MARS SPACE CONSTRUCTION, LLC

Section 4

PUMPS

4.1 GENERAL

Pumps add energy to a fluid, This energy can move the fluid through pipe and equipment, elevate the fluid, or increase its pressure and velocity.

Pumps are rated as follows:

- Capacity - the quantity of fluid discharged per unit time (gallon per minute)
- Increase in Pressure - frequently reported as "head" (feet of the fluid)
- Power - the energy consumed by the machine (horsepower)
- Efficiency - ratio of energy supplied to the fluid, divided by energy supplied to the pump (percent)

4.2 TYPES

We can classify pumps as centrifugal or positive displacement.

/

4. 2. 1 Centrifugal Pumps

Perhaps 90 percent or rnore of the pumps in process industr i. s are centrifugal. This is be("ause their clesign allows such great flexLbility in flow rates, pressure rang s, etc.

Centrifugal pumps convert rotary energy into liquid pt·essure by a spinning impeller inside a casina. These pumps are usually driven *by* electric motors or steam turbines. Most centrifugal pu·mps have only one irnpellor or are single staged. However, if high pressure difference is required, multistage designs are used. Wecan mount centrifuoal pumps either horizontally or vertically to suit the process.

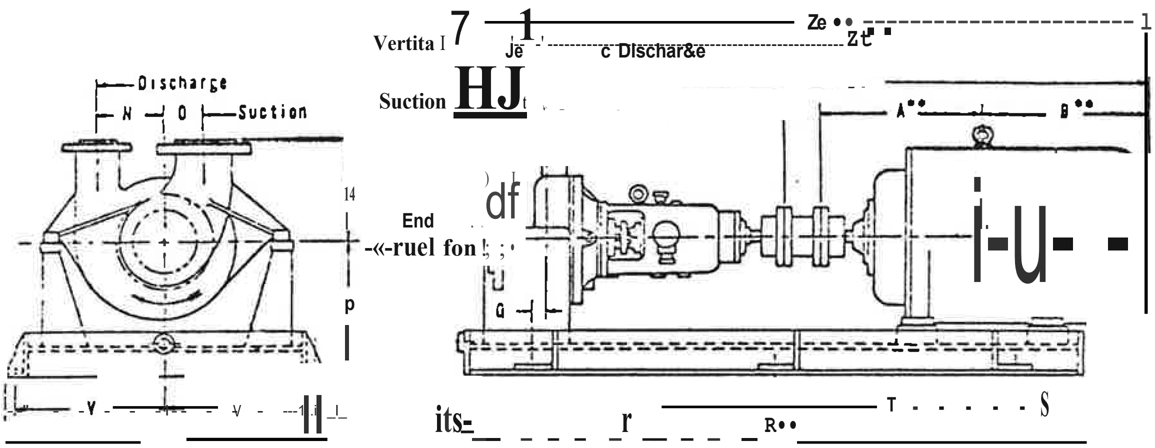
Figures 4-1 throngh -1-- 10 are outline and cross-section drawings, showing design f aturE"s of centrifugal pumps.

4.2.2 Positive Displacement Pumps

Positive displacement pumps are used to inject additives in very small amo nts into main product streams, to transfer viscous liquids, and to pump quantities which are too small for centrifugal pi1mps. Figures 4-11 and 4-12 show recipro-cating pumps, andFigure 4 - 13 shows nine classes of rotary pumps.

Positive displacement pumps trap a quantity of fluid in a chamber which is alternately filled from inlet and emptied through dis-

OUTLINE DIMErSIONS TYPE-CAD



;.:, Ze, Zt, A, B &: R vary with driver - - Dimensions shown are for highest horsepower motor and stock base size.

;:, Ali pu=ps listed with one size case except 4: x 6 x 1 3 which is furnished with two size cases (L) a._-r1.C:. rHl.

All dimensions are in inches. Donot use for construction unless certified.

Applies to Standard 300 = ASA Raised Face F langs Only.

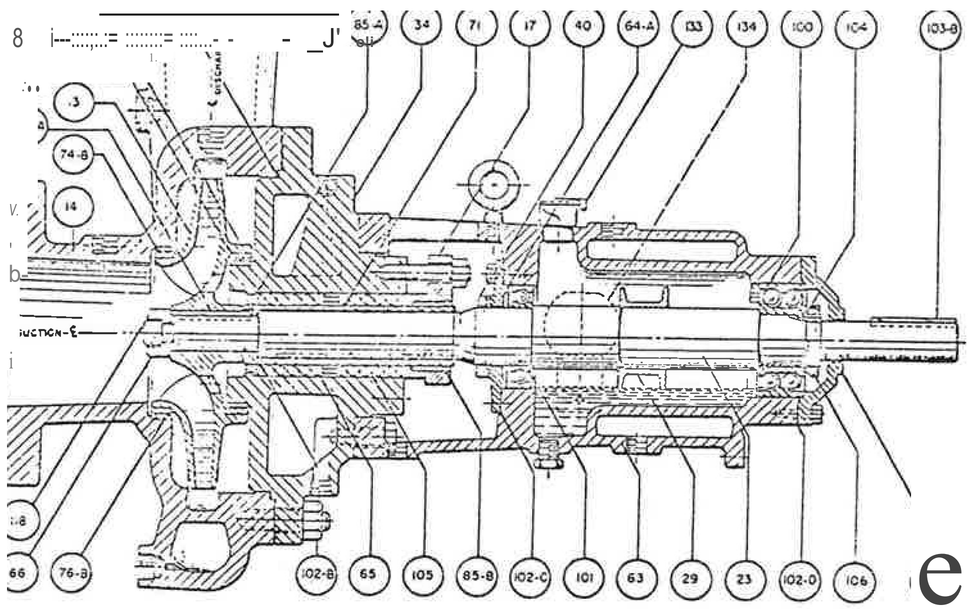
Size Dii., S-uc. b np	Brg Prk1	ArD	Je	Jt	K	L	'''	N	0	p	Q	R	S	S-IQ	T	ZV	W	Z	Zt
I xi I /2 x 6 1/4		2.4' 5/6	5	I 1 :2	23 1 /4	4 3/8	7	3 i /4	2 I /2	1 3 1 /4	I /4	56 1 /2	6 1/4	6 I /2		25	27 1 /2	:ii 1/4	53 3/4
I 1/2x2x6I/4		30	5	I]/?_	B 1/4	-4 3/8	7	4		1 J 1 /4	1/4	eo 1 f	6 I/4	6 I /2		30	31 1 / 2	02 3/8	59 1 /8
2x3x61/4	7	311/2	6	2	23I/4	43/8	8	4I/2		13J /4	i I /4	60 1 /4	6 I /4	7 1 /2	Bolts Only	30	31 1/2	65 1/4	51 I/8
3x4x61/-¼		321 /2	7	2 1 /2	23 1 /£	-! 3/8	8	5		15 1 /4	2 1 /z	60	6 1/4-	8 3/4		32	33 1/Z	67 3/8	52 7/8
I1/2x2x81/2		301/8		2	273/8	; 3/B	9	5	2 1/2	I 5 I /4	3/8	69	6 I /4	6 3/8	4 Bolts Only	32	33 1 / 2	&9 1 /4	65 I /8
Zx3x81/2		37I /2	6	2 1 /2	27 3/ 8	4 3/8	9	51/-1	3 I /2	I7 I /4		72 1 /4	6 I /4	7 I /4	30 1 /8	35	3o 1 i 2	75 1 /	71 3/4
3 x 4 x 6 1/2		39 1 /2	7	3	27 3/ 8	-½ 3/8	JO	5 1 /Z	..J.1 /4	! 7 I-	2 1 /2	72 1 /4-	6 1 /4	S 3/4	30 1/8	35	3t 1/2	76 1 /4	74 1/4
4x6x6J/2		43 3/8	8	4	27 I i8	f4 3/8	1 3	7	6 1/4	18 3/4	5 1/8	81 1 /4	c; 1/4	Il 3/8	34 3/8	35 1 t	36 1 12	83 7/8	79 1 /8
I I/Zx2x101/;		34	,	2	271/8	?3/8	JO	ti	2 I /2	15 1 /8	3/ 8	60	6 I /4	0 7 /8	4 Bolts Only	32 1	33 I /2	71 I /2	57 I /2
2x3x101/Z		rt-9 3/4	7	2 1 /2	27 1 /8	• 3/8	IO	6	21/2	1 8 1 /4	I I /8	81 1/4	6 1 /-!	7 3/8	34 3/8	361/2331/2		831/4	833/4
3x4x101/Z		93/4	7	3	271/8	43/8		16 1/2	4	18 1 /4	Z 1 /2	90 J 1,4	6 I /4	8 3/4	39 1 / 8	35 J /;	33 1/2	85 1 /4	8s I /4
4x6x LO 1/2		52 3/4	8	"	30 1 5/ Ii. !I		1 2 7 1 /4		6 1 /2	22 I /2	5 3/8	i (I.,!, 1 /4	6 I /2	12 1 /4	45 1 /8	43 1/21-tS.	1 ;..;.	I06 I /Ji	104 I /Ii
6x8x101/2		139 I /2	9	;	31 I /I 6	5	128]/2		B	25	7 3/8	1 07 1 /	6 I /2	13 7/8	47 3/8	4g [I-!151	1 /4	1123/16	103 3/1 I
I 1 /2 x 3 x }1]/;		9 3/	7	2 1 /2	30 3/1 6		14 6 1/2		4	I 8 I /-1	2 7/8	90 1 /.;	b 1 /Z	9 3/8	39 I /8	361/2133	112	n 9/10	;1 13/1!
2 x 3 x }3	II	!2 3/	7	3	3013/1(	5	I2 7 1/2		3	22 I /Z	2 1/Z	1 00 1/Z	6 1 /2	9	43 3/4	42 1/21 ..;.	1 I Z	1 07 7/16	103 7 /1 b
3 x -4 x 13		O I /4	8	3	30 1J /1 Ci s		1 2 7 1 /2		31/Z	25	21/Z	IO 1 /	6 I /2	9	45 7 /8	481/2151	I r4	10 13 /1(,	1 05 11116
'1Ax6x13		9 I /4	6	4	3013/1		14 9			Z.5	5 ! /8	1 07 I I..;.	6 I /2	II 3/8	45 7 /8	-B 1/4 i51	1/-t	110 II/Iti	I 05 11/1
t)X] X 11 1/2		9 I /	1(1	5	34		14 9		$	25	7 3/8	I 07 114	6 I /2	13 7 /8	47 3/8	45 1/ 1 51	1,..;.	1171/8	1J 2 1 /8
-'H"t x 6 x 13		bo I /4	9		34		14			25	5 1 /8	1 07 I /4	6 I /2	11 3/8	47 3/8	40 1/..;, Is	I ,4	1 1 61 /8	III 1/8
3 x 4 x J4	13	59 1 /4	9	3	33 3/4	6	14 8		5 I /2	ZS	3 I /8	1 07 I /4	6 1 /2	9 3/8	47 3/8	.t-8 11..;. ·51	1/-i	!1b 7/8	I09 7 /8
4 x 5 x]4		,9 1/4		4	34		14 1 0		5	25	5 1 /8	I(!7 I /4	6 1 /2	II 3/B	47 3/8	-!-8 1 1-I-I	1/.J,	116 7/B	III I /8
6x6x14		!93/1	II	S	34 1_q	6	14 11		7	25	7 3/8	I 07 !/4	6 I /2	J3 3/8	47 3/8	-1-s 11..;. Is1	1·	11 B 3/B	112 3/B
4 x G x 1 i		S9 1 /4	q		34		I (, 10 ! /2			25	5 1 /8	1 07 i /4	b I /2	11 3.'8	47 3/B	4tl 11..;. Is1	1 /4	I1 8 J/8	11 I I /8

Figure 4-1. Single Stage Horizontal Process Pun1.p - End Suction.

C2 • .,1.. Z.aZ
CAJ C,JSS SECT I CN
atu:tl U. IU2

BINGHAM TYPE CAD

PROCESS **PUWP** - ENO SUCTION



D AW/NG NO. WP·131

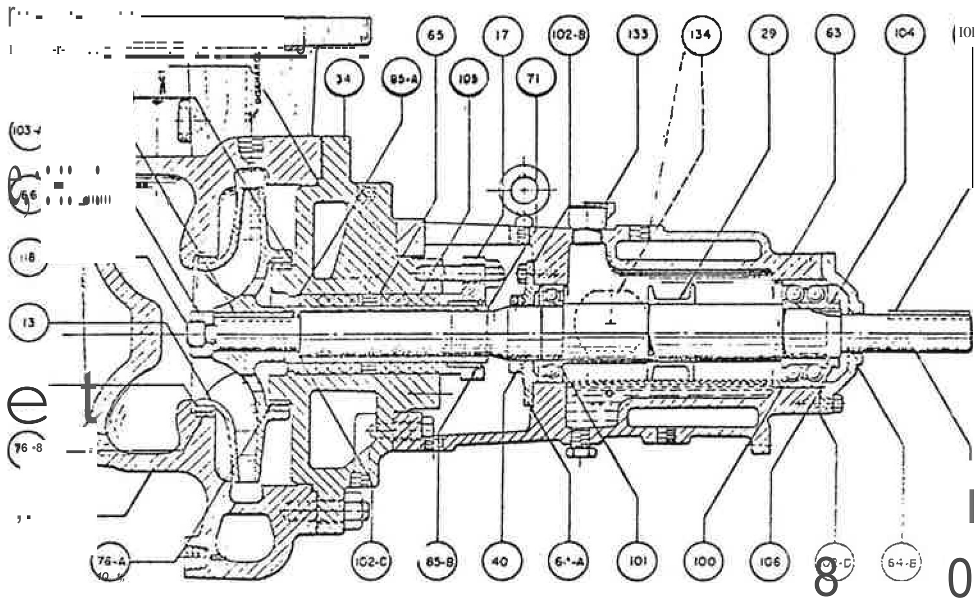
P;. RT H il.	OESC IPTI0H	rUT HC•	HS-RIPTI0H	PHT H0•	OEH,l?TION
13	l r.iz Ii er	66	Lockcol lar-tmpel lar	102·8	Gasket-Shaft Steiva
14	YeIi.te Casi I.,	71	Shaft Sleeve	102-c	Gasket-Cover,Pu..p tr.d
17	GI ar.d	74-A	Impeller Rini-Hub	102-0	Gaskat-Cover,Oriva End
23	Shaft	74·8	lm el ler Rini:-Eya	103-A	Key•l pel ler
23	Gi I Spcol	76-A	Casin, Ring-Hub	103·B	Key-Shaft Extansion
H	Stuffin;; 6ox	75•8	Cas i n6 Rini;-Eya	104	Lockwashe r-Saar i n6
40	Odlector u:sc	65-A	Packin, ain,	I05	Packinz
SJ	aaaring iiracket	S5-a	Sp Ii t Ring-GI and	106	Locknut-Bear in•
ii4·A	Cover-Sa rini nadial	100	Thrust Baa ring	118	Lockscrew-tr:;pel ler
6-4-B	Ccver-3earing Thrust	101	ilad i a I Bearinz	133	Oi I Inspection Covar
65	lantern Rln,	102·A	Gasket-Yo lute	134	Constant Leval Oil ar.

Sup1r,1d11 ZS·2551

F igur e 4-2. Single Stage Horizontal Process Pump - End Suction.

