Appendix B
Illustrative Plates

Plate No.	Title
B-1	Gate Machinery, Miter Gate, Panama Style, Machine Assembly
B-2	Gate Machinery, Miter Gate, Modified Ohio Type, Machine Assembly
B-3	Gate Machinery, Miter Gate, Ohio Type, Machine Assembly
B-4	Gate Machinery, Miter Gate, Direct Connected, Machine Assembly
B-5	Gate Machinery, Miter Gate, Spring -Type, Gate Strut
B-6	Gate Machinery, Miter Gate, Belleville(Disk), Spring-Type Gate Strut, Strut Assembly
B-7	Gate Machinery, Miter Gate, Belleville(Disk), Spring-Type Gate Strut, Spring Assembly
B-8	Direct Connected Linkage, Operating Torque
B-9	Direct Connected Linkage, Gate Torque About Pintle
B-10	Miter Gates, Ohio River Linkage, Effect of Submergence on Instantaneous Torque
B-11	Miter Gates, Modified Ohio Linkage, Effect of Submergence on Instantaneous Torque
B-12	Miter Gates, The Panama Canal, Miter Gate Operation, Closing
B-13	Miter Gates, The Panama Canal, Miter Gate Operation, Opening
B-14	Ohio River Type Linkage, Kinematics
B-15	Ohio River Type Linkage Load Calculation

B-16 Ohio River Type Linkage Load Calculation, cont.

B-17 Ohio River Type Linkage, Relative Effect of Gate Bottom Clearance on Torque

B-18 Ohio River Type Linkage Load, Effect of Submergence on Instantaneous Torque

B-19 Ohio River Linkage, Miter gate Machinery, Operating Data, Opening

B-20 Ohio River Linkage, Gate Torque About Pintle, Opening

B-21 Ohio River Linkage, Load Calculations

B-22 Ohio River Linkage, Miter gate Machinery, Operating Data, Closing

B-23 Ohio River Linkage, Gate Torque About Pintle, Closing

B-24 Ohio River Linkage, Temporal Loading

B-25 Ohio River Linkage, Temporal Loading, cont.

B-26 Panama Canal Linkage, Kinematics

B-27 Panama Canal Linkage, Kinematics, cont.

B-28 Panama Canal Linkage, Kinematics, Load Calculations

B-29 Panama Canal Linkage, Calculations

B-30 Panama Canal Linkage, Calculations, cont.

B-31 Panama Canal Linkage, Miter Gate Operation, Opening

B-32 Panama Canal Linkage, Miter Gate Operation, Closing

B-33 Panama Canal Linkage, Required Power, Opening

B-34 Panama Canal Linkage, Required Power, Opening, cont.

B-35 Panama Canal Linkage, Required Power, Opening, cont.

B-36 Panama Canal Linkage, Required Power, Opening, cont.

B-37 Panama Canal Linkage, Available Power, Opening

B-38 Panama Canal Linkage, Torque about Pintle

B-39 Direct Connected Linkage, Kinematics

B-40 Direct Connected Linkage, Load Calculation

B-41 Direct Connected Linkage, Load Calculation, Opening

B-42 Direct Connected Linkage, Load Calculation, cont.

B-43 Direct Connected Linkage, Load Calculation, Closing

B-44 Direct Connected Linkage, Miter Gate Machinery, Operating Data, Opening

B-45 Direct Connected Linkage, Miter Gate Machinery, Operating Data, Opening, cont.

B-46 Direct Connected Linkage, Miter Gate Machinery, Operating Data, Closing

B-47 Direct Connected Linkage, Miter Gate Machinery, Operating Data, Closing, cont.

B-48 Direct Connected Linkage, Miter Gate Machinery, Pump Capacity

B-49 Miter Gate Machinery, Hydraulic System Schematic, Inundated Locks

B-50 Miter Gate Machinery, Hydraulic System Schematic

B-51 Miter Gate Pintle Lubrication Details

B-52 Miter Gatch Latch

B-53 Miter Gate, Fixed Pintle Assembly Details

B-54 Miter Gate, Floating Pintle Assembly

B-55 Gate Machinery, Sector Gate, Cable-Type Drive Machine

B-56 Gate Machinery, Sector Gate, Rack and Pinion Drive Machinery

B-57 Gate Machinery, Ear Sector Gate, Direct Acting Hydraulic Cylinder

B-58 Lock - Vertical Lift Gate Machinery, Three Leaf System

B-59 Lock - Vertical Lift Gate Machinery, Two Leaf System

B-60 Lock - Vertical Lift Gate Machinery, Three Leaf Elevation

B-61 Lock - Vertical Lift Gate, Three Leaf Hoist Detail

B-62 Lock - Vertical Lift Gate Machinery, Two Leaf Elevation

B-63 Lock - Vertical Lift Gate, Two Leaf Hoist Detail

B-64 Lock - Vertical Lift Gate, Two Leaf Operating Procedure

B-65 Lock - Vertical Lift Gate, Two Leaf Reeved Hoist

B-66 Lock - Vertical Lift Gate, Tidal Gate Reeved Hoist

B-67 Tainter Valve, Wire Rope-Motor Drive, Plan & Elevation

B-68 Tainter Valve, Hydraulic Cylinder/Bellcrank, Plan & Elevation

B-69 Tainter Valve, Hydraulic Cylinder, Elevation

B-70 Tainter Valve, Hydraulic Cylinder/Direct-Acting, Elevation

B-71 Tainter Gate, Wire Rope-Motor Drive, General Arrangement

B-72 Tainter Gate, Wire Rope-Motor Drive, Plan

B-73 Tainter Gate, Wire Rope-Motor Drive, Elevations

B-74 Tainter Gate, Hydraulic Cylinder, General Arrangement

B-75 Tainter Gate, Hydraulic Cylinder, Mounting Arrangement

B-76 Tainter Gate, Hydraulic Cylinder, Hydraulic Schematic

B-77 Tainter Gate, Pocket Wheel, Elevation

B-78 Tainter Gate, Pocket Wheel, Details

B-79 Tainter Gate, Pocket Wheel, Gate Connection & Details

B-80 Vertical Lift Gate, Screw Stem Hoist, General Arrangement

B-81 Wicket Gate, Manual Operated, Plan and Sections

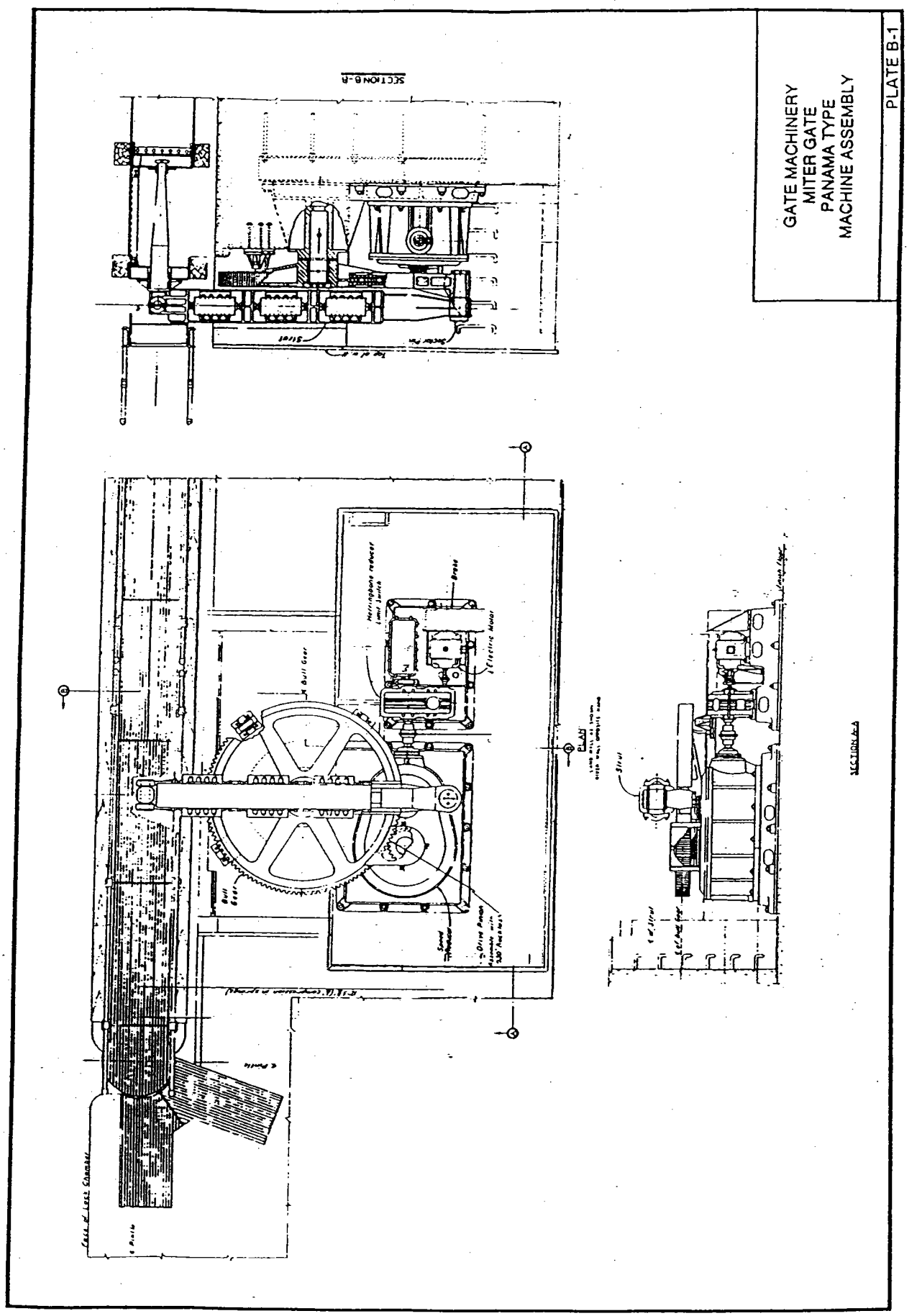
B-82 Wicket Gate, Hydraulic Cylinder Operated, Sections

B-83 Hinged Crest Gate, Torque Tube Gate - Section

B-84 Hinged Crest Gate, Torque Tube Gate - Elevation

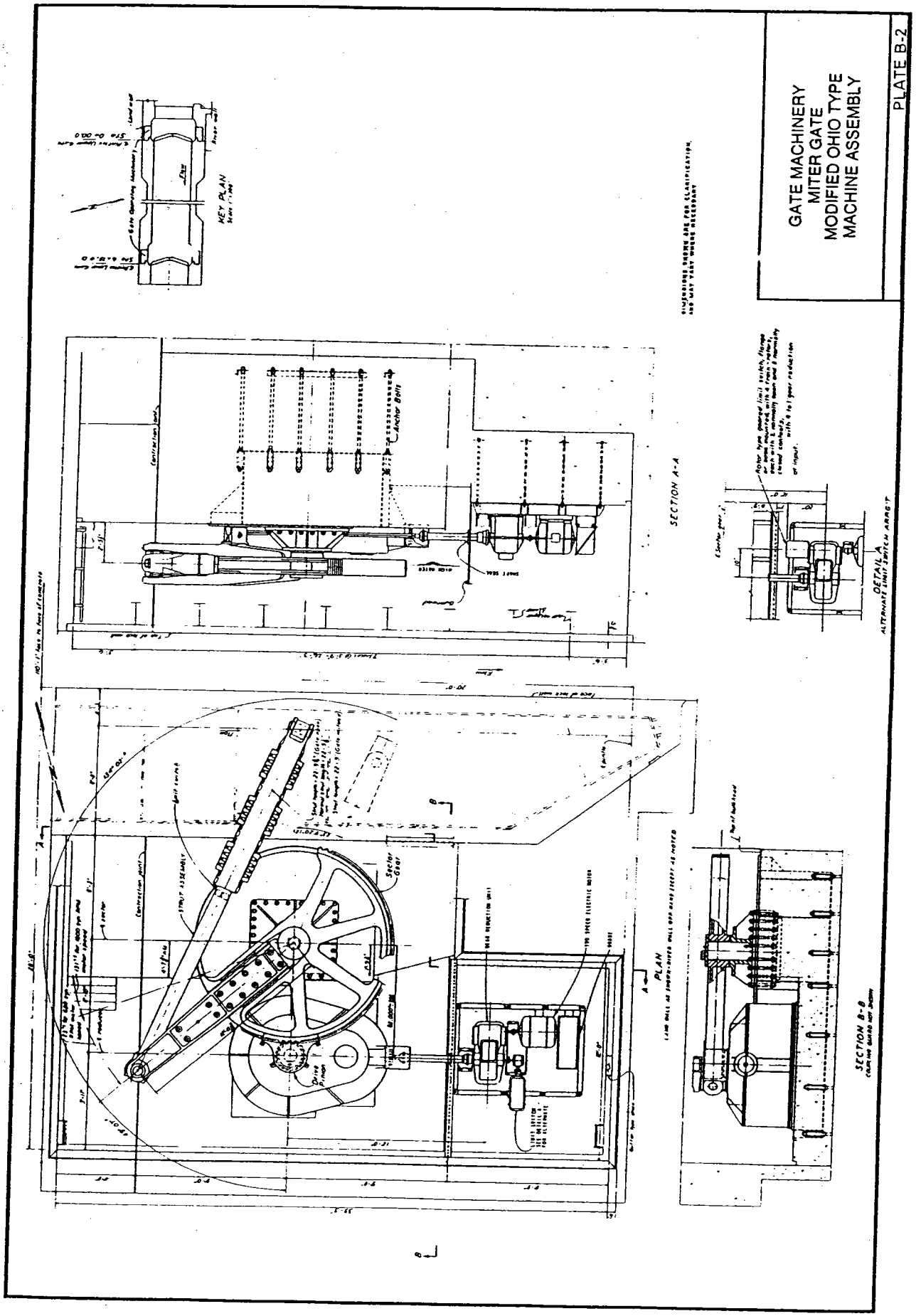
B-85 Submergible Tainter Gate, Plan and Sections

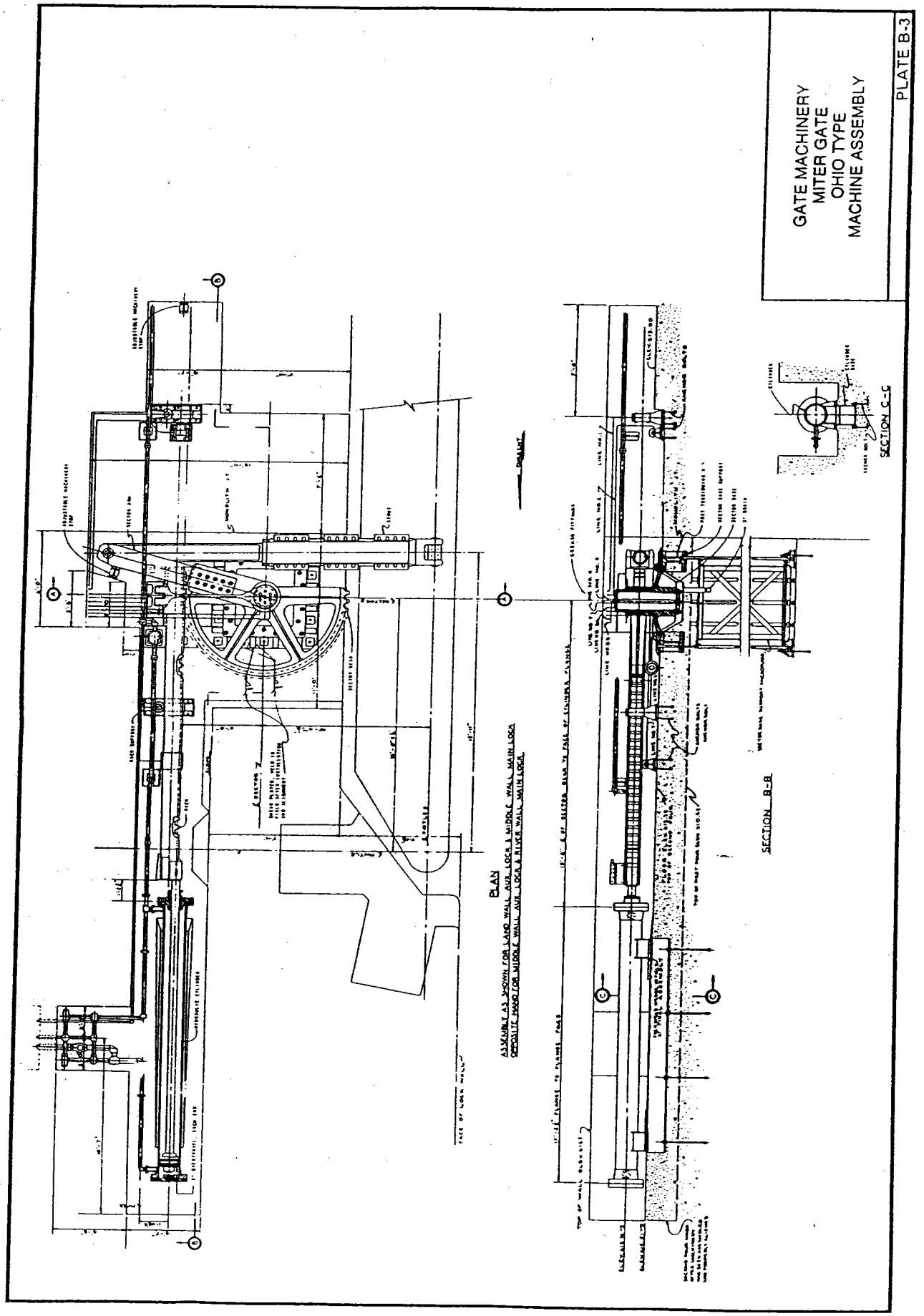
B-86 Electrical Control System, Sequence of Design Flowchart

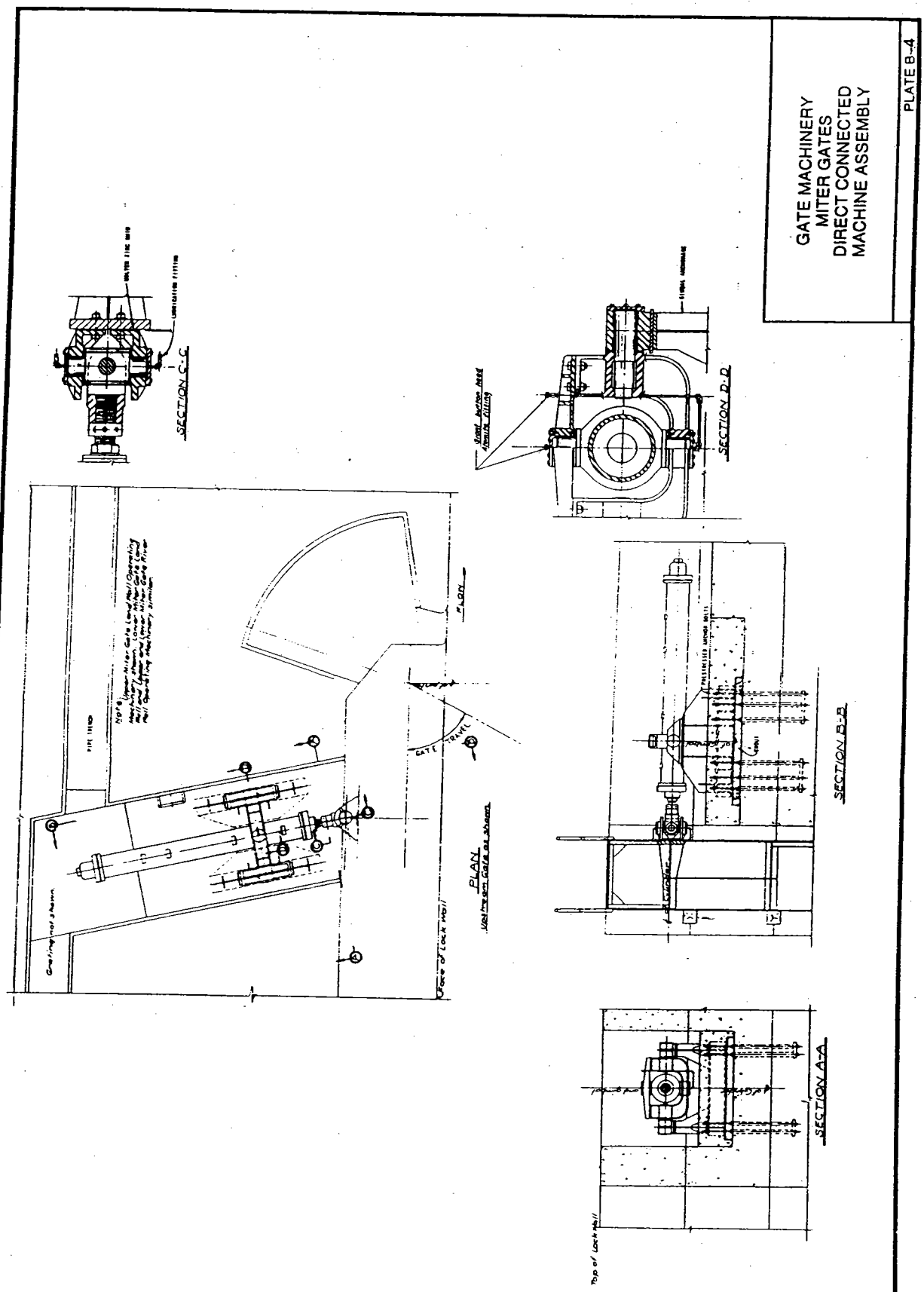


GATE MACHINERY
MITER GATE
PANAMA TYPE
MACHINE ASSEMBLY

PLATE B-1

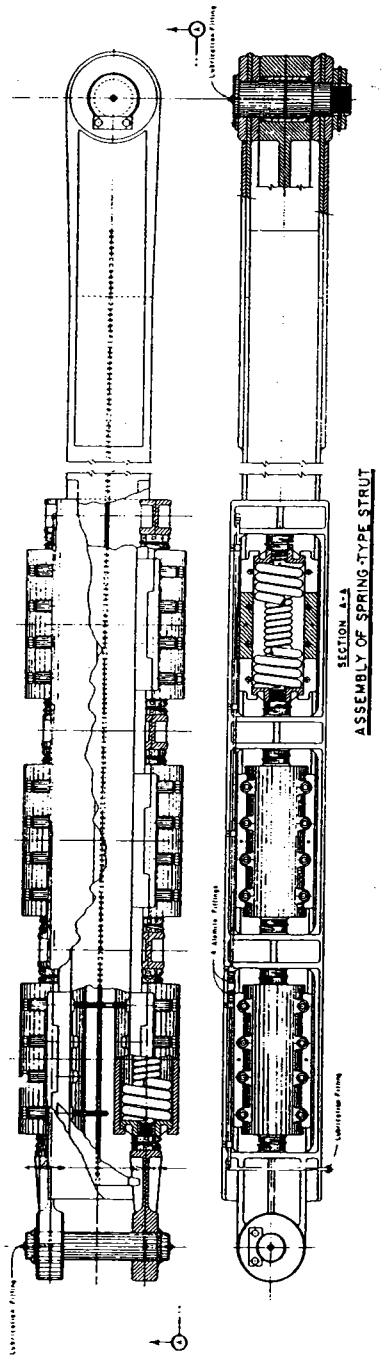

GATE MACHINERY
MITER GATE
MODIFIED OHIO TYPE
MACHINE ASSEMBLY
PLATE B-2
KEY PLAN
SECTION A-A
Anchor Bolts
DETAIL A
ALTERNATE LIMIT SWITCH ARRGT
PLAN
SECTION B-B


GATE MACHINERY
MITER GATE
OHIO TYPE
MACHINE ASSEMBLY
PLATE B-3
PLAN
SECTION B-B
SECTION C-C



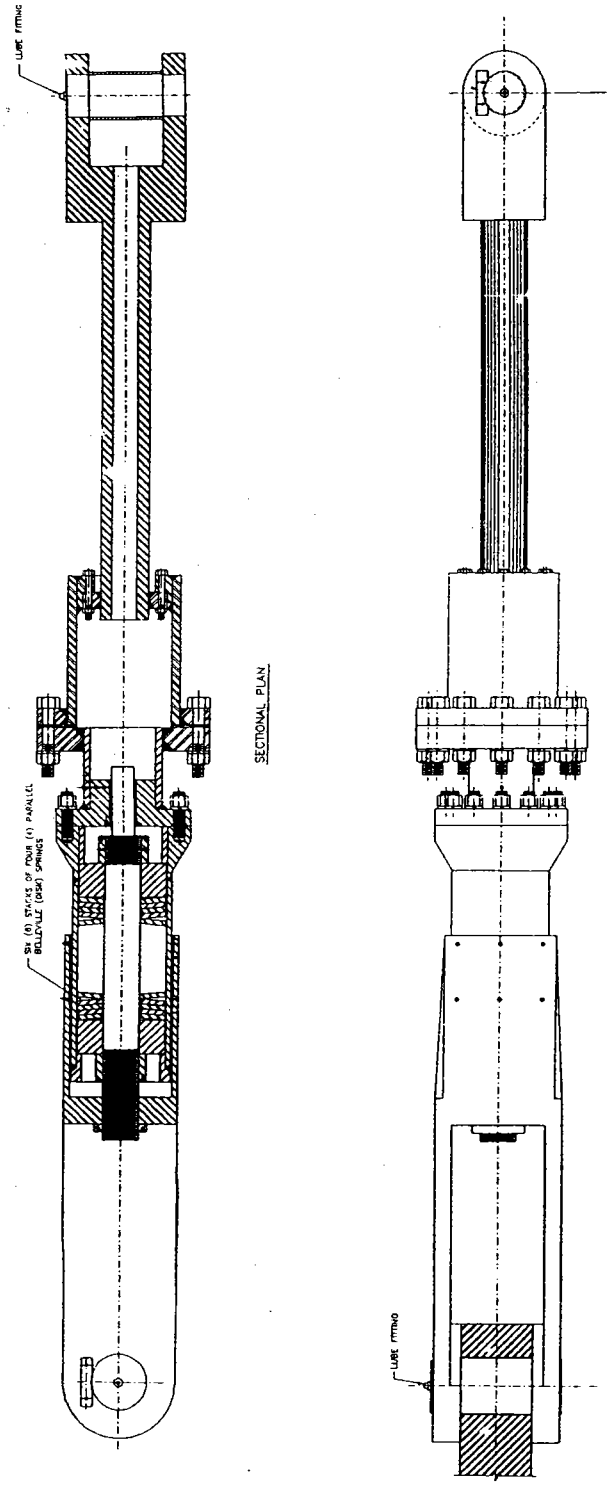
GATE MACHINERY
MITER GATES
DIRECT CONNECTED
MACHINE ASSEMBLY

PLATE B-4



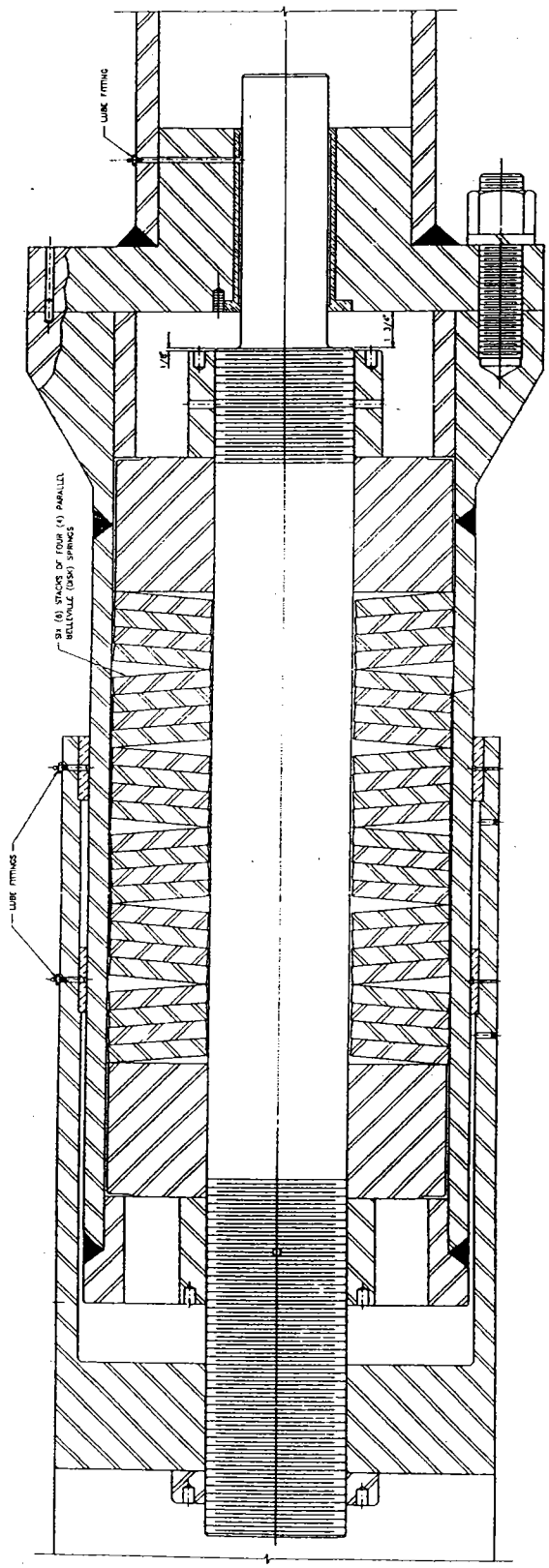
GATE MACHINERY
MITER GATE
SPRING-TYPE
GATE STRUT

