DRAWN <i>WJ</i>	SCALE <i>—</i>
CHECKED	DATE <i>6-12-47</i>
REG. # <i>33,0075</i>	
EL-906-432	

INDICATOR AS SHIPPED
FROM FACTORY BY Y-W, CO.

NO	NAME
4	NIPPLE 3/4" X 36" (N.F.)
7	NIPPLE 3/4" X 6" (N.F.)
8	TUBE COUPLINGS (N.F.)
11	INDICATOR UNIT
12	TUBE ADAPTERS
13	TUBES 3/8" O.D. COPPER
15	VALVES 1/4" VOGT
16	NIPPLE 1/4" X 1/2"
18	VENT VALVES (1/8" N.P.T.)
19	UNION 1/4"
20	CONNECTING NIPPLES
21	REDUCER 3/4" TO 1/4" (N.F.)
22	RED. BUSH. 1/2" TO 1/4" (N.F.)
31	TEE 1/2" X 1/2" X 1/4" (N.F.)
32	NIPPLE 1/2" X 6" (N.F.)
33	REDUCER 1/2" TO 1/4" (N.F.)
34	VALVES 1/4" (DRAIN) (N.F.)
37	NIPPLE 1/4" X 1/2" (N.F.)

VALVES (18) AND CONNECTING
NIPPLES (20) MUST BE TRANSPOSED
IF ARRANGEMENT SHOWN
BELOW IS USED.



LMCF00176

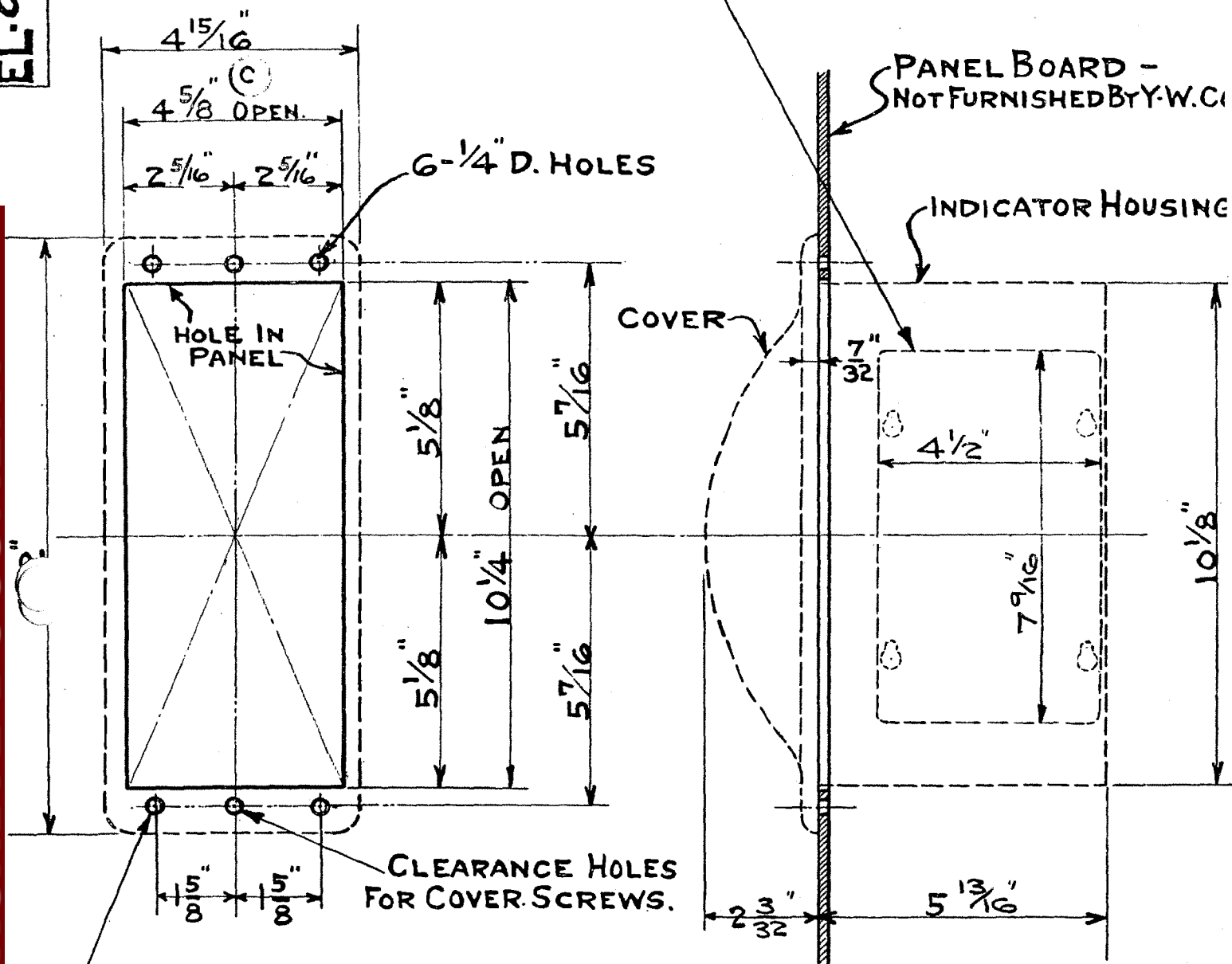
YARWAY REMOTE WATER LEVEL INDICATOR
ALTERNATE CONNECTION TO INSTRUMENT
FROM BELOW FLOOR
YARNALL - WARING CO.
PHILADELPHIA, PA.