BINGHAM TYPE CAD

S■r l ll I.OJ • (;j
CAD mss mr10K
uc" 20, 1111



DRAWISG SG ?-130

R T H 0.	DES CR I PT fOK	PBT HO.	DESCRIPTION	PART NO.	ESC I IJh
1:;	Imps l l er	66	Lcckcol lar-lmpel ler	102-B	Gaske t- C' ov er , aea r i ili
14	Volute Casini	71	Shaft Slasve	102-C	Gasket-Shaft Sleeve
17	61 and	H-A	Impeller Ring-Hub	102-D	Gaska t-Cova r, Bear in.;
23	Shaft	H·B	lffipeller Ring-Ey1	103-A	Key-Jm el !er
29	Di I Spool	76-A	Casi·ng Ring-Hub	103-8	Key-Shaft Extension
34	Stuffin, Box	76·B	Casini Ring-Eye	104	Lockwashsr-aearin
40	Deflector Disc	85-A	Packing Rini	105	Packing
63	Searin,; aracket	85-8	Split Rin.;-Cland	106	Locknut-Bear ir.,;
64-A	Cover-Bearing Radial	100	ihrust Bearing	11B	Lockscrsw-l peller
64-B	Cover-Searin2 Thrust	101	Radial Bearing	133	0 i I Inspection Covar
65	Lantern Rini	102-A	Gasket-Volute	1H	Constant Level Di lu

Supersedes ZS-2185

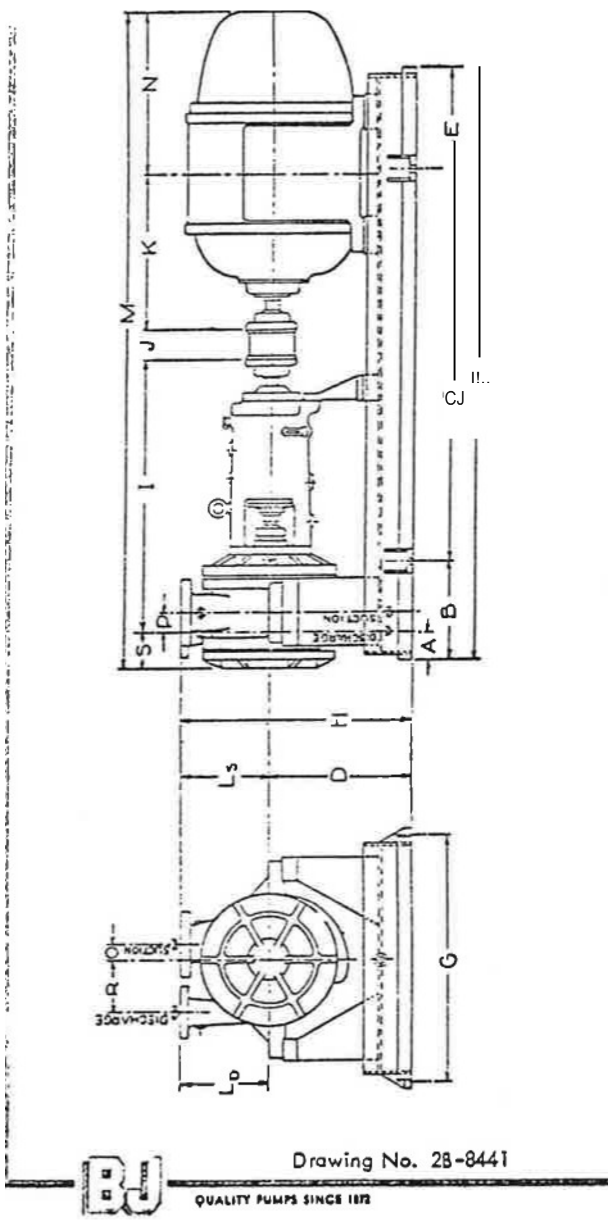
Bingham FACTORIES: PORTLAND, ORE. VANCOUVER, B.C., CANADA

Figure 4-3. Single Stage Horizontal Process Pump - Top Suction.

HORIZONTAL MULTI-STAGE - SM PROCESS PUMPS

2 STAGE SM PROCESS PUMPS

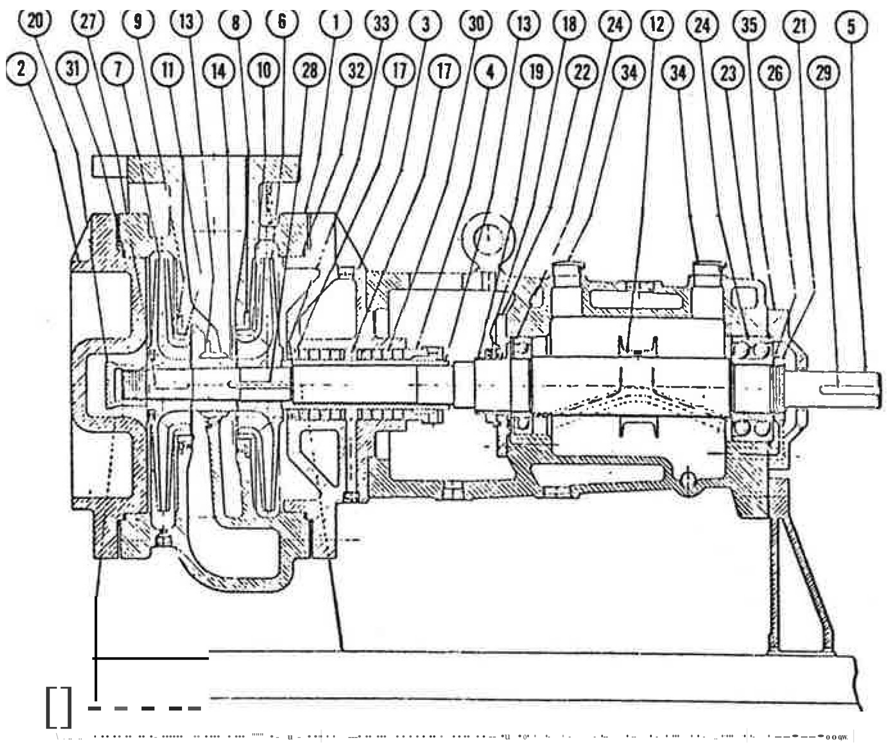
OUTLINE DIMENSIONS



SIZE	Disch.	Suct.	I	J	L_D & L_S	O	P	R	S
1½x2½x10	1½	2½	31-7/8	4-3/8	9	1-1/4	2-1/4	5-3/4	3-11/16
2x3x11½	2	3	[illegible]	[illegible]	[illegible]	[illegible]	2¼	6½	4-1/4
2x4x13	2	4	[illegible]	[illegible]	[illegible]	[illegible]	2-7/8	7½	4-1/8
3x4x11½	3	4	[illegible]	[illegible]	[illegible]	[illegible]	[redacted]	7½	6-1/8
4x6x13½	4	6	[illegible]	[illegible]	[illegible]	[illegible]	[redacted]	9½	4-1/4

All Dimensions Are In Inches & Are [illegible]
Used For Construction Purposes.
Dimensions Not Given Depend On Driver Us

Figure 4-4. TwoStage Horizontal Process Pump.

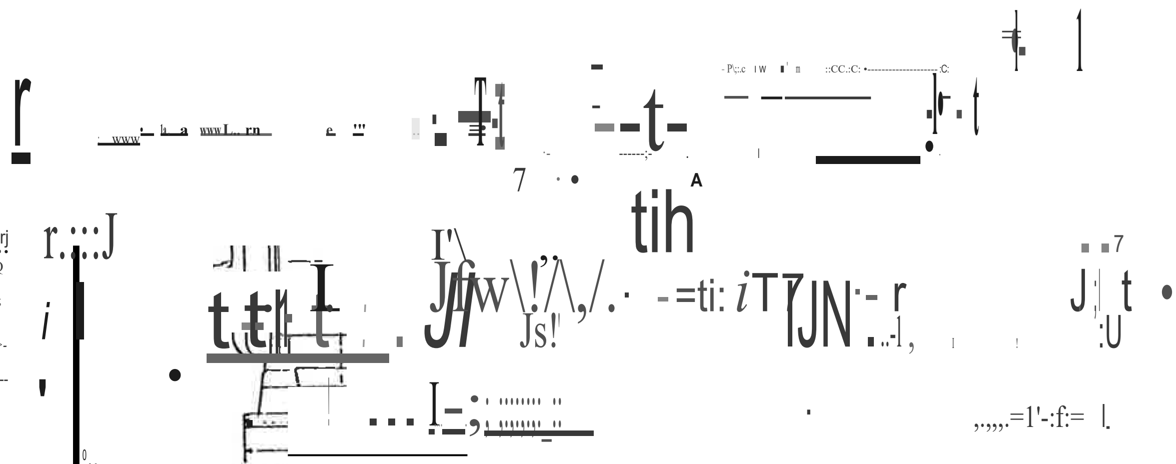


PART NO,	NAME OF PART
	PUMP CASE
2	PUMP COVER - OUTBOARD
3	PUMP COVER
4	GLAND
5	SHAFT
6	!MP}:LLER - I st STAGE
7	IMPELLER - 2nd STAGE
8	IMPELLER WEAR RING - I st STAGE
9	IMPELLER WEAR RING - 2nd STAGE
10	CASE WEAR RING - 1st. STAGE
1I	CASE WEAR RING - 2nd STAGE
12	OIL FLINGER
13	SHAFT SLEEVE
14	IMPELLER SPACER SLEEVE
15	CENTER BUSHING
1(,	THROAT BUSHING
17	GAGE RING
18	°DEFLECTOR
19	DEFLECTOR SLEEVE
20	IMPELLER NUT
21	THRUST BEARING NUT
22	BEARING COVER - INSIDE
23	BRACKET
24	BALL BEARING - THRUST
25	BALL REARING - RADIAL
26	BEARING LOCK
27	IMPELLER KEY - 2nd STAGE
28	IMPELLER KEY - 1st STAGE
29	COUPLING KEY
30	PACKING
31	GASKET - CASE &, COVER
32	GASKET - PUMP CASE g, COVER
33	GASKET - SHAFT SLEEVE
34	OIL FILLER CUP
35	BEARING COVER - COUPLING END

WHEN ORDERING PARTS REFER TO
DWG, NO, IF 17121 AND TO PART NO.

<•WHEN GLAND IS BUSHED
ORDER PART NO. 113
GLAND BUSHING

Figure 4-5. Two Stage Horizontal Process Pump.

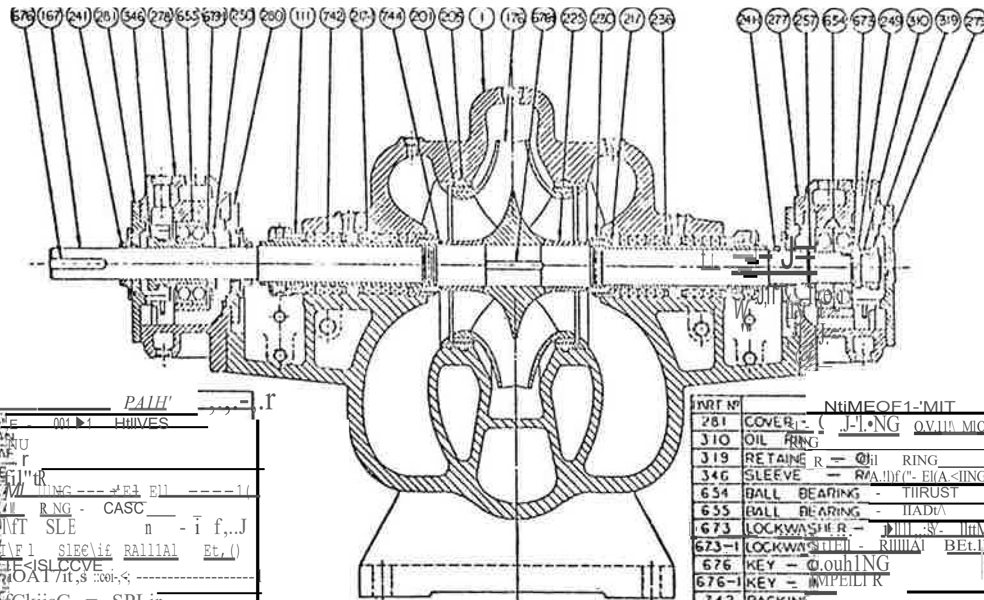


PUMP 1t1(	DISCH.	\Ut r.	a	I I	C	•	I	r	•	•		J	L.	lo	•·	n1tst oiutm.1O11:. p1rrn0 0:1 on :1 1 u:co
h 6113		6	15½	19	Y,	1¾	3	9	8	11½	MI	20	12	14	¾1)(,	
h 1111 61 8112 6I I I 14		8 8	7¼ 21¼ 21¼	21¼ 2G¾ 2G¾	¼ ¼	2½ 2¼	4¼ 4¼	10 10¼	8½ Bl,	5½ 17	14 14	26¼ 26¼	6 18 18	14 14 14	¾x)(, ½•¼ ½•¼	
1110114 I1 101 16		10 ID	22½ 20	27¼ 27	¼ I(,	121(, 21(,	14¼ 4¼	IOV, II½	9¼ 12	8 ½ 12	2G	30 30	19 20	ISV, ISV,	¼'Ii, ¼1),',	
10,10112 101 10114	10 10	10 ID	23 22½	28 27½	1(, >„	2!(, 2!(,	S 5	IOV, 12	9¼ 12	18½ 12½	18 28	30 31	20v 22	2ov, 21	,¼ If, ¾ I,,	
101141181 10114120 10114123	ID 10 10	14 14 14	24 2G)', 24	129 3 3 29	I(I(, >„	2! 2¾ 2!{,	5 5¼ 5	15 14¾ 15	IS 12¾ 15	15 2J 15	31 2 2 31	38 3 8 40	24 24	12 2 4 21	¼II(, ¼•I(, ¼11(,	
12,12,1c 14, 14,2o	12 14	12 14	24 2GY,	In 31½	Y.a 1(,	2'1 2•	5 51	IZ 1	12 ti)-	17 Ii,	38 L	42	25 30	25 30	¾•¾ ¾,:}	
161 IG1 201 201 201 21	16 20	16 20	JG 361/,	40 37	¼ ¼	1¾ 4V.	1 8	18 ID¼	18 ?D1,	12)}, 70¼	134 45	18 50	30 34	JO 34	Ji', 1 X 1 1{,	

U1mcn ian ll1own .Jrc In inc.tics and ;uc JN"° imJtc only Nol lo be used fo, conslwction purpo ses.

All d1mcn1ion'..; ;uc for pun1ps of co1.1111c, cln,c•. mt' tol.1l1on wt,rn vrcwcd hoin couplin2 end. Pumps may be furnished w1lh cludw1s JOIJl1cm 1f dL· 11r'1

Suction aniJ thscl..ucc tl,1nccs arc slJutl.1rd AS A, Ilic 11,int:c sc11cs bt"1nr, dck rn:incd by prcssu11:·s involved,



PART Nº	NAME OF PART
1	CAS[illegible]
111	GLAN[illegible]
167	SHAF[illegible]
176	IMPE[illegible]
201	WEA[illegible]
205	WEAR RING - CASE
217	SH[illegible] SLE[illegible]
217-1	SH[illegible] SLEEVE - RADIAL BEARING
225	SP[illegible]
230	THR[illegible]
236	CAS[illegible]
241	DEF[illegible] - OUTBOARD
241-1	DEF[illegible]
249	NUT - THRUST BEARING
250	NUT[illegible]
257	LOC[illegible]
277	HOUSING - THRUST BEARING
278	HOU[illegible]
279	[illegible]
280	C[illegible] BEARING

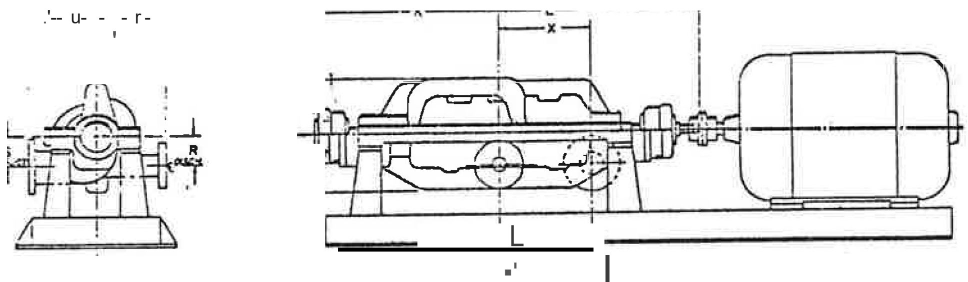
PART Nº	NAME OF PART
281	COVER [illegible]
310	OIL RING
319	RETAINER - OIL RING
346	SLEEVE - RA[illegible]
654	BALL BEARING - THRUST
655	BALL BEARING - RADIAL
673	LOCKWASHER - [illegible]
673-1	LOCKWASHER - RADIAL BEARING
676	KEY - COUPLING
676-1	KEY - IMPELLER
742	PACKING
744	GASKET [illegible] SLEEVE

IM RTAHT ::::'.: ! f .::
F l•• , -1 lin 111 IIPP1,oll111\I

OUTLINE DIMENSIONS TYPE MS B STYLED

SINGLE SUCTION - nouaLE VOLUTE PUMPS

MSB-D DIMENSIONS
L"'•utr lie 111•



Ty; ▮ MSl·0 puops •r▮ n al ll bl1 •i i ▮ll h▮r clodwiu (Cl) or counl ▮re lack• lu (CCI) rau ll an, u vined frao lh▮ co1i1plini •nd, u:.d ,n)' lyP.t ol ▮ator , aur. turbine or 1ncln1 drlv1. r,u di,ur111on1 b1 l a▮ 1r1 lar ball bu ina puapo ol er ra lal ion, Wini ,.u▮ 11,n,, r▮1inl en noul• 11; 11111 a11ln1 - 3001 AU, cul Iron cuina - z50, AU.

All di.. naion, ▮r▮ In inchu and fir 1uld1nc1 inly, C11llll1d druln11 1111 b▮ provl d▮d In 111 01111 al aclual 111111ructlan.