PLATE B-5



GATE MACHINERY
MITER GATE
BELLEVILLE (DISK)
SPRING-TYPE GATE STRUT
STRUT ASSEMBLY

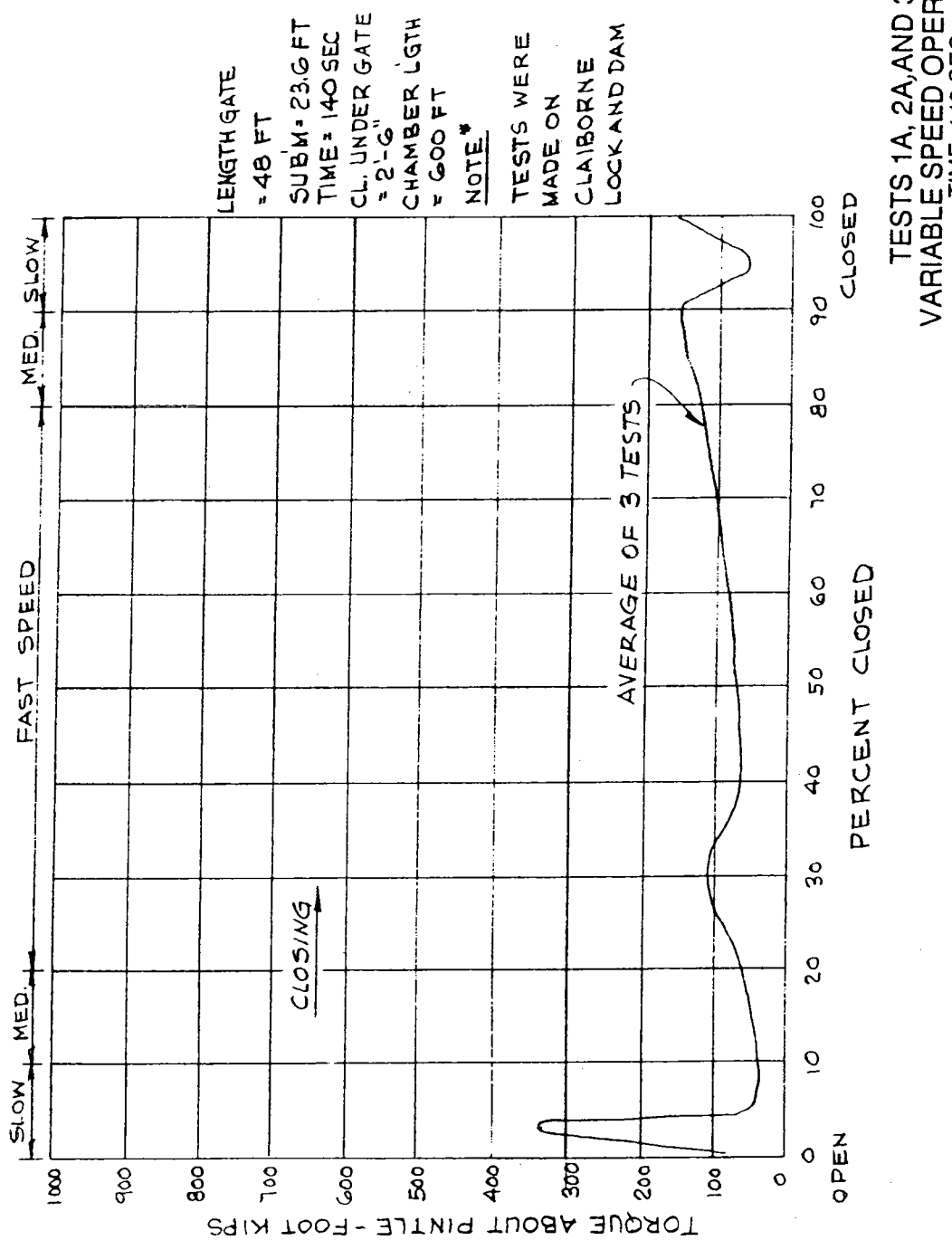
PLATE B-6



SECTIONAL ELEVATION
STRUT SPRING ASSEMBLY

GATE MACHINERY
MITER GATE
BELLEVILLE (DISK) SPRING-TYPE GATE STRUT SPRING ASSEMBLY

PLATE B-7



TESTS 1A, 2A, AND 3A
VARIABLE SPEED OPERATION
TIME, 140 SEC

PLATE B-8

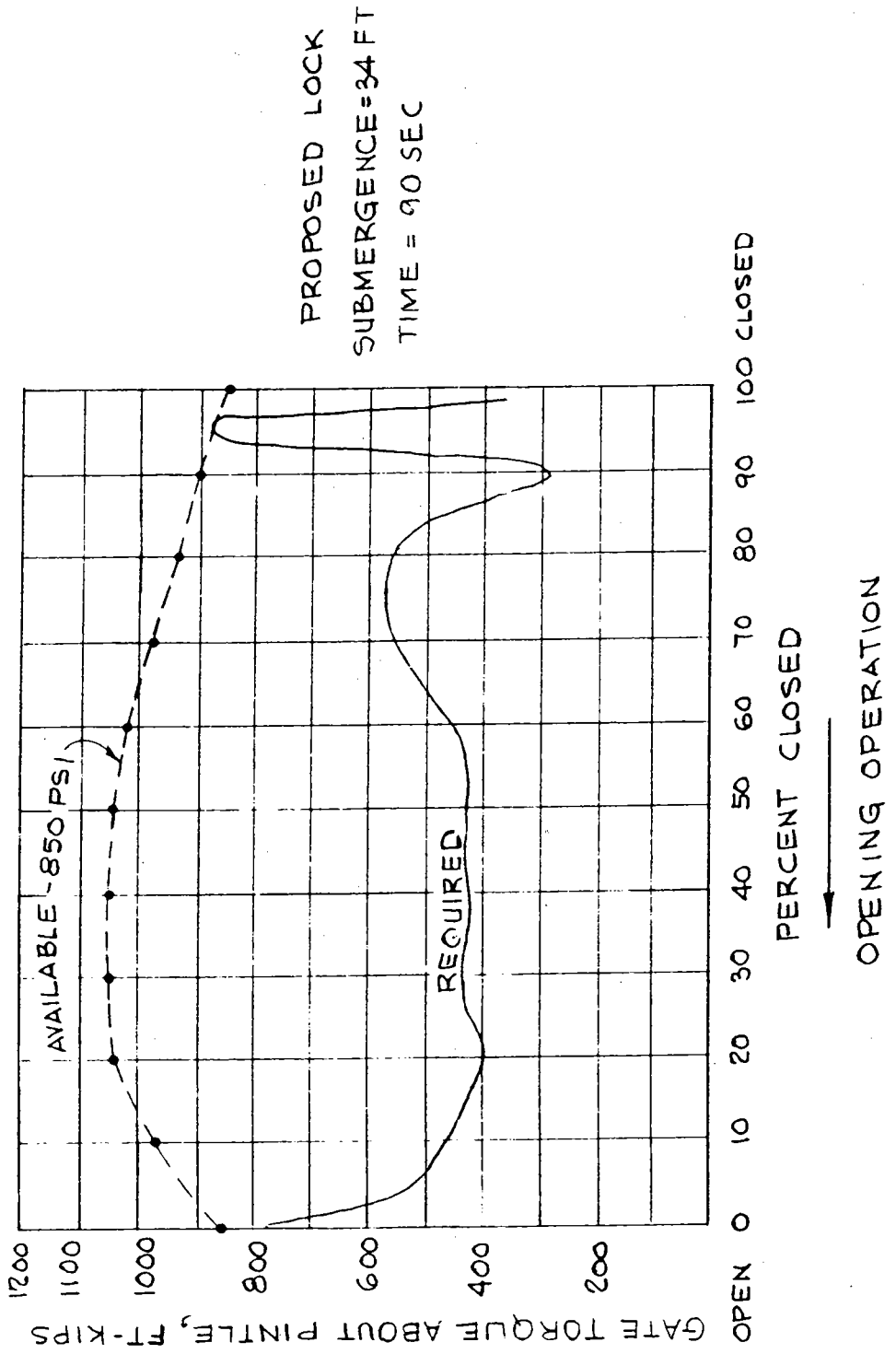
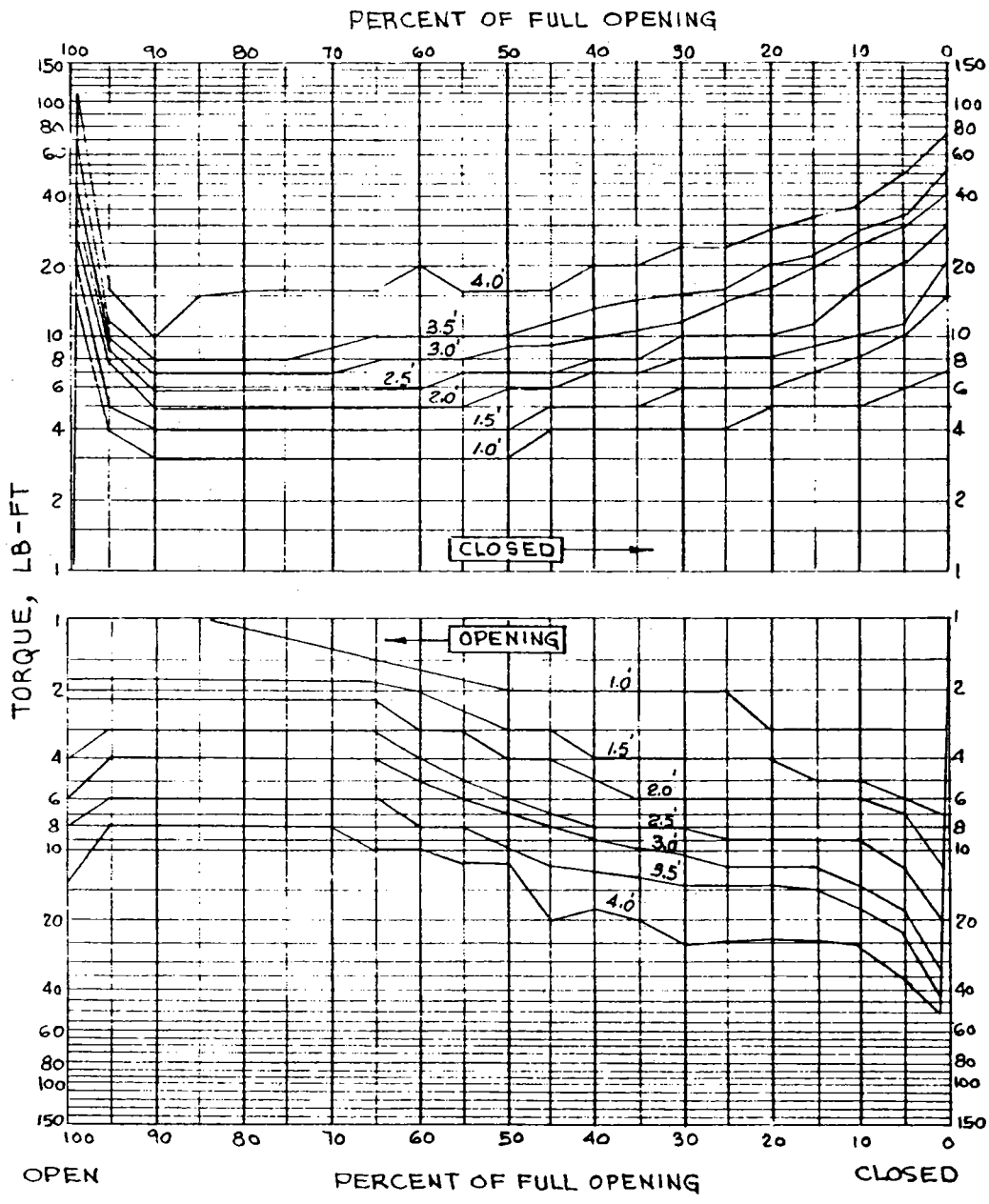

PROPOSED LOCK
SUBMERGENCE=34 FT
TIME = 90 SEC
AVAILABLE - 850 PSI
REQUIRED
GATE TORQUE ABOUT PINTLE, FT-KIPS
1200
1100
1000
800
600
400
200
OPEN
0
10
20
30
40
50
60
70
80
90
100 CLOSED
PERCENT CLOSED
OPENING OPERATION

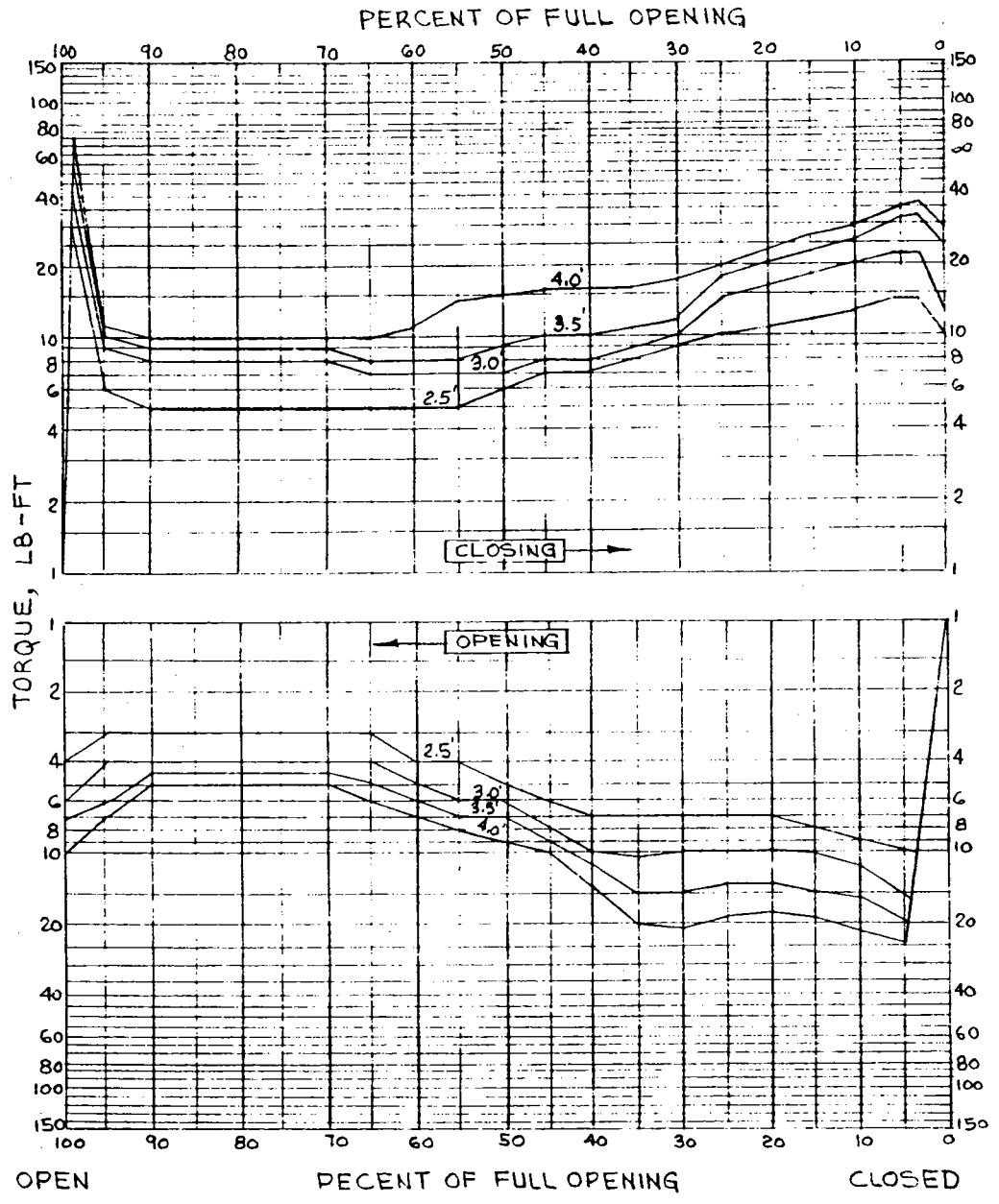
PLATE B-9



SUBMERGENCE - AS SHOWN IN FEET
CHAMBER LENGTH
UPSTREAM - 25 FT
DOWNSTREAM - 25 FT
BOTTOM CLEARANCE 0.25 FT

MITER GATES
OHIO RIVER LINKAGE
EFFECT OF SUBMERGENCE
ON INSTANTANEOUS TORQUE
OPERATING TIME, 20.1 SEC

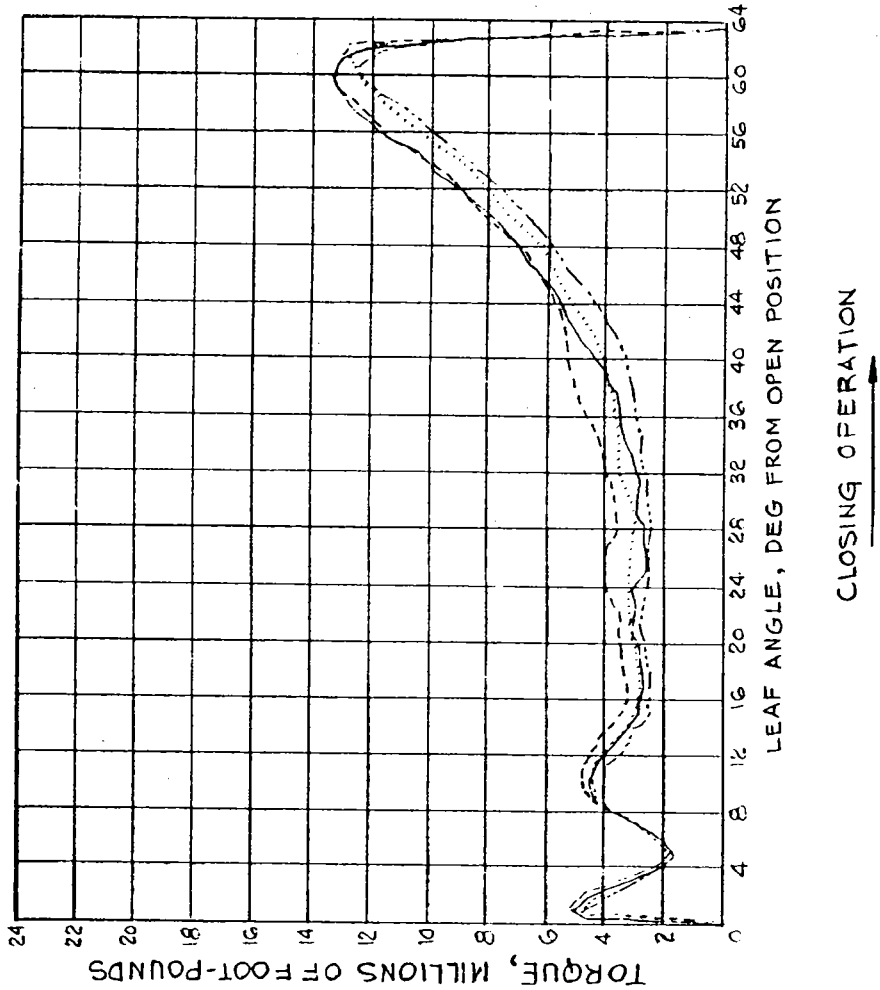
PLATE B-10



SUBMERGENCE - AS SHOWN IN FEET
BOTTOM CLEARANCE 0.25 FT

MITER GATES
MODIFIED OHIO RIVER LINKAGE
EFFECT OF SUBMERGENCE
ON INSTANTANEOUS TORQUE
OPERATING TIME, 20.1 SEC
CHAMBER LENGTHS, 30 FT

PLATE B-11



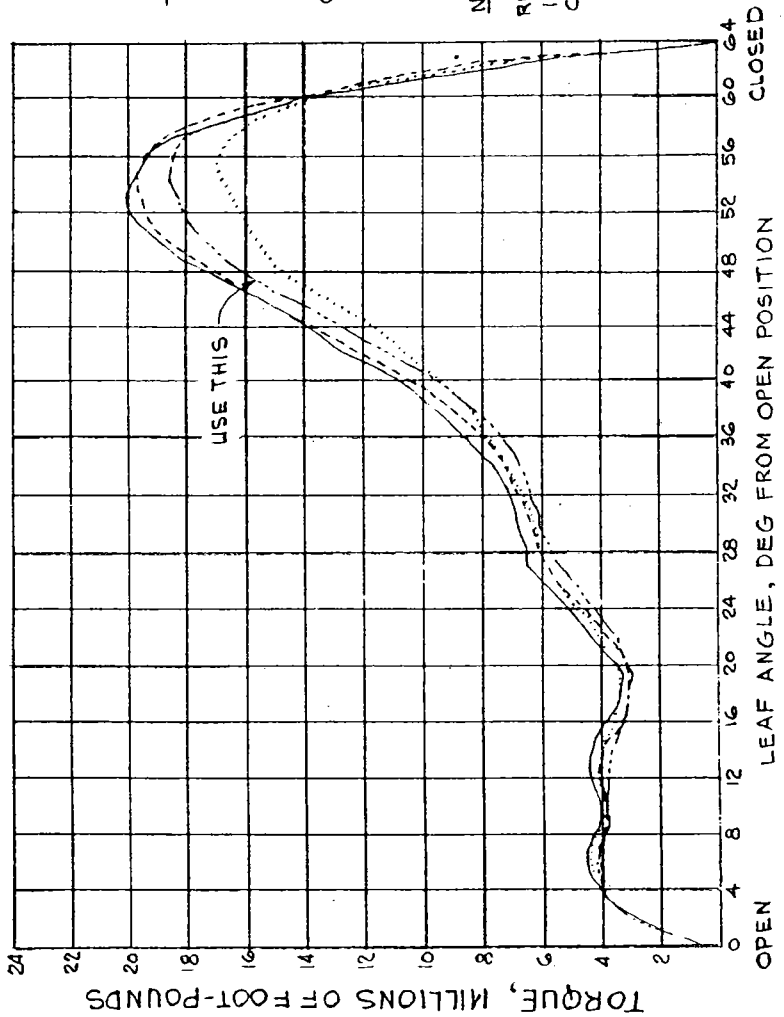
BASE CONDITIONS

OPERATING TIME: 2 MIN
SUBMERGENCE: 82.5 FT
CHAMBER LENGTHS:
UPSTREAM: 1,105 FT
DOWNSTREAM: 200 FT

NOTE:
CURVES SHOW VARIATION OF RESULTS OBTAINED UNDER IDENTICAL OPERATING CONDITIONS.

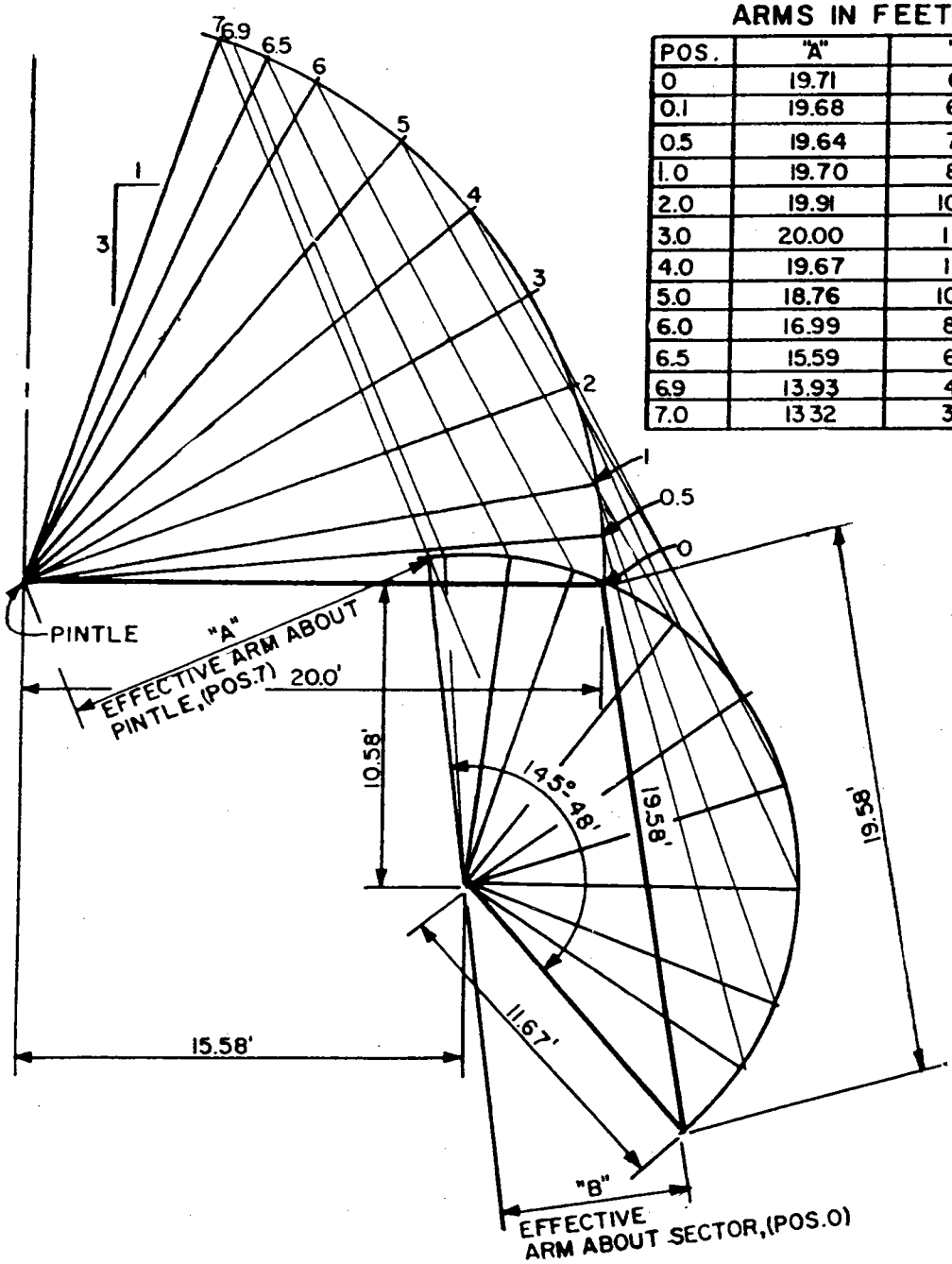
MITER GATES
THE PANAMA CANAL
SPECIAL ENGINEERING DIVISION
BALBOA HEIGHTS, CANAL ZONE
THE THIRD LOCKS PROJECT
HYDRAULIC MODEL Y
MITER GATE OPERATION
THIRD LOCKS TEST CURVES

PLATE B-12



MITER GATES
THE PANAMA CANAL
SPECIAL ENGINEERING DIVISION
BALBOA HEIGHTS, CANAL ZONE
THE THIRD LOCKS PROJECT
HYDRAULIC MODEL Y
MITER GATE OPERATION
THIRD LOCKS TEST CURVES

PLATE B-13



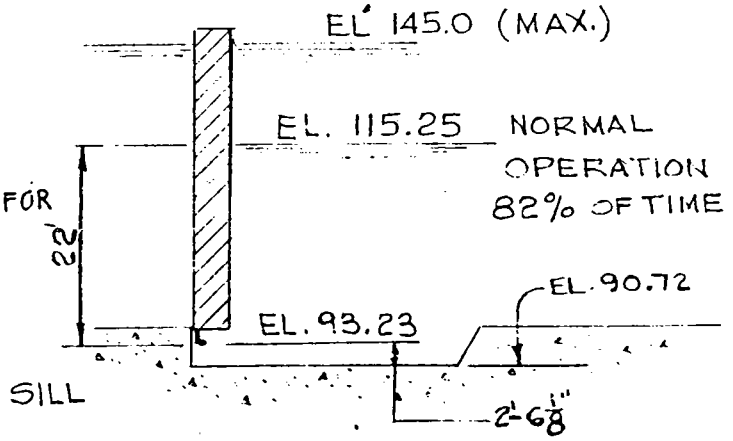
EFFECTIVE MOMENT ARMS IN FEET

POS.	"A"	"B"
0	19.71	6.16
0.1	19.68	6.46
0.5	19.64	7.57
1.0	19.70	8.73
2.0	19.91	10.48
3.0	20.00	11.47
4.0	19.67	11.62
5.0	18.76	10.80
6.0	16.99	8.63
6.5	15.59	6.70
6.9	13.93	4.19
7.0	13.32	3.20

KINEMATICS
OHIO RIVER TYPE LINKAGE

PLATE B-14

ALL INFORMATION IS THE SAME AS THAT FOR ALICEVILLE LOCK AND DAM



OPENING OPERATION (NORMAL OPERATION 82% TIME)

OPENING TIME 90 SEC ($1\frac{1}{2}$ MIN)
UNDERGATE CLEARANCE = $2'-6\frac{1}{8}''$
SUBMG (ASSUMED) = 22 FT
CYLINDER DIAM = 12" I.D.
ROD DIAM. = 5.0'
STROKE = $12'-8\frac{5}{8}''$
OHIO TYPE LINKAGE

* TECHNICAL REPORT No. 2-651, JUNE '64,

NOMENCLATURE		WES MODEL		PROPOSED LOCK ALICEVILLE		FACTOR
LENGTH GATE	L	3.0	L_1	60.0 FT	$\frac{L_1}{L}$	= 20
SUBMG	S S_2	2.0 * (SEE PLATE B-64) 40.0	S_1	22.0	$\frac{S_1}{S_2}$	= 0.55
TIME	T T_2	20.1 SEC'S * (SEE PLATE B-64) 90.0 SEC	T_1	90.0		
ARC OF TRAVEL GATE	K	71.567	K_1	71.565	$\frac{T_2}{T_A}$	$= \frac{90}{90}$

FACTOR $L_1 \div L = 60 \div 3 = 20$
S_1 = SUB. = 22 FT $S_2 = S\,(L_1/L) = 2 \times 20 = 40$
T_1 = 90 SEC ADJ. $T_2 = T\sqrt{L_1/L} = 20.1\sqrt{20} = 20.1 \times 4.47 = 90$

PLATE B-15

ANGULAR TRAVEL $T_A = T_1\left(\frac{K}{K_1}\right) = 90\left(\frac{71.565}{71.565}\right) = 90$

FACTOR $\frac{T_2}{T_A} = \frac{90}{90} = 1$

$P_1 = P_0\left(\frac{L_1}{L}\right)^4\left(\frac{S_1}{S_2}\right)^{2.1}\left(\frac{T_2}{T_A}\right)^{1.0} \times$ BOTTOM EFFECT FACTOR

$= P\,(20)^4(0.55)^{2.1}\left(\frac{90}{90}\right)^{1.0} \times 1.23 = P \times 160{,}000 \times 0.285 \times 1 \times 1.23$

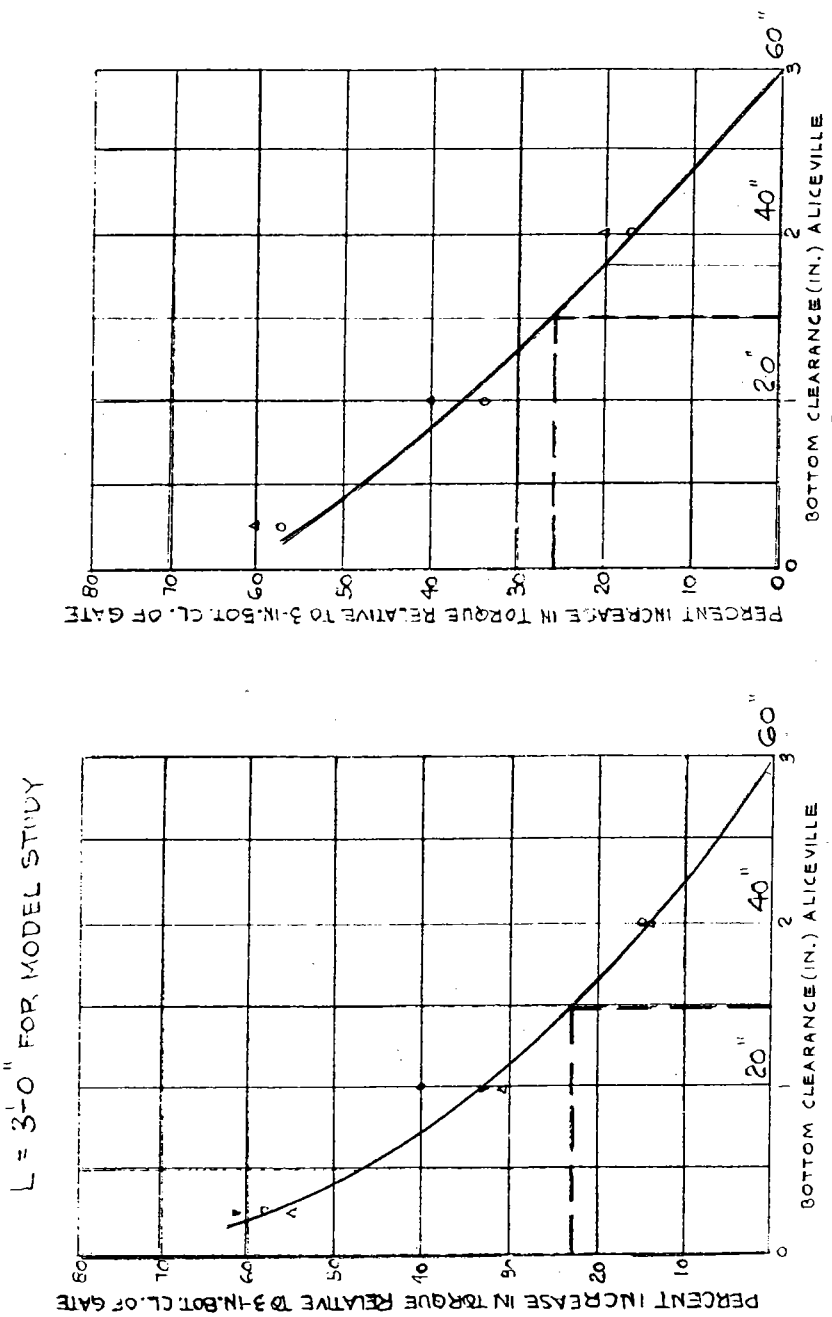
$= P \times 45{,}600 \times 1.23$

$= P \times 56{,}100$

EFFECT OF BOTTOM CLEARANCE SEE PLATE 52 OF REPORT 2-651 OPENING CYCLE - INCREASE TORQUE 23% FACTOR 1.23, CLOSING CYCLE - INCREASE TORQUE 27% FACTOR 1.27

AVAILABLE TORQUE BASED ON 900-PSI NET CYL. PRESS.