DRAWN FCC
CHECKED wja
SCALE
DATE 4-7-41

EL-908-57

ALTERATIONS
FOR PRESSURES 0 TO 600#

COVER PLATE ON FAR SIDE - PROVIDE 6" CLEARANCE FOR REMOVAL OF THIS PLATE.

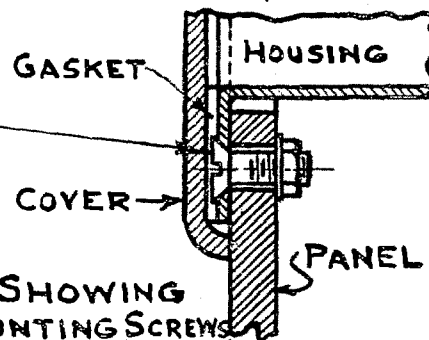


4- #10-24 FLATHEAD MACHINE SCREWS ARE REQUIRED TO MOUNT INDICATOR WITH LENGTH TO SUIT PANEL THICKNESS.

LMCF00177

FOR INDICATOR MOUNTING INSTRUCTIONS SEE EL-906-721

DETAIL SHOWING LOCATION OF MOUNTING SCREWS



WAS 4 1/4	9-12-47	JTC
REVISED	2-25-47	WTC
REVISED	1-7-44	WTC
ALTERATIONS		

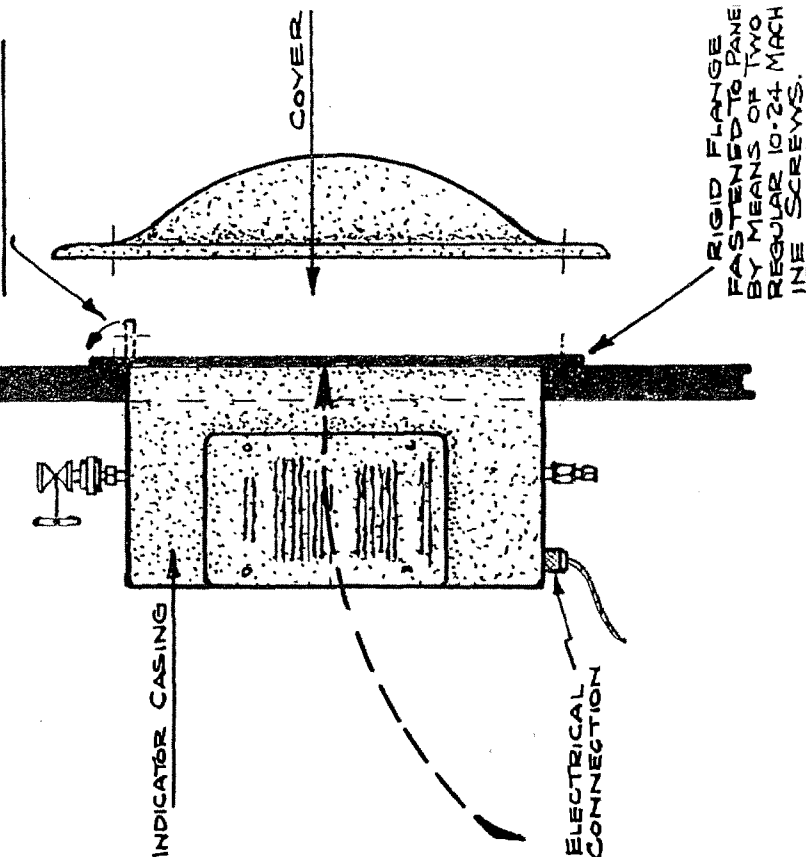
YARWAY REMOTE LIQUID LEVEL INDICATOR
PANEL DRILLING
FOR FLUSH PANEL MOUNTING OF INDICATOR
YARNALL - WARING CO.