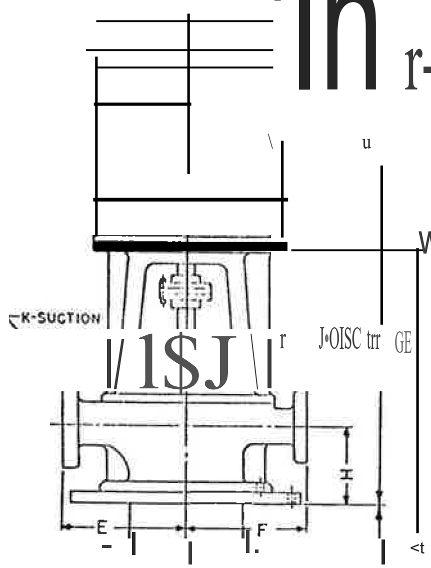
Size	Nu;;;te r Stagas	G	H	K	L	R&S	T	U	X
	4			25 I/2					
	5				31 5/1				I2
	6			29 1/2					
	7				35 ua				15
3 X , X g	,1	12	12	33 1/2	39 5/1	6.!i	14	14	g
	9			37 1/2					
	I0								
	II				43 5/B				2
	12			41 1/2	47 5/i				2'
				27 1/2	H 1/4				I ...,
	5			32					
	5				38 3/4				19 I/2
	7			36 1/2					
3 X 6 l I0	S	13	13		43 i,1	7	15	15	H i,1
▮ X 6 X I0	S			4i					
	10				47 3/4				27
	11			45 1/2					
	I2				52 1/4				31 3/<
				26 11,	35 3/8				I ,n
				II					
	●				40 1/1				Ig 11,
4 X 6 X I0!1l	1	14 I/1	14 3/8	37 31,		8	17	17	
	a				44 7/8				H
	9			42 I/2					
	I0				50 5/8				2; J/4

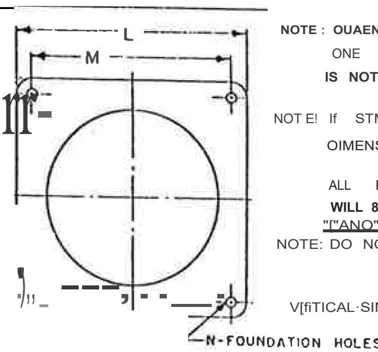
Suparsedes April 15, 1953

Di!l.'ii/ NGNO. ·n P· 182

Bingham Factories: PORTLAND, OREGON • VANCOUVER, I. C, CINIOI

Figure 4-8. Horizontal Split Case Multi-Stage Pump.





NOTE : OUAENSIOtl "'0'" IS THE MIU. TI\NY. LFt/G1H FOR ONE STAGE WtIERE AODITIOU'L TANK LE.,GTH IS NOT RCouinro Fon N.P. II.

NOT E! If STMIDSRO SPACER TYPE COIJf'I ING IS USCO, OIMENSIDII •O• WILL BE INCR[AS[O [IV t INCII [!;

ALL PIPE TAP SIZES? III. EXCEPT I X& WII <CII WILL 8E { Hi, "['ANO"f"AR[DASEQ ON 150LO.FLM<Gi:S.

NOTE: DO NOT US(OII,CNSIONS ron CONSTRUCTIOtl.

TYPE WY

V[fiTICAL·SINGLE OR MUL TI-STAGE PUMP

PUMP SIZE	BOWL PATT. NO.	A	8	Ei'	C	D	E	F	G	H	J	K	L	M	N	!1ri	M4' GPI,I	
1½ X6			15	3i		24i	9	;T	';r	G1	L	2	'15	!!!	i	!500<	BO	r—
2X8	V-517		17	4		21:	!.!.IL	I	10	\	2	3	18	&	rb	'.,o(	2SO	
2&x9	Y·B66		ie	5		2el 2	II}	u5 a	lol	7	2½	4	1B		•&		2S0	r--
2XIOL	V-53(		21	5L2		211	II	IIIj	O¾	6&	2	3	IB	13}	"'e	T 420(	250	
3XIOL	Y·530		21	s1		29i	12	12	12t	11	3	4	21	16¾	■	•00<	475	
4XIOL	Y-53C		21	si		31i	13	13	14	Bij	4	6	24	20	IG	IIIOC	50	
4XI2L	Y·sn		24	7		31a	13	13	14	el	4	6	24	20	1b	3GOC	000	
4XI2M	Y·60n		27	el		3,ij_	13	13	14	el	4	6	24	20	I h	j,11:;II	950	
6X12L	y-571'		24	7	--	34J	13	13i	16	II	6	e	28	24	I b	IIt;OC	BOO	-
6XI2M	I'·GOI:		26	0J		34	r,.;r	13i	i6	II	6	0	ZB	24	111	T C	1100	
6XI'1H	V·365		30.	9		n,?		13	16	II	G	B	2B	24	d;	,100	1 00	
6X14M	y-355		32	II		34i	13J	;;J	16	u	6	B	28	24	1r	I!'.K)(	1200	
OXI4 H	Y-36!:>		!	r9		r—,•	16	16	18	1'1	0	10	3G	32	1Pi	IOO	1600	
OXI4M	Y-355		33	II		J	IG	16	IO	I'I	0	10	36	32	Ii	ZIQO	600	
8XI6M	Y•'i 6?.		36	12		394I	IG	16	20	14	8	10	36	32	,a	L[18oo	2;00	
8XI6H	Y·3!>7		30	!'l-.°		iX	16	16	20	14	8	KI	36	32			-700	
IOXI6M	Y·46?		36	12		42	IG	16	20	14	10	12	36	32	,f;;o		161)(	
10X16H	Y·3'.)7		30	12		42	IG	IG	20	14	10	12	36	32	Iij	000	)20(	

MINIMUM FOR ONE STIIGE ADDITIONAL PER STAGE

L-G-J

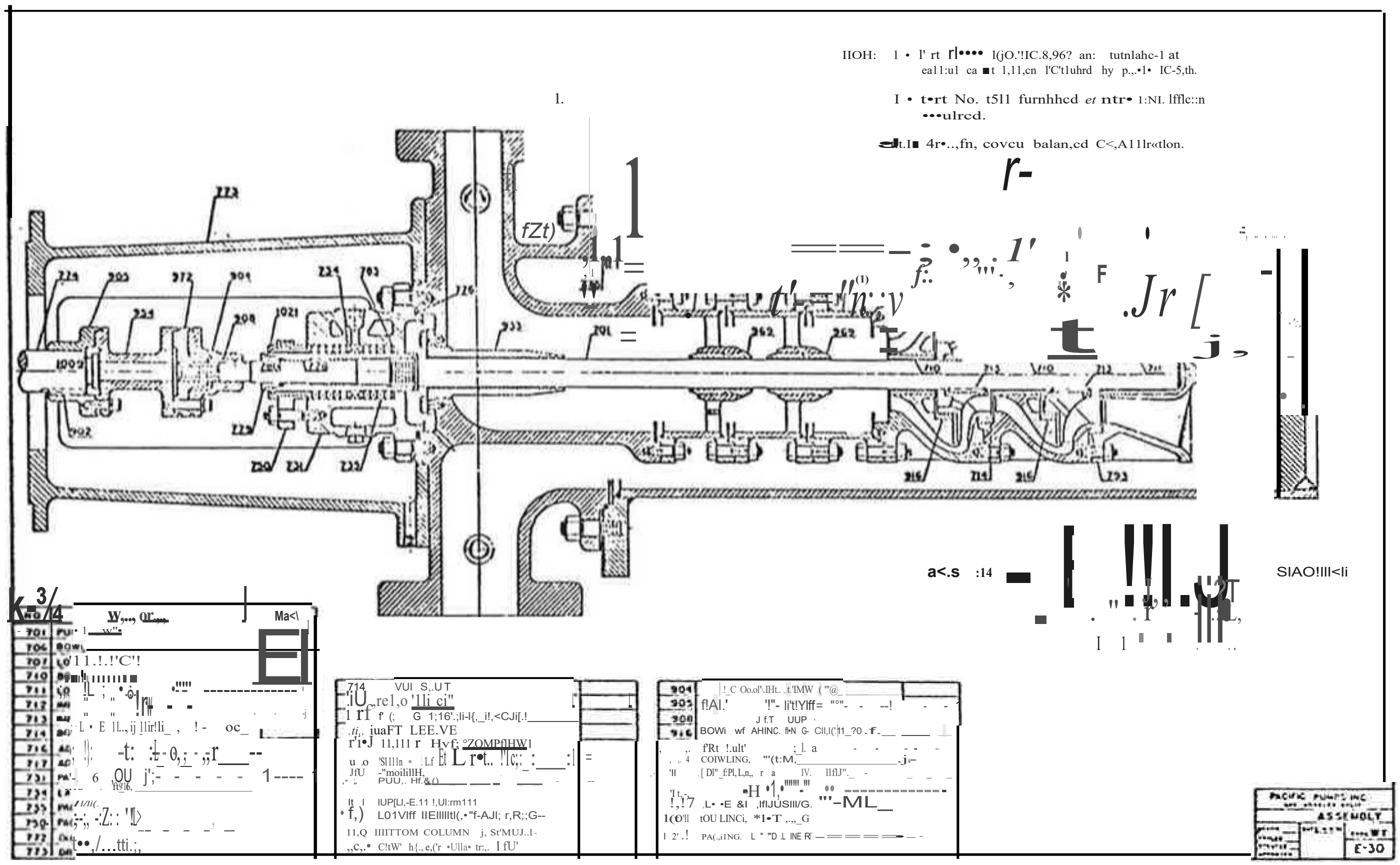


Figure 4-10. Vertical Stage or Multi-Stage Pump.

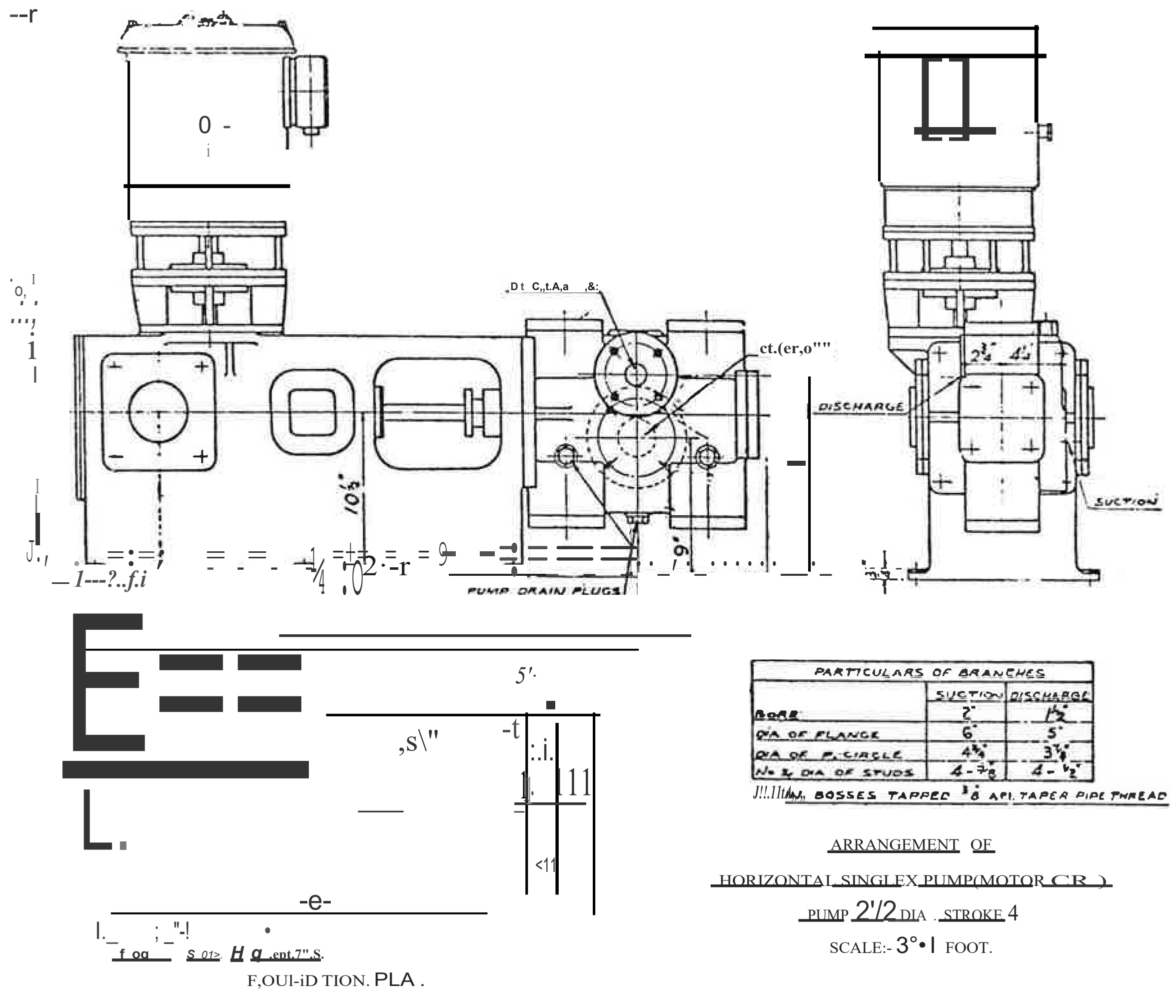


Figure 4-11. Horizontal Singlex Pump.

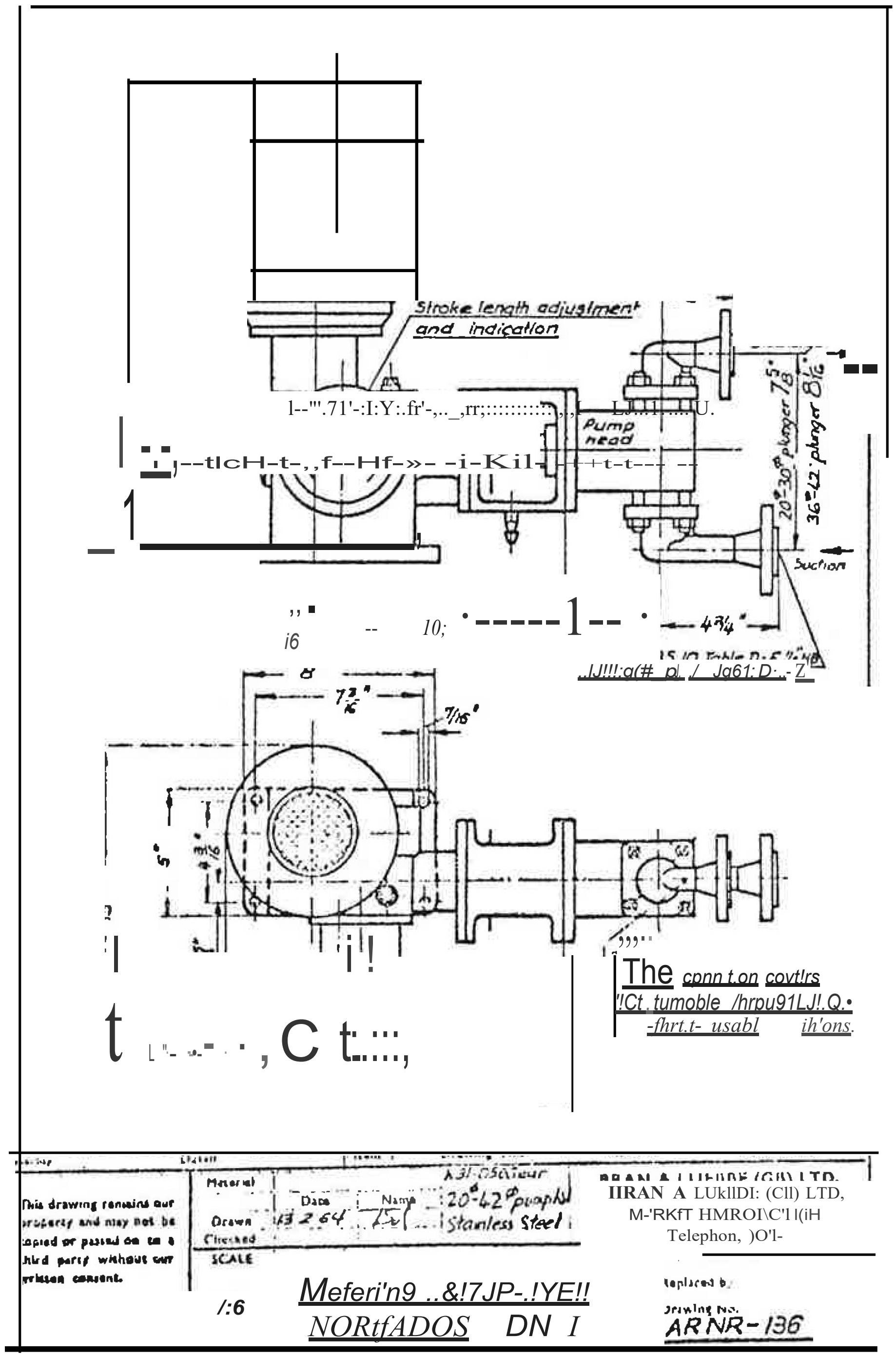
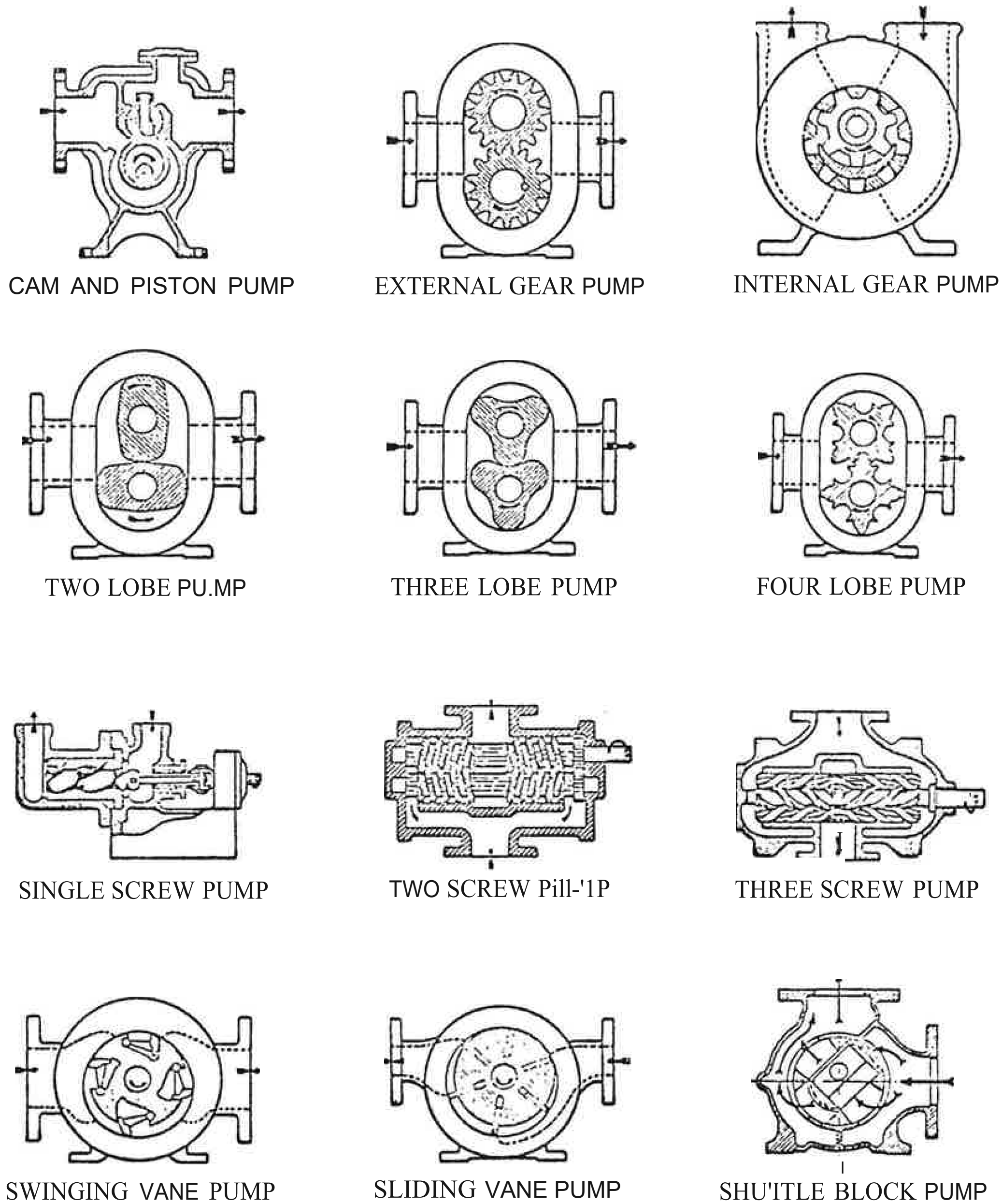