PLATE B-16



$\frac{L_1}{L} = \frac{60}{3} = 20:1$ ADJUST BOTTOM CLEARANCE IN RELATION TO SCALE RATIO

OPENING CYCLE

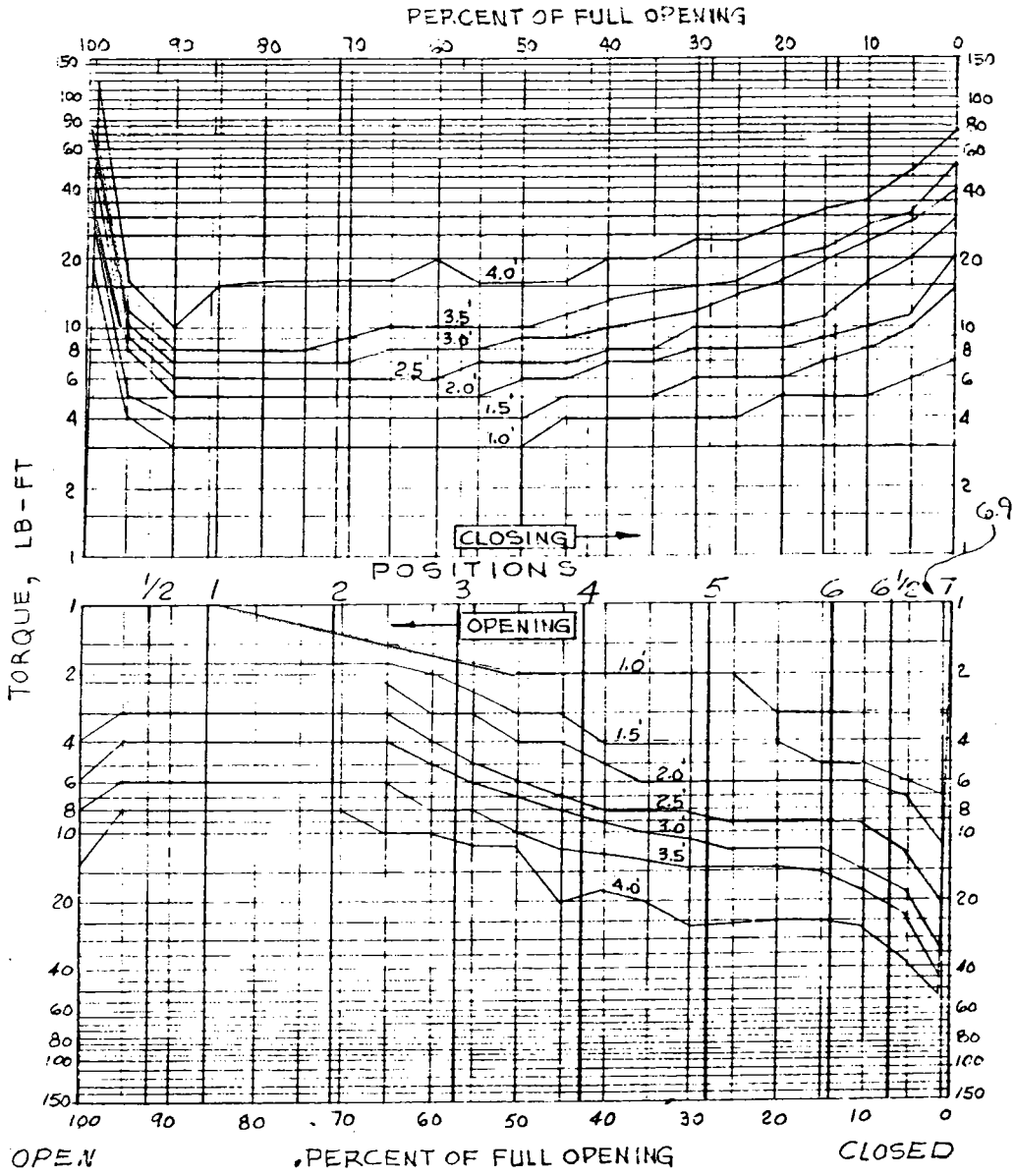
CLOSING CYCLE

CLEARANCE UNDER ALICEVILLE GATE = 2'-6 1/8" (30 1/8")

SYMBOL	OPERATING TIME SEC	TORQUE LB-FT (3-IN BOT. CLEAR) OPENING CYCLE	CLOSING CYCLE
○	13.4	40	35
△	20.1	29	20
▽	26.8	18	12

RELATIVE EFFECT OF GATE BOTTOM CLEARANCE ON TORQUE
4.0-FT SUBMERGENCE

PLATE B-17



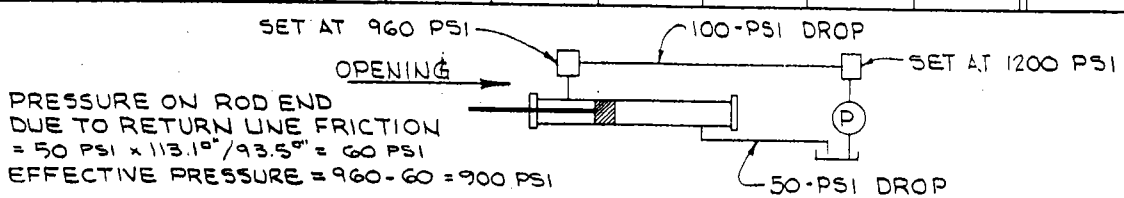
SUBMERGENCE-AS SHOWN IN FEET
CHAMBER LENGTH
UPSTREAM - 25 FT
DOWNSTREAM - 25 FT
BOTTOM CLEARANCE 0.25 FT

OHIO RIVER LINKAGE
EFFECT OF SUBMERGENCE
ON INSTANTANEOUS TORQUE
OPERATING TIME, 20.1 SEC

PLATE B-18

OPENING OPERATION

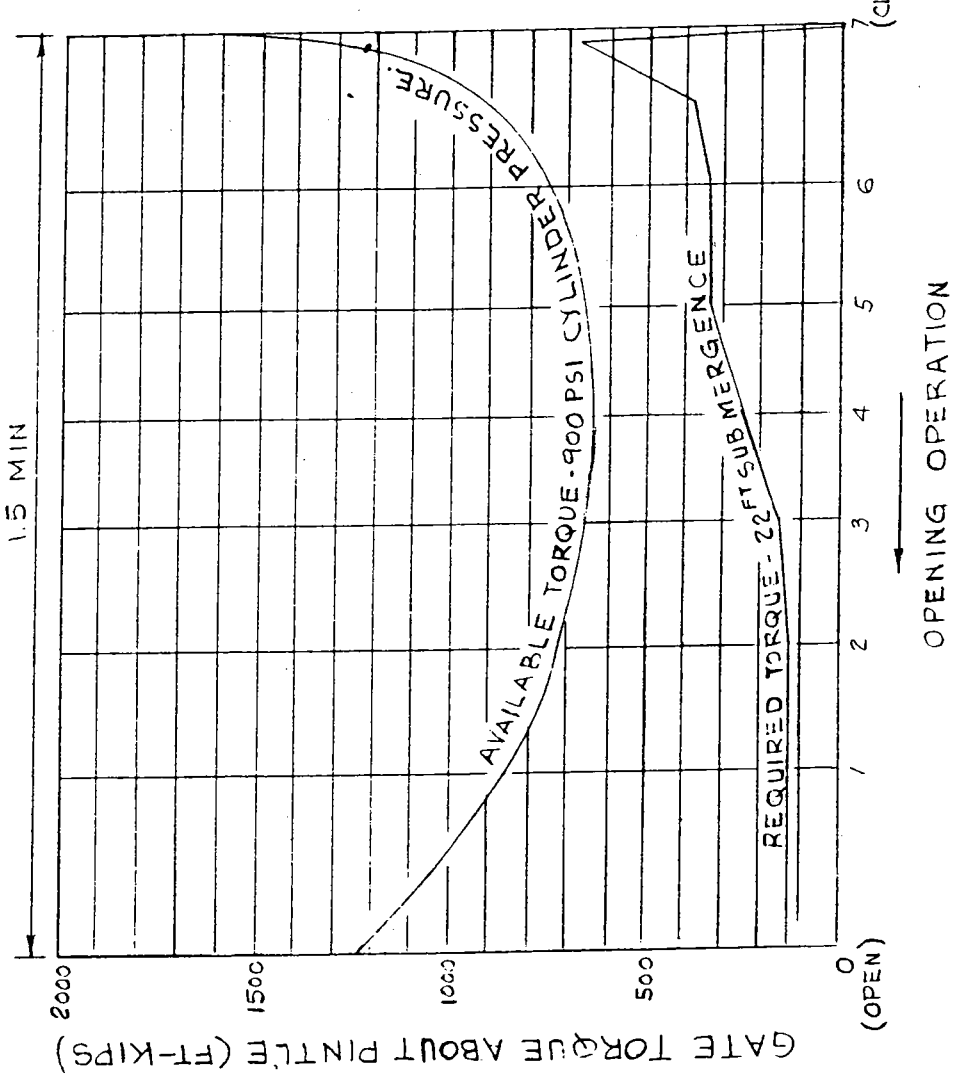
	REQUIRED LOADS										AVAILABLE TORQUE				
	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮
POSITION	WES TORQUE ABOUT PINTLE LB-FT	CORR. FACTOR	TORQUE ABOUT PINTLE (ALICEVILLE) ③=①×② LB-FT	EFFECT. ARM ABOUT PINTLE FT	FORCE IN STRUT ⑤=③/(④×1000) KIPS	EFFECT. ARM ABOUT SECTOR FT	TORQUE ABOUT SECTOR (0.95 EFF.) ⑦=(⑤×⑥)/0.95 FT-KIPS	SECTOR GEAR RADIUS FT	FORCE ON PISTON (0.95 EFF.) ⑨=⑦/(⑧×.95) KIPS	CYL PRESS. (93.5") ⑩=(⑨×1000)/93.5 + 60 psi Loss PSI	CYL PRESS. (93.5") PSI	FORCE ON PISTON (0.95 EFF.) ⑫=(⑪×93.5)/0.95 KIPS	TORQUE ABOUT SECTOR (0.95 EFF.) ⑬=(⑫×⑧)/0.95 FT-KIPS	FORCE IN STRUT ⑭=⑬/⑥ KIPS	TORQUE ABOUT PINTLE ⑮=⑭×④ FT-KIPS
0	2.2	56×10^3	123,000	19.71	6.2	6.16	40.	5.0	8.4	150	900	79.9	379.5	61.6	1210
0.5	2.2		123,000	19.64	6.3	7.57	50.		10.5	170				50.1	980
1	2.2		123,000	19.70	6.2	8.73	57.		12.0	190				43.5	860
2	2.2		123,000	19.91	6.2	10.48	68.		14.3	210				36.2	720
3	3.0		168,000	20.00	8.4	11.47	101.		21.3	290				33.1	660
4	4.5		250,000	19.67	12.7	11.62	155.		32.6	410				32.7	640
5	6.0		340,000	18.76	18.1	10.80	206.		43.4	520				35.1	660
6	6.0		340,000	16.99	20.	8.63	182.		38.3	470				44.0	750
6.5	6.7		380,000	15.59	24.	6.70	169.		35.6	440				56.6	880
6.9	12.0		670,000	13.93	48.	4.19	212.		44.6	540				90.6	1260
7	0		0	13.32	0	3.20	0		0	0				119.0	1590



PRESSURE ON ROD END
DUE TO RETURN LINE FRICTION
= 50 PSI × 113.19"/93.5" = 60 PSI
EFFECTIVE PRESSURE = 960 - 60 = 900 PSI

OHIO RIVER LINKAGE
MITER GATE MACHINERY
OPERATING DATA
OPENING

PLATE B-19



OHIO RIVER LINKAGE
GATE TORQUE ABOUT PINTLE
OPENING TIME
1.5 MIN

PLATE B-20

OPENING TIME = 1.5 MIN (ASSUMED)

$$\text{FLOW RATE} = \frac{(12^2 - 5^2)\,0.7854 \times 12 \times 12.7234}{231 \times 1.5\,(\text{MIN})} = 41.2 \text{ GPM}$$

$$\text{CLOSING TIME} = \frac{12^2 \times 0.7854 \times 12 \times 12.7234}{41.2 \times 231} = 1.82 \text{ MIN.}$$

CLOSING OPERATION

NOMENCLATURE		WES MODEL		PROPOSED LOCK ALICEVILLE		FACTOR
TIME	T T_2	20.1 SEC'S 90 SEC'S	T_1	110		
ARC OF TRAVEL	K	71.567°	K_1	71.565°	$\frac{T_2}{T_A}$	$\frac{90}{110} = 0.82$

TIME T_1 = 110 SEC

ADJUST $T_2 = T\sqrt{\frac{L_1}{L}} = 20.1\sqrt{20} = 20.1 \times 4.47 = 90$

ADJ. ANGULAR TRAVEL $T_A = T_1\left(\frac{K}{K_1}\right) = 110 \times 1 = 110$

$$\text{FACTOR} = \frac{T_2}{T_A} = \frac{90}{110} = 0.82$$

$$P_1 = P\left(\frac{L_1}{L}\right)^4\left(\frac{S_1}{S_2}\right)^{1.5}\left(\frac{T_2}{T_A}\right)^{1.0} \text{(BOTTOM EFFECT)}$$

$$= P\,(20)^4(0.55)^{1.5}(0.82)^{1.0} \times \left(\begin{matrix}\text{INCREASE DUE TO}\\ \text{BOTTOM EFFECT}\end{matrix}\right)$$

$$= P \times 160{,}000 \times 0.408 \times 0.82 \times 1.27$$

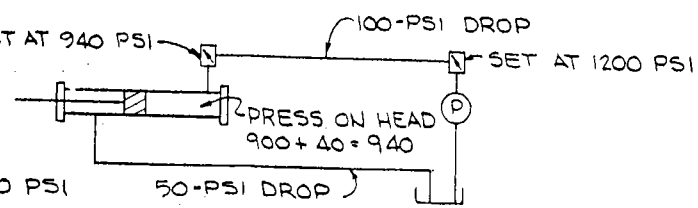
$$= P \times 68{,}000$$

PLATE B- 21

CLOSING OPERATION

	REQUIRED LOADS										AVAILABLE TORQUE				
	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮
POSITION	WES TORQUE ABOUT PINTLE LB-FT	CORR. FACTOR	TORQUE ABOUT PINTLE (ALICE-VILLE) ③ × ① × ② LB-FT	EFFECT. ARM ABOUT PINTLE FT	FORCE IN STRUT ⑤ = ③ / ④ × 1000 KIPS	EFFECT. ARM ABOUT SECTOR FT	TORQUE ABOUT SECTOR (0.95 EFF.) ⑦ = ⑤ × ⑥ / 0.95 FT-KIPS	SECTOR GEAR RADIUS FT.	FORCE ON PISTON (0.95 EFF.) ⑨ = ⑦ / ⑧ × 0.95 KIPS	CYL PRESS. (113.1°") ⑩ = ⑨ × 1000 / 113.1 + 40 PSI LOSS PSI	CYL PRESS. (113.1°") PSI	FORCE ON PISTON (0.95 EFF.) ⑫ = ⑪ × 113.1 × 0.95 × 1/1000 KIPS	TORQUE ABOUT SECTOR (0.95 EFF) ⑬ = ⑫ × ⑥ × 0.95 FT-KIPS	FORCE IN STRUT ⑭ = ⑬ / ⑥ KIPS	TORQUE ABOUT PINTLE ⑮ = ⑭ × ④ FT-KIPS
0	0	68×10^3		19.71		6.16		5.0		0	900	96.7	459.	74.5	1470
0.1	40		2700×10^3	19.68	137.	6.46	930		195	1760				71.0	1400
0.5	6.3		430×10^3	19.64	22.	7.57	175		37.	370				60.6	1190
1.0	5.0		340×10^3	19.70	17.3	8.73	159		33.	330				52.6	1040.
2	5.0		340×10^3	19.91	17.1	10.48	189		40.	390				43.8	870
3	5.0		340×10^3	20.00	17.0	11.47	205		43.	420				40.0	800
4	6.4		440×10^3	19.67	22.	11.62	270		57.	540				39.5	780
5	8.0		540×10^3	18.76	29.	10.80	330		69.	650				42.5	800
6	9.0		610×10^3	16.99	36.	8.63	330		69.	650				53.2	900
7	20.0		1360×10^3	13.32	102	3.20	340		72.	680				143.4	1910.

PRESSURE ON HEAD END DUE TO RETURN LINE FRICTION = $50 \times 93.5°/113.1° = 40$ PSI ±
EFFECTIVE PRESSURE = 940 − 40 = 900 PSI



OHIO RIVER LINKAGE
MITER GATE MACHINERY
OPERATING DATA
CLOSING

PLATE B-22

* WHEN REQUIRED GATE TORQUE EXCEEDS AVAILABLE TORQUE, SOME HYDRAULIC OIL WILL BE BYPASSED AT RELIEF VALVE AND THE GATE WILL AUTOMATICALLY TRAVEL AT A SPEED THAT WILL REDUCE THE REQUIRED GATE TORQUE TO THE GATE TORQUE AVAILABLE FROM 900 PSI EFFECTIVE CYLINDER PRESSURE.

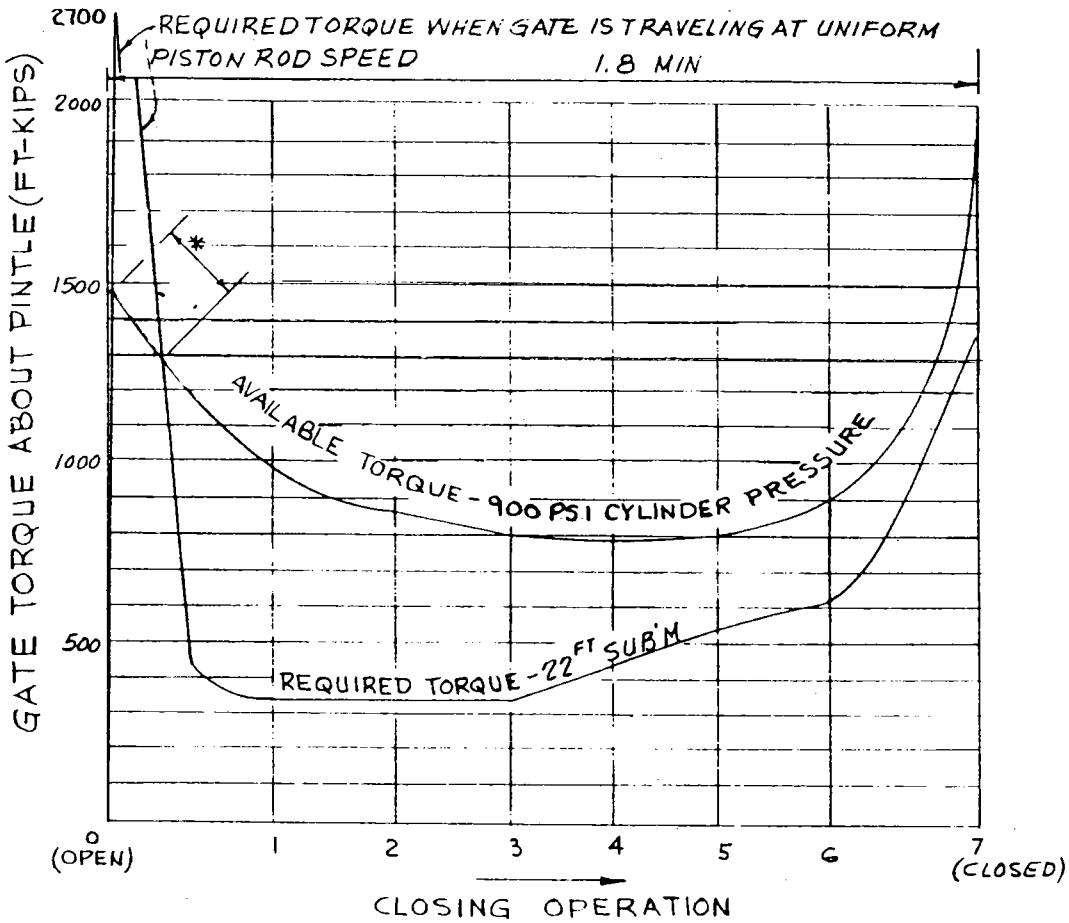
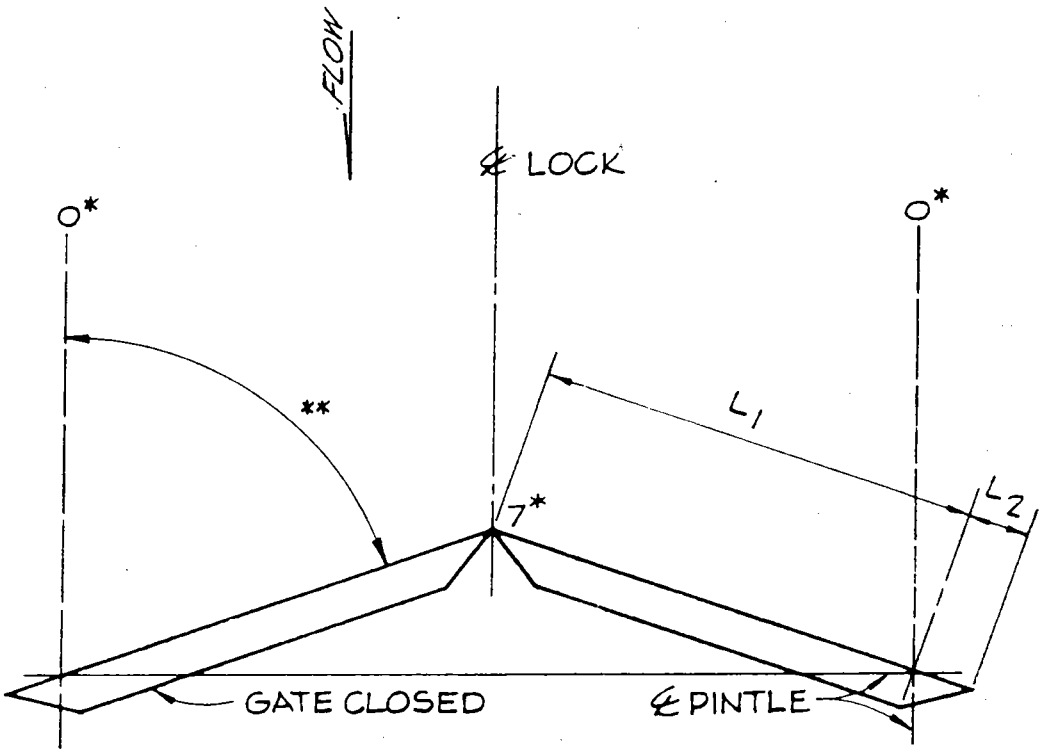


PLATE B- 23

OHIO RIVER LINKAGE
GATE TORQUE ABOUT PINTLE
CLOSING TIME
1.8 MIN

TEMPORAL LOADING



** AREA OF TRAVEL WHERE NORMAL LOADS APPLY

* POSITION WHERE TEMPORAL LOADS APPLY

$$T_t = \frac{62.4}{4}(L_1^2 - L_2^2)(h_2^2 - h_1^2)$$

T_t = GATE TORQUE ABOUT PINTLE DUE TO TEMPORAL LOAD (FT-LB)

L_1 = GATE LENGTH PINTLE TO MITER (FT)

L_2 = GATE LENGTH PINTLE TO QUOIN (FT)

h_1 = GATE SUBMERGENCE (FT)

h_2 = GATE SUBMERGENCE PLUS TEMPORAL HEAD (FT)

PLATE B-24

TEMPORAL FORCES EXAMPLE COMPUTATIONS

$$T_t = \frac{62.4}{4}(L_1^2 - L_2^2)(h_2^2 - h_1^2)$$

FOR ALICEVILLE LOCKS

$L_1 = 718.34'' = 59.86'$

$L_2 = 21.65'' = 1.804'$

$h_1 = 22'$

$h_2 \quad 23.25'$

$$T_t = \frac{62.4}{4}\left[(59.86)^2 - (1.804)^2\right]\left[(23.25)^2 - (22)^2\right]$$

$$T_t = \frac{62.4}{4}\left[3579.96\right]\left[56.56\right]$$

$T_t = 3{,}159{,}000$ FT-LB

REFERENCE PLATE B-22 POSITION 7

CALCULATE ⟶ THE FORCE IN THE STRUT FOR A PINTLE TORQUE OF 3,159,000 FT-LB

$$\text{STRUT FORCE} = \frac{3{,}159{,}000}{13.32} = 237{,}000 \text{ LB}$$

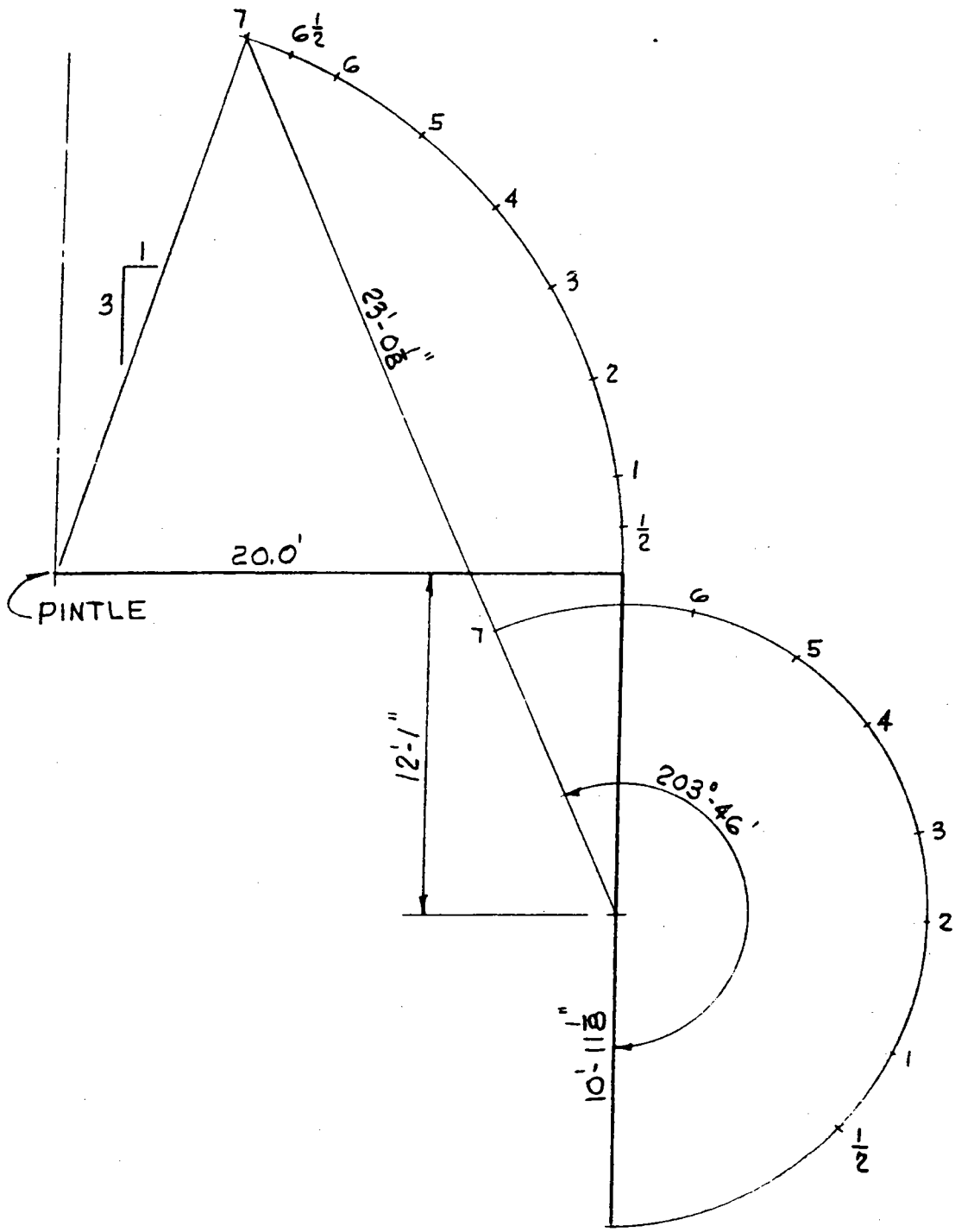
$$\text{TORQUE ABOUT SECTOR} = \frac{237{,}000}{0.95} = 798{,}000 \text{ FT-LB}$$

$$\text{FORCE ON PISTON} = \frac{798{,}000}{5.0 \times 0.95} = 168{,}000 \text{ LB}$$

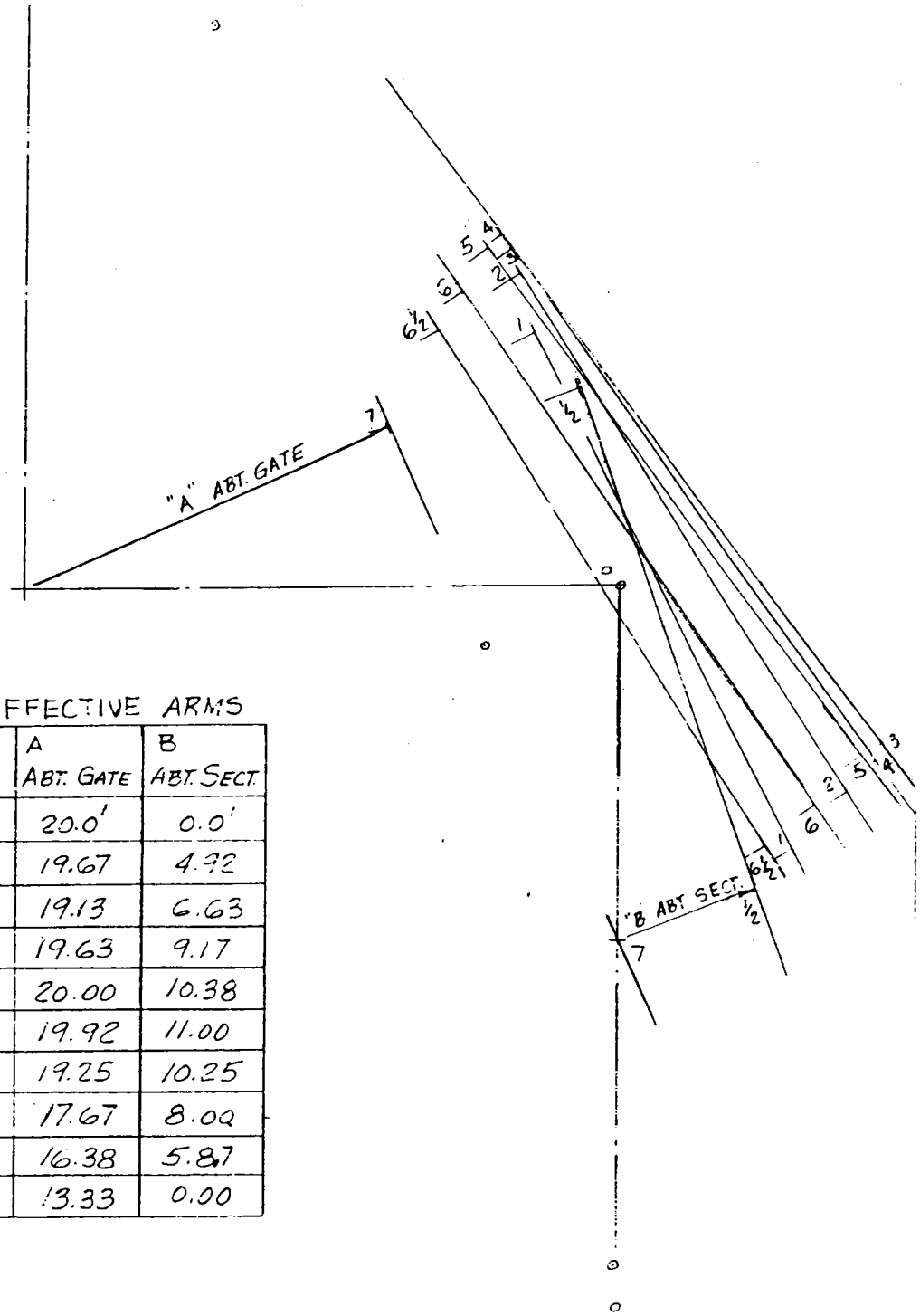
$$\text{CYLINDER PRESSURE} = \frac{168{,}000}{113.1} + 40 \text{ PSI} = 1525 \text{ PSI}$$

A CYLINDER PRESSURE OF 1525 PSI IS REQUIRED TO MAINTAIN THE GATE IN THE MITER POSITION AGAINST A TEMPORAL HEAD OF 1.25 FT.