DRAWN	WTC	SCALE	4"=12"
CHECKED		DATE	7-22-47

EL-902-108

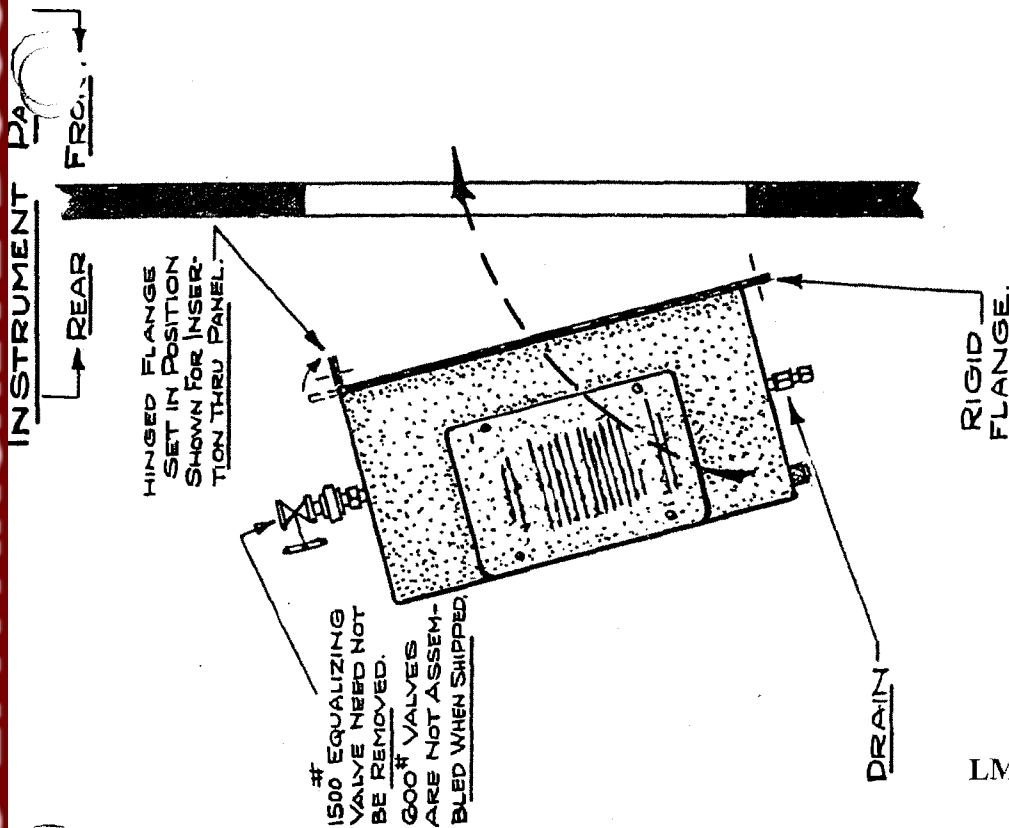
EL-906-721

HINGED FLANGE FOLDED
BACK AND FASTENED
TO PANEL WITH TWO
REGULAR 10-24 MACH
LINE SCREWS.



2ND - POSITION

CASING MOUNTED ON PANEL
PREPARATORY TO RECEIVING COVER.