Figure 4-12. Metering Pwnp.



A rotary pun,p is **a** positive displacement pump, co1W1ting of a fixed casing **containing geara,** cams, acrews, vanes, plungers or similar elements actuated by rototion of tho drive ,haft. These pump• **aro** characterized by their close running clearances and **the abaenc1 of 1uotion** and discharge **valvea, Va.rio111** types **are ahown** by the cross-sectional **drawings.**

Figure 4-13. Classes of Rotary Pun,ps.

charge. These pumps do not allow free flow oi fluid through the pump. Pas itive displace, ent pumps are ither r c ipro-cating or rotary. In r eci procating pumps, th fluid chamb r is stationery: in rotary pumps, the chamber moves.

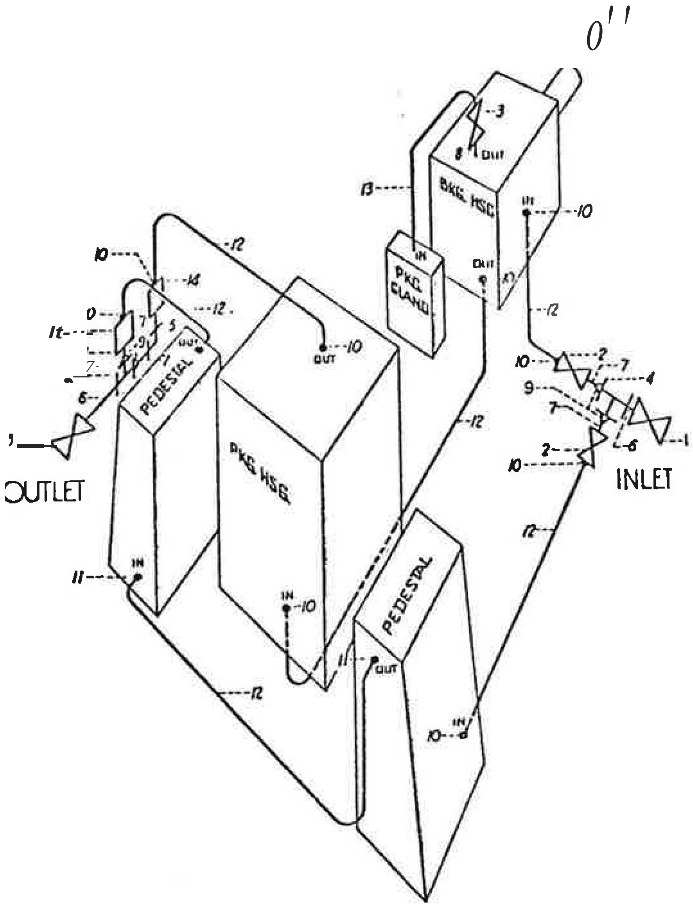
-L 3 GENERAL PUi\l{P INFORMATION

Certain features of pump desi n are o(direct interest to the pi pi ng designer:

- Each pump will have connections tern--ied "s uct io n'' and ''de li ve r y" or ''d i s c h a r g e•·. Thes connections vary witl the size of the pump and may be flanged or sc ewed to th required standard.
- Wh re cast iron is used as a cas ing material, fl:inoed connections are flat-f ac e d ASA 125 or 250 rating. anc-l with steel or alloy cas s they ar e r aised- fa c e ASA 150 or hi ghe r .
- Pump casings may have \·ent and drain connections to suit the customer. This may require special pi pin g of vents and drains.
- Most baseplates, especially those for centrifugal pumps in hydrocarbon service, have drain rims to collect leak-ages from the pump. The drain rim has a tapped connect-ion which is usually piped to a drain hub.

- Most centrifugal and positive displacement rotary pumps have mechanical seals. The pump make1· usually supplies a mechanical seal harness. When the pumped fluid is used for seal circulation, piping is attached to the vent connection on the casing. The circulated seal fluid must be returned to the pumped stream and maybe piped back to the suction -or returned through the seal and pump internal clearances.
- When pumping viscous or high temperature hydrocarbon liquids, the seal fluid (usually clean gas oil) circulates from an external source through connections on the pump seal.
- Double mechanical seals have inlet andoutlet connections for seal fluid circulation.
- External seal oil piping appears on the P&ID.
- High temperature pumps usually need water cooling for stuffing boxes, bearings and pedestals supports. The pump outline drawing shows how much cooling water is needed, and the connections, points, and sizes for the inlet and outlet. Figure 4-14 shows a typical water cooling circuit.

Figul'e 4-15, a pitmp data sheet, summarizes opeating conditions, design limits and materials of construction.



, ll,.	f(j'4 011[	'Sol .U	ouc..1.-110H	llUIAIAL
I	'	, i	•07 CUHt vav,c	IRiCWlf
Z	1		ll&H ("1""4['fl,LVI!	
)	l	•̣·	11u1 cu"'c v,v,f	lltONI[
•	l	_"_	ll Hf - CM. .,E	ll AL.. I
5	l	1i	ll!D IH..110'111 • (IIJNI	...... tlllOti
I	1	11	Si401i1T HlfP\.(• I HT :0[ti!LlU	SHK
l	•	?'	1,_ R1 Nl" j,l,.(- I Mt 5,[.t."L	iufi.
•	I	i'·	SHOIII NIPPL[- 1 hl' ';Cl!'llH\	IIHL
'	•	n'•-̣	MCl BU lrtG	HHL
10	•	l'112	l'AMU H' (.Ofil'l.	IRUS
II	l	!"112	,urJC.U (a.I COH,,4.	-14L-
//	as 11f)•o	?°1i1	PARKO: fl.IBIHG	COPI'U
u.	I	• •	r'=.(.1 ffO C W/ HAL[UfillON Co.tH. • lafK 0t01	llf&SS
	1	•	.l&Cttl now BGI .. aov u MDI I	C0111•L

lOT't1 ..11:S rtrnn AllnANOF:r:EN'T Jit>.Y or. tnr.D VITH T'HF. POl.UlilJ.NO:

n : 11•s-l!"L-ll"..1j"L-2•..r...,1••-o!;kl"S-J".......•L-6"s-6•1..e•s-e·..-1a·..10· L

!YC • 2"':!-2" •:.....5.rz-\"l•""':'1-6"'1'-:0\"'L-r ." -ll" L.- •... &..L-&•L

_ : L1·-•··•l"·l"·'"

Figure 4-14. Water Cooling Circuit.

DATA SHEET FOR CENTRIFUGAL PUMPS

FOR ________ REQUISITION NO ________
ITEM NO Zr, 3T9t 26 · 370
SITE ________ UNIT ________
SERVICE ________ MOTOR DRIVE 2 TURBINE DRIVE ________
PUMP MFR ________ SIZE AND TYPE 3! 4 L1/4 NO. REQ'D ________
API STD, 610 APPLIES YES ________ NO

OPERATING CONDITIONS — RATED NORMAL — PERFORMANCE

LIQUID ________ U.S. gpm at P.T. ________ PROPOSAL CURVE NO ________
DISCH PRESS., PSIG ________ NPSH REQ'D (WATER), ________
P.T. °F ________ SUCT PRESS., PSIG 8 NO OF STAGES ________ RPM ________
SP GR at P.T. ________ DIFF PRESS., psi ________ DES EFF ________
VAP PRESS ________ psia ________ DIFF HEAD, ft / Z-r MAX BHP RATED IMP ________
VIS at P.T. ________ NPSH AVAIL ft So, a MAX HEAD RATED IMP. 16;5
CORR/EROS ________ MIN CONTINUOUS gpm ________ MFR ________
CASING MOUNTING ________ ROTATION FACING COUPLING END ________

CONSTRUCTION AND MATERIALS — VERTICAL

SPLIT <AXIAL | <RADIAL // | WATER COOLING ________
TYPE SINGLE VOLUTE | DOUBLE VOLUTE | DIFFUSER | RINGS ________ No
TAPPED OPENINGS (VENT) (DRAIN) (GAGE CONNS) STUFF BOX ________ YE! No
NOZZLES | SIZE | ASA RATING | FACING | POSITION | JACKET ________
SUCTION ________ GLAND ________
DISCHARGE | 3 | 300 | RI' | ________ | TOTAL WATER REQ'D ________
IMPELLER DIAM RATED ________ MIN ________ MAX ________ TYPE ________
MFR'S BEARING NO RADIAL ________ THRUST ________ PACKING COOLING ________
LUBRICATION ________ LUBRICATOR TYPE ________ SIZE ________
COUPLING TYPE OR MAKE ________ SIZE ________ BASE PLAT ________ FLUSHING ________
CPL'G GUARD, MEETING API CIQ SAFETY REQMTS.
PACKING ________ AUX PIPING ________
MECH SEAL Yt ________ CLASS CODE XF- ________

MATERIAL CODE — EXTERNAL CASING — INTERNAL PARTS — X — SHOP TESTS REQUIRED — WITNESSED

MATERIAL CODE	INTERNAL PARTS						SHOP TESTS	REQUIRED	WITNESSED
I - CAST IRON	INT'L PARTS CODE	I	B	S	C	X	RUNNING PERF	Yf	No
B - BRONZE	IMPELLER	I	9	s	C		NPSH	I.I 0	-
S - STEEL	INNER CASE PARTS	I	I	S	C	S			
C - 11-13% CHROME	SLEEVE (PACKED)	Ch	Ch	Af	Af				
A - ALLOY	SLEEVE (SEAL)	C	C	G	C		HYDROSTATIC	PSIG	No
h - HARDENED	WEAR PARTS	I	B	ch	Ch		MAX ALLOW WP	PSIG	100
f - FACED	SHAFT	S	S	S	S		WEIGHTS PUMP	BASE 75S	
X "							MOTOR	TURBINE	

MOTOR DRIVER BY ________ — TURBINE DRIVER BY ________ — MFR FINAL DATA (AS BUILT)

ITEM ________ | ITEM NO ________ MTD BY ________ | ACTUAL IMPELLER DIAM ________
HP ________ RPM ________ FRAME ________ | HP ________ RPM ________ MATL ________
MFR ________ | MFR and TYPE ________ | TEST CURVE NO ________
TYPE ________ INSUL ________ | INLET STEAM psig ________ TEMP F ________ | OUTLINE DWG NO ________
ENC ________ TEMP RISE C ________ | EXHAUST ________ | PUMP SECT DWG NO ________
VOLTS/ PH• S£/ CYCLES ________ | STEAM RATE, LB ________ lb/BHP/HR | SEAL DIM DWG NO ________
BEARINGS ________ LUBE ________ | BEARINGS ________ LUBE ________ |
FULL LOAD AMPS | NOZZLES | SIZE ________ | PUMP SERIAL No2 6'-36 1 2.rc 48 16-37o 2.1:0484
| EXHAUST |

NOTE: ________ VENDOR SHALL STATE BHP FOR BOTH CONDITIONS

REV	DATE	DESCRIPTION	BY	CHK	APPR
2	6/2/65	REV. OPER. CONDS, PERF., ADDED DATA	JRH		
1	4/15/65	ISSUED FOR PURCHASE	JRH		
0	2/25/65	ISSUED FOR QUOTATION	JRH		
3		ISSUED TO CANCEL	JRH		

BECHTEL

JOB NO 5099 | DRAWING NO DS-2G-69 | REV 3
SHEET ____ / ____ OF ____

30 - JAN 64

Figure 4-15.

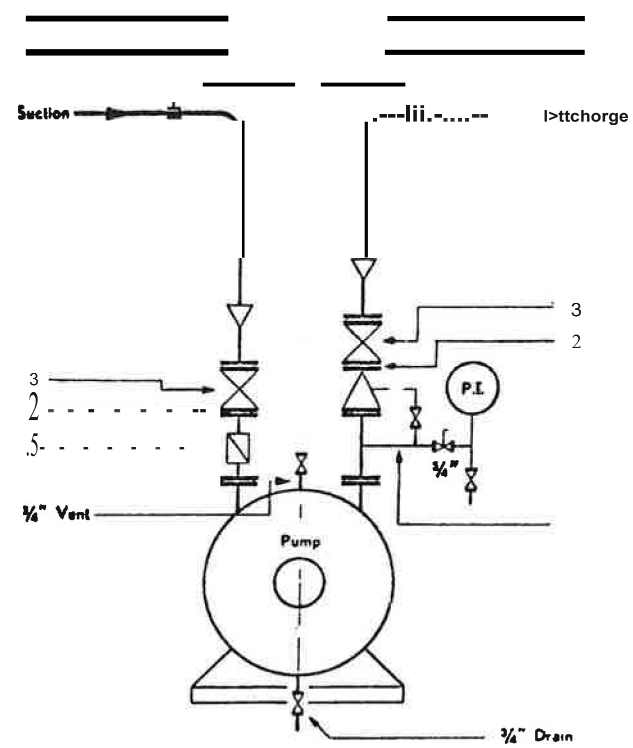
4.4 PIPING

The piping designer should assist the engineer in selecting a pump so connections will suit the best piping hook-up. This includes choosing between such combinations as end suction - top discharge or top suction - top discharge, etc. The designer is in a good position to look into stress andexpansion problems which develop when pumps are manifolded together. He can also check vendors' drawings and auxiliary piping drawings for vents, drains, cooling water to bearings, etc.

The pump outline drawing (supplied by the vendor) tells the piping designer the size, rating, and position of suction and discharge connections on the pump (Drawing 29-041-211). Figures 4-16, 4-17 and 4-18 show typical piping hook-ups for centrifugal and reciprocating process pumps. We can classify most piping at the pumps into suction and discharge lines. The two sections which follow list the important principles used in piping lines of this type. Although the engineer is responsibile for most of these aspects, the piping designer should also check to see that they are fulfilled by the P&ID.

4.4.1 Suction

- Use a minim.um of fittings such as bends and reducers
- Keep suction lines as short as possible



NOTES,

Piping al pump, lhould be odequ1tely 1upporled 10 11 to prevent 1ny 1tr1in on the pump during operl1lion and lurlher lo •llow euy remo••I of the pump.