PLATE B-25



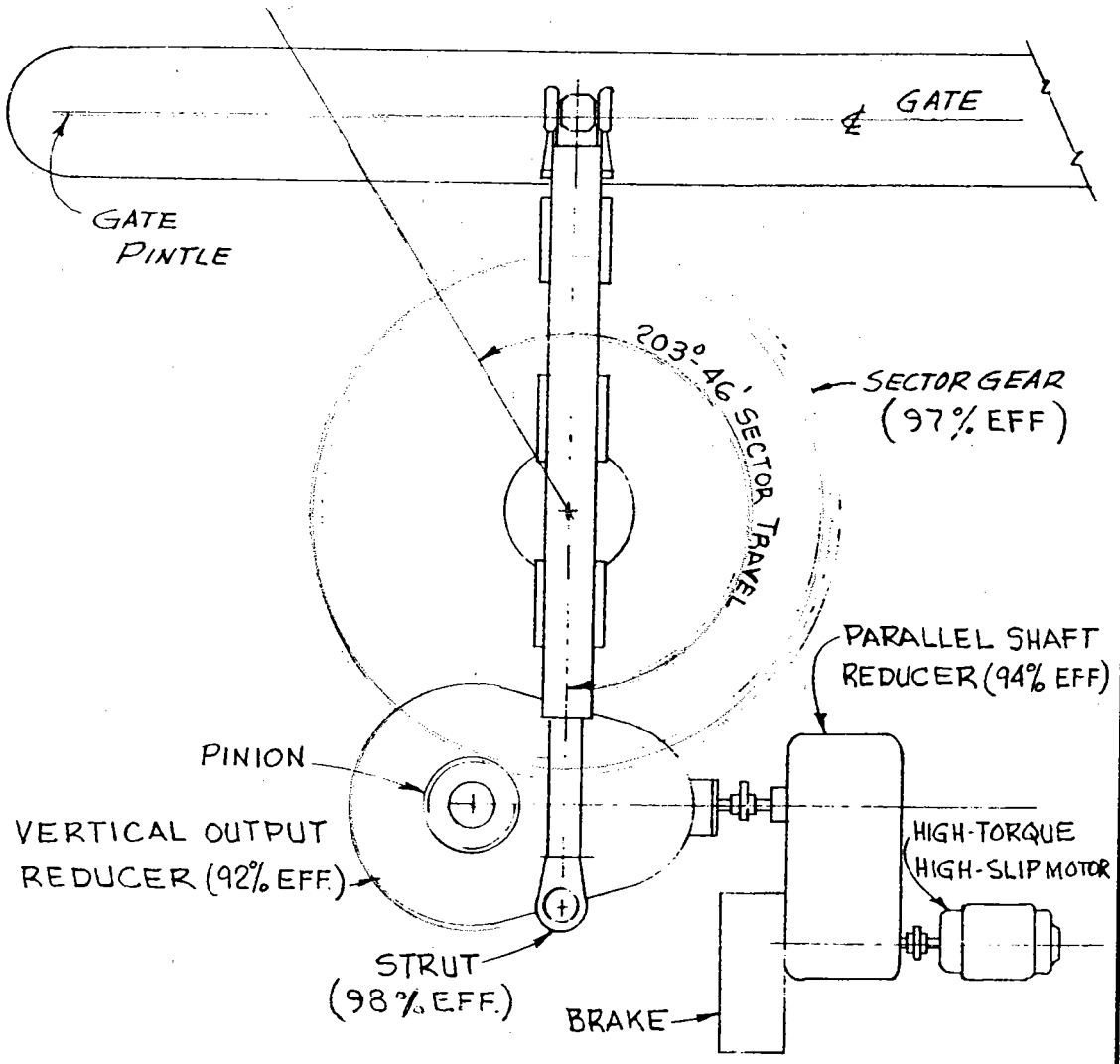
KINEMATICS
PANAMA CANAL LINKAGE
SCALE: 3/16"=1'-0"
PLATE B-26



EFFECTIVE ARMS

POS.	A ABT. GATE	B ABT. SECT.
0	20.0'	0.0'
½	19.67	4.92
1	19.13	6.63
2	19.63	9.17
3	20.00	10.38
4	19.92	11.00
5	19.25	10.25
6	17.67	8.00
6½	16.38	5.87
7	13.33	0.00

PLATE B-27



NL SPEED-MOTOR 1800
FL " " 1600

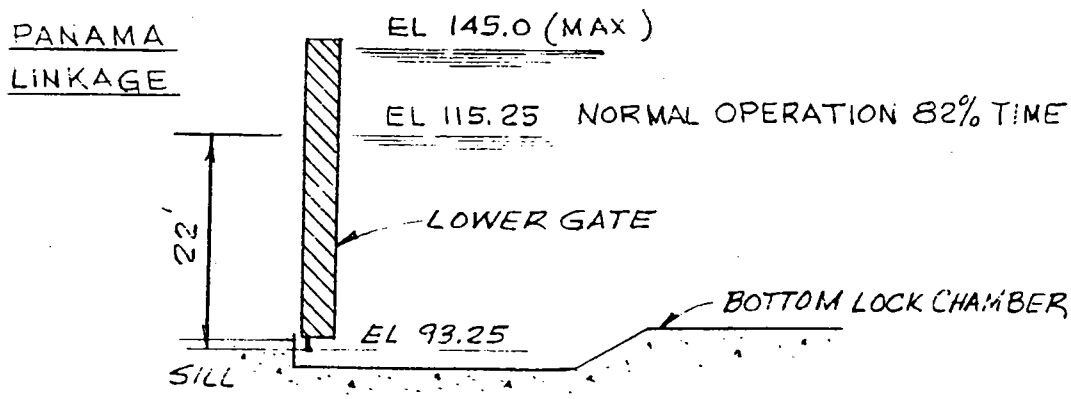
$$\text{RPM OF SECTOR} = \frac{203.765}{1.65 \times 60} = 2.07^{\circ/\text{SEC}} \therefore \frac{2.07 \times 60}{360} = 0.345$$

AVERAGE OPERATING TIME

OVERALL RED. RATIO = 1600/0.345 = 4640 (MOTOR TO SECTOR)

OVERALL EFFICIENCY = 0.98 × 0.97 × 0.92 × 0.94 = 0.82

PLATE B-28



NORMAL OPERATION (ELECTRIC-MOTOR DRIVE)

ASSUME OPENING TIME = 99 SEC (SAME TOTAL TIME AS HYDR OPERATION)

$$\text{HYD OPER} = \left(\frac{1.5 + 1.8}{2}\right)60 = 99 \text{ SEC}$$

SUBMERGENCE = 22 FT

NOMENCLATURE		PANAMA CANAL		PROPOSED LOCK (ALICEVILLE)		FACTOR
LENGTH GATE	L	84.304	L_1	60.0	L_1/L	= 0.712
SUBMERGENCE	S S_2	82.5 58.7	S_1	22.0	$\frac{S_1}{S_2}$	= 0.375
TIME	T T_2	120 SEC 101.3 SEC	T_1	99.0	$\frac{T_2}{T_1}$	= 1.023 SEC
ARC OF TRAVEL	K	63.436°	K_1 T_A	71.565 111.7	$\frac{T_2}{T_A}$	= 0.907

$$\text{FACTOR } \frac{L_1}{L} = \frac{60}{84.304} = 0.712$$

SUBMERGENCE = 22

$$\text{ADJ. SUBMERGENCE} = S = S_2\left(\frac{L_1}{L}\right) = 82.5 \times 0.712 = 58.7$$

$$\text{FACTOR } \frac{S_1}{S} = \frac{22}{58.7} = 0.375$$

PLATE B-29

T_1 = TIME FOR PROPOSED LOCK = 99 SEC

T = TIME FOR PANAMA CANAL = 120 SEC

$T_2 = T\sqrt{\frac{L_1}{L}}$ = ADJ TIME = 101.3 MODEL

T_A = ANGULAR ADJ $= T_1\left(\frac{K_1}{K}\right) = 111.7$

TIME T_1 = 99 SEC (PROPOSED GATE)

ADJ TIME $= T_2 = T\sqrt{\frac{L_1}{L}} = 120\sqrt{0.712} = 120 \times 0.844 =$
$= 101.3$ MODEL

ANGULAR TRAVEL $T_A = T_1\left(\frac{K_1}{K}\right) = 99\left(\frac{71.565}{63.436}\right) = 111.7$

ALICEVILLE

PANAMA CANAL

FACTOR $\frac{T_2}{T_A} = \frac{101.3}{111.7} = 0.907$

EFFECT OF BOTTOM CLEARANCE - NO ADJUSTMENT NECESSARY WHEN USING PANAMA TESTS

(NORMAL OPERATION 82% TIME)

$P_1 = P\left(\frac{L_1}{L}\right)^4\left(\frac{S_1}{S}\right)^{1.7}\left(\frac{T_2}{T_A}\right)^{1.3}$ P_o (FROM PANAMA TEST CURVES)

$= P(0.712)^4(0.375)^{1.7}(0.907)^{1.3}$

$= P(0.25)(0.188)(0.881) = P_o(0.0414)$

(MAX SUB'MG - LESS THAN 18% TIME)

$H = 145.0 - 93.25 = 51.75$ - SAY 52'

ADJ FACTOR $= \frac{52}{58.7} = 0.8859$

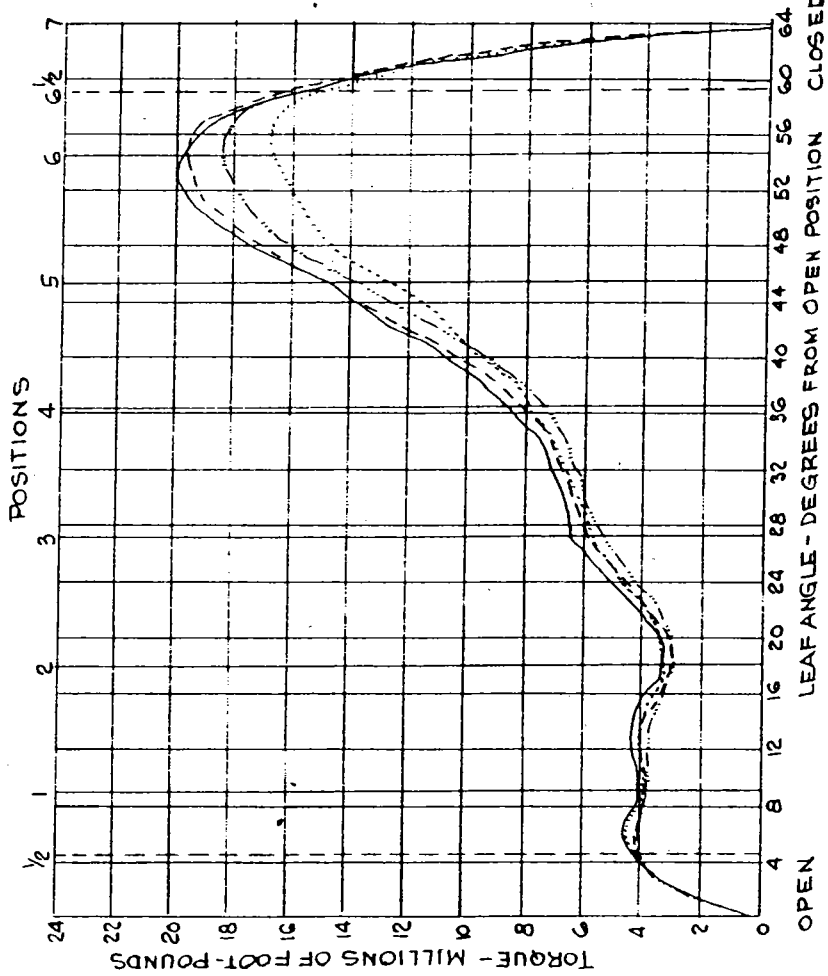
$P_1 = P(0.714)^4(0.8859)^{1.7}(0.907)^{1.3}$

$= P(0.25)(0.814)(0.881) = P_o(0.1793)$

CORRECTION FACTOR FOR 52' SUB'MG.)

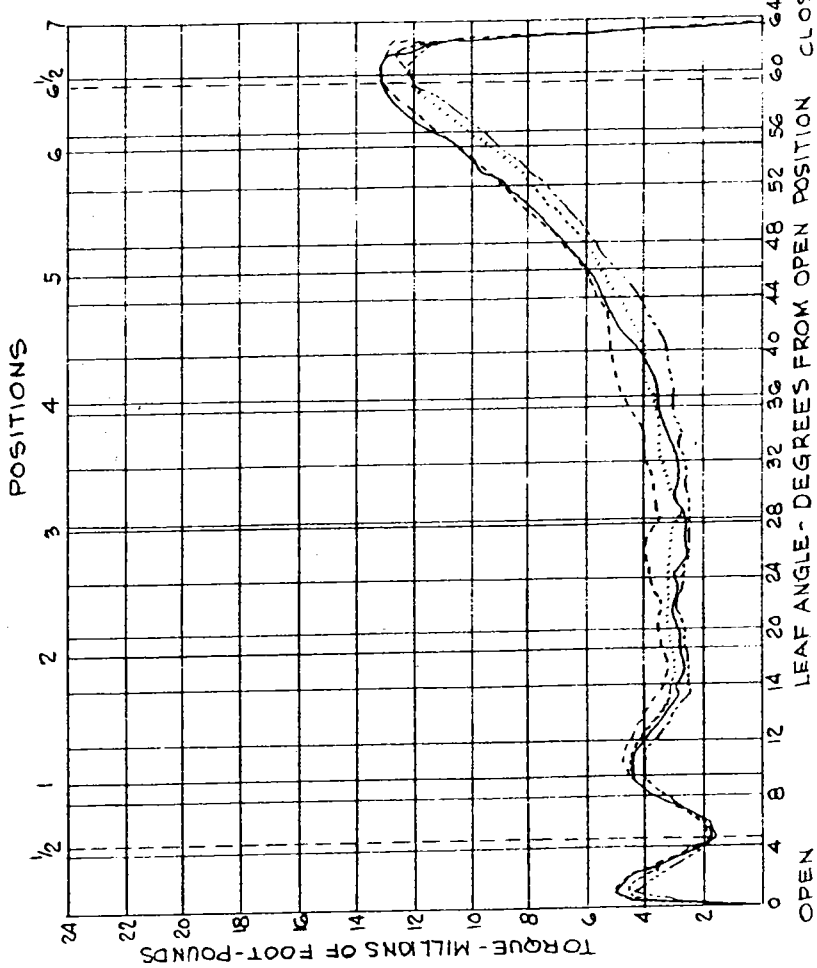
$\frac{P_{52}}{P_{22}} = \frac{0.1793}{0.0414} = 4.33$

PLATE B-30



THE PANAMA CANAL
SPECIAL ENGINEERING DIVISION
BALBOA HEIGHTS, CANAL ZONE
THE THIRD LOCKS PROJECT
HYDRAULIC MODEL Y
MITER GATE OPERATION
THIRD LOCKS TEST CURVES

PLATE B-31



BASE CONDITIONS

OPERATING TIME : 2 MIN
SUBMERGENCE : 82.5 FT
CHAMBER LENGTHS:
UPSTREAM: 1105 FT
DOWNSTREAM: 200 FT

NOTE:
CURVES SHOW VARIATION OF RESULTS OBTAINED UNDER IDENTICAL OPERATING CONDITIONS.

FOR INFORMATION ONLY: MOTOR WOULD BE SELECTED ON THE OPENING CYCLE.

THE PANAMA CANAL
SPECIAL ENGINEERING DIVISION
BALBOA HEIGHTS, CANAL ZONE
THE THIRD LOCKS PROJECT
HYDRAULIC MODEL Y
MITER GATE OPERATION
THIRD LOCKS TEST CURVES

PLATE B-32

REQ'D POWER - OPENING OPERATION

(22 FT SUB'M)

POS.	TORQUE ABT PINTLE PANAMA C. FT-LB	CORR. FACTOR	TORQUE ABT PINTLE ALICEVILLE FT-KIPS	EFFECT. ARM ABT PINTLE FT	FORCE IN STRUT (0.98 EFF)	EFFECT. ARM ABT SECTOR FT	TORQUE ABT SECTOR (0.97 EFF)	REDUCT RATIO (0.865 EFF)	REQ'D MOTOR TORQUE FT-LBS	HP: $\frac{T \times RPM}{5250}$
0	0	0.0414	0	20.0	0	0	0	4640	0	0
0.5	4.0×10^6		165.6×10^3	19.67	8.59 K	4.92	43.6 K		10.9	3.32
1	3.8×10^6		157.3×10^3	19.13	8.39 K	6.63	57.4 K		14.3	4.4
2	3.0×10^6		124.2×10^3	19.63	6.46 K	9.17	61.0 K		15.2	4.6
3	5.9×10^6		244.3×10^3	20.00	12.46 K	10.38	133.4 K		33.2	10.1
4	7.9×10^6		327.0×10^3	19.92	16.75 K	11.00	190.0 K		47.3	14.4
5	14.0×10^6		579.6×10^3	19.25	30.70 K	10.25	324.7 K		80.9	24.7
6	18.4×10^6		761.8×10^3	17.67	43.99 K	8.00	362.8 K		90.4	27.5
$6\frac{1}{2}$	15.4×10^6		637.6×10^3	16.38	39.72 K	5.87	240.4 K		59.9	18.3
7	0		0	13.33	0	0	0		0	0

PLATE B-33

FORCES AT MAX SUB'M. (52 FT)

REQUIRED POWER - OPENING OPERATION

POS.	TORQUE FROM P.C. CURVES	CORR FACTOR = 0.1793 / 0.0414	FORCE IN STRUT 22-FT SUB'M.	FORCE IN STRUT 52-FT SUB'M.	TORQUE ABT PINTLE 22-FT SUB'M.	TORQUE ABT PINTLE 52-FT SUB'M.
0	0	4.33	0	0	0	0
0.5	4.0×10^6		8.59 K	37.2	165.6×10^3	717.1×10^3
1	3.8×10^6		8.39 K	36.3	157.3×10^3	681.1×10^3
2	3.0×10^6		6.46 K	28.0	124.2×10^3	537.8×10^3
3	5.9×10^6		12.46 K	53.9	244.3×10^3	1057.8×10^3
4	7.9×10^6		16.75 K	72.5	327.0×10^3	1415.9×10^3
5	14.0×10^6		30.70 K	132.9	579.6×10^3	2509.6×10^3
6	18.4×10^6		43.99 K	190.5	761.8×10^3	3298.6×10^3
$6\frac{1}{2}$	15.4×10^6		39.72 K	172.0	637.6×10^3	2760.8×10^3
7	0		0	0	0	0

PLATE B-34

MOTOR SELECTION

22' SUB. MOTOR MUST PROVIDE REQ'D TORQUE AT ALL POSITIONS AND AT NORMAL SPEED.

52' SUB. MOTOR MUST PROVIDE PEAK TORQUE W/OUT EXCEEDING 150% OF F.L.T. GATE WILL BE SLOWED DUE TO MOTOR SPEED LOSS AT OVERLOAD. THEREFORE REQ'D TORQUE AS SHOWN IN PLATE B-36 WOULD REQUIRE CORRECTION.

PEAK OCCURS AT POS 6.
TORQUE ABOUT PINTLE = 3,298.6 FT-LB FOR NORMAL SPEED.

AT 150 % O.L.
MOTOR SPEED = (1,800)(0.77) = 1,386 RPM

1. GATE SPEED AT 1,386 MOTOR RPM
   $T_1 = (99)\left(\frac{1386}{1600}\right) = 114$ SEC
2. ADJ PINTLE TORQUE FOR CHANGED TIME
   $T_1 = 114$
   $T_2 = 101.3$
   $T_A = 114\left(\frac{71.565}{63.436}\right) = 128.6$
   FACTOR $T_2/T_A = 101.3/128.6 = 0.788$

PLATE B-35

3. CALCULATE PINTLE TORQUE AT POS 6

$P_1 = P_o(0.25)(0.814)(0.788)^{1.3}$

$= P_o(0.204 * 0.73) = P_o(0.149)$

$P_1 = 18.4 \times 10^6 * 0.149 = 2{,}742$ FT-KIPS

4. MOTOR TORQUE AT 150% OL.

$$\text{MOTOR TORQUE} = \frac{2742 \text{ FT-KIPS} * 8.00}{17.67 * 0.98 * 0.97 * 4640 * 0.865} = 322. \text{ FT-LB}$$

$$\text{NORMAL F.L. TORQUE} = \frac{322}{1.5} = 214.7 \text{ FT-LB}$$

$$\text{MOTOR HP} = \frac{214.7 * 1{,}600}{5250} = 65.4 \text{ HP}$$

75 HP REQUIRED.

PLATE B-36

PLATE B-37

AVAILABLE POWER-OPENING OPERATION

POS	F.L.* MOTOR TORQUE	RED. RATIO (0.865 EFF)	TORQUE ABT SECTOR	EFFECT. ARM ABT SECTOR (0.97)	FORCE IN STRUT	EFFECT. ARM ABT PINTLE	TORQUE ABT PINTLE (0.98 EFF.)
0	246 FT.LB.	4640	987.3 ^{1K}	0	0	20.00	0
0.5				4.92	194.6 ^{K}	19.67	3752 $^{FT/K}$
1				6.63	144.4	19.13	2708
2				9.17	104.4	19.63	2009
3				10.38	92.3	20.00	1808
4				11.00	87.1	19.92	1700
5				10.25	93.4	19.25	1762
6				8.00	119.7	17.67	2073
$6\frac{1}{2}$				5.87	163.1	16.38	2619
7				0	0	13.33	0

* 75 HP AT 1,600 RPM F.L. SPEED

$$T = \frac{HP \times 5250}{RPM} = 246 \text{ FT-LB}$$

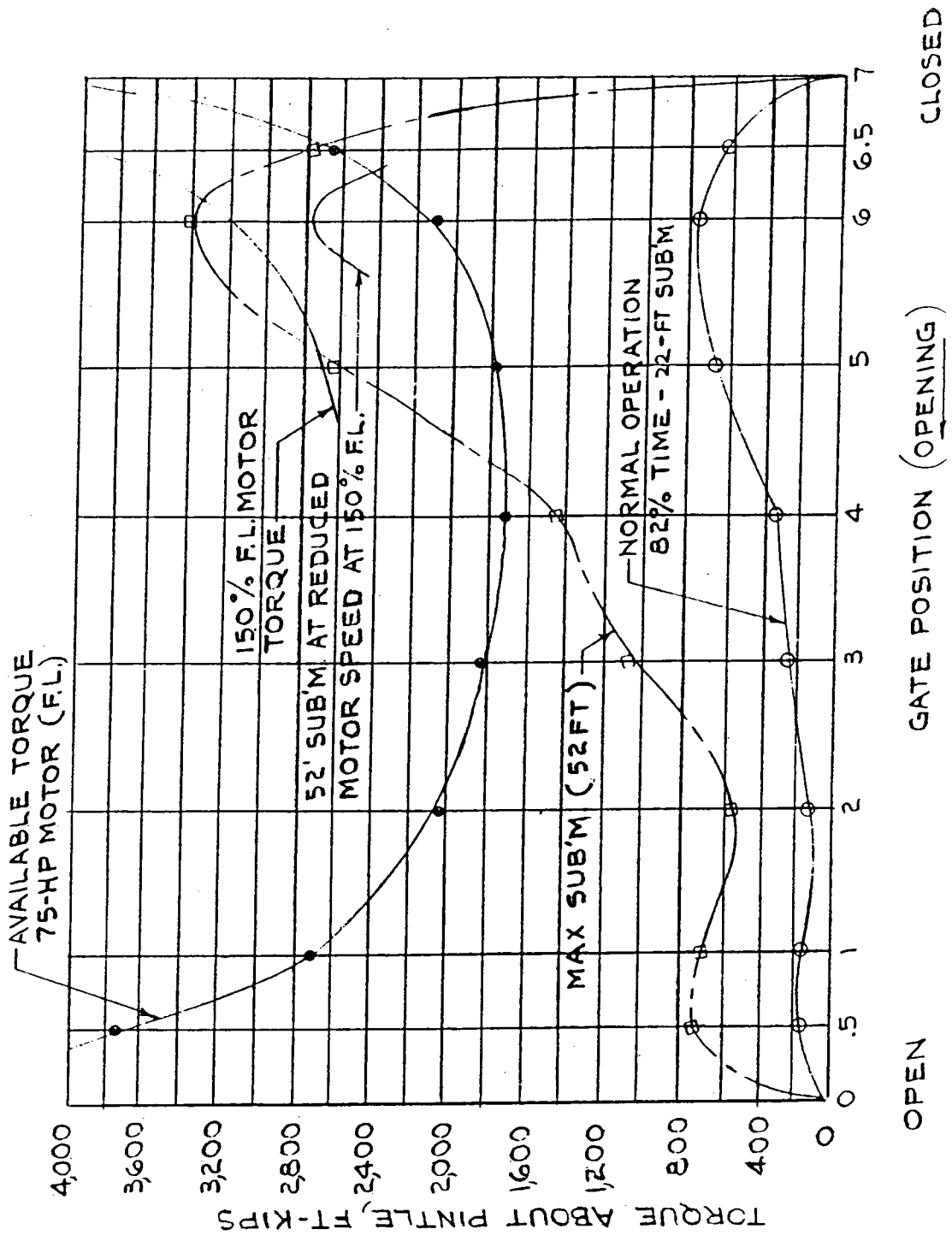
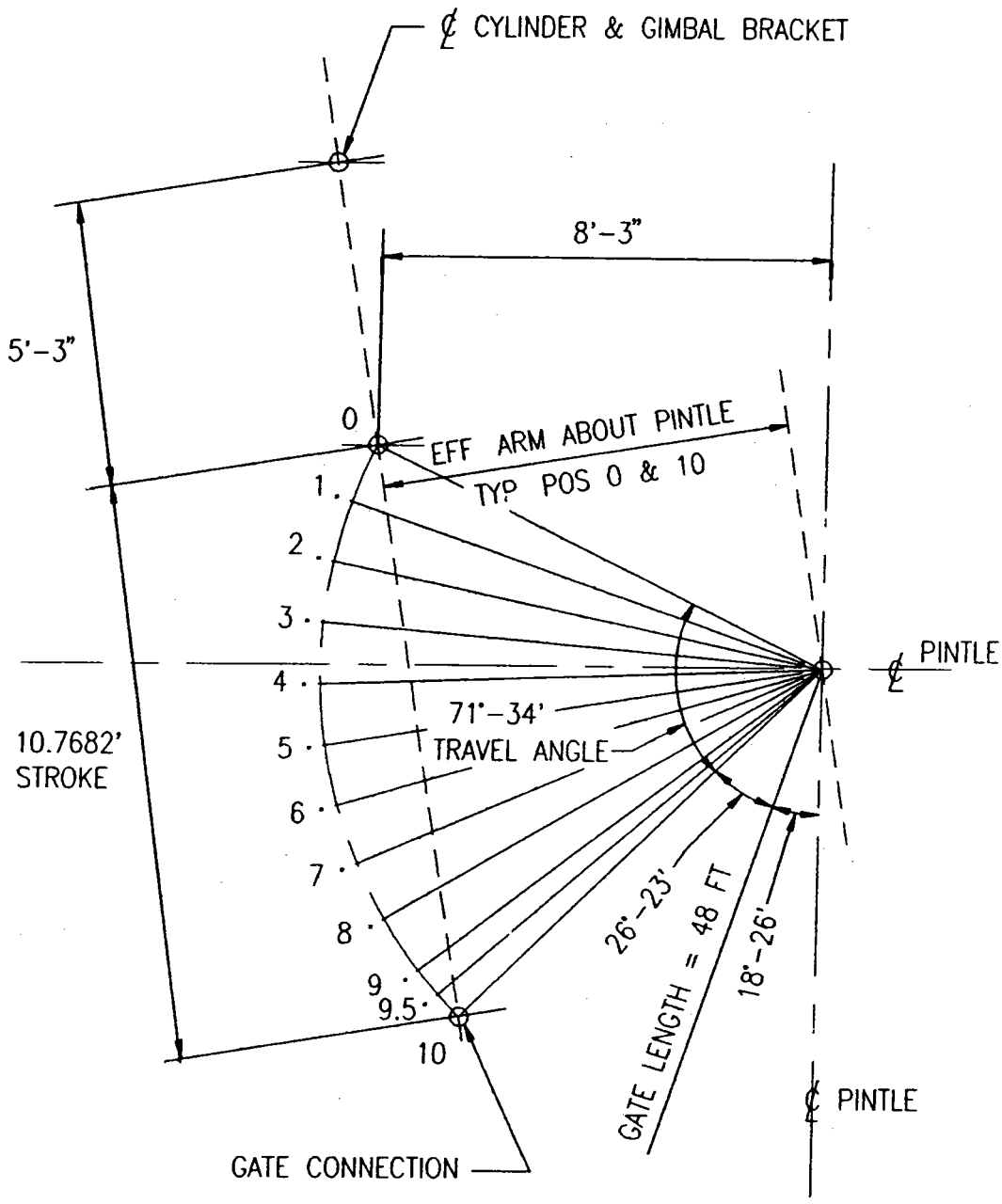
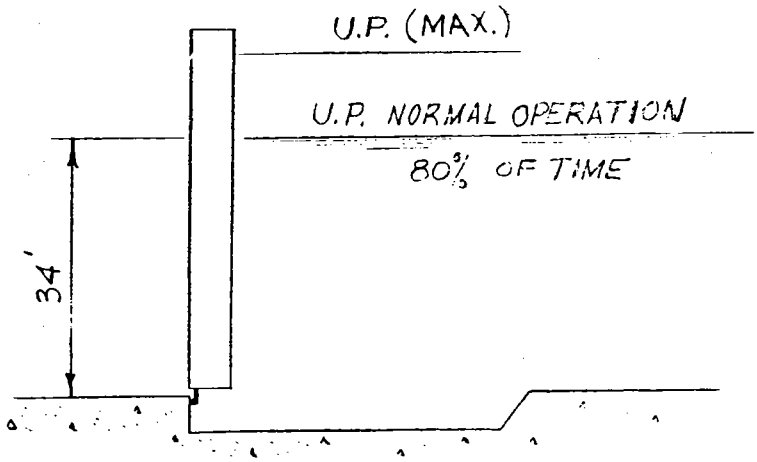