1ST - POSITION

CASING WITH COVER REMOVED, IN
POSITION AT REAR OF PANEL SHOWN.
HINGED FLANGE TURNED FORWARD.
PREPARATORY TO INSERTION THRU
PANEL OPENING.

LMCF00178

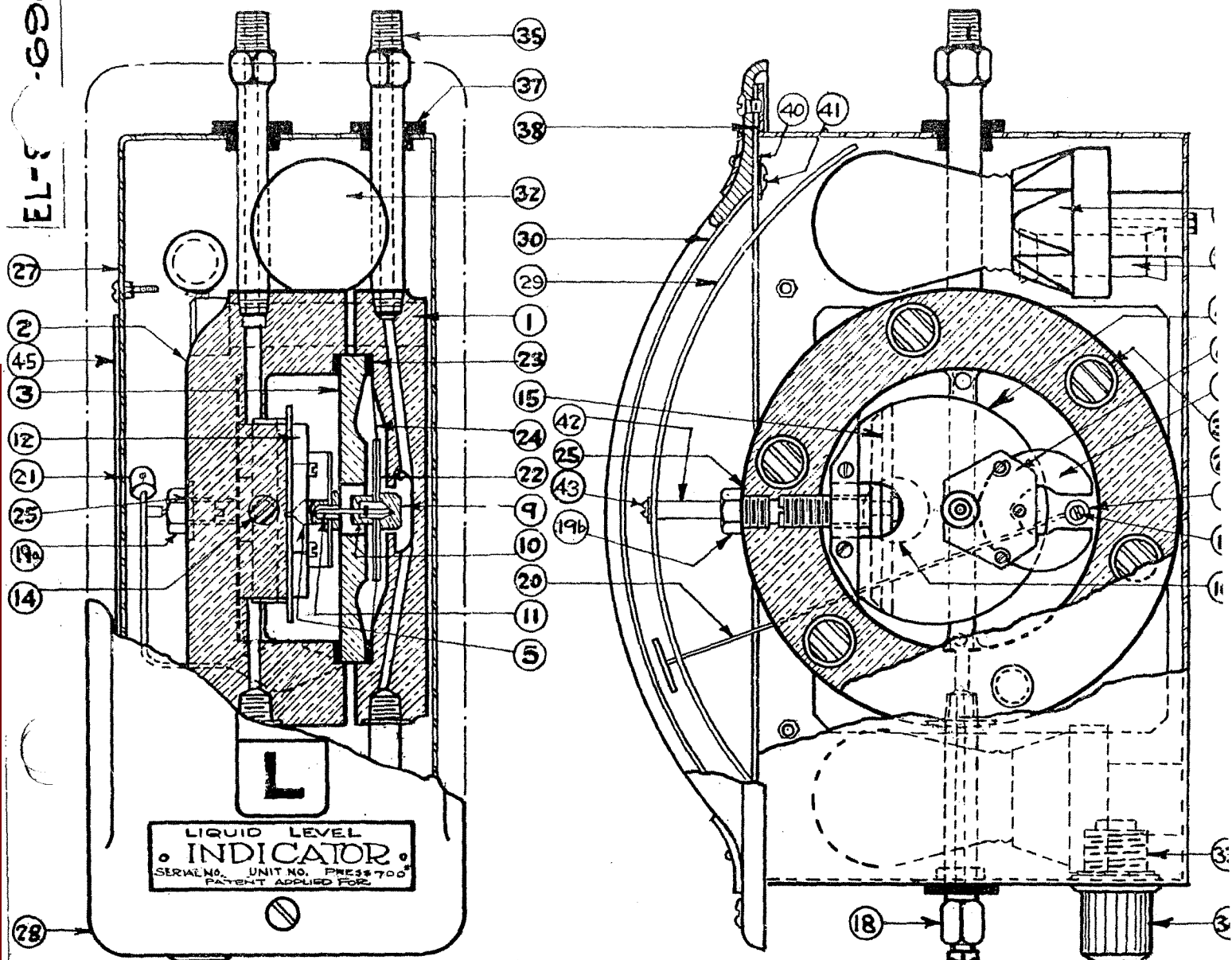
YARNALL REMOTE LIQUID LEVEL INDICATOR
INSTRUCTIONS FOR MOUNTING UNIT
IN PANEL - UTILIZING HINGED FLANGE
YARNALL - WARING CO.
PHILADELPHIA, PA.