2 Spect•tl• blind, lhould be pro•lded ii piping i1 - rigid for in1t1lling slip blind,.

3 Vol••• should normally **be** of lhe ••m• 1ize **u** lhe pump ll•n;e. However, rhe 1uction condi,ion1 should **be** carefully checked.

• Pumps n1ndlin; hor or hi;h pour point liquid, should be equipped with •)/4" ;minimum) by-poll •round the check vofve,

5 T.mpor•ry 111rl-up llr•iners ••• lo be provided wilh projecting indentilying 11b or h• ndle .

CENTRIFUGAL PUMPS PIPING ARRANGEMENT FOR PROCESS PUMPS	January 1960
ROYAL DUTCH/SHELL GROUP	**DE 31. 29. 02. SO - Cen.**

Figure 4-16.

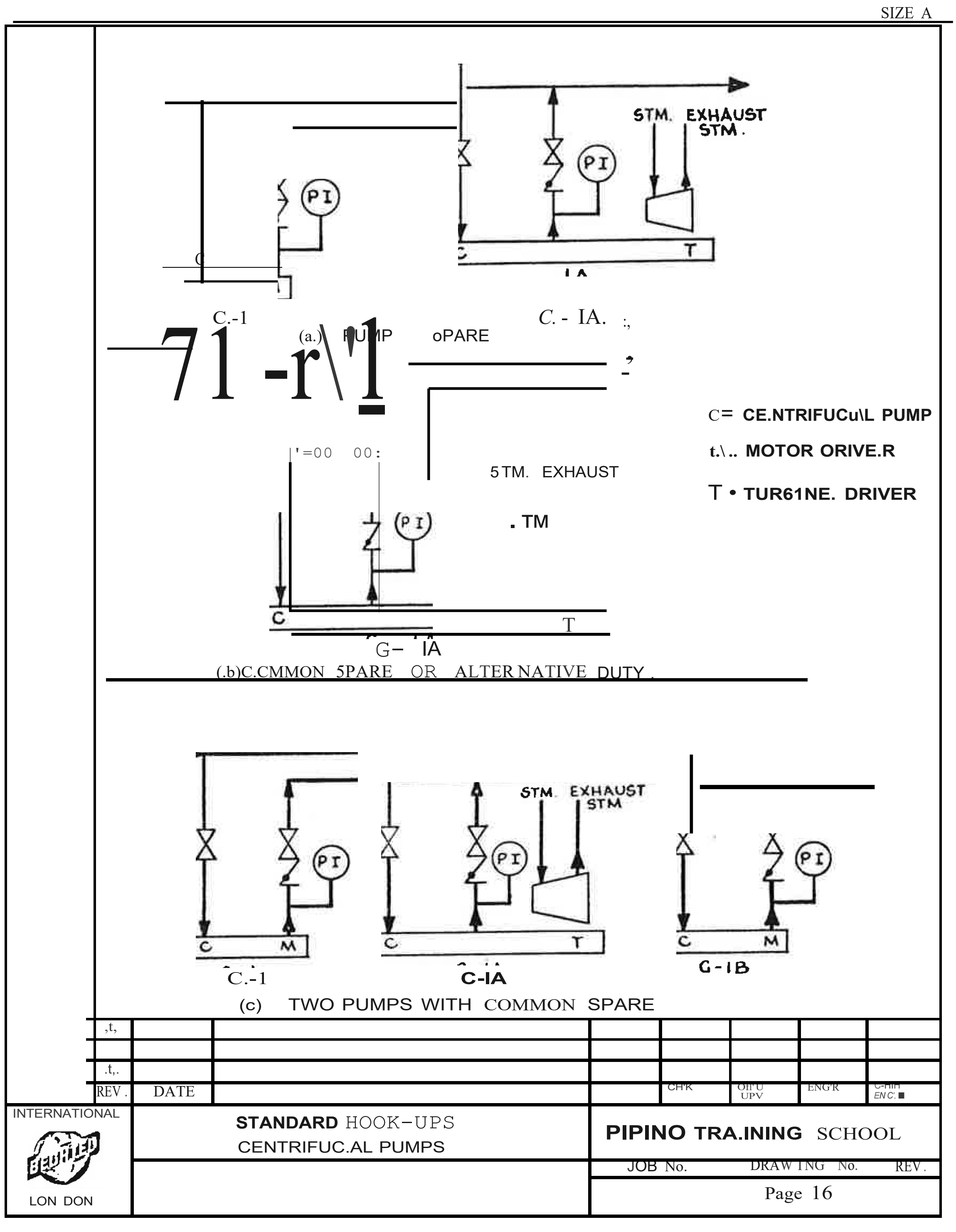
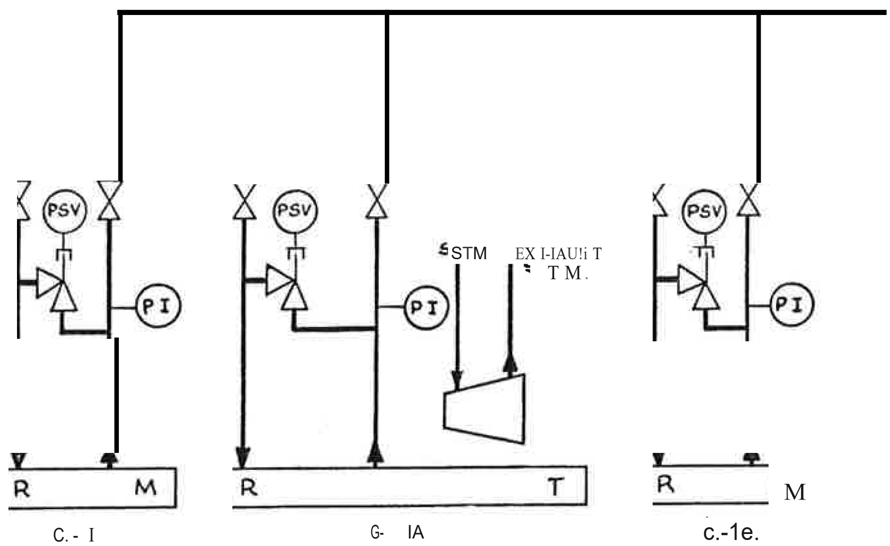

SIZE A
STM. EXHAUST
STM.
PI
C
T
C-1
C-IA
(a.) PUMP SPARE
C = CENTRIFUGAL PUMP
M = MOTOR DRIVER
T = TURBINE DRIVER
STM. EXHAUST
STM
C
T
C-IA
(b) COMMON SPARE OR ALTERNATIVE DUTY
STM. EXHAUST
STM
C
M
C-1
C-IA
C-IB
(c) TWO PUMPS WITH COMMON SPARE
REV.
DATE
CH'K
ENG'R
INTERNATIONAL
LONDON
STANDARD HOOK-UPS
CENTRIFUGAL PUMPS
PIPING TRAINING SCHOOL
JOB No.
DRAWING No.
REV.
Page 16

Figure 4-17.



(a) PUMP AND SPARE

(b) TWO PUMPS AND COMMON SPARE

R = RECIPROCATING PUMP

M = MOTOR DRIVER

T = TURBINE DRIVER

& REV.	DATE		OK	CH'K	DR'G SUPV		CHIEF ENG'R

INTERNATIONAL BECHTEL LONDON

STANDARD HOOK-UPS
RECIPROCATING PUMPS

PIPING TRAINING SCHOOL

JOB No. DRAWING No. REV.

Page 15

Figure 4-18.

- Check P&ID to see that the suction lines are not smaller than the pump nozzle .
- Don't allow pockets that can trap air
- Arrange eccentric reducers so they will release vapor bubbles . This usually means inverting the eccentric reduce.r (Figure 4-1 9)
- Provide temporary strainers in lines
- If possible, don 't place an elbow horizontally at the suction nozzle of a centrifugal pump. If such an elbow is needed, place it at least three pipe diameters from the pump
- If you must use a right angle bend next to the suction nozzle of a double entry centrifugal pump, then install the bend vertically. This prevents an unbalanced flow to the impellor

4.4.2 Discharge

- Provide an orifice on horizontal centrifugal pumps to by-pass some discharge at low flow rates
- Protect positive displac ment pumps by a pressure relief valve that connects the discharge back to the suction. However, the pump may have a built-in safety valve
- Provide a check valve between a cenrt ifu.g a l pump and the shut-off valve. Locate a drain on the upstream side of the valve

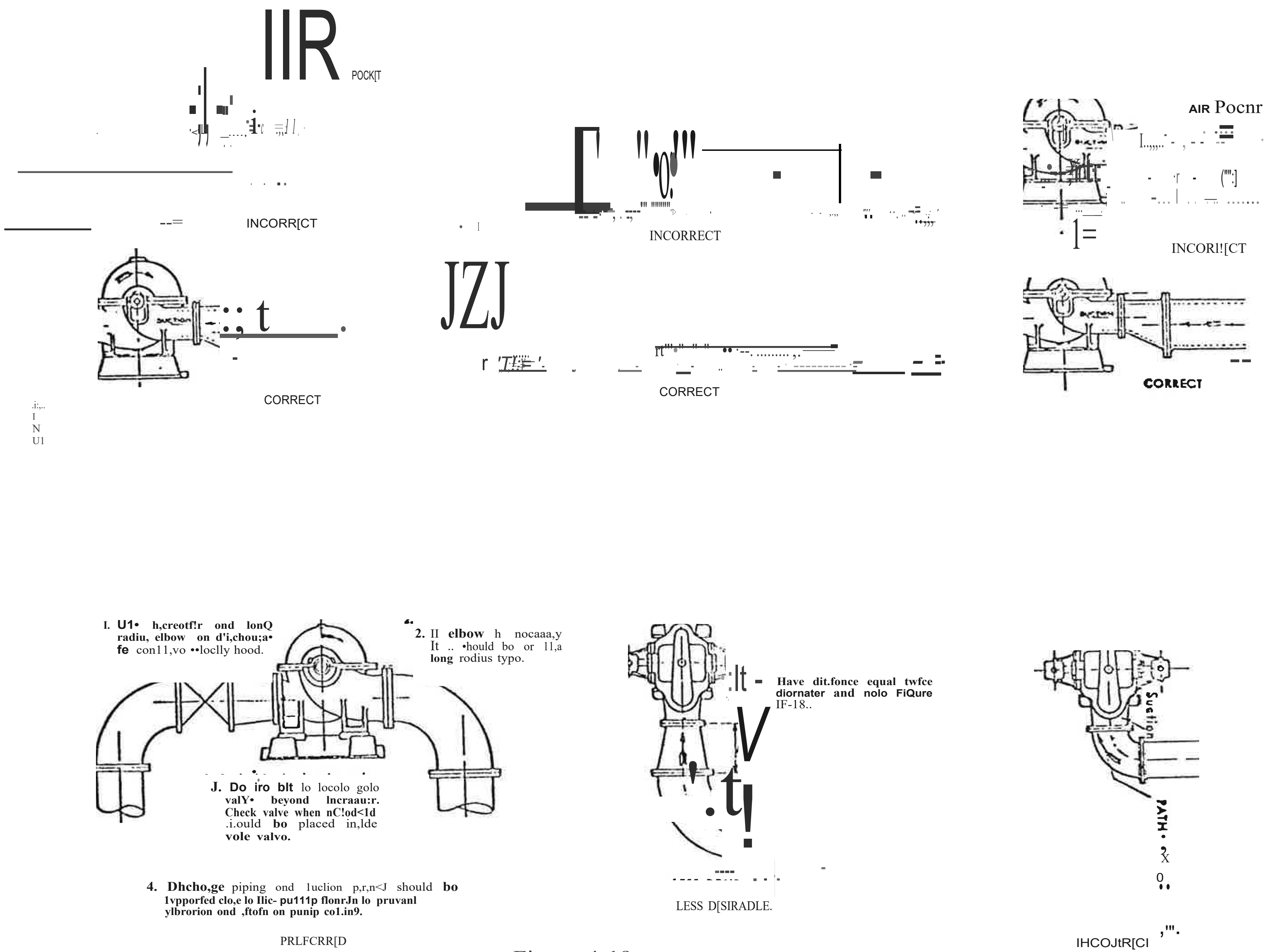


Figure 4-19. Cavitation Problems.

- Put a pressure gage on discharge lines upstream from the block valve

4.4.3 Valves and Auxiliary Piping

This section describes other important piping principles which aren't classified under suction and discharge. Again, the piping designer should check to see if the P&ID follows these principles:

- Arrange valves and piping so the maintenance crew can easily work on the pump, and so that other equipment doesn't have to be shut down
- Keep suction and discharge valve handwheels on a common center line above the operating floor
- Make block valves full line size, up to and including two inches. Above that size, if there's only one pipe size difference between pump nozzle and line, then the valve will be line size. If there are two or more size differences, then the valve may be one size less than line size
- Arrange and support piping to prevent strain on the pump from thermal stress or unsupported pipe
- Provide pumps handling liquids that might freeze with a casing drain. For other than freezing service, provide a drain valve between the block valve and pump suction

- Trace and jacket pumps handling liquids that may solidify
- Use a drain hub at all pumps. Connect all pump drips and vents to the pump bedplate or drain hub. Pipe all drains except those for solvents to the oily sewer
- Check the mechanical seal flushing system for inlet, outlet, drain, and vent connections

4.5 LAYOUT

4.5.1 Pumps

Pump piping has been a subject of considerable controversy. Why? Basically, we have two conflicting schools of thought:

(1) Isolate pump from piping, to provide maximum access for both in-place maintenance or removal.

(2) Combine pump and piping in a compact area surrounded by well-defined walking areas free from hazards such as projecting valve stems.

Both of these concepts have obvious merit, but we cannot satisfy both completely, Again, we compromise.

However, before we examine the "ideal" pump layout (a hypothetical case tailored to illustrate just what we want it to), let's look at a few more basic considerations:

(1) What kind of a pump do we want? Obviously, we will select a pump of a type which will perform in the service specified,

but once the process design conditions are satisfied, we will tend to base our choice on economic values.

An example: for a given service, we may be offered pumps with end, top or side suction. One, and only one of these choices will be ideal from the piping standpoint. However, when possible, we should select the most economical pump.

In general, the following suggestions (Table A) will provide some guidance to choice between end and top suction pumps, but individual situations involve so many variables (pump size, line size, valve size and type), that there is really no proper substitute for early consultation with the piping lead draftsman.

<u>TABLE A</u>

Small (up to 4" suction)	Elev. vessel	Top suction and discharge
Small (up to 4" suction)	Low vessel	End suction and top discharge
Medium (6" and 8")	Elev. vessel	Top suction and top discharge, if possible (check this with piping)
Medium (6" and 8")	Low vessel	End suction and top discharge
Large (10" and up)	Elev. or low vessel	End suction and top discharge

Side suction pumps will be a nuisance from the space standpoint in most *cases,* and should be avoided unless no other pump will satisfy the pumping conditions or in those rare cases (such as alongside a cooling tower basin) where side suction might be ideal, In the event that a side-connected pump of the double -suction type is selected, another problem appears: suction piping must be arranged so that one-half of the inlet flow is directed to each side of the impeller or reduced efficiency and improper loading of the pump bearings will result, This can be done in three ways:

(a) High-suction source: suction line should drop vertically at the pump with the elbow at inlet in the vertical plane

(b) Low-suction source where there is plenty of room: allow at least five diameters of srt aight pipe dri ectly befo e the inlet

(c.) Low-suction source where space is not available and an elbow in the horizontal plane must imm di at ely precede the inlet: .install a splitter vane in the elbow

Now, assuming we are dealing with a p\;lm p which is well selected for our particular situation, we can go on to the rest of our considerations.

(2) Ease of Access to Pump for Minor (in place) Maintenance:

(a) Pump maintenance points a-re lat·gely concentrated in the packing gland area. A1..1xiliary piping connections to coolant or seal fittings contain small valves and strainers which must also be accessible

(b) Turbine drivers have similar maintenance points and auxiliary connections

(3) Ease of Removal of Pump or Driver for Shop Maintenace:

(a) Small pwnps are not much of a problem. Two men can lift them onto a hand truck, but adequate space must be left for the men and the tn1ck

(b) Medium size pumps will be handled by an A-frame or a motorized crane. Space must be left over the pumps for A-frame or crane boom with reasonable clearance for rigging. Eleven feet clearance abo\·e grade in the area around and over the pump is needed if a small crane of the "cherry-picker" variety is to he used. If such a crane will not be used, this clearance can be reduced, but should not be less than eight feet

(.c) Large pumps will definitely require a heavy duty crane. Over head clearance must allow for the size of the creme, the overall height of the pump and adjacent pumps, and space for the necessary r igging. In instances where a large crane cannot be positioned, monorail, gantry structure or in-place maintenance provisions might be consider ed.

(4) Positioning of Valves: Locate valve handwheels in natural positions for ease of opera.tion, but avoid creating hazards to personnel with p1otr uding valve steins or head-knocking handwheels.

(5) Reasonable Support ofP i ping: Pump flanges can normally support only small piping not subject to great expansion stress. Piping must be arxanged so that suitable supports and anchor s can be provided. This is part of the original design problem. and s hould not be handled as an afterthought. li piping is to be supported from grade, then supports should rest ona slab which is integral with the pump foundation.