AVAILABLE TORQUE
75-HP MOTOR (F.L.)
150% F.L. MOTOR
TORQUE
52' SUB'M AT REDUCED
MOTOR SPEED AT 150% F.L.
MAX SUB'M (52 FT)
NORMAL OPERATION
82% TIME - 22-FT SUB'M
TORQUE ABOUT PINTLE, FT-KIPS
4,000
3,600
3,200
2,800
2,400
2,000
1,600
1,200
800
400
0
OPEN
.5
1
2
3
4
5
6
6.5
7
CLOSED
GATE POSITION (OPENING)

PLATE B-38



KINEMATICS
DIRECT CONNECTED CYLINDER
SCALE: 1"=3'-0"
PLATE B-39



DESIGN CRITERIA (OPENING OPERATION) 80% TIME

OPENING TIME: ASSUME 90 SEC ($1\frac{1}{2}$ MIN) SEE PLATE B-41

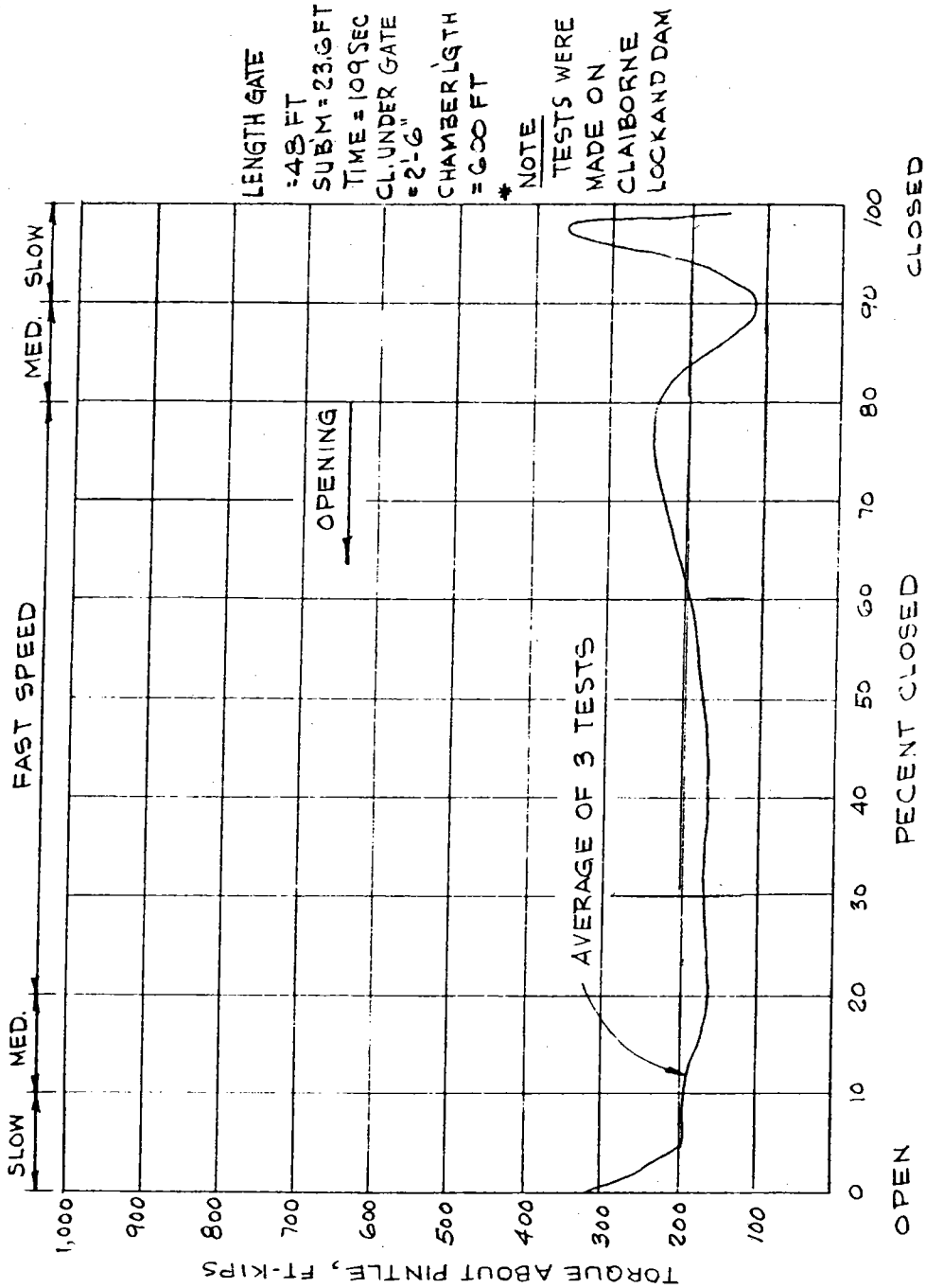
SUBMERGENCE: ASSUME 34 FT. (80% TIME OR LESS)

STROKE OF PISTON: 10.768 FT.

NOMENCLATURE		MODEL (CLAIBORNE L.)		PROPOSED LOCK		FACTOR
LENGTH GATE	L	48.0	L_1	48.0	$\frac{L_1}{L}$	1.0
SUBMERGENCE	S S_2	23.6' 23.6	S_1	34.0	$\frac{S_1}{S_2}$	1.441
TIME	T T_2	109 109	T_1	90	$\frac{T_2}{T_1}$	1.211
ARC OF TRAVEL	K	71.567°	K_1	71.567°	$\frac{K}{K_1}$	1.00

SINCE LENGTH OF GATE, ARC OF TRAVEL, AND CLEARANCE UNDER GATE ARE THE SAME ON MODEL AND PROPOSED LOCK, NO ADJUSTMENTS ARE REQUIRED, FOR THESE FACTORS.

PLATE B-40



TESTS 1A, 2A, AND 3A
VARIABLE SPEED OPERATION
TIME, 109 SEC

PLATE B-41

OPENING GATE

$$P_1 = P\left(\frac{L_1}{L}\right)^4\left(\frac{S_1}{S_2}\right)^{1.7}\left(\frac{T_2}{T_1}\right)^{1.3}$$

$$= P(1.0)^4(1.441)^{1.7}(1.211)^{1.3} = P \times 1.86 \times 1.283$$

$$P_1 = 2.39 \times P$$

CLOSING GATE

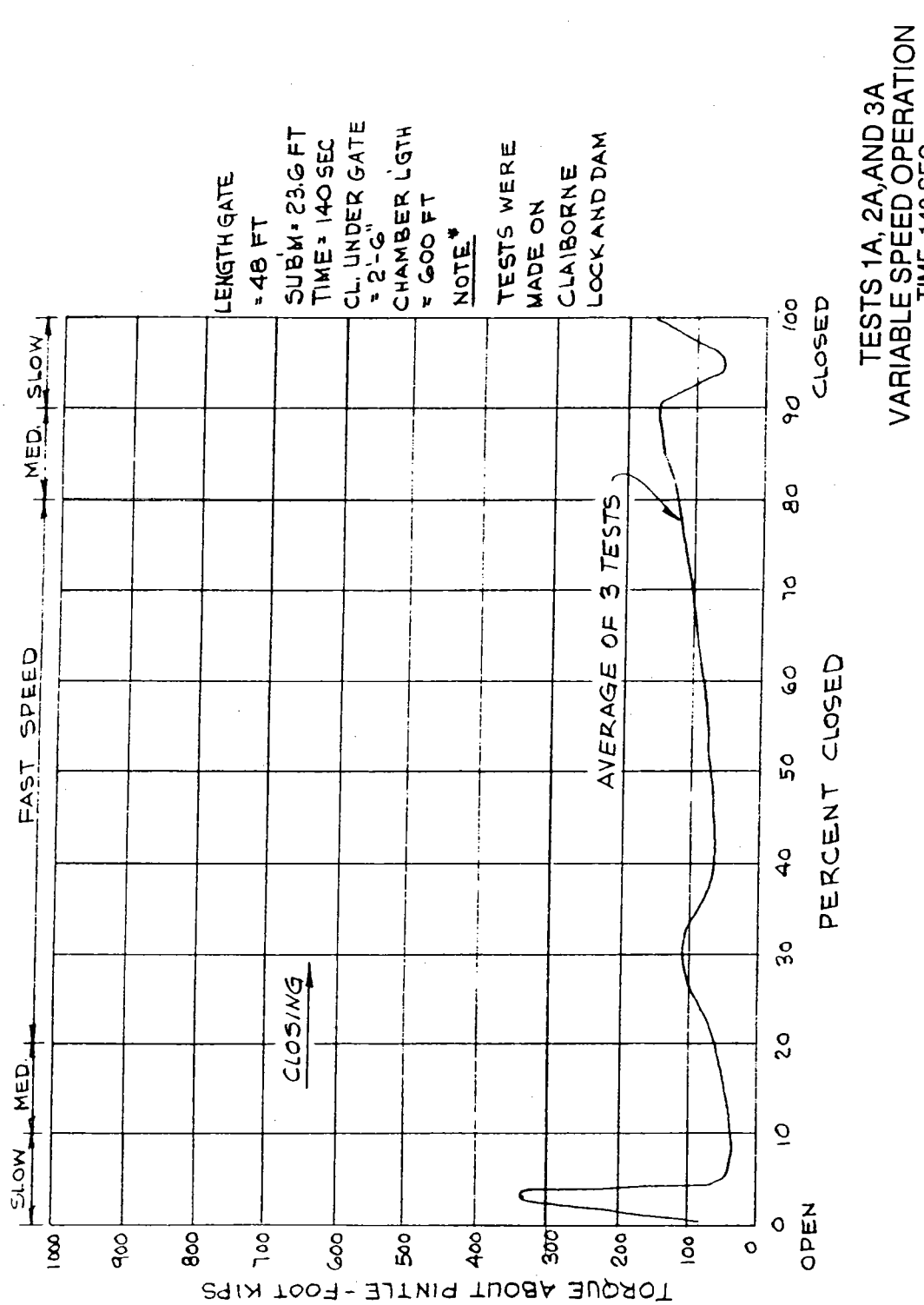
NOMENCLATURE		MODEL (CLAIBORNE L.)		PROPOSED LOCK		FACTOR
LENGTH GATE	L	48.0 FT	L_1	48.0 FT	$\frac{L_1}{L}$	1.0
SUBMERGENCE	S S_2	23.6 23.6	S_1	34.0	$\frac{S_1}{S}$	1.441
TIME	T T_2	140 SEC 140 SEC	T_1	113	$\frac{T_2}{T_1}$	1.24
ARC OF TRAVEL	K	71.567	K_1	71.565	$\frac{K}{K_1}$	1.0

$$P_1 = P\left(\frac{L_1}{L}\right)^4\left(\frac{S_1}{S}\right)^{1.5}\left(\frac{T_2}{T_1}\right)^{1.1}$$

$$= P(1.0)^4(1.441)^{1.5}(1.24)^{1.1} = P \times 1.0 \times 1.73 \times 1.267$$

$$P_1 = 2.19\,P$$

PLATE B-42



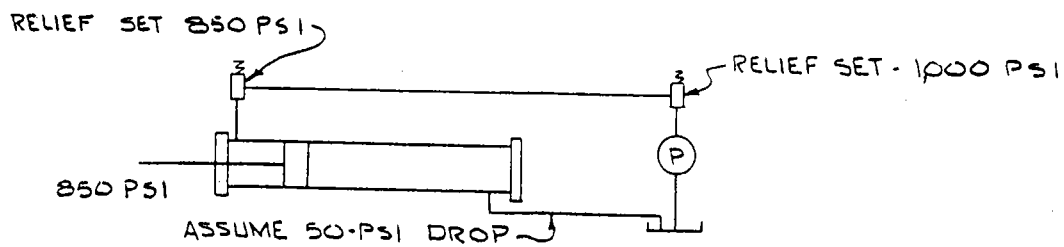
TESTS 1A, 2A, AND 3A
VARIABLE SPEED OPERATION
TIME, 140 SEC

PLATE B-43

OPENING GATE

REQUIRED TORQUE										AVAILABLE TORQUE		
1	2	3	4	5	6	7	8	9	10	11	12	13
POS	MODEL TORQUE (CLAIBORNE) (FT-KIPS)	ADJ FACTOR	TORQUE ABT PINTLE (PROPOSED L) FT-KIPS 2 x 3	EFFECT. ARM ABOUT PINTLE (FT)	FORCE ON PISTON ROD (ROD END) KIPS 4÷5÷0.97*	NET AREA HEAD END (SQ IN)	RETARDING FORCE DUE TO 50 PSI FRICT. KIPS 7 x 50 PSI	REQ'D FORCE ROD END KIPS 6÷8	REQ'D CYL PRESS. ROD END PSI 9÷150.83**	AVAIL. CYL PRESS. PSI	AVAIL. PISTON FORCE KIPS 11 x 150.83 x 0.97 ÷ 1000 − 8	AVAIL. TORQUE ABOUT PINTLE FT-KIPS 12 x 5
CLOSED 10	0	2.39	0	7.4792	0	201.1	10.1	0	0	850	114.3	854.6
9½	360		860.4	7.6790	112.0			122.1	810			877.4
9	115		274.8	7.8958	35.9			45.9	305			902.2
8	230		549.7	8.2917	68.3			78.4	520			947.4
7	225		537.8	8.6250	64.3			74.3	493			985.5
6	185		442.1	8.8958	51.2			61.2	407			1016.4
5	175		418.3	9.1042	47.4			57.5	381			1040.2
4	170		406.3	9.2083	45.5			55.6	369			1052.1
3	175		418.3	9.1875	46.9			57.0	378			1049.7
2	160		382.4	8.9792	43.9			54.0	358			1025.9
1	190		454.1	8.4688	55.3			65.4	433			967.6
0	315		752.8	7.4792	103.8			113.9	755			854.6
OPEN												

* 0.97 - EFFIC MACHINE
** AREA ROD END = 150.83 □"



DIRECT CONNECTED LINKAGE
MITER GATE MACHINERY
OPERATING DATA
OPENING

PLATE B-44

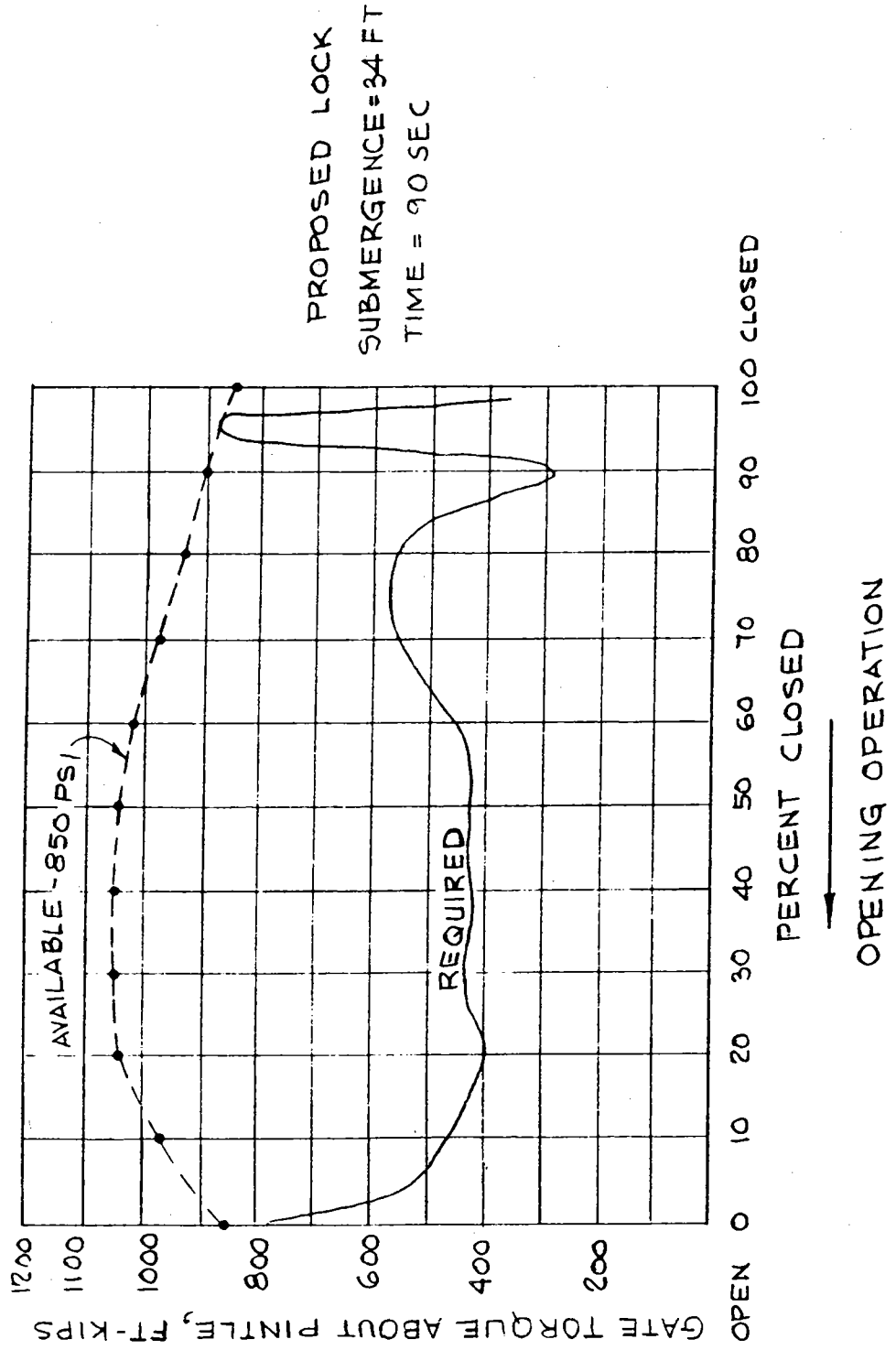

PROPOSED LOCK
SUBMERGENCE = 34 FT
TIME = 90 SEC
AVAILABLE - 850 PSI
REQUIRED
GATE TORQUE ABOUT PINTLE, FT-KIPS
1200
1100
1000
800
600
400
200
OPEN
0
10
20
30
40
50
60
70
80
90
100 CLOSED
PERCENT CLOSED
OPENING OPERATION

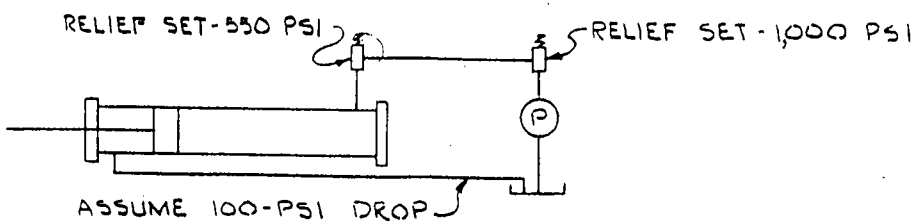
PLATE B-45

CLOSING GATE

REQUIRED TORQUE										AVAILABLE TORQUE		
1	2	3	4	5	6	7	8	9	10	11	12	13
POS	MODEL TORQUE (CLAIBORNE) (FT. KIPS)	ADJ FACTOR	TORQUE ABT. PINTLE (PROPOSED L.) FT-KIPS 2 x 3	EFFECT. ARM ABOUT PINTLE (FT)	FORCE ON PISTON ROD (HEAD END) KIPS 4÷5÷0.97*	NET AREA ROD END (SQ IN)	RETARDING FORCE DUE TO 100-PSI FRICT. KIPS 7x100 PSI	REQ'D FORCE HEAD END KIPS 6+8	REQ'D CYL PRESS. HEAD END PSI 9÷200.1**	AVAIL. CYL PRESS. PSI	AVAIL. PISTON FORCE KIPS 11x200.1**x 0.97÷1000-8	AVAIL. TORQUE ABOUT PINTLE FT-KIPS 12x5
OPEN 0	0	2.19	0	7.4792	0	150.83	0	0	0	550	91.7	686
1/2	330		722.7	8.0790	92.2		15.1	107.3	534			741
1	35		76.7	8.4688	9.3			24.4	121			777
2	65		142.5	8.9792	16.4			31.5	157			823
3	110		240.9	9.1875	27.0			42.1	209			842
4	70		153.3	9.2083	17.2			32.3	161			844
5	75		164.3	9.1042	18.6			33.7	168			835
6	85		186.2	8.8958	21.6			36.7	182			816
7	100		219.0	8.6250	26.1			41.3	206			791
8	125		273.8	8.2917	34.0			49.1	245			760
9	160		350.4	7.8958	45.8			60.9	304			724
10	165		361.4	7.4792	49.8			64.9	324			686

CLOSED

* 0.97 - EFFIC MACHINE
** AREA HEAD END = 200.1



DIRECT CONNECTED LINKAGE
MITER GATE MACHINERY
OPERATING DATA
CLOSING

PLATE B-46

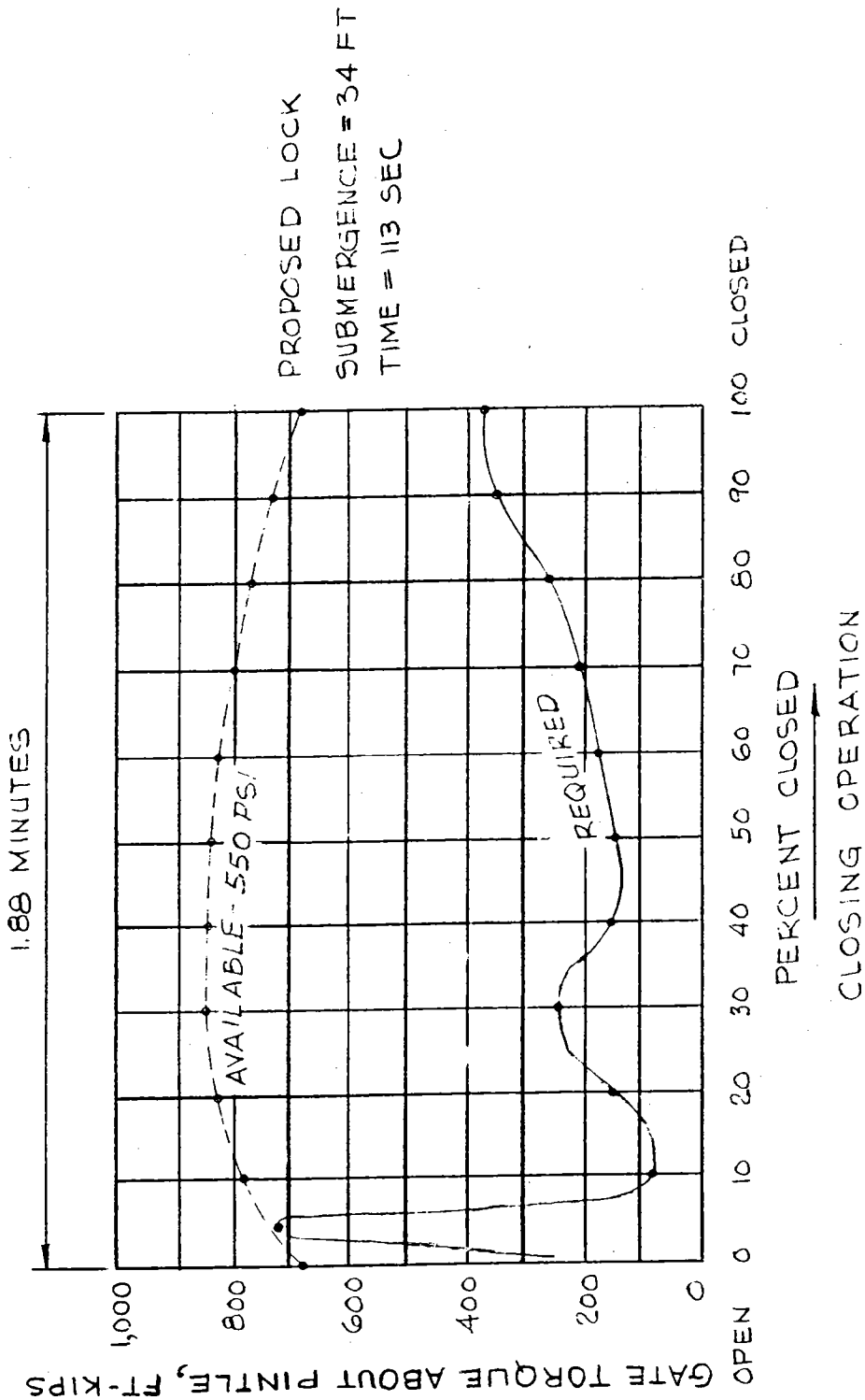

PROPOSED LOCK
SUBMERGENCE = 34 FT
TIME = 113 SEC
1.88 MINUTES
AVAILABLE - 550 PSI
REQUIRED
GATE TORQUE ABOUT PINTLE, FT-KIPS
1,000
800
600
400
200
0
OPEN
0
10
20
30
40
50
60
70
80
90
100
CLOSED
PERCENT CLOSED
CLOSING OPERATION

PLATE B-47

PUMP CAPACITY:

USE 90 SEC OPERATING TIME-OPENING-SEE PLATE B-40

NET AREA ~ ROD END = 150.83 □"

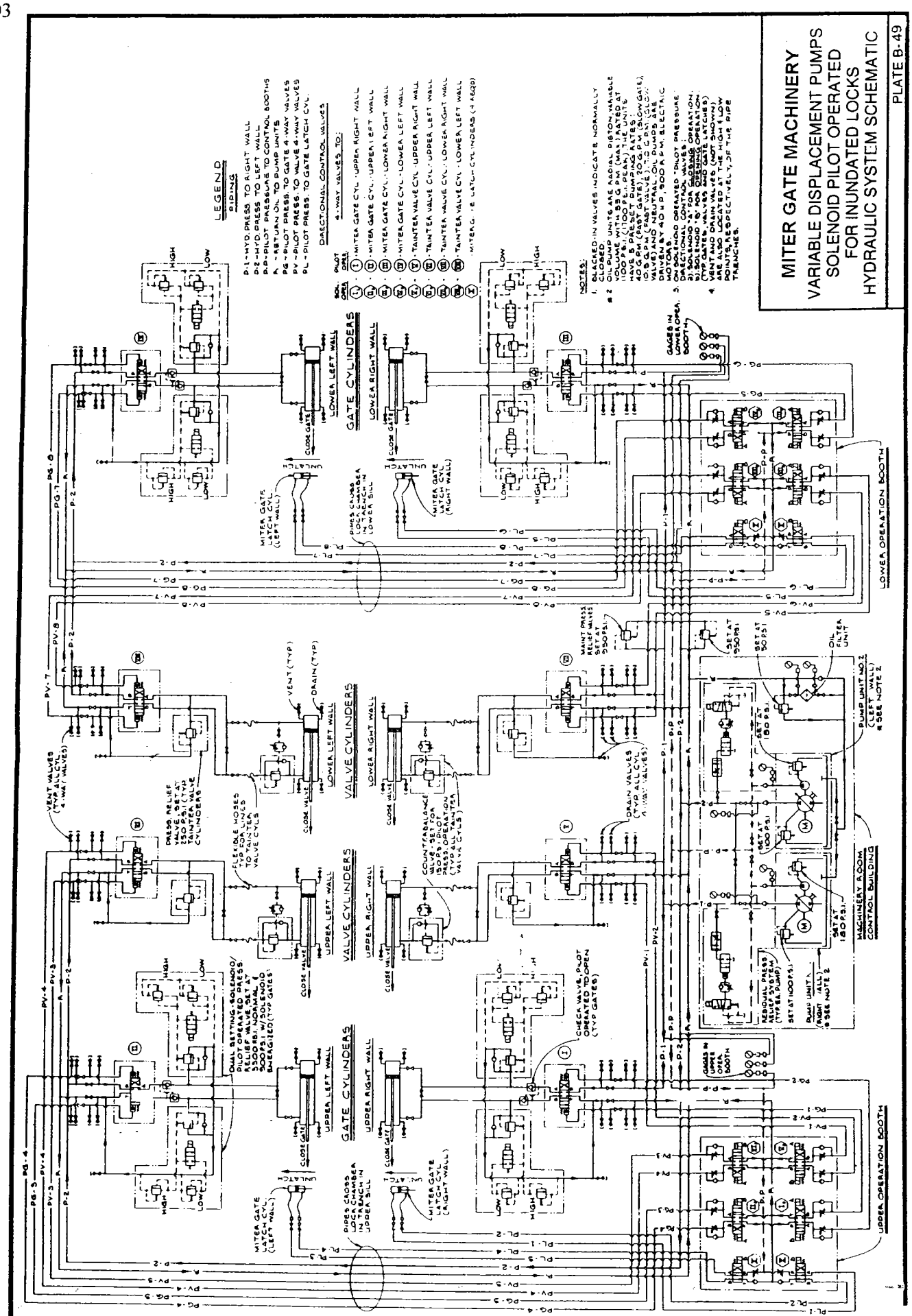
$$GPM = \frac{150.83 \times 12 \times 0.1459 \times 60}{231} = 68.6 \text{ FAST SPEED}$$