DRAWN E.O.R. SCALE
CHECKED W.A. DATE 9-22-41

EL-906-721

ALTERATIONS

EL-903-690



Nº	NAME	MATERIAL
1.	REAR HOUSING	BRONZE
2.	FRONT HOUSING	BRONZE
3.	BACKING PLATE	BRONZE
4.	DEFLECTION PLATE	BERYLLIUM COPPER
5.	PIN BEARING	BRONZE
6.	MAGNET PLATE	BRASS
7.	MAGNET	ALNICO
8.	POINTER WELL	BRONZE
9.	DIAPHRAGM SCREW	BRONZE
10.	DIAPHRAGM NUT	BRONZE
11.	PIN	BRONZE
12.	SPRING CLAMP	BRONZE
14.	ADJUSTMENT SCREW	BRONZE
15.	FILCRUM BAR	BRONZE

Nº	NAME	MATERIAL
16.	ADJUSTMENT SCREW	BRONZE
17.	SPIRAL ARMATURE	NORWAY IRON
18.	DRAIN VALVE ASSEMBLY	BRONZE
19a.	SEAL PLUG - PTR. ADJT.	BRONZE
19b.	SEAL PLUG - RANGE ADJT.	BRONZE
20.	POINTER	ALUMINUM
21.	POINTER BALANCE	BRONZE
22.	DIAPHRAGM PLATES	BRONZE
23.	GASKETS	ASBESTOS
24.	DIAPHRAGM	WHITE NYLON CLOTH
25.	GASKETS FOR #19	COPPER
26.	GASKET FOR #8	COPPER
27.	CASING BODY	SHEET IRON
28.	CASING COVER	ALUMINUM ALLOY
29.	DIAL	PLEXIGLASS
30.	CURVED WINDOW	PLEXIGLASS

Nº	NAME	MATERIAL
31.	SOCKETS	LAMINATED PLAS
32.	LAMPS 15 W	FROSTED
33.	RECEPTACLE	
34.	CORD CONNECTOR	
35.	CONNECTING NIPPLE	BRONZE
36.	RESISTANCE COIL	
37.	DUST PLUGS	RUBBER
38.	GASKET	CORIC
39.	CAP SCREWS	STEEL
40.	WASHER CLAMP	BRASS
41.	DRIVE SCREW	STEEL
42.	SPACERS	TOBIN BRONZE
43.	WASHER HD. SCREW	BRASS
45.	SIDE COVER PLATE	ALUMINUM

YARWAY REMOTE LIQUID LEVEL INDICATOR
PARTS LIST
700# MAX. W.S.P.
YARNALL - WARING CO.
PHILADELPHIA, PA.

DRAWN E.O.R. SCALE
CHECKED G.C.T. DATE 9-26

EL-903-690

ALTERATIONS

LMCF00179

MAINTENANCE

(1) Replacing Light Bulbs

Two (115 volt - 15 watt standard frosted Mazda lamps) per indicator. Remove front cover screws and cover, loosen dial screws, gently push pointer arm to uppermost position and remove dial screws and dial. Replace lamp, screw down securely and, with pointer raised to upper non-interfering position, replace dial. Make certain pointer can move freely across the entire face of the dial. Replace cover. Note - A resistance coil is used to increase lamp life.

(2) Gaskets (Part #23 - Parts List Drawing)

These gaskets between housings and backing plate are of a high uniform density type 1/16" thick, made of wire inserted Klingerit. For this purpose only, gaskets furnished by the Yarnall-Waring Company should be used in the instrument, as gaskets of a different density will result in incorrect readings.

(3) Blow-down

Dirt legs on side of indicator (or at lowest point in tubing) should be blown down when necessary, depending on type of service, to remove suspended matter from the lines.

Drain or vent cocks (18) at the instrument are principally used for priming the system. Blow-down of instrument lines should only be made through the dirt legs.

LMCF00181

LMCF00181A