Nowwe are ready to pipe up a pump. We have selected a s imple case and piped it in the wor st possible manner (Figure 4-20).

With this simple example, which at a glance appears reasonable, we have managed to violate all of our basic concepts o(good practice. Let us examine this arrangement in detail:

(1) A top suction pump would have been a more suitable choice

(2) Discharge piping interferes with in-place maintenance

(3) Discharge cross-over line interferes with removal of pump

(4) Suction valve is a hazard

(5) Discharge valve is a hazard and *is* not conveniently placed for operation

(6) Suction line is supported by removable suction spool

(7) Discharge piping cannot be reasonably supported at all

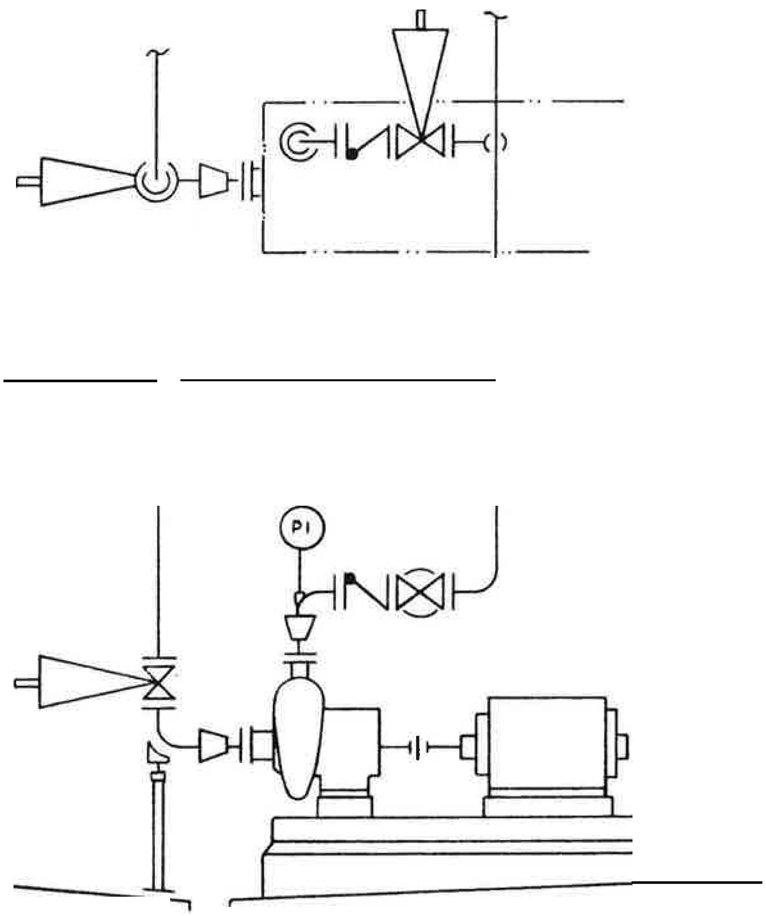


Figure 4-20.

As a bonus F ig ur e 4-20 illustrates a few additional "hon r s".

(I) Valves should have been "pump size", not"lin size"

(Z) R e d uc e r (if not relocated in ris r on th oth r side of va l ve) on suction nozzle should have been eccentric to avoid line pocket

{3) Extra cost in unnecessary fittings

Howshould the pump in Figure 4-21 be piped? Let's assume that we are stuck with the same end-suction pump, anrl ;.nnlv the principles we have outlined:,

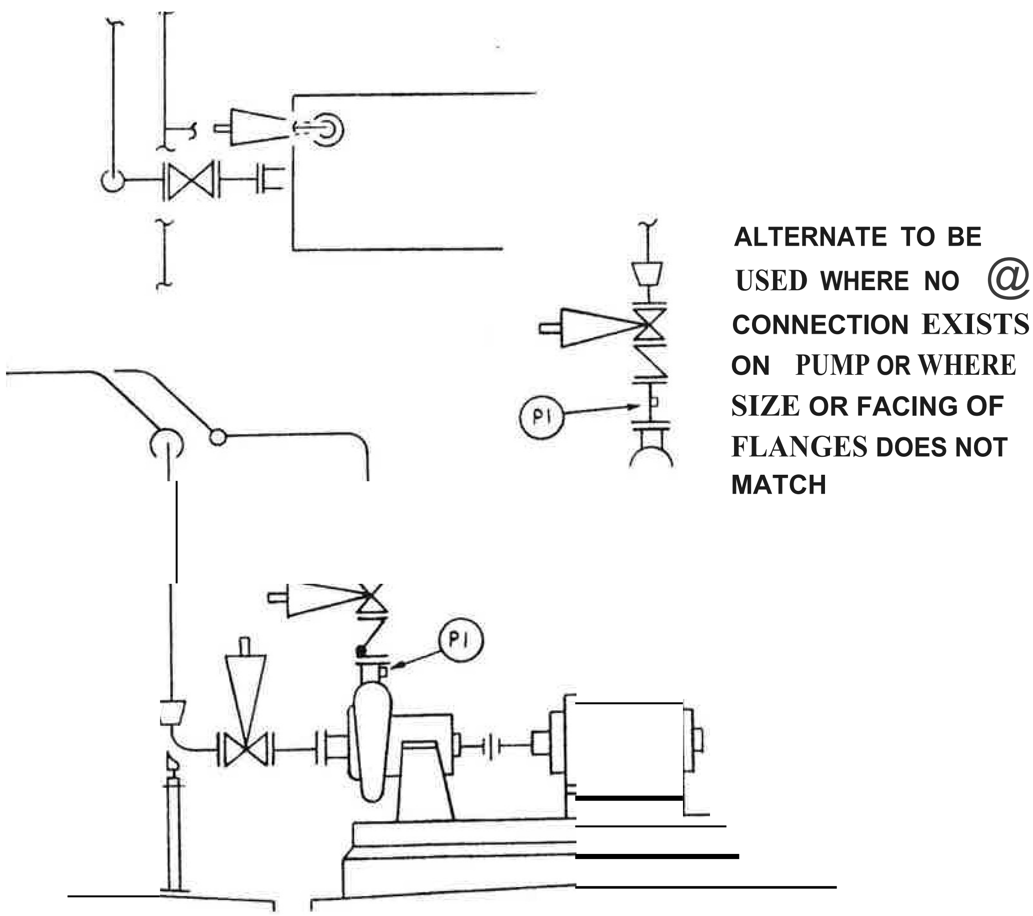


Figure 4-21.

Not only have most of the problems disappeared, but we have saved an appreciable amount of money through the use of fewer fittings and smaller valves.

The foregoing example demonstrates the one major rule to remember for fulfilling most of our basic requirements more easily:

> "The general mass of piping, valves, and manifolding for a pump should be placed in a compact area in front of the pump."

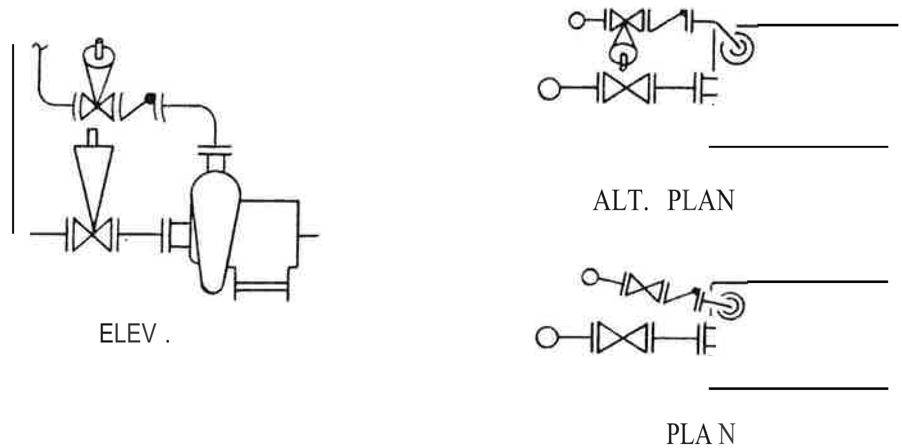
Most of our recent plant designs have recognized this as a fact, and space consistent with the size and complexity of the piping (usually about four feet) has been allotted for this purpose. Most of the poor arrangements *of* the past have resulted from failure to recognize this need. Consequently, piping was crowded over and around the pump.

Piping should enter and leave the pump with a minimum number of offsets. Discharge valves, for example, should always be placed in the riser above a top discharge nozzle unless one of the following conditions governs:

(I) Confined gasket facings are involved, and piping is so inflexible that gaskets or removable spools can not be extricated

(2) Pump and v.alves are so large that valve placed in riser will be too high to reach

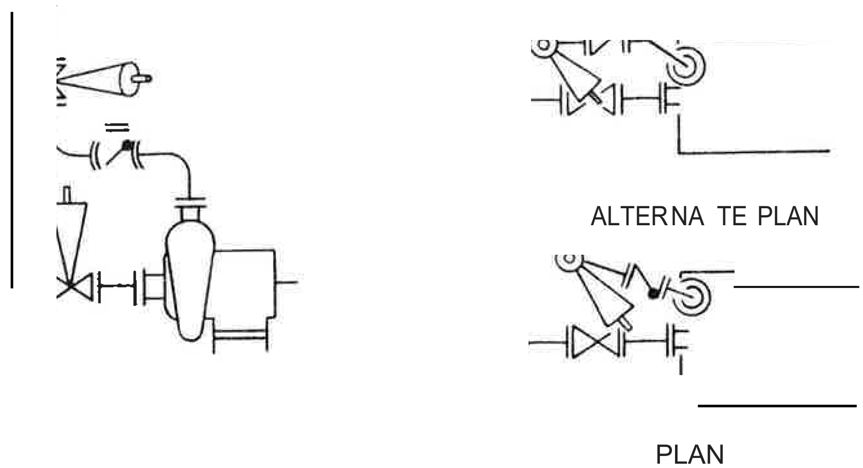
In these cases, offsets should be made in piping and should be done as shown in the examples of Figures 4-22, 4-23, and 4-24. Note that the offsets are made toward the all otted piping sp.a c e , and <u>not</u> back over the pump.



GOOD USE WHEN DISCHARGE CHECK AND GATE **CAN BE** FLANGED TOGETHER

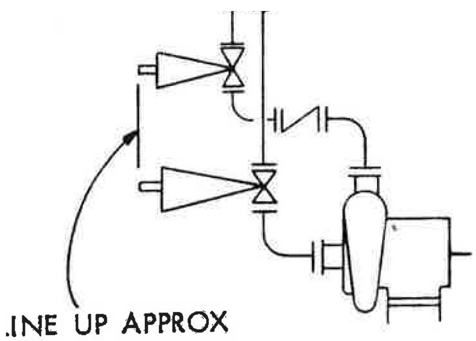
Figure 4-2-2.

The basic considerations for piping turbines are much like those for pun ps , Unfortunately, most tur b in e s have side connections, but we can, in most cases, at least specif y right- or left-band exhaust connections. This means that we have an initial choice of whether or not to have inlet and exhaust on the same side of the turbine. What governs the de c is ion ? The complexity of the pi ping . lithe piping is



GOOD USE WHERE DISCHARGE CHECK AND GATE VALVES CAN NOT BE FLANGED TOGETHER. (T. & G. FACING)

Figure 4-23.



FAIR: USE ONLY WHEN SUCTION VALVE MUST BE IN VERTICAL RUN. (OCCURS WHEN HANDWHEEL OF A LARGE VALVE WOULD BE TOO HIGH IF INSTALLED AS IN A.)

Figure 4-24.

simple ("inlet valve; exhaust valve; no relief valve), it will be best to have connecti.ons on the same side. If an APS is involved, a simple study should be made to see if both connections can be on the same side.

Let's look *at* steam piping to a turbine (Figure 4-25):

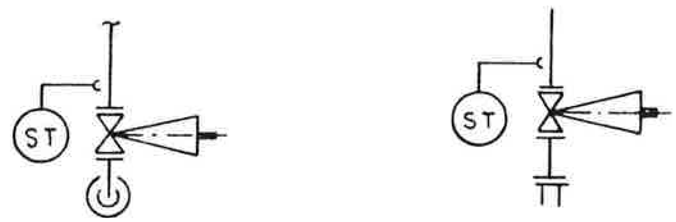


Figure 4-25.

These examples appear simple and, at a glance, reasonable, but this piping will be right alongside the turbine, the valve stern protrudes, the trap or blowdown valve will not completely drain the inlet piping, and there is no suitable location for a support.

Corre c.,.:; these faults, we have Figure 4-26:

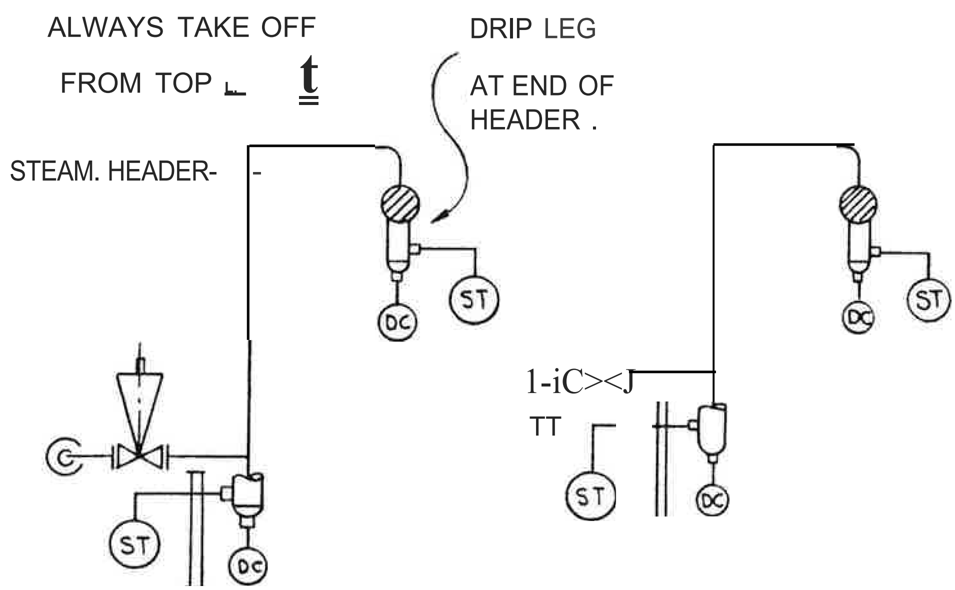


Figure 4-26.

The good features we find here also apply to A PS installations for single stage turbines (Figure 4-27):

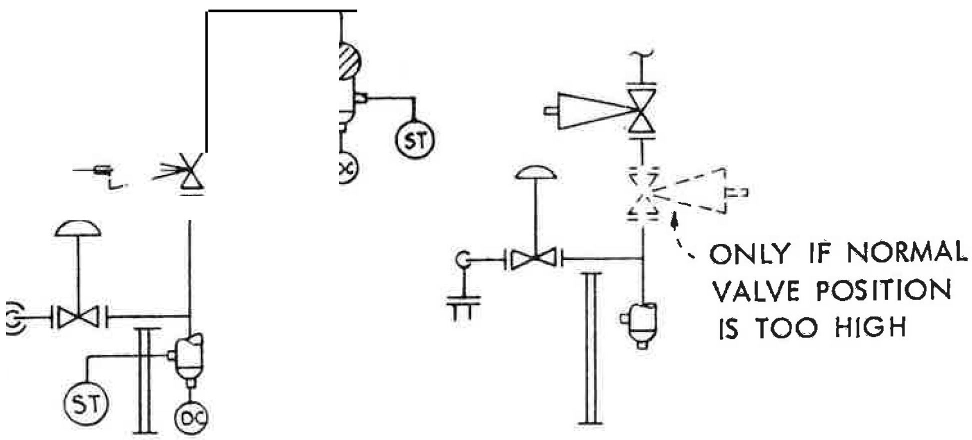


Figure 4-27.

These are good basic patterns for single stage turbines.

In the case of multi-stage steam turbines it is even more important to prevent carry-over of condensate. Water slugging will result in failure of the thrust bearings.

To accomplish this end, piping must have the following features: (see Figure 4-28.)