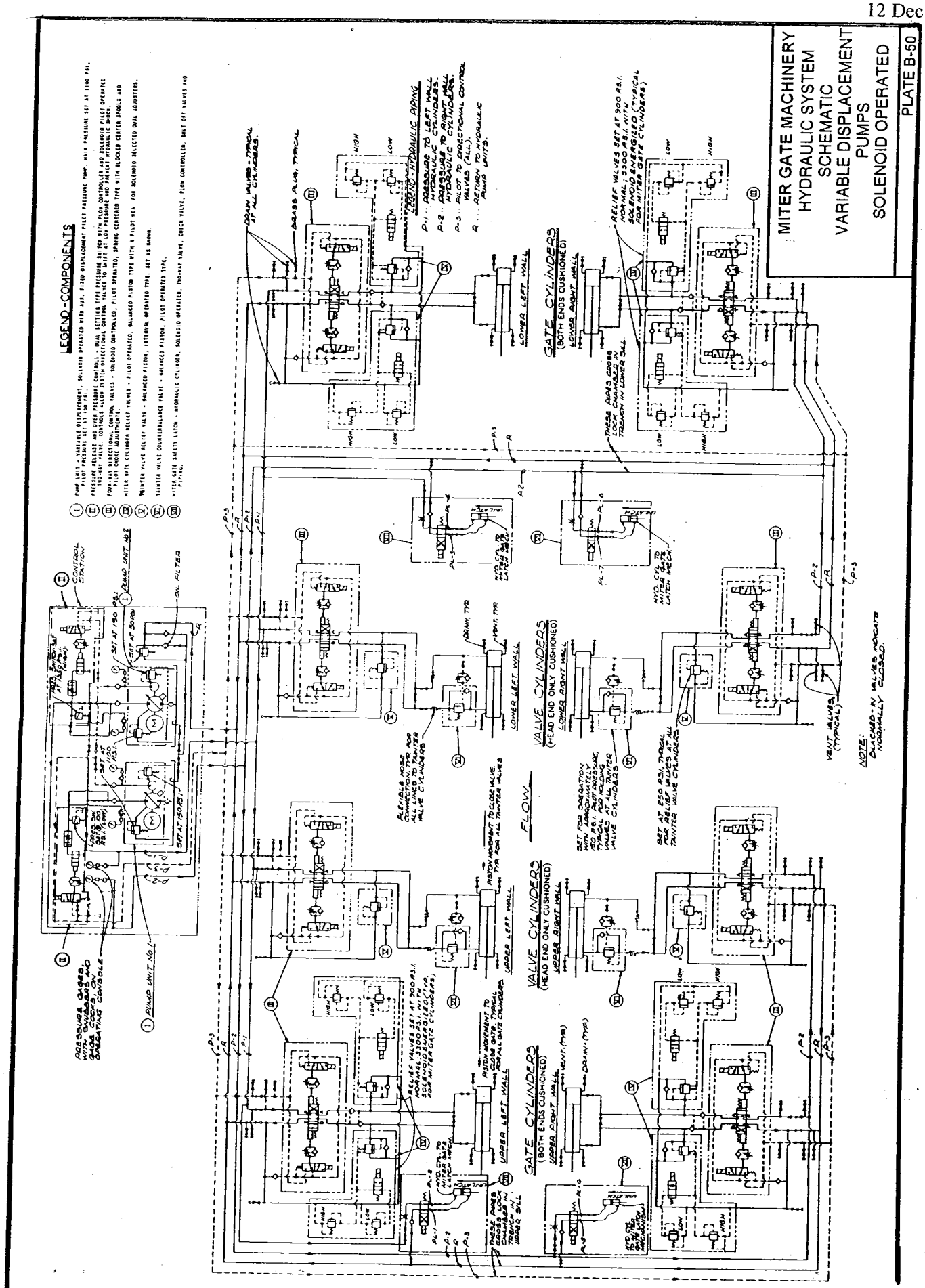
$$GPM = 68.6 \times 0.8 = 54.9 \text{ MED SPEED}$$

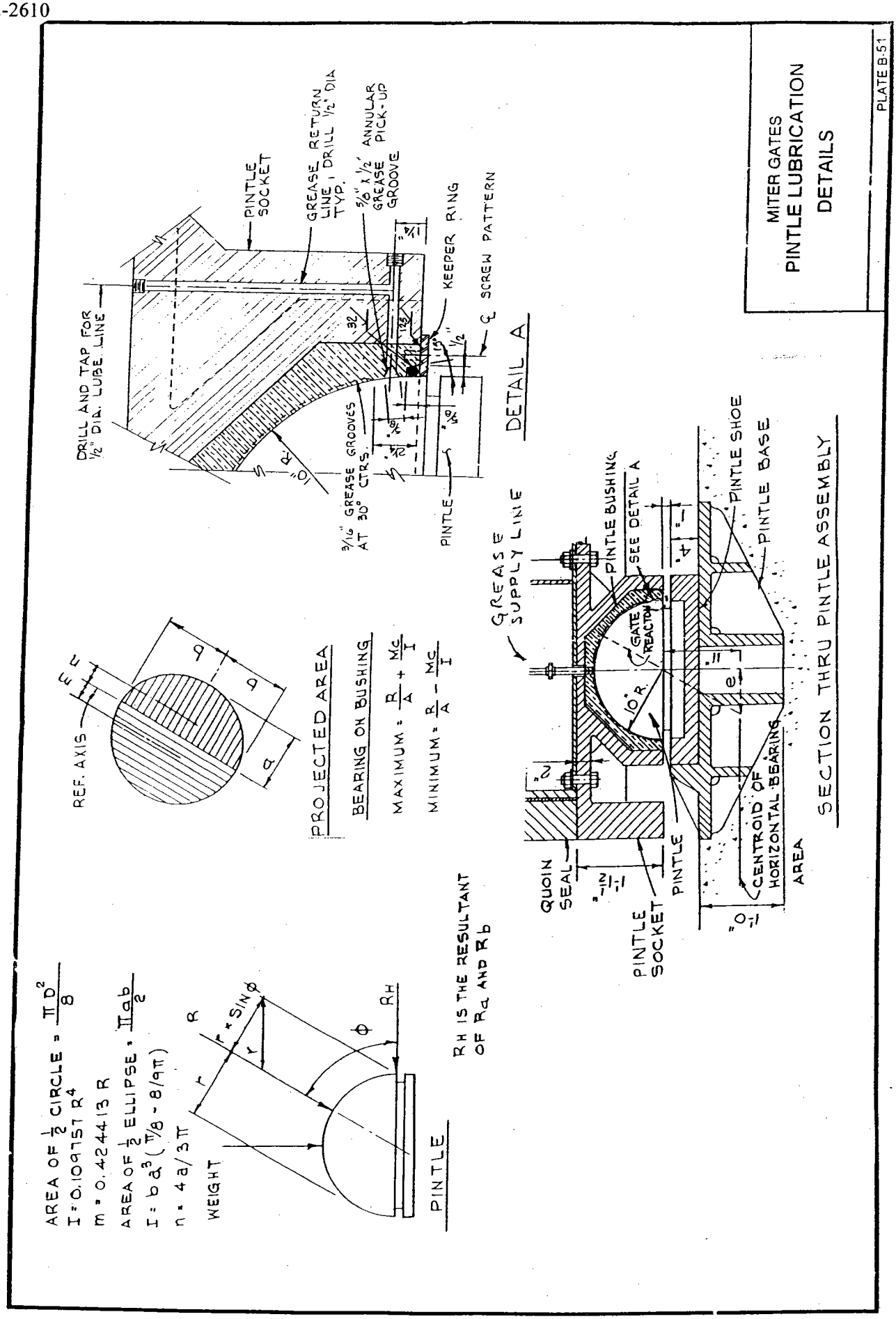
$$GPM = 68.6 \times 0.3 = 20.6 \text{ SLOW SPEED}$$

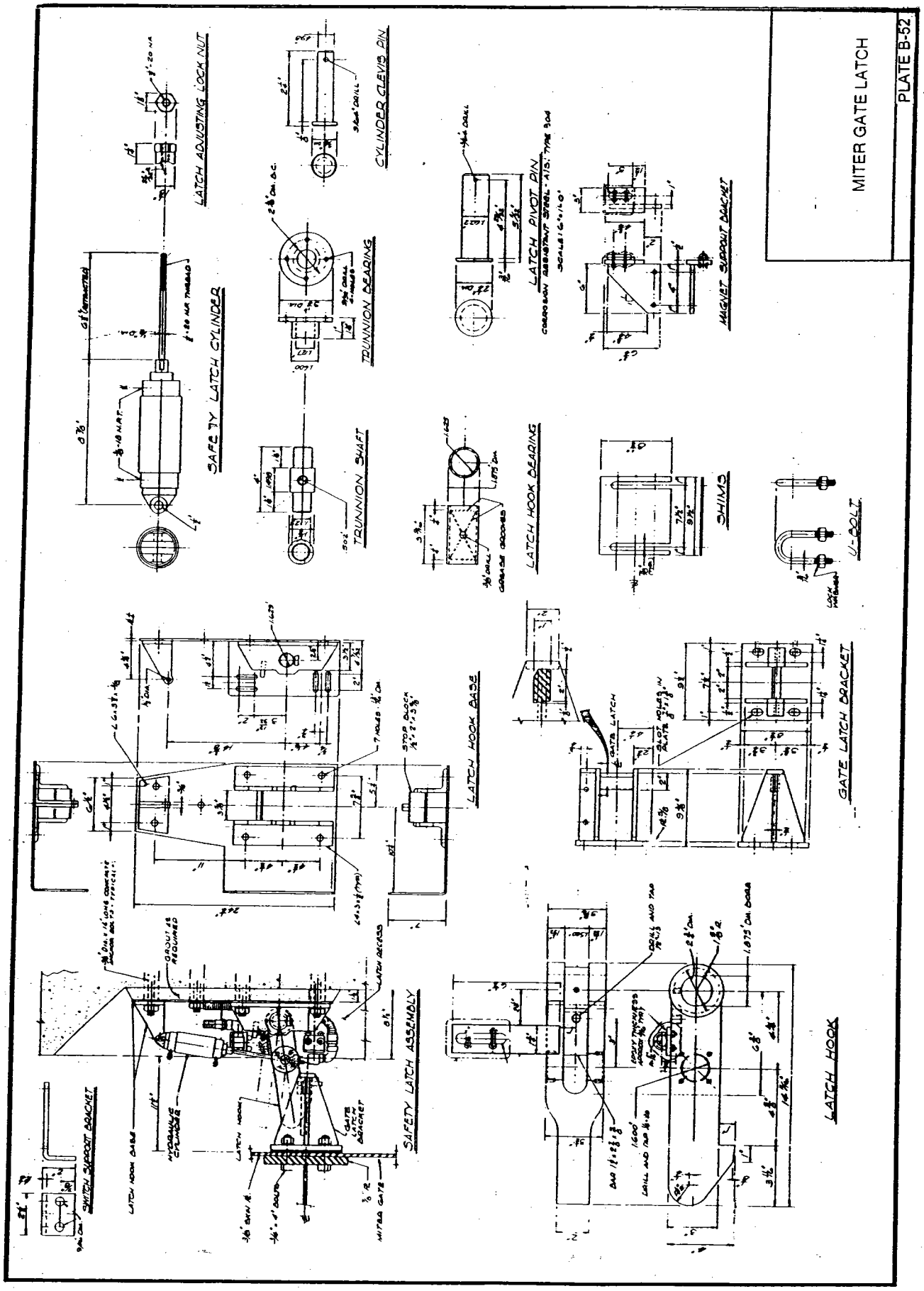
USE VARIABLE VOLUME PUMP WITH AT LEAST 4 SETTINGS, "NEUTRAL", "SLOW", "MEDIUM", AND "FAST", WITH PUMP DELIVERIES AS SHOWN ABOVE.

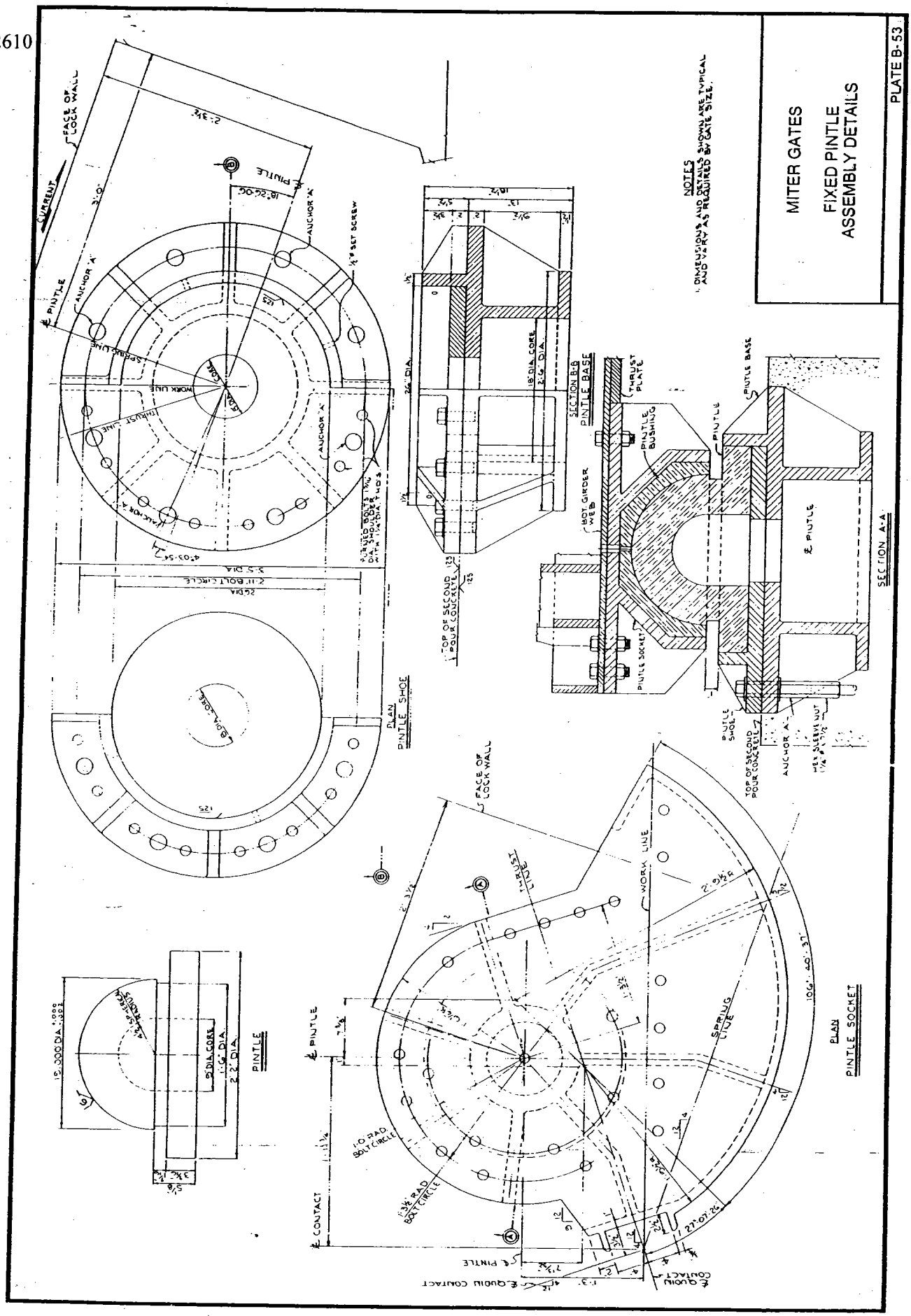
PLATE B-48

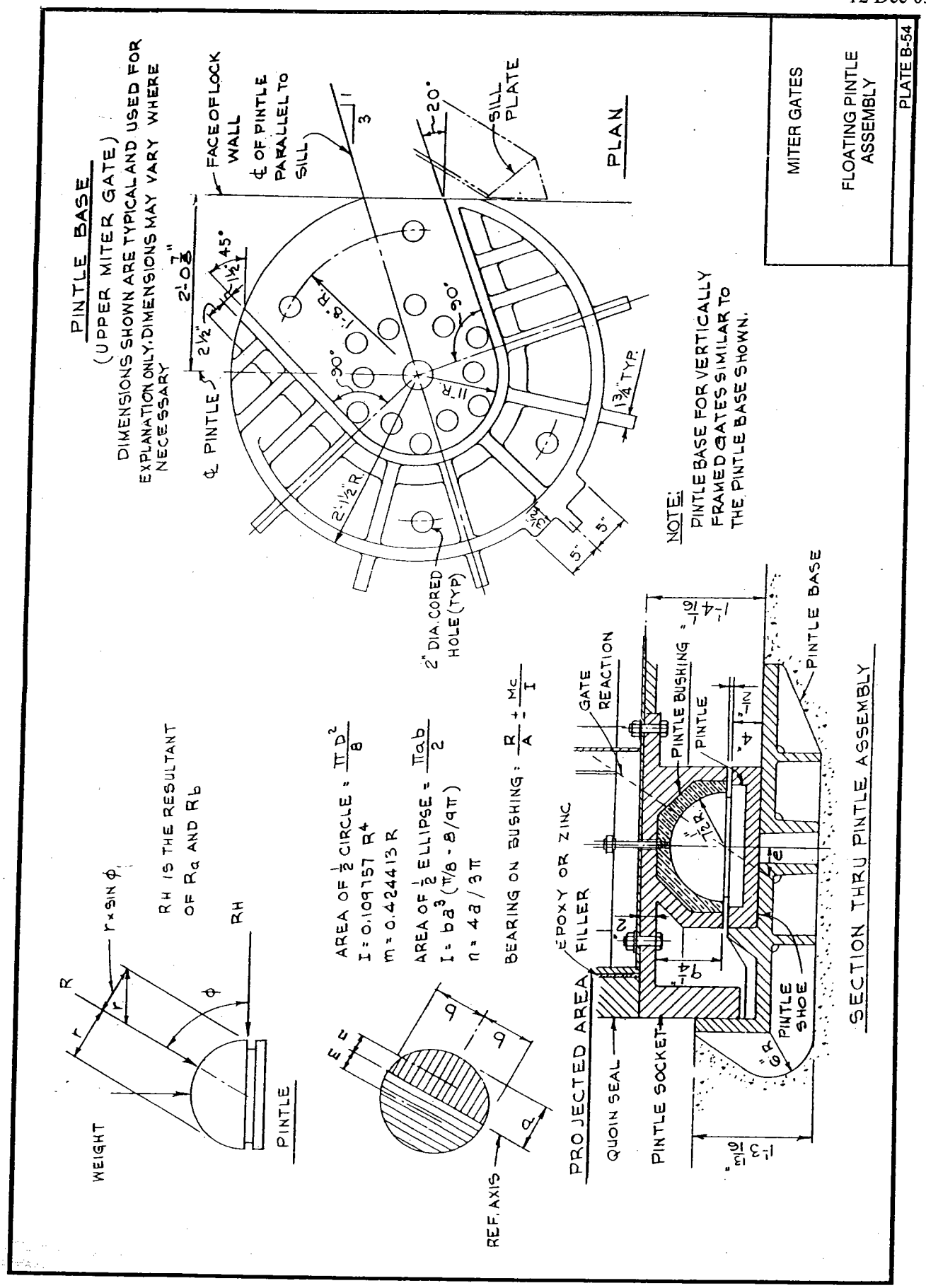

MITER GATE MACHINERY
VARIABLE DISPLACEMENT PUMPS
SOLENOID PILOT OPERATED
FOR INUNDATED LOCKS
HYDRAULIC SYSTEM SCHEMATIC
PLATE B-49
LEGEND
PIPING
DIRECTIONAL CONTROL VALVES
4-WAY VALVES TO:
NOTES:
GATE CYLINDERS
VALVE CYLINDERS
LOWER LEFT WALL
LOWER RIGHT WALL
UPPER LEFT WALL
UPPER RIGHT WALL
LOWER OPERATION BOOTH
UPPER OPERATION BOOTH
MACHINERY ROOM
CONTROL BUILDING

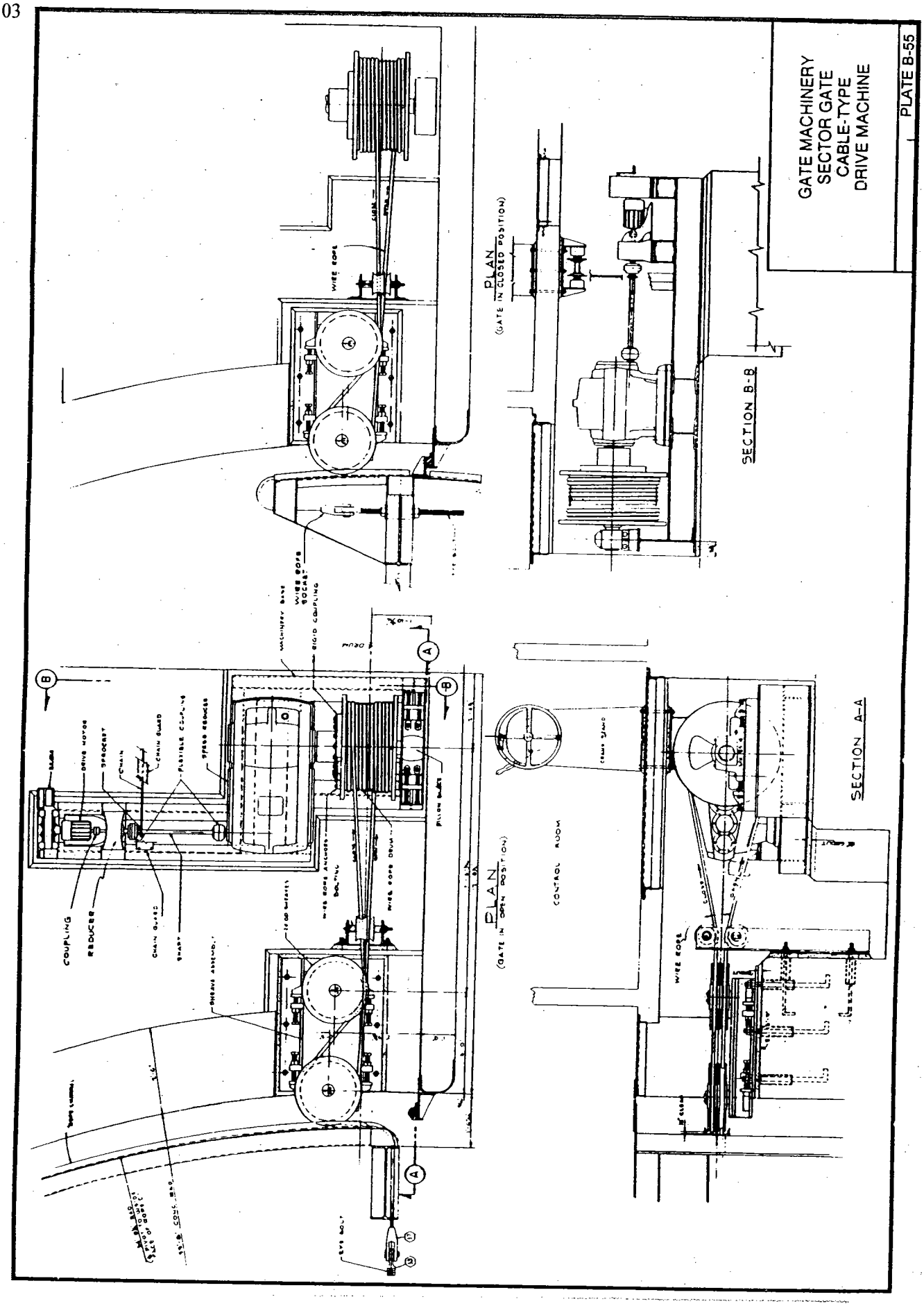

MITER GATE MACHINERY
HYDRAULIC SYSTEM
SCHEMATIC
VARIABLE DISPLACEMENT
PUMPS
SOLENOID OPERATED
PLATE B-50
LEGEND-COMPONENTS
LEGEND-HYDRAULIC PIPING
GATE CYLINDERS
(BOTH ENDS CUSHIONED)
VALVE CYLINDERS
(HEAD END ONLY CUSHIONED)
FLOW
NOTE:
BLACKED-IN VALVES INDICATE NORMALLY CLOSED.
PUMP UNIT NO 1
PUMP UNIT NO 2
CONTROL STATION
OIL FILTER
LOWER LEFT WALL
LOWER RIGHT WALL
UPPER LEFT WALL
UPPER RIGHT WALL
HIGH
LOW

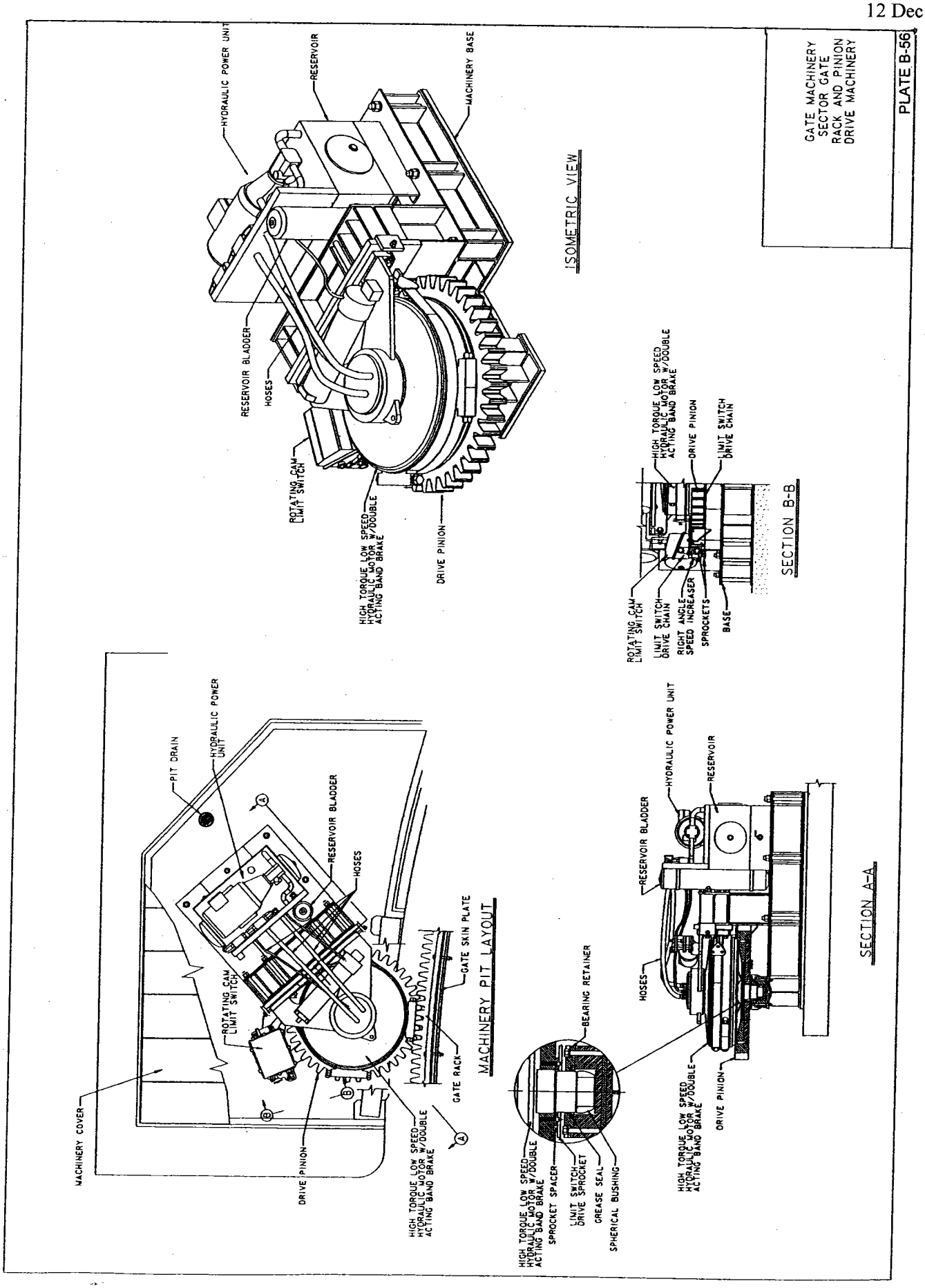

MITER GATES
PINTLE LUBRICATION
DETAILS
PLATE B-51
DETAIL A
PINTLE SOCKET
GREASE RETURN LINE, DRILL 1/2" DIA TYP.
5/8" x 1/2" ANNULAR GREASE PICK-UP GROOVE
KEEPER RING
℄ SCREW PATTERN
DRILL AND TAP FOR 1/2" DIA. LUBE LINE
3/16" GREASE GROOVES AT 30° CTRS.
PINTLE
SECTION THRU PINTLE ASSEMBLY
GREASE SUPPLY LINE
PINTLE BUSHING
SEE DETAIL A
GATE REACTION
PINTLE SHOE
PINTLE BASE
QUOIN SEAL
PINTLE SOCKET
PINTLE
CENTROID OF HORIZONTAL BEARING AREA
PROJECTED AREA
REF. AXIS
BEARING ON BUSHING
MAXIMUM = R/A + Mc/I
MINIMUM = R/A − Mc/I
RH IS THE RESULTANT OF Ra AND Rb
AREA OF 1/2 CIRCLE = πD²/8
I = 0.109757 R⁴
m = 0.424413 R
AREA OF 1/2 ELLIPSE = πab/2
I = ba³(π/8 − 8/9π)
n = 4a/3π
WEIGHT
PINTLE

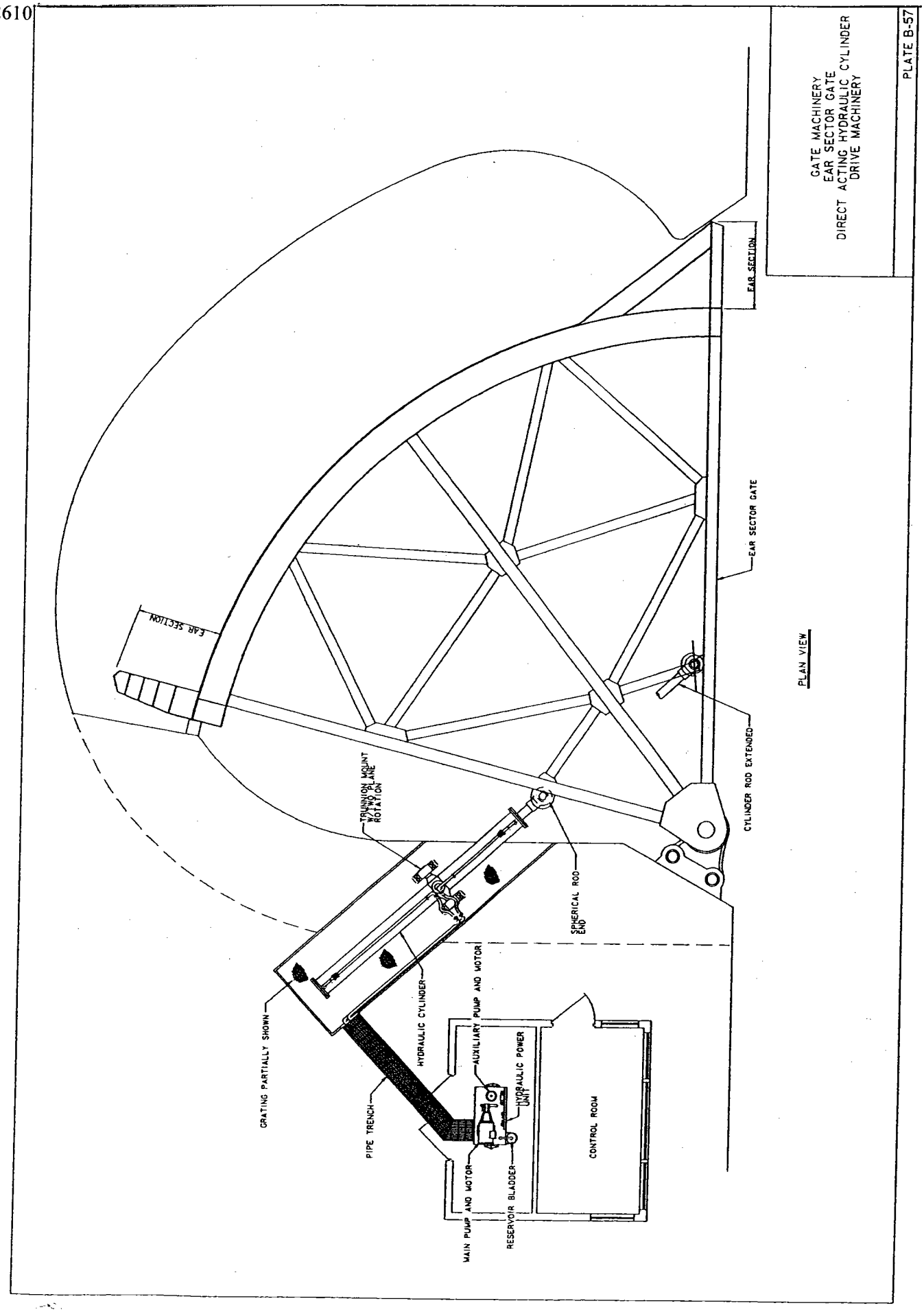

MITER GATE LATCH
PLATE B-52
LATCH ADJUSTING LOCK NUT
CYLINDER CLEVIS PIN
SAFETY LATCH CYLINDER
TRUNNION BEARING
LATCH PIVOT PIN
MAGNET SUPPORT BRACKET
TRUNNION SHAFT
LATCH HOOK BEARING
SHIMS
U-BOLT
LATCH HOOK BASE
GATE LATCH
GATE LATCH BRACKET
SWITCH SUPPORT BRACKET
SAFETY LATCH ASSEMBLY
LATCH HOOK