1. Steam header must have at its termination a drip leg for continuous removal of condensate.
2. Vertical steam line to turbine must have:
   a) A dial thermometer located at least one pipe diameter below branch to turbine, to indicate presence of water

b) A steam trap take-off below the sensing element of the dial thermometer

c) A two-inch minimum blow-down valve, easily accessible, to allow complete removal of condensate to an exhaust stack located far enough from valve for safe operation

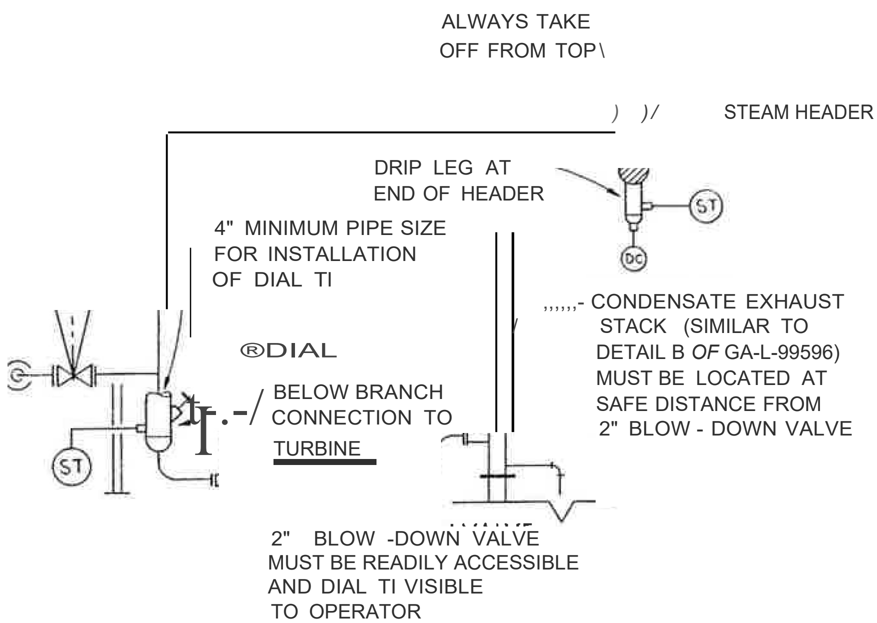


Figure 4-28.

What about exhaust piping? The problem is a bit different. We need not worry about drainage as much, since the exhaust valve will usually stand open and drain the line through the cas·e trap. This also keeps the case warm, avoiding thermal shock on startup.

The simplest choice may be appropriate (Figure 4-29), but if there is a support or anchor problem, or if the valve stem will project in an unsafe manner, we should consider the arrangement of Figure 4-30. This arrangement is also advisable in cases where a relief valve is involved (Figure 4-31).

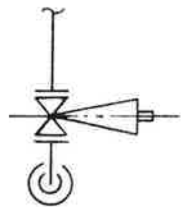


Figure 4-29.

Figure 4-30.

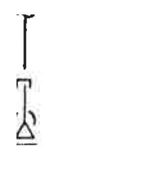


Figure 4-31.

In placing any of the · ive recommended piping around a turbine, keep in mind the problem of access to packing glands, lube oil connections, and the governor. A plan view of a proper piping arrangement might look like Figure 4-32 or, alternatively, Figure 4-33.

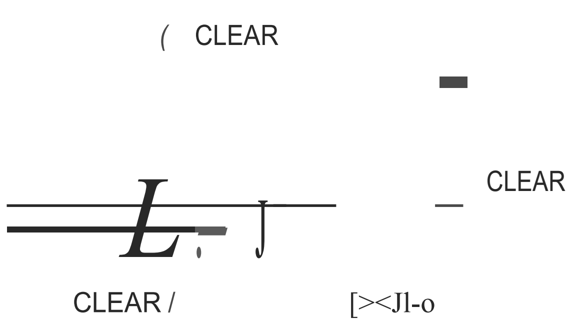


Figure 4-32.

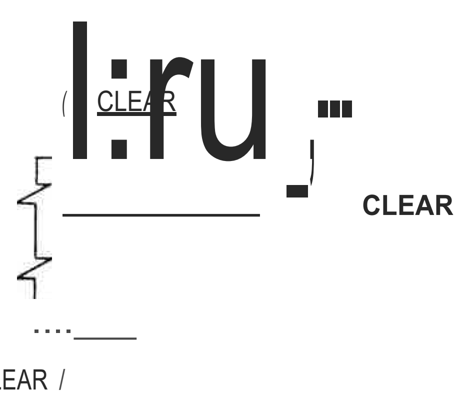


Figure 4-33.

-L 6 EXAMPLES OF PIPING ARRANGEMENTS

Drawings 21 E - L - 1 02 and 21 E - L - 7 3 show typical piping arrangements at centrifugal pumps for off-site location.

Figures 4-34, 4-35, 4-36, and 4-37 are photographs of scale models and show typical piping arrangements at centrifugal pumps for on-site location.

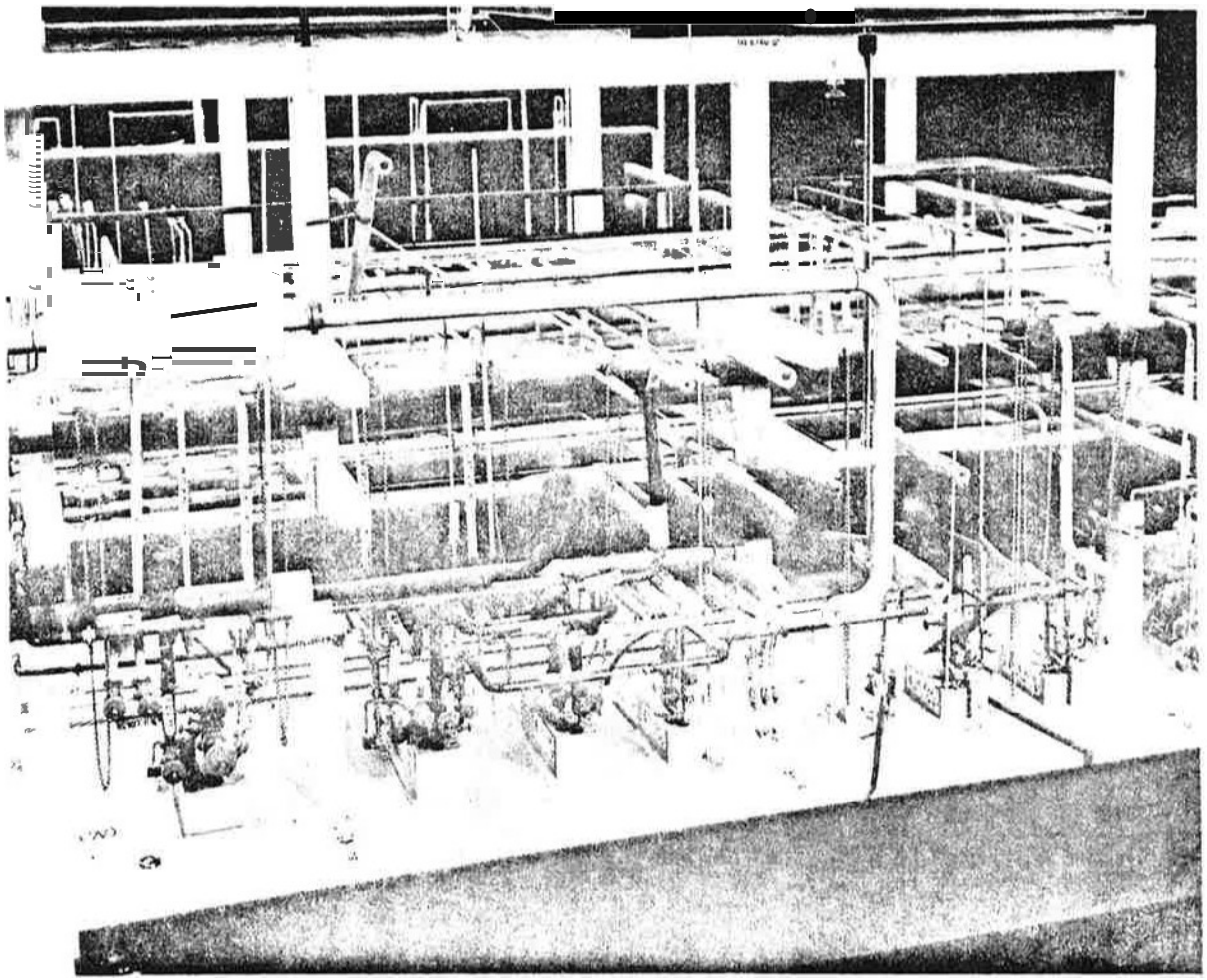


Figure 4-34

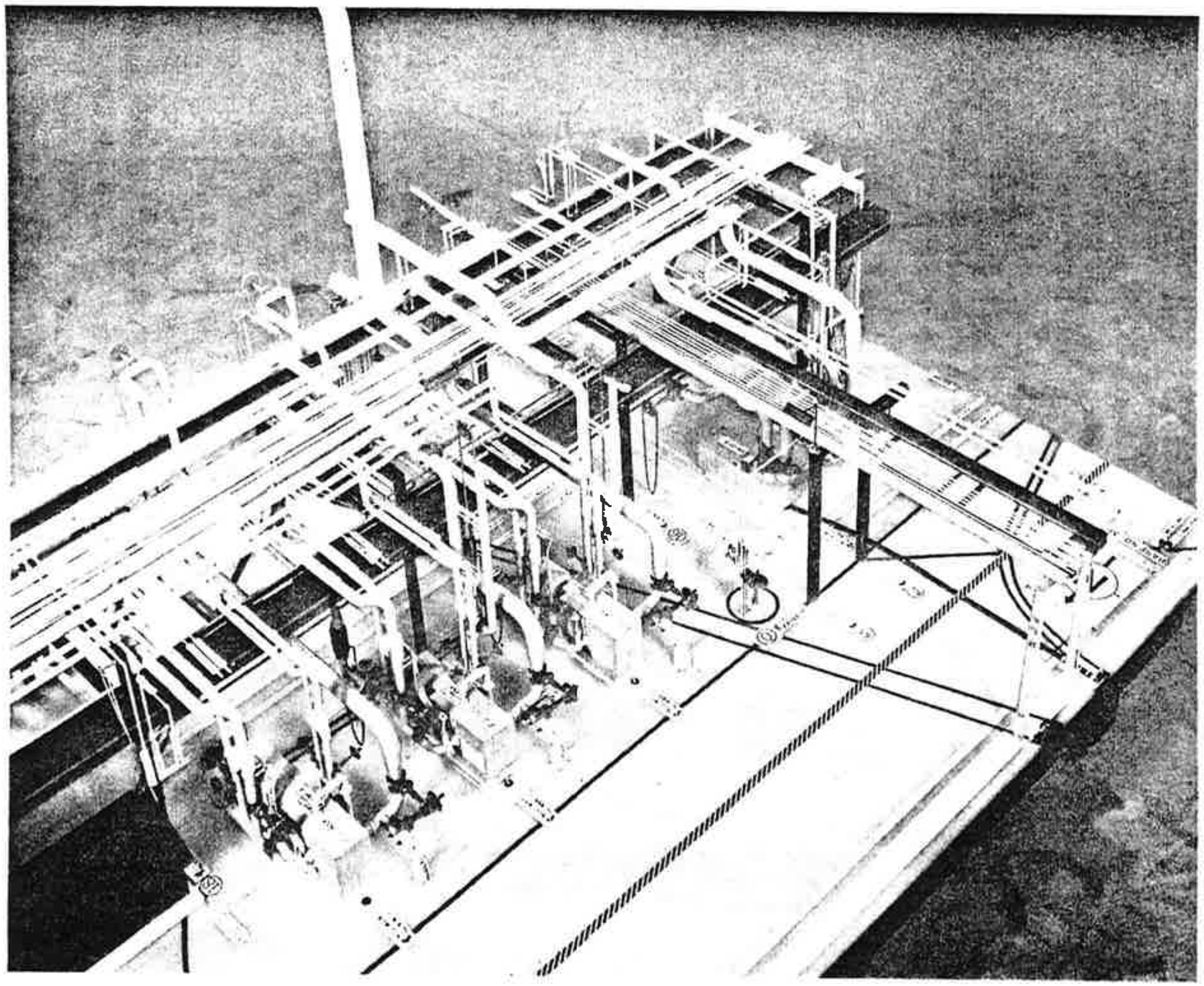


Figure 4-35.

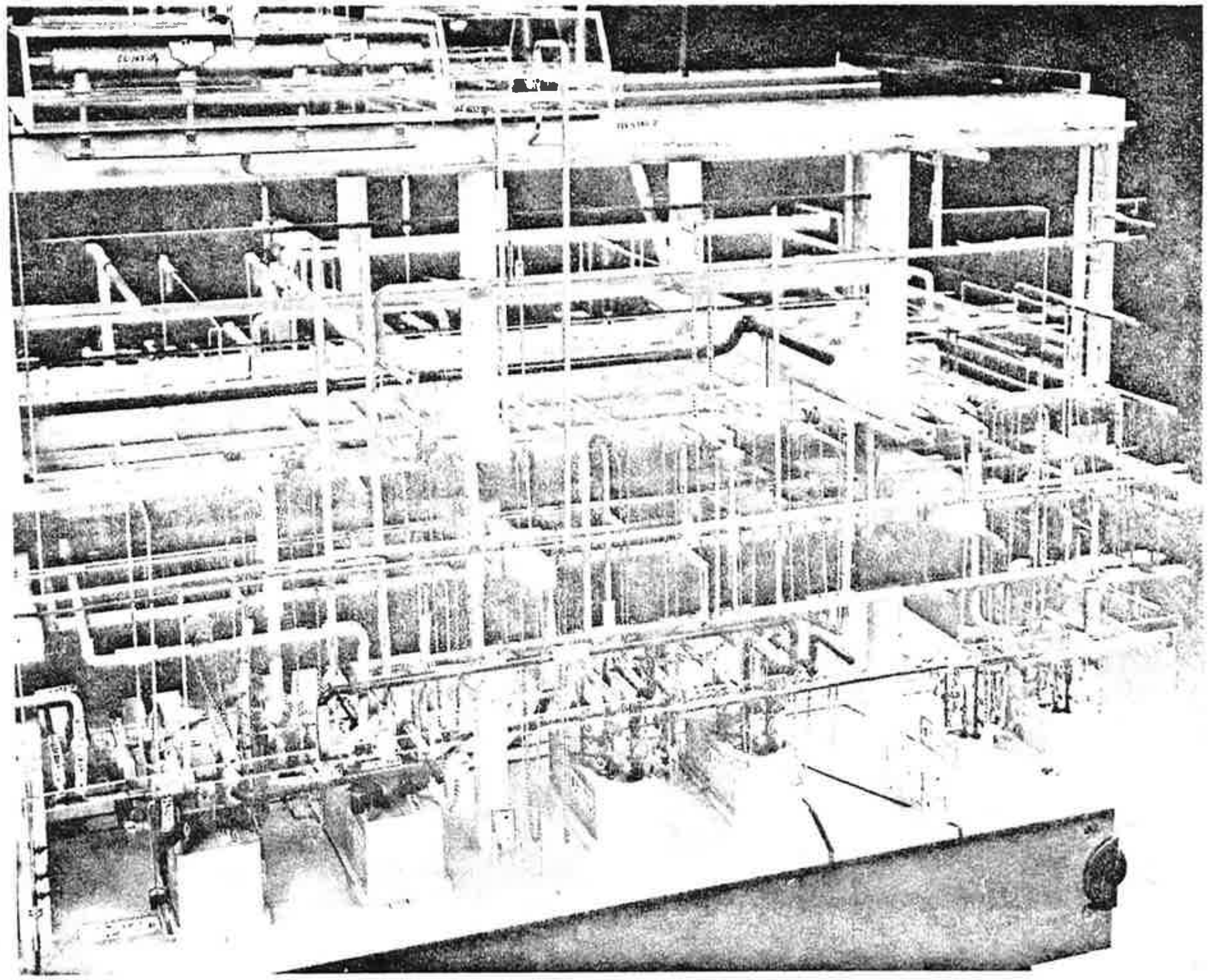


Figure 4-36.