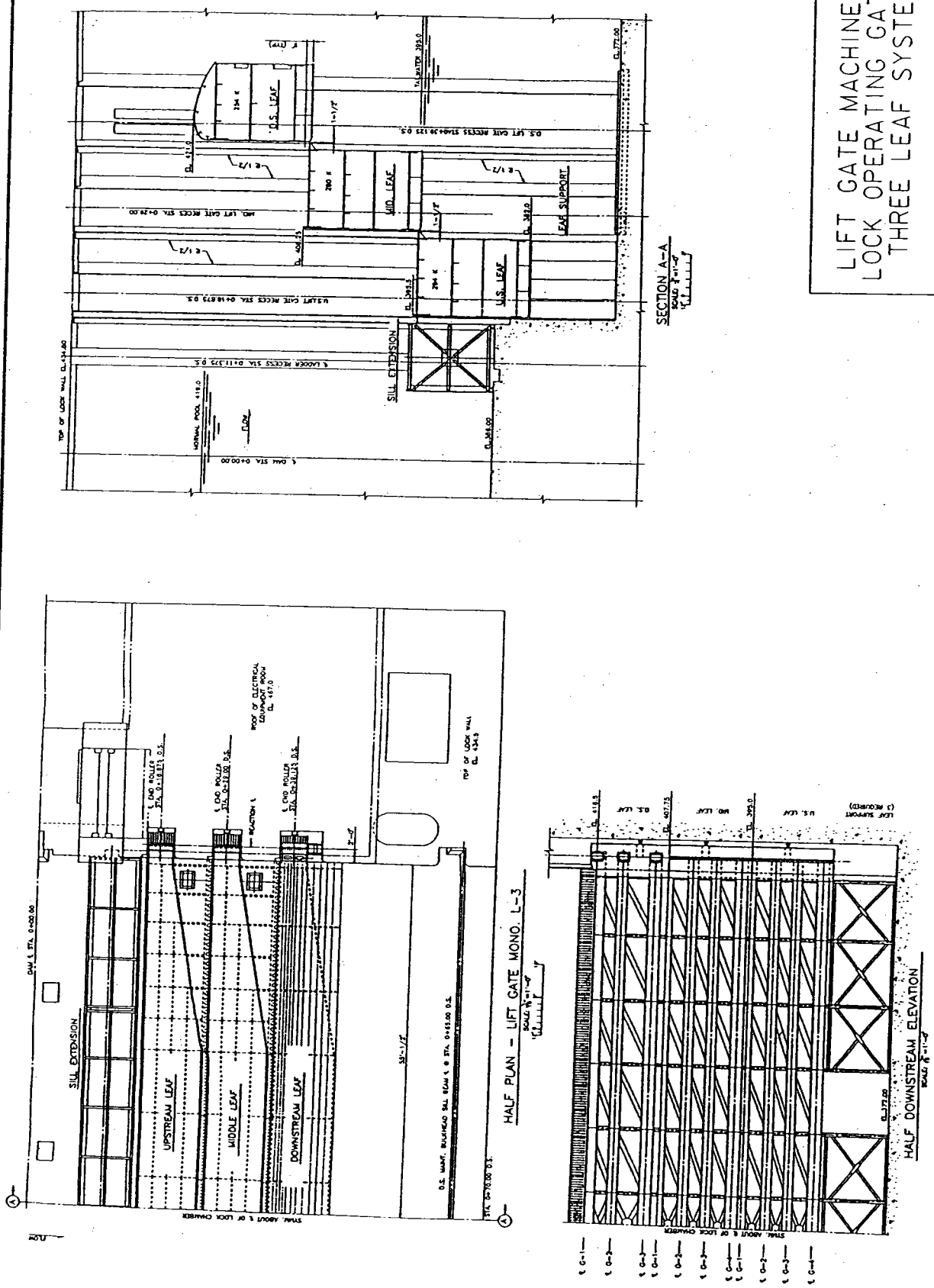

MITER GATES
FIXED PINTLE
ASSEMBLY DETAILS
PLATE B-53
NOTES
1. DIMENSIONS AND DETAILS SHOWN ARE TYPICAL AND VARY AS REQUIRED BY GATE SIZE.
PLAN
PINTLE SHOE
SECTION B-B
PINTLE BASE
SECTION A-A
PLAN
PINTLE SOCKET
PINTLE
CURRENT
FACE OF LOCK WALL
ANCHOR "A"
SPRING LINE
WORK LINE
THRUST LINE
PINTLE BASE
PINTLE BUSHING
THRUST PLATE
BOT. GIRDER WEB
PINTLE SOCKET
PINTLE SHOE
TOP OF SECOND POUR CONCRETE
HEX SLEEVE NUT
1.0 RAD. BOLT CIRCLE
1.3½ RAD. BOLT CIRCLE
℄ CONTACT
℄ QUOIN CONTACT
℄ PINTLE


PINTLE BASE
(UPPER MITER GATE)
DIMENSIONS SHOWN ARE TYPICAL AND USED FOR EXPLANATION ONLY. DIMENSIONS MAY VARY WHERE NECESSARY
FACE OF LOCK WALL
℄ OF PINTLE PARALLEL TO SILL
SILL PLATE
PLAN
℄ PINTLE
2" DIA. CORED HOLE (TYP)
NOTE:
PINTLE BASE FOR VERTICALLY FRAMED GATES SIMILAR TO THE PINTLE BASE SHOWN.
MITER GATES
FLOATING PINTLE ASSEMBLY
PLATE B-54
WEIGHT
PINTLE
RH IS THE RESULTANT OF Ra AND Rb
AREA OF ½ CIRCLE = πD²/8
I = 0.109757 R⁴
m = 0.424413 R
AREA OF ½ ELLIPSE = πab/2
I = ba³(π/8 - 8/9π)
n = 4a/3π
BEARING ON BUSHING = R/A ± Mc/I
REF. AXIS
PROJECTED AREA
EPOXY OR ZINC FILLER
QUOIN SEAL
PINTLE SOCKET
GATE REACTION
PINTLE BUSHING
PINTLE
PINTLE SHOE
PINTLE BASE
SECTION THRU PINTLE ASSEMBLY


GATE MACHINERY
SECTOR GATE
CABLE-TYPE
DRIVE MACHINE
PLATE B-55
PLAN
(GATE IN CLOSED POSITION)
SECTION B-B
PLAN
(GATE IN OPEN POSITION)
SECTION A-A
CONTROL ROOM
COUPLING
REDUCER
WIRE ROPE
MACHINERY BASE
RIGID COUPLING
DRUM
PILLOW BLOCK
CRANK STAND

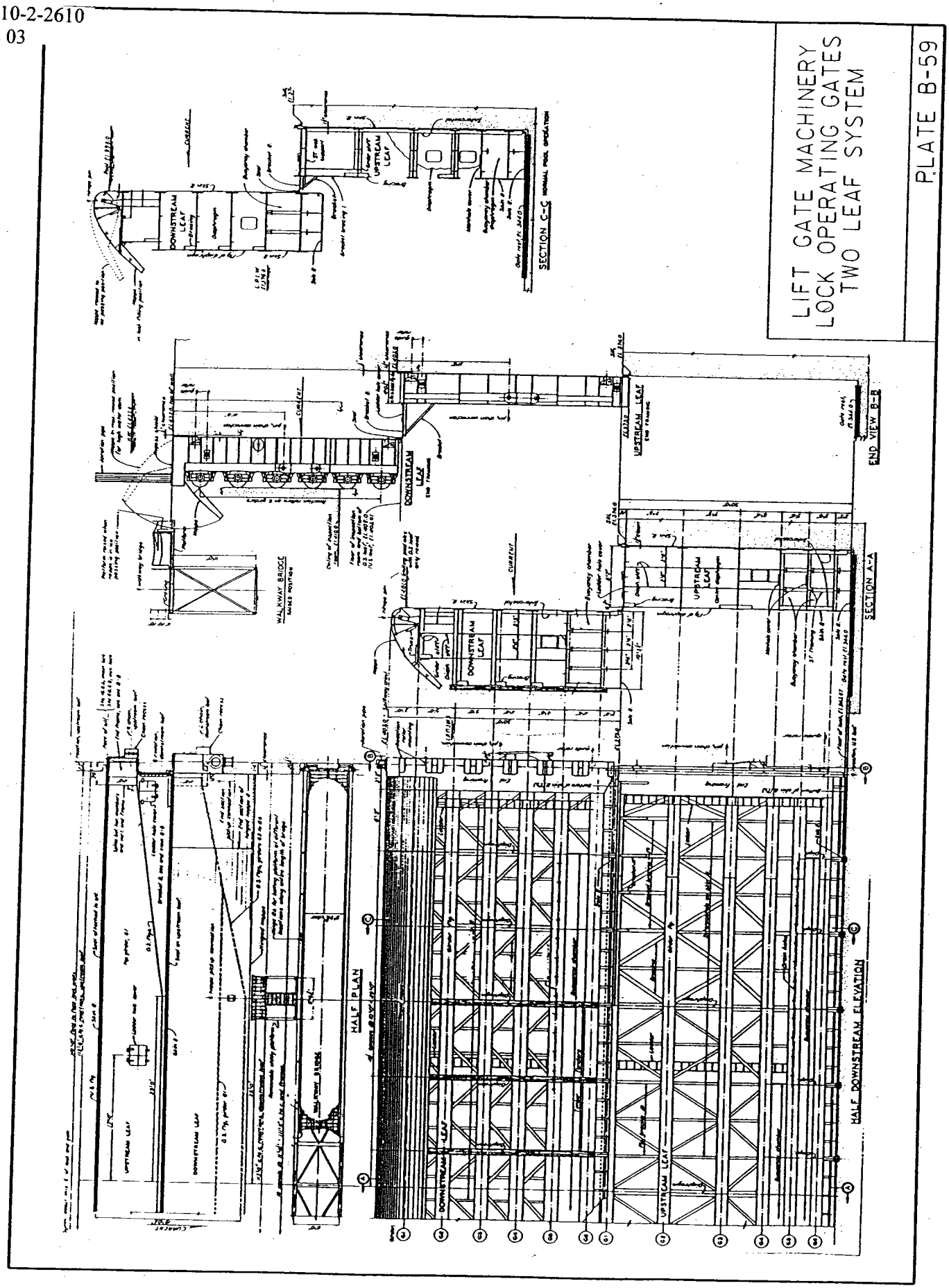

HYDRAULIC POWER UNIT
RESERVOIR
MACHINERY BASE
RESERVOIR BLADDER
HOSES
ROTATING CAM LIMIT SWITCH
HIGH TORQUE LOW SPEED HYDRAULIC MOTOR W/DOUBLE ACTING BAND BRAKE
DRIVE PINION
ISOMETRIC VIEW
HIGH TORQUE LOW SPEED HYDRAULIC MOTOR W/DOUBLE ACTING BAND BRAKE
DRIVE PINION
LIMIT SWITCH DRIVE CHAIN
ROTATING CAM LIMIT SWITCH
LIMIT SWITCH DRIVE CHAIN
RIGHT ANGLE SPEED INCREASER
SPROCKETS
BASE
SECTION B-B
GATE MACHINERY
SECTOR GATE
RACK AND PINION
DRIVE MACHINERY
PLATE B-56
PIT DRAIN
HYDRAULIC POWER UNIT
RESERVOIR BLADDER
HOSES
ROTATING CAM LIMIT SWITCH
GATE SKIN PLATE
GATE RACK
MACHINERY PIT LAYOUT
MACHINERY COVER
DRIVE PINION
HIGH TORQUE LOW SPEED HYDRAULIC MOTOR W/DOUBLE ACTING BAND BRAKE
BEARING RETAINER
HIGH TORQUE LOW SPEED HYDRAULIC MOTOR W/DOUBLE ACTING BAND BRAKE
SPROCKET SPACER
LIMIT SWITCH DRIVE SPROCKET
GREASE SEAL
SPHERICAL BUSHING
HYDRAULIC POWER UNIT
RESERVOIR
RESERVOIR BLADDER
HOSES
HIGH TORQUE LOW SPEED HYDRAULIC MOTOR W/DOUBLE ACTING BAND BRAKE
DRIVE PINION
SECTION A-A

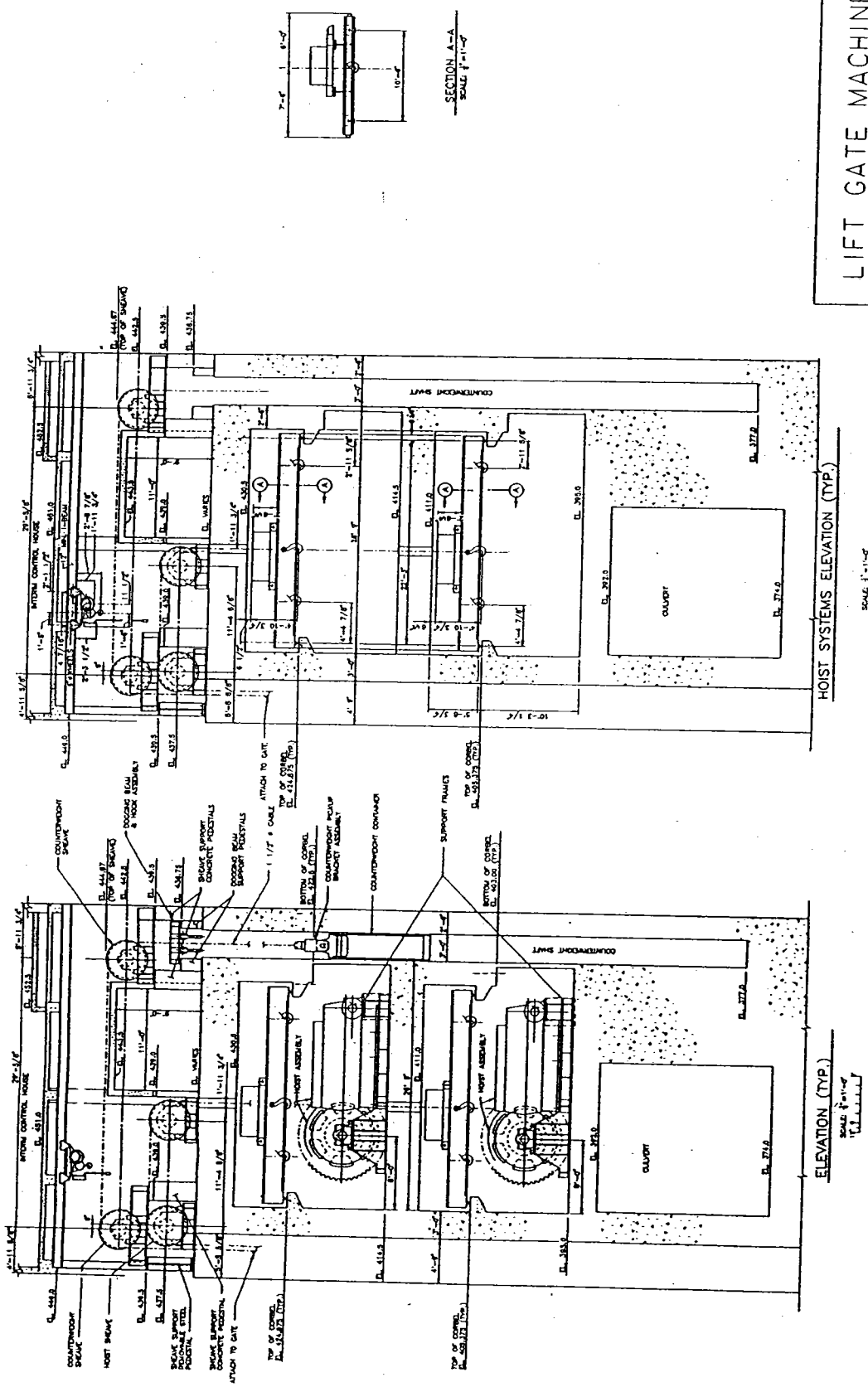

GATE MACHINERY
EAR SECTOR GATE
DIRECT ACTING HYDRAULIC CYLINDER
DRIVE MACHINERY
PLATE B-57
EAR SECTION
EAR SECTOR GATE
PLAN VIEW
CYLINDER ROD EXTENDED
EAR SECTION
TRUNNION MOUNT
W/TWO PLANE
ROTATION
SPHERICAL ROD
END
HYDRAULIC CYLINDER
AUXILIARY PUMP AND MOTOR
HYDRAULIC POWER
UNIT
GRATING PARTIALLY SHOWN
PIPE TRENCH
CONTROL ROOM
MAIN PUMP AND MOTOR
RESERVOIR BLADDER



LIFT GATE MACHINERY
LOCK OPERATING GATES
THREE LEAF SYSTEM

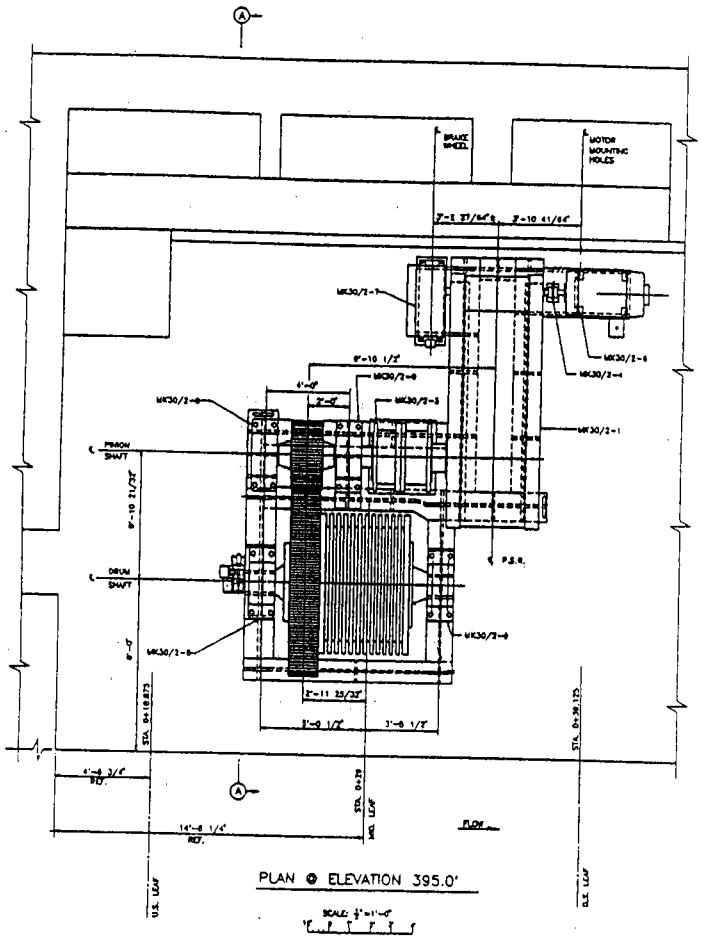
PLATE B-58


LIFT GATE MACHINERY
LOCK OPERATING GATES
TWO LEAF SYSTEM
PLATE B-59
SECTION C-C
END VIEW B-B
SECTION A-A
HALF PLAN
HALF DOWNSTREAM ELEVATION
WALKWAY BRIDGE
DOWNSTREAM LEAF
UPSTREAM LEAF
CURRENT



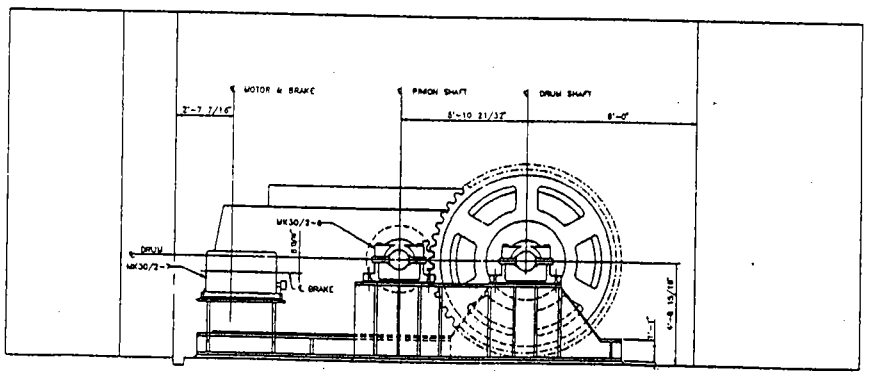
LIFT GATE MACHINERY
LOCK OPERATING GATES
THREE LEAF SYSTEM
ELEVATION

PLATE B-60



PLAN @ ELEVATION 395.0'

SCALE: ½"=1'-0"



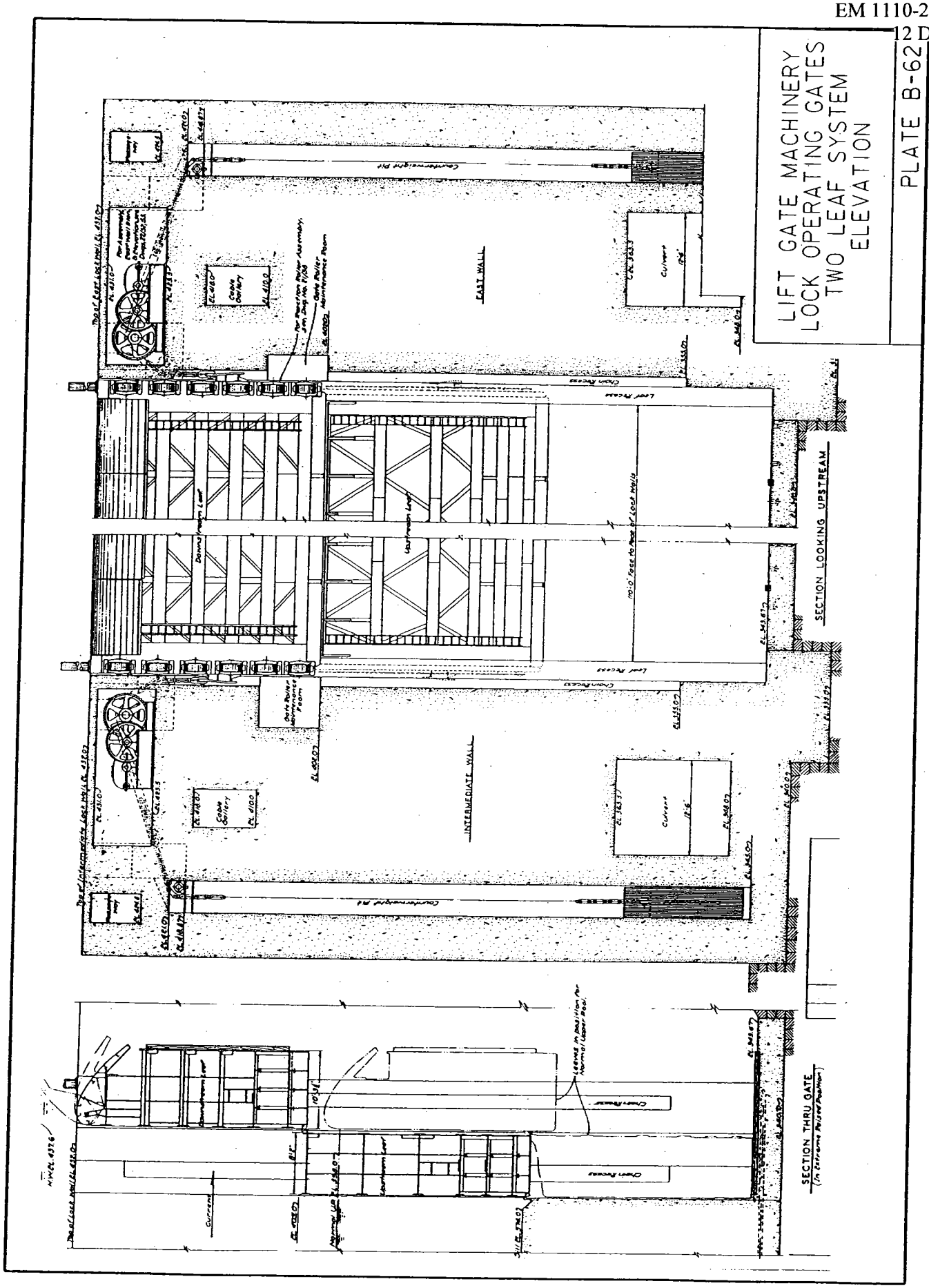
SECTION A-A

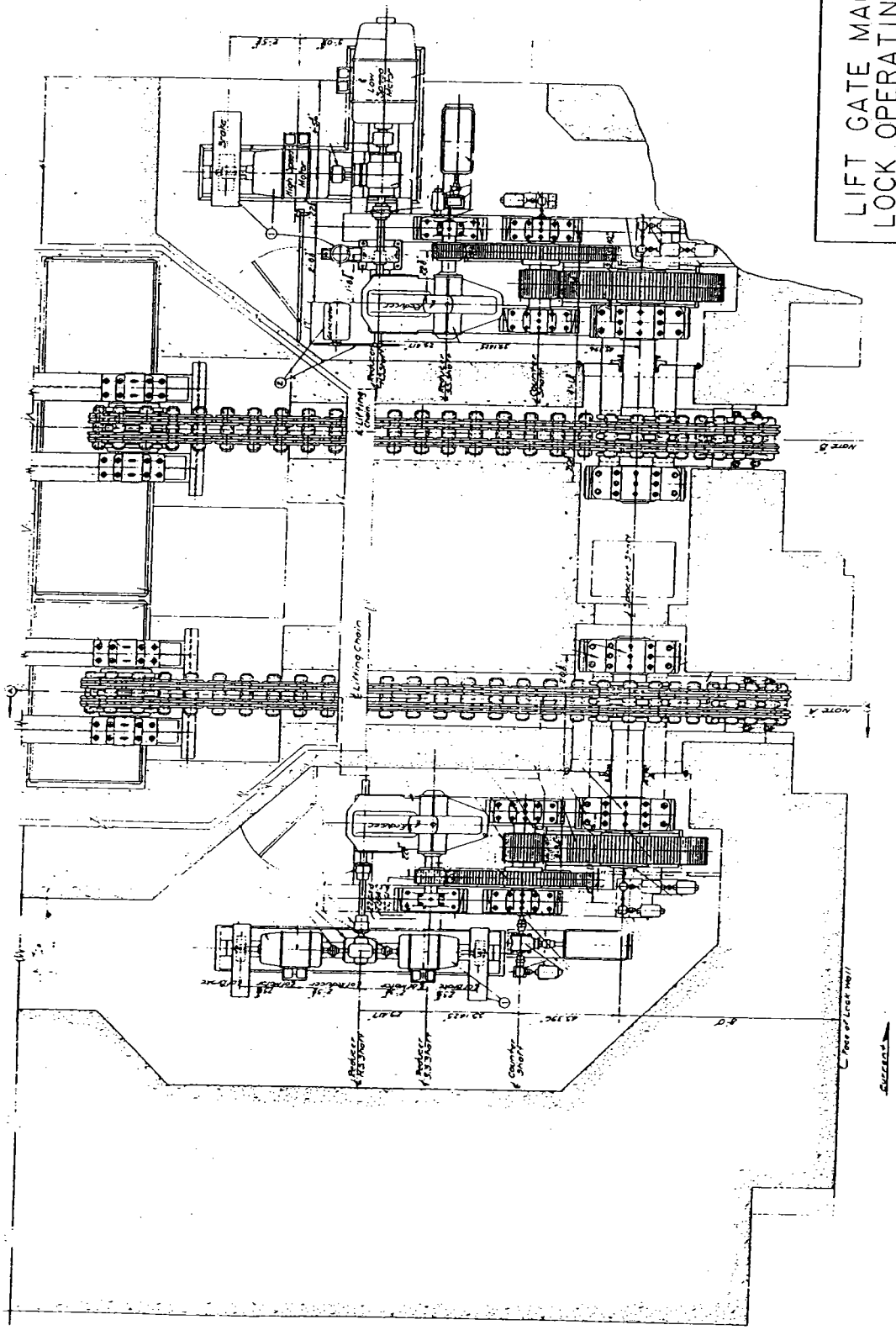
SCALE: ½"=1'-0"

LIST OF PARTS NOT DETAILED			
MARK NO.	NO. REQ'D.	DESCRIPTION	MATERIAL
MK30/2-1	3	PARALLEL SHAFT REDUCER-SIMILAR AND EQUAL TO "PHILADELPHIA GEAR CORP." UNIT SIZE 215HP4, FIG.7, AS MODIFIED HEREIN, WITH EXTENDED SHAFT TO MK30/2-7, AS REQUIRED.	COMM. GRADE
MK30/2-2	3	PARALLEL SHAFT REDUCER-SIMILAR AND EQUAL TO "PHILADELPHIA GEAR CORP." UNIT SIZE 215HP4, FIG.8 AS MODIFIED HEREIN, WITH EXTENDED SHAFT TO MK30/2-7, AS REQUIRED.	COMM. GRADE
MK30/2-3	6	FLEXIBLE COUPLING-SIMILAR AND AND EQUAL TO "FALK" TYPE 020, SERIES 2100G.	COMM. GRADE
MK30/2-4	6	FLEXIBLE COUPLING-SIMILAR AND AND EQUAL TO "FALK" TYPE GS2, SERIES 1025C.	COMM. GRADE
MK30/2-5	2	ELECTRIC MOTOR-75HP, 400-1200 RPM ADJUSTABLE, 500 VOLT D.C. -SIMILAR AND EQUAL TO "NORTHWESTERN ELECTRIC" FRAME NO. 508AT.	COMM. GRADE
MK30/2-6	4	ELECTRIC MOTOR-40HP, 400-1200 RPM ADJUSTABLE, 500 VOLT D.C. -SIMILAR AND EQUAL TO "NORTHWESTERN ELECTRIC" FRAME NO. 508AT.	COMM. GRADE
MK30/2-7	6	HOLDING BRAKE, 500-1000 FT-LB., 16" ø WHEEL-SIMILAR AND EQUAL TO "EATON-CUTLER HAMMER" TYPE GH505, SIZE 16.	COMM. GRADE
MK30/2-8	12	PILLOW BLOCK-SIMILAR AND EQUAL TO "TORRINGTON" SDAFS24160, FIXED TYPE, WITH LOCKNUT M060 AND LOCKPLATE P60.	COMM. GRADE
MK30/2-9	12	PILLOW BLOCK-SIMILAR AND EQUAL TO "TORRINGTON" SDAFS24160, FLOAT TYPE, WITH LOCKNUT M060 AND LOCKPLATE P60.	COMM. GRADE
MK30/2-10	22	TUBING-RECTANGULAR 2 X 3 X 0.12" X 1'-7" LONG.	ASTM A511, GR. MT304
MK30/2-11	4	BAR 1/4 X 4 X 4'-0"	ASTM A666, TYPE 304
MK30/2-12	4	L-6 X 3 ½ X ½ X 4'-4 ½".	ASTM A36
MK30/2-13	44	HEX. HD. CAPSCREW- ¾"-13UNC-2A X 3" LONG WITH NUT AND LOCKWASHER.	ASTM A193, GR. B8 & ASTM A194, GR. 8