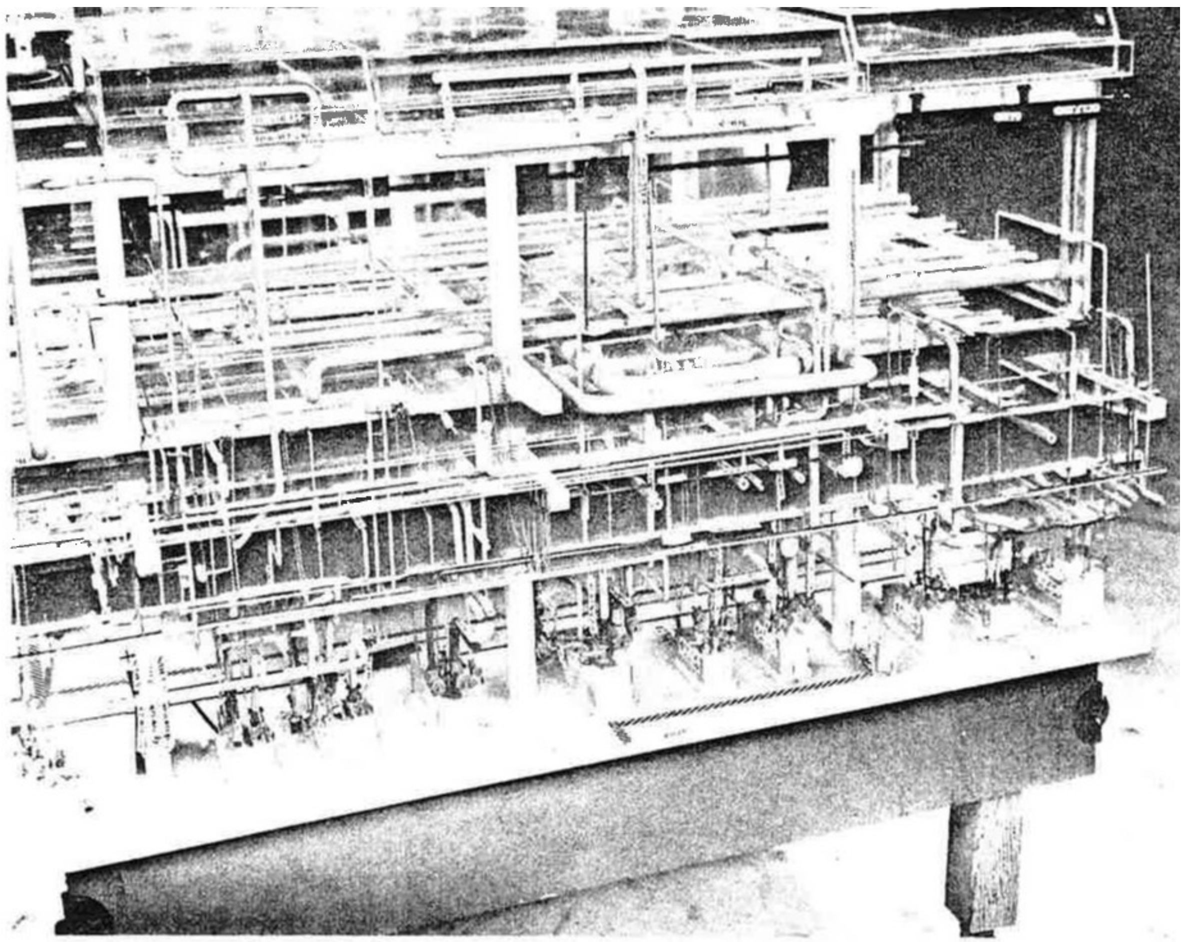
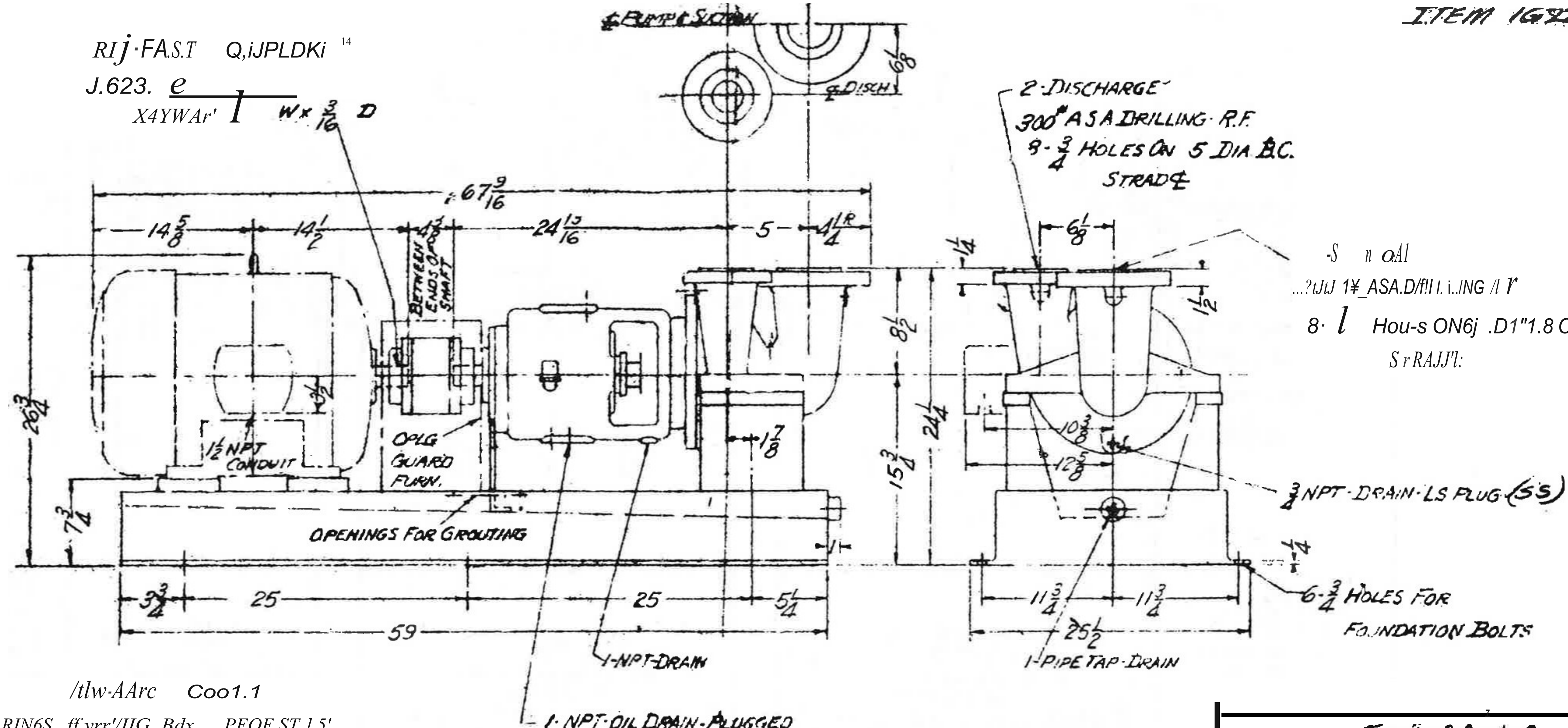


Figure 4-37.

ITEM 1G22



·Aa. /tlw·AArc Coo1.1

....IU':ARIN6S. ff.vrr'/IIG..Bdx PEOE.ST l.5'

M(.8r N/A!lVI.S-N£0 BY lw" SON-..>,VYOE ·

SEAL OIL PIPING BY W-S.

V. P.- 50-6-2A-1-0

EQUIP. NO. / J1 /

CERTIFIED FOR CONSTRUCTION

FOR TEXACO CO LOC. LOUISIANA PLANT

PROCESS SERVICE HEAVY ATM. GAS OIL

rn;:A{l.' G,.,tts. Esr Alo <9 Q M, .ft16'L.

;fb.,,.//cM/, CCIII1 DttlJ1,.T1r H,r;;,Lou r/11.:t ls

DRIVER MOTOR 30 HP 3550 SPEED No .3.?6:t

MOTOR CURRENT F.L. LOCKED ROTOR

Jvr , ..36Sv BA.II" 535-- D,/k'tr'" /0

BrotrE"l. a.r11U"lf Ah .S-0.39 ·SO<i·? =A IGl 2l ,1..

1YJ'N11 -,r,1.1· J04 SJIUe, rvMP8.3!7

.DAh' "1,3-w, .If –

☐.J.it AP EQi fAllfCATION AS If'(1A) MARKB>, a£V1SB> r:NIO. MOT :£01>·

0 121 APPIOYB> POI p,Ua1CA110N AS MARKED. IEVISEO DWG. IEQ'D. 'D

0 (j) NOT APflOVS>. IMSB> D)VG. IEQ

CHm

Da.e

K r£

IrbrA rION Cl:;oNTE. C'A-()CKWl t WHEN 1;.A,-.:, . .,11'-tP .Cov P L1Nv

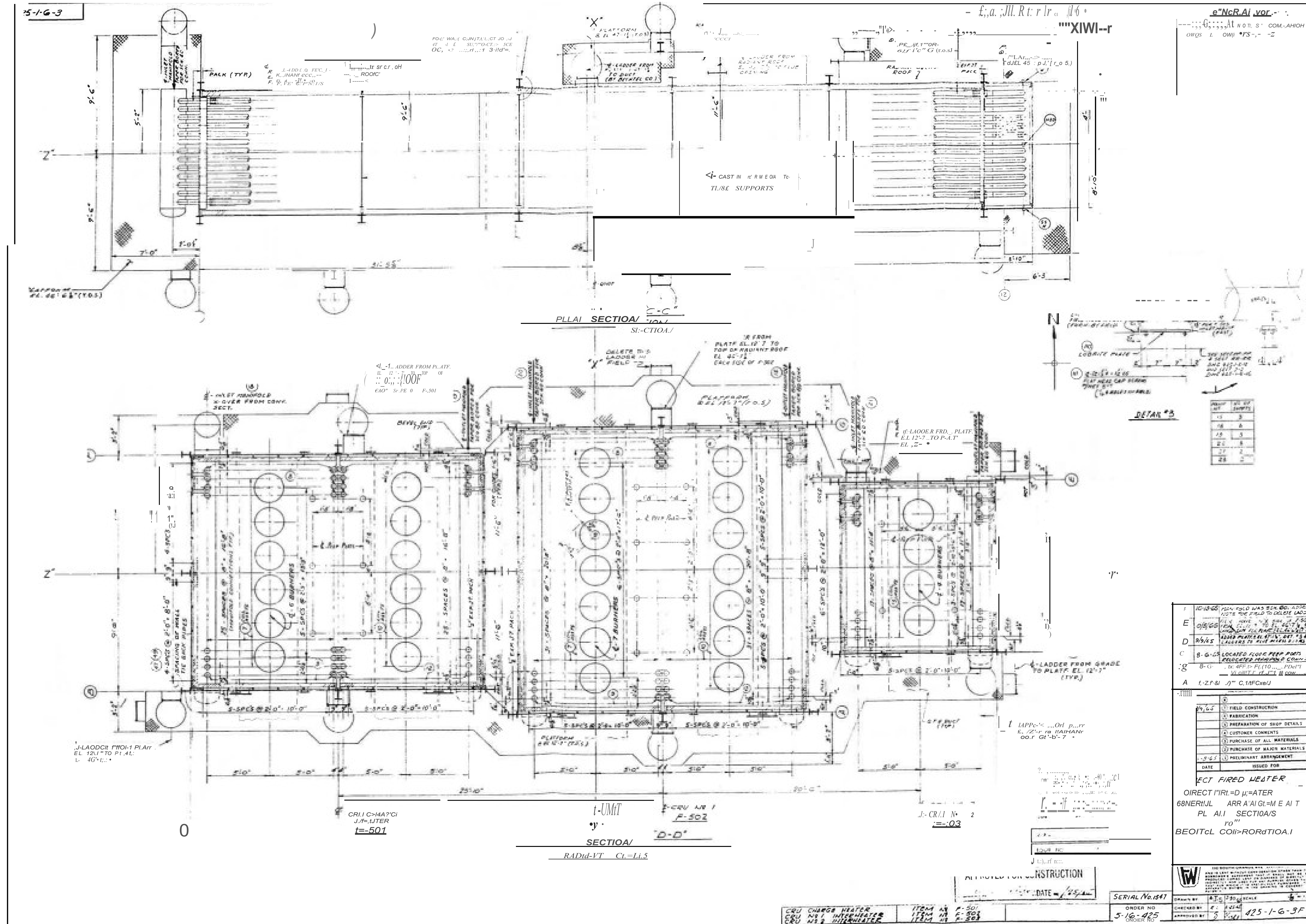
WILSON-SNYDER PUMPS

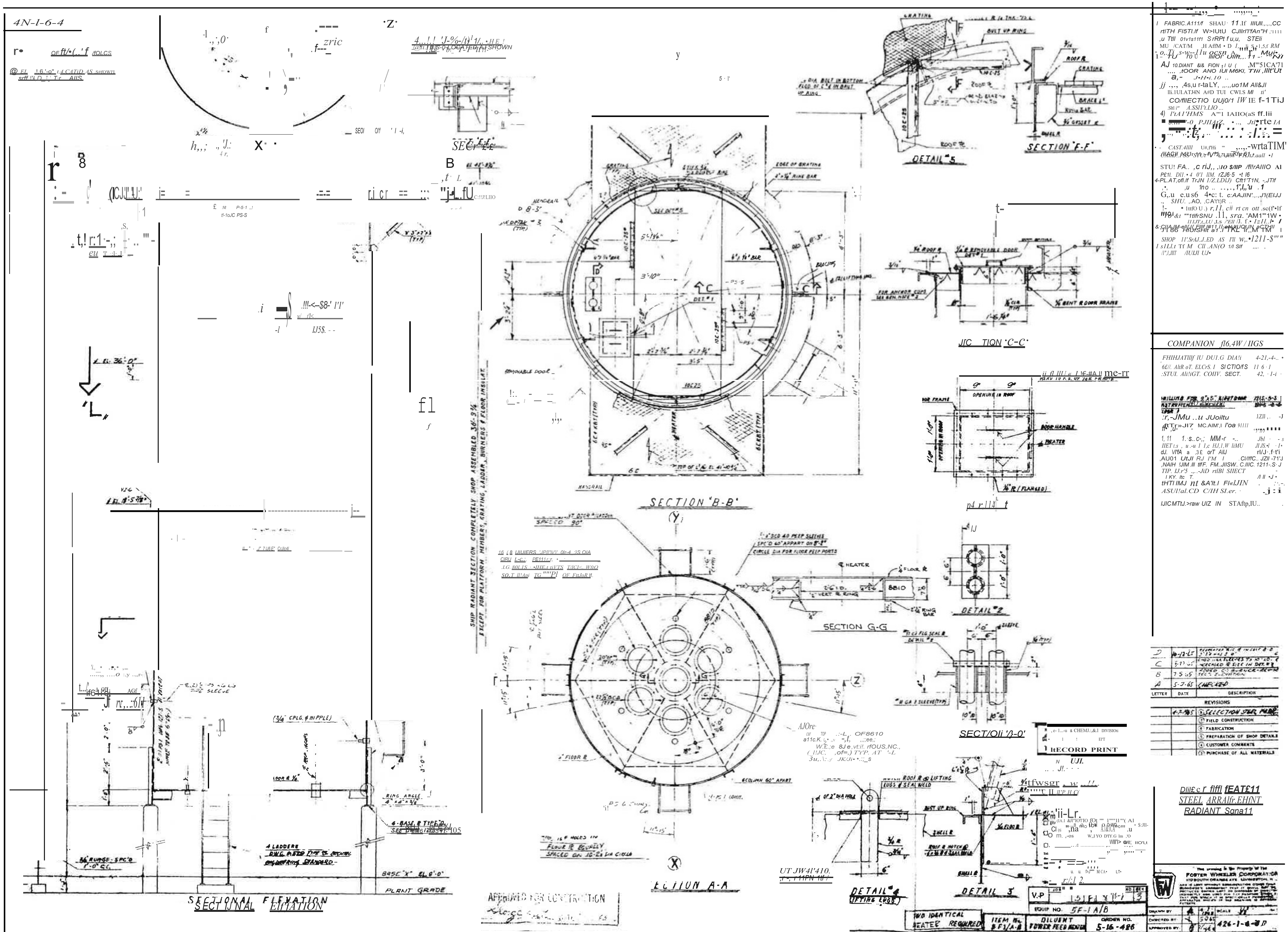
ovrt.1Nr 'Aw1NG

Zx3.Jt10 tSN•r. C A:di J-

DRAWN

?9·04/-2/ / B


PLAN SECTION
SECTION
RADIANT SECTION
CRU CHARGE HEATER F-501
F-502
DIRECT FIRED HEATER
ARRANGEMENT
BECHTEL CORPORATION
APPROVED FOR CONSTRUCTION
SERIAL No. 1547
ORDER NO 5-16-425
425-1-6-3F
CRU CHARGE HEATER ITEM No F-501
CRU No 1 INTERHEATER ITEM No F-502
CRU No 2 INTERHEATER ITEM No F-503
FIELD CONSTRUCTION
FABRICATION
PREPARATION OF SHOP DETAILS
CUSTOMER COMMENTS
PURCHASE OF ALL MATERIALS
PURCHASE OF MAJOR MATERIALS
PRELIMINARY ARRANGEMENT
DATE
ISSUED FOR
DETAIL "3"
CAST IN INTERMEDIATE TUBE SUPPORTS
LADDER FROM GRADE TO PLATF. EL. 12'-7" (TYP.)
5-SPCS @ 2'-0" = 10'-0"
6-8 BURNERS
6-7 BURNERS
6-6 BURNERS
31'-5 5/8"
25'-10"
DRAWN BY
CHECKED BY
APPROVED BY
SCALE


4N-1-6-4
SECTIONAL ELEVATION
BASE "X" EL. 0'-0"
PLANT GRADE
4 LADDERS
SHIP RADIANT SECTION COMPLETELY SHOP ASSEMBLED
EXCEPT FOR PLATFORM MEMBERS, GRATING, LADDER, BURNERS & FLOOR INSULAT.
SECTION "B-B"
SECTION A-A
SECTION G-G
DETAIL 5
SECTION "F-F"
SECTION "C-C"
DETAIL 2
DETAIL 3
DETAIL 4
(LIFTING LUGS)
HANDRAIL
REMOVABLE DOOR
COMPANION DRAWINGS
REVISIONS
FIELD CONSTRUCTION
FABRICATION
PREPARATION OF SHOP DETAILS
CUSTOMER COMMENTS
PURCHASE OF ALL MATERIALS
RECORD PRINT
APPROVED FOR CONSTRUCTION
TWO IDENTICAL HEATERS REQUIRED
EQUIP NO. 5F-1 A/B
DILUENT TOWER FEED HEATER
ORDER NO. 5-16-486
FOSTER WHEELER CORPORATION