LIFT GATE MACHINERY
LOCK OPERATING GATES
THREE LEAF SYSTEM
TYPICAL HOIST

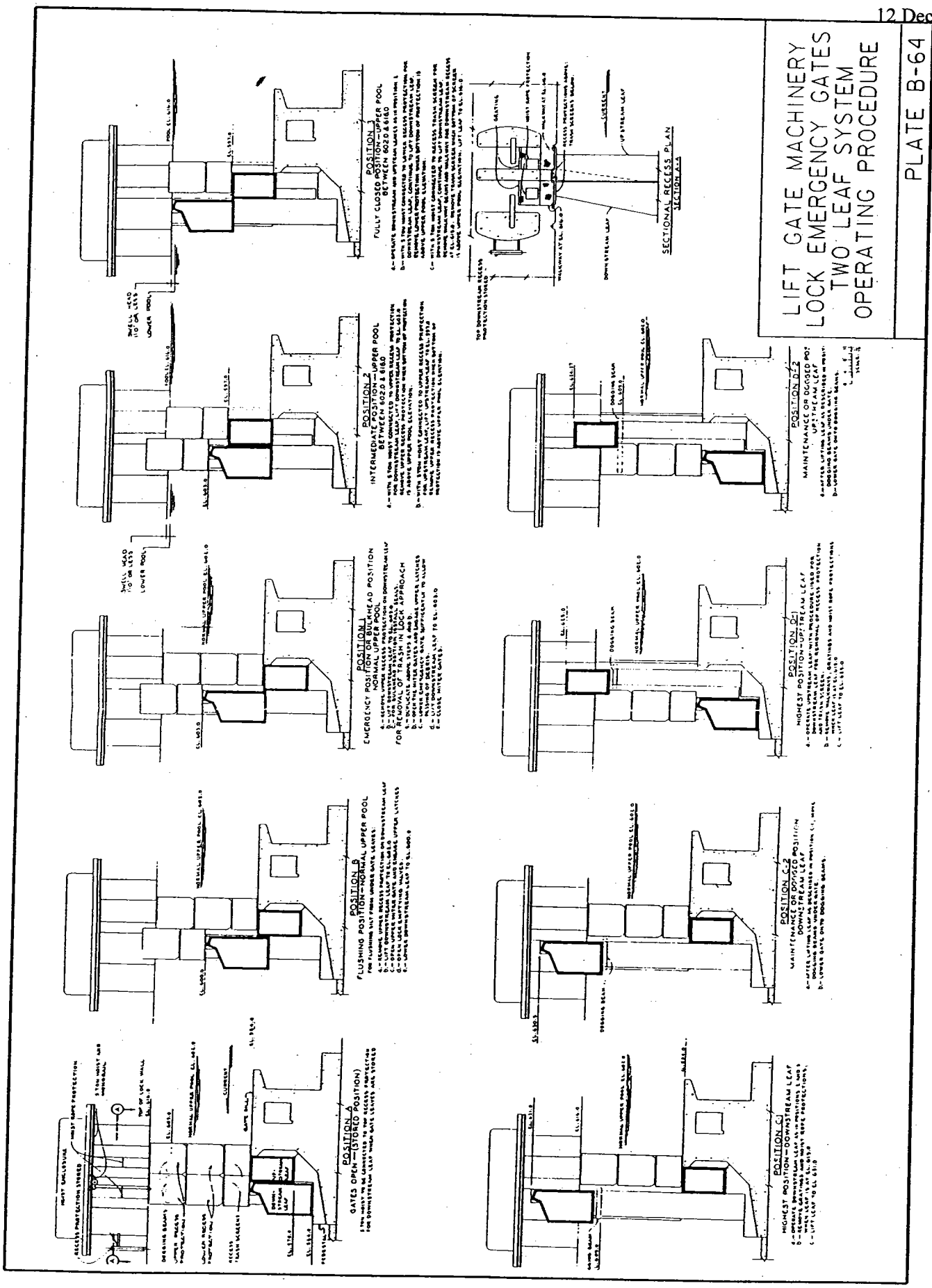
PLATE B-61

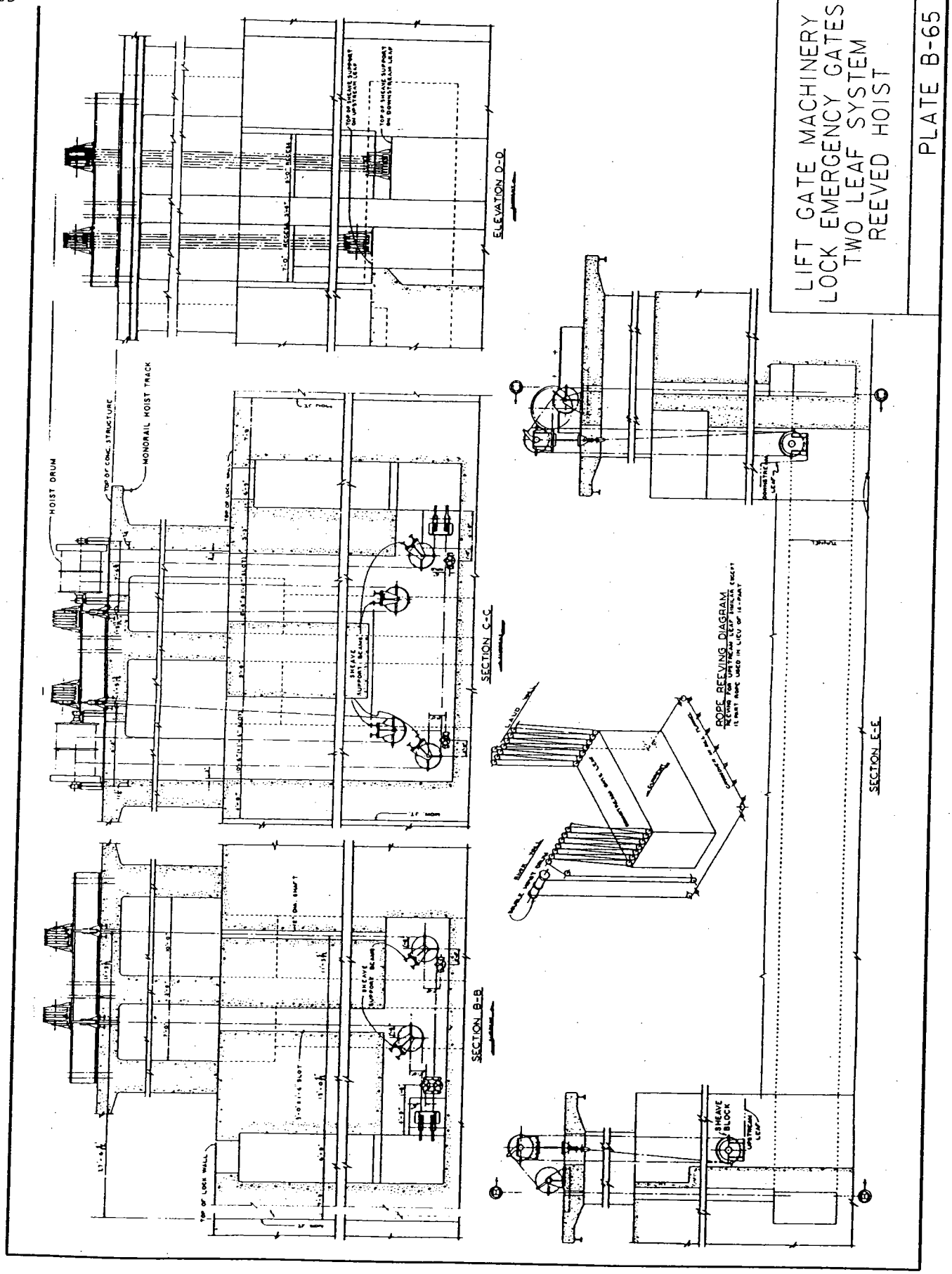

LIFT GATE MACHINERY
LOCK OPERATING GATES
TWO LEAF SYSTEM
ELEVATION
PLATE B-62
EAST WALL
INTERMEDIATE WALL
SECTION LOOKING UPSTREAM
SECTION THRU GATE

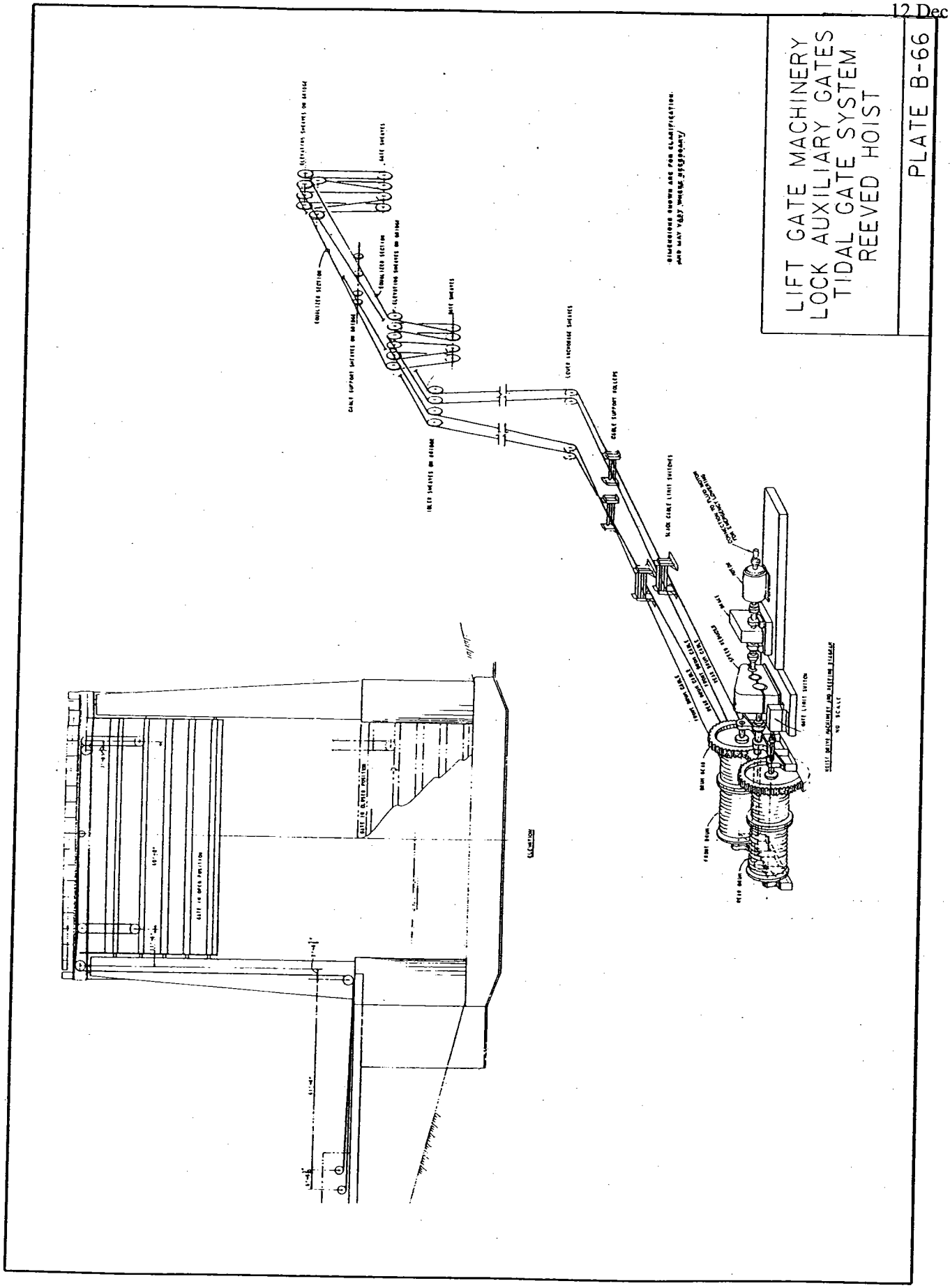


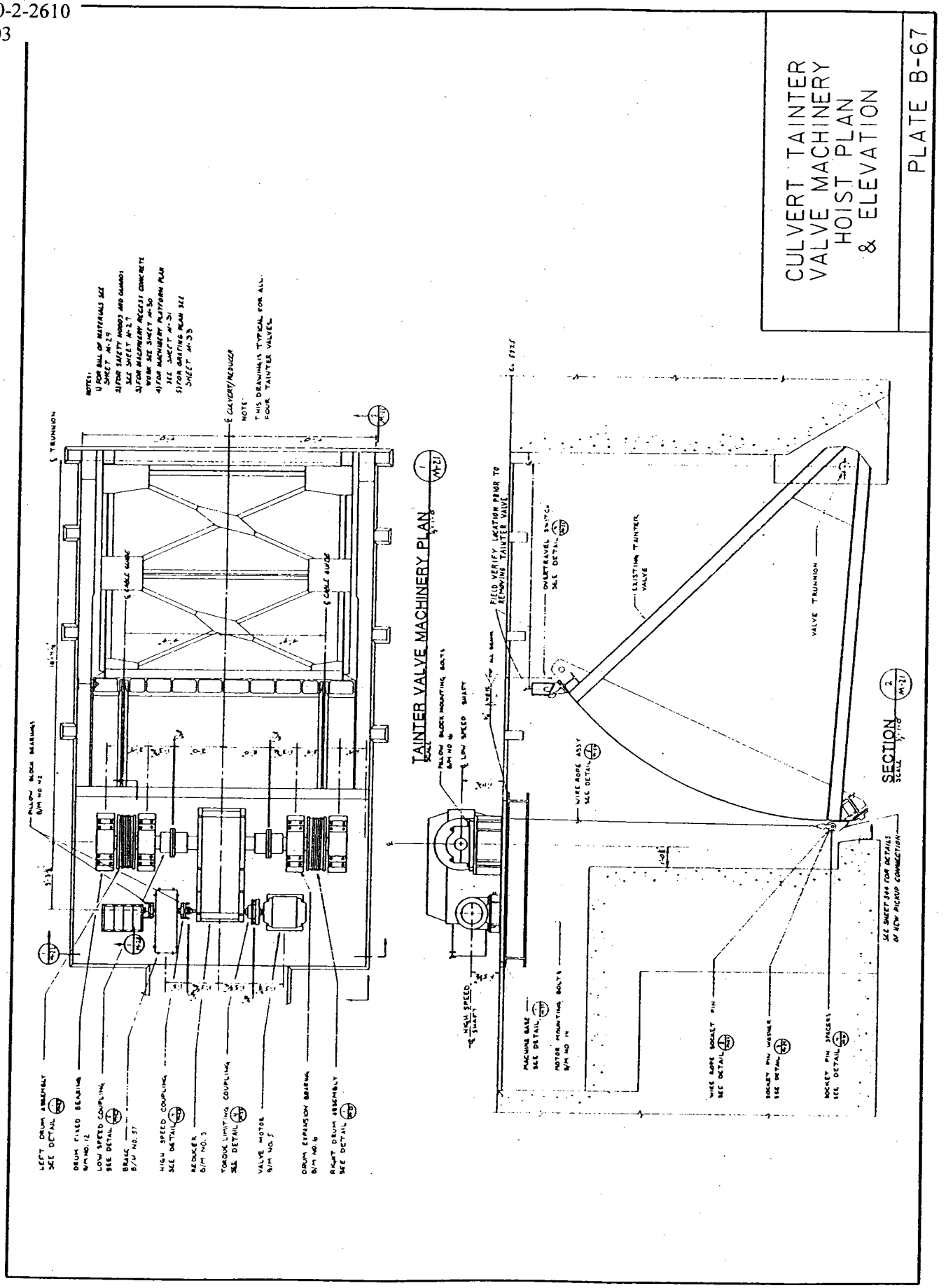
LIFT GATE MACHINERY
LOCK OPERATING GATES
TWO LEAF SYSTEM
TYPICAL HOISTS

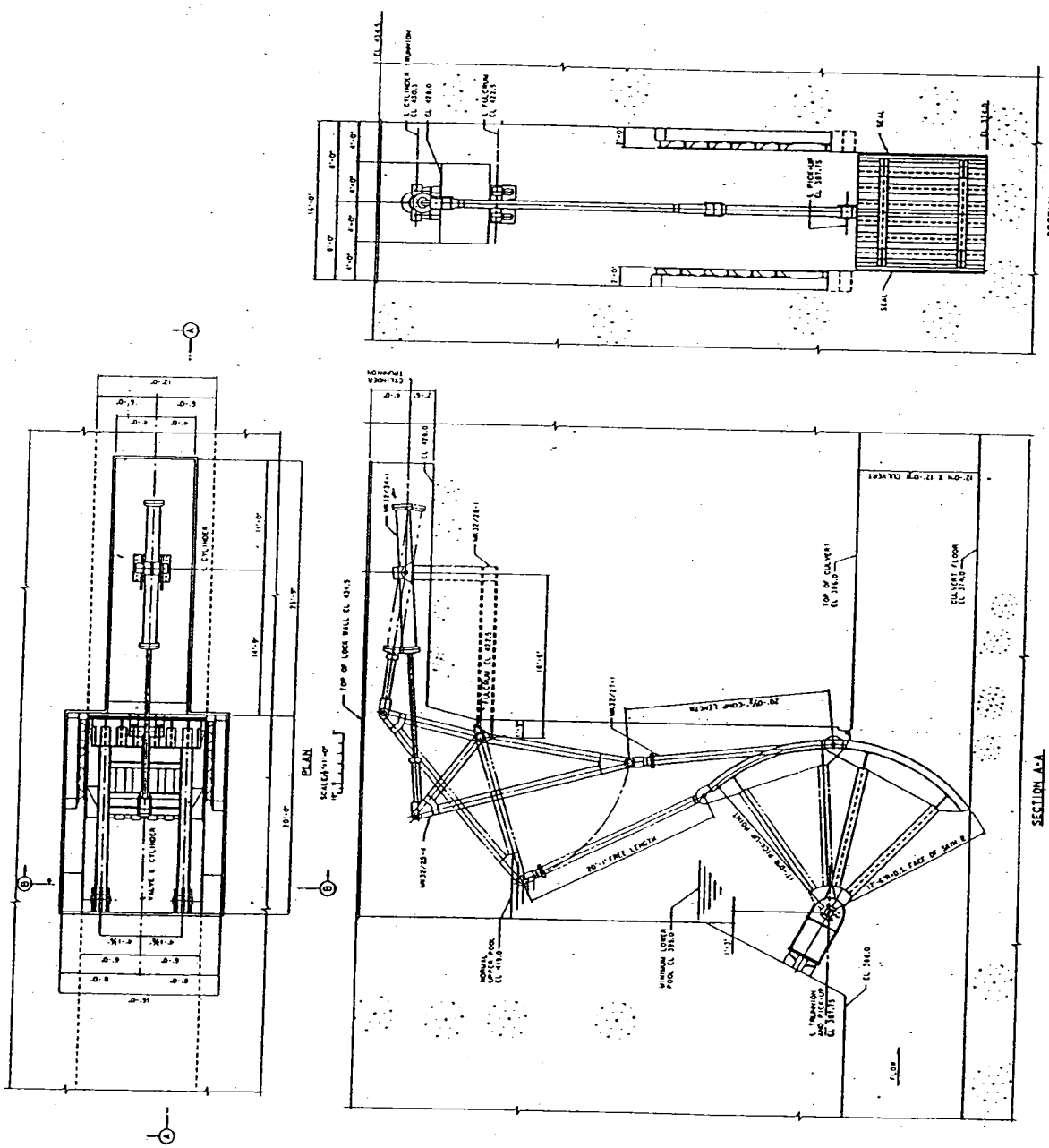
PLATE B-63

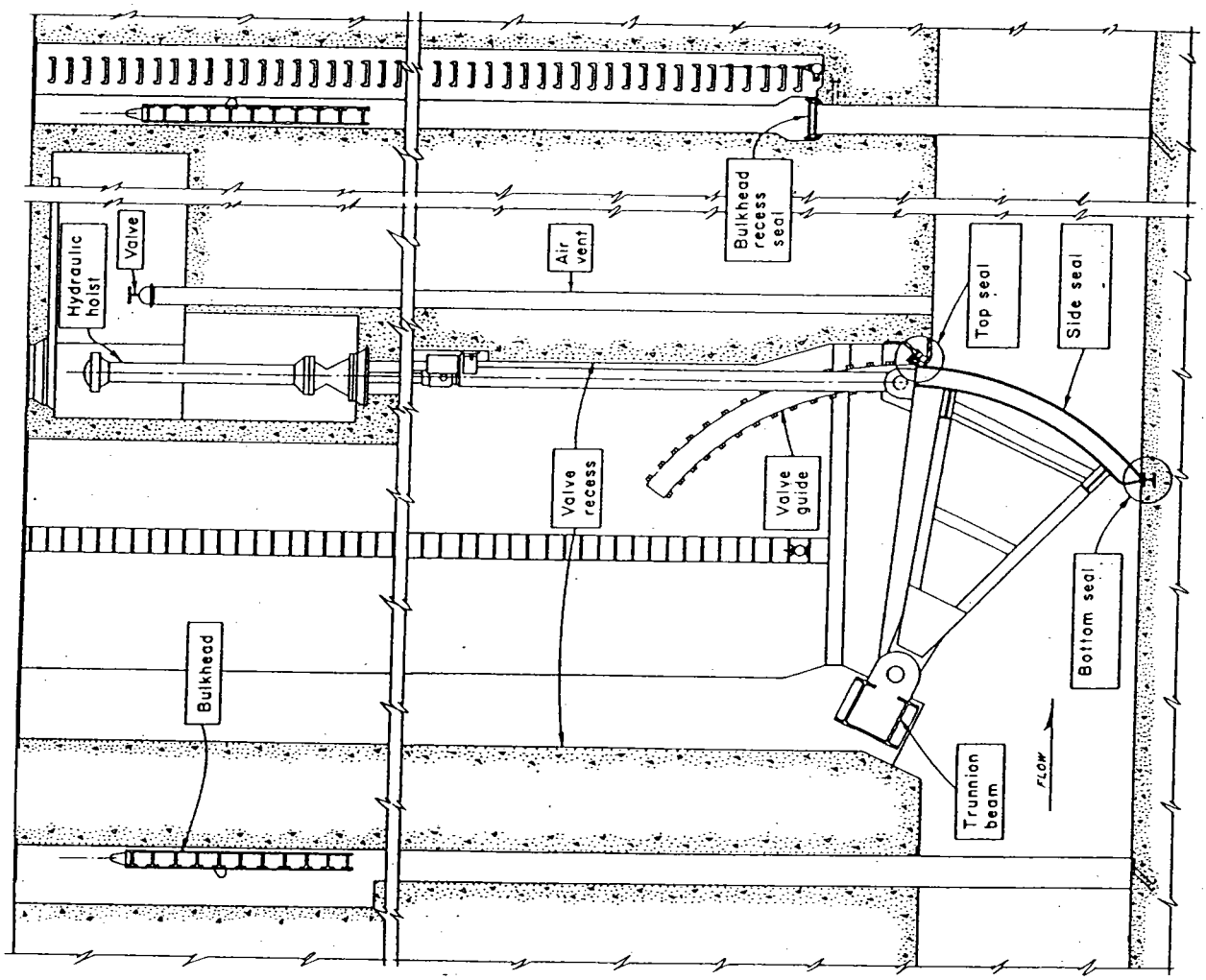

LIFT GATE MACHINERY
LOCK EMERGENCY GATES
TWO LEAF SYSTEM
OPERATING PROCEDURE
PLATE B-64
GATES OPEN—(STORED POSITION)
POSITION 1
EMERGENCY POSITION OR BULKHEAD POSITION
NORMAL UPPER POOL
POSITION 2
INTERMEDIATE POSITION—UPPER POOL
BETWEEN 6020 & 6160
POSITION 3
FULLY CLOSED POSITION—UPPER POOL
BETWEEN 6020 & 6160
SECTIONAL RECESS PLAN
SECTION A-A
POSITION 4
FLUSHING POSITION—NORMAL UPPER POOL
POSITION C-1
HIGHEST POSITION—UPSTREAM LEAF
POSITION C-2
MAINTENANCE OR DOGGED POSITION
DOWNSTREAM LEAF
POSITION C-3
HIGHEST POSITION—DOWNSTREAM LEAF
POSITION D-2
MAINTENANCE OR DOGGED POSITION
UPSTREAM LEAF


LIFT GATE MACHINERY
LOCK EMERGENCY GATES
TWO LEAF SYSTEM
REEVED HOIST
PLATE B-65
ELEVATION D-D
SECTION C-C
SECTION B-B
SECTION E-E
HOIST DRUM
TOP OF CONC. STRUCTURE
MONORAIL HOIST TRACK
SHEAVE SUPPORT BEAM
TOP OF LOCK WALL
ROPE REEVING DIAGRAM
SHEAVE BLOCK


LIFT GATE MACHINERY
LOCK AUXILIARY GATES
TIDAL GATE SYSTEM
REEVED HOIST
PLATE B-66

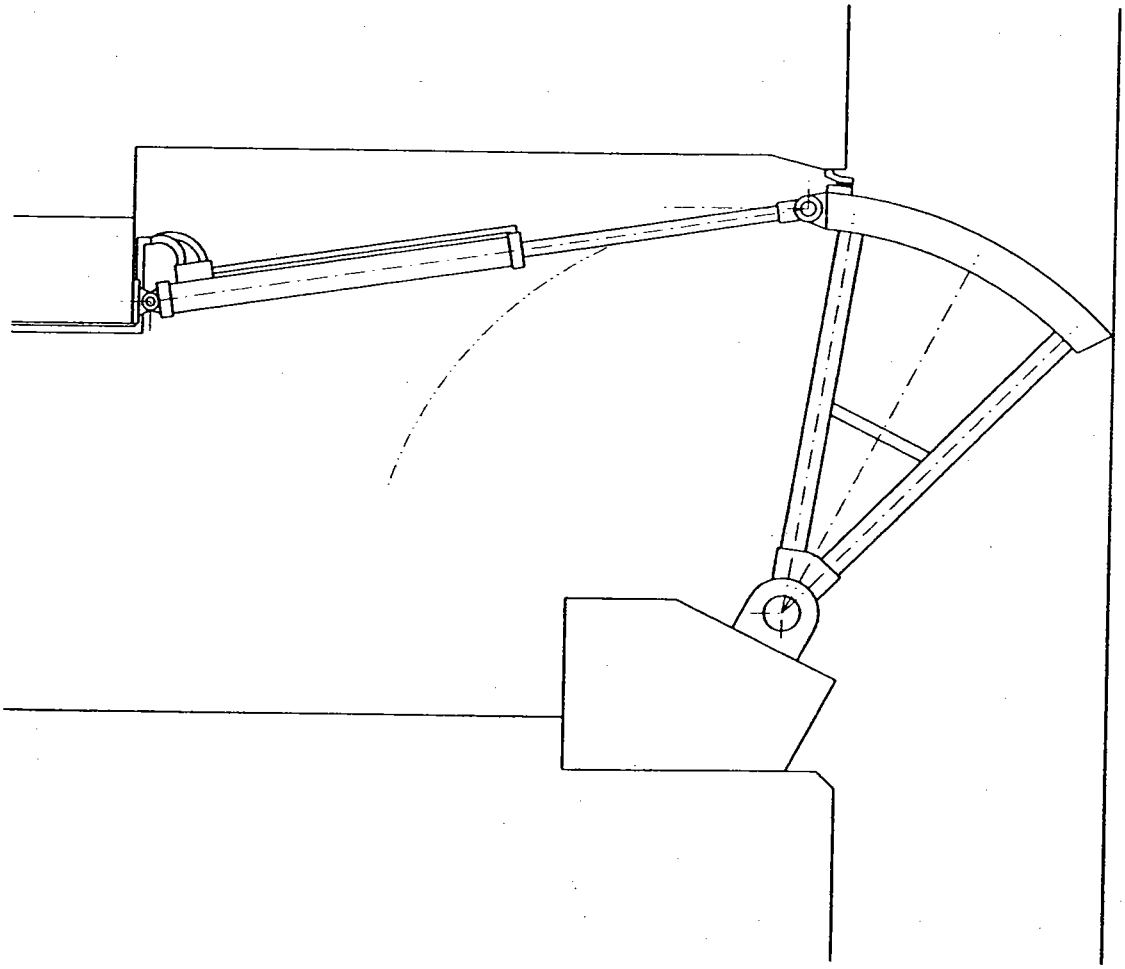

CULVERT TAINTER VALVE MACHINERY HOIST PLAN & ELEVATION
PLATE B-67
TAINTER VALVE MACHINERY PLAN
SECTION
NOTES:
1) FOR BILL OF MATERIALS SEE SHEET M-29
2) FOR SAFETY HOOD AND GUARD SEE SHEET M-27
3) FOR MACHINERY RECESS CONCRETE WORK SEE SHEET M-30
4) FOR MACHINERY PLATFORM PLAN SEE SHEET M-31
5) FOR GRATING PLAN SEE SHEET M-33
NOTE:
THIS DRAWING IS TYPICAL FOR ALL FOUR TAINTER VALVES.
℄ TRUNNION
℄ CULVERT/REDUCER
℄ CABLE GUIDE
PILLOW BLOCK BEARINGS B/M NO 42
LEFT DRUM ASSEMBLY SEE DETAIL
DRUM FIXED BEARING B/M NO. 12
LOW SPEED COUPLING SEE DETAIL
BRAKE B/M NO. 57
HIGH SPEED COUPLING SEE DETAIL
REDUCER B/M NO. 3
TORQUE LIMITING COUPLING SEE DETAIL
VALVE MOTOR B/M NO. 5
DRUM EXPANSION BEARING B/M NO. 6
RIGHT DRUM ASSEMBLY SEE DETAIL
PILLOW BLOCK MOUNTING BOLTS
LOW SPEED SHAFT
HIGH SPEED SHAFT
MACHINE BASE SEE DETAIL
MOTOR MOUNTING BOLTS B/M NO 14
FIELD VERIFY LOCATION PRIOR TO REMOVING TAINTER VALVE
OVERTRAVEL SWITCH SEE DETAIL
EXISTING TAINTER VALVE
WIRE ROPE ASSY SEE DETAIL
VALVE TRUNNION
WIRE ROPE SOCKET PIN SEE DETAIL
SOCKET PIN WASHER SEE DETAIL
SOCKET PIN SPACERS SEE DETAIL
SEE SHEET S44 FOR DETAILS OF NEW PICKUP CONNECTION


PLAN
SECTION A-A
SECTION B-B
CULVERT TAINTER
VALVE MACHINERY
HOIST PLAN
& ELEVATIONS
PLATE B-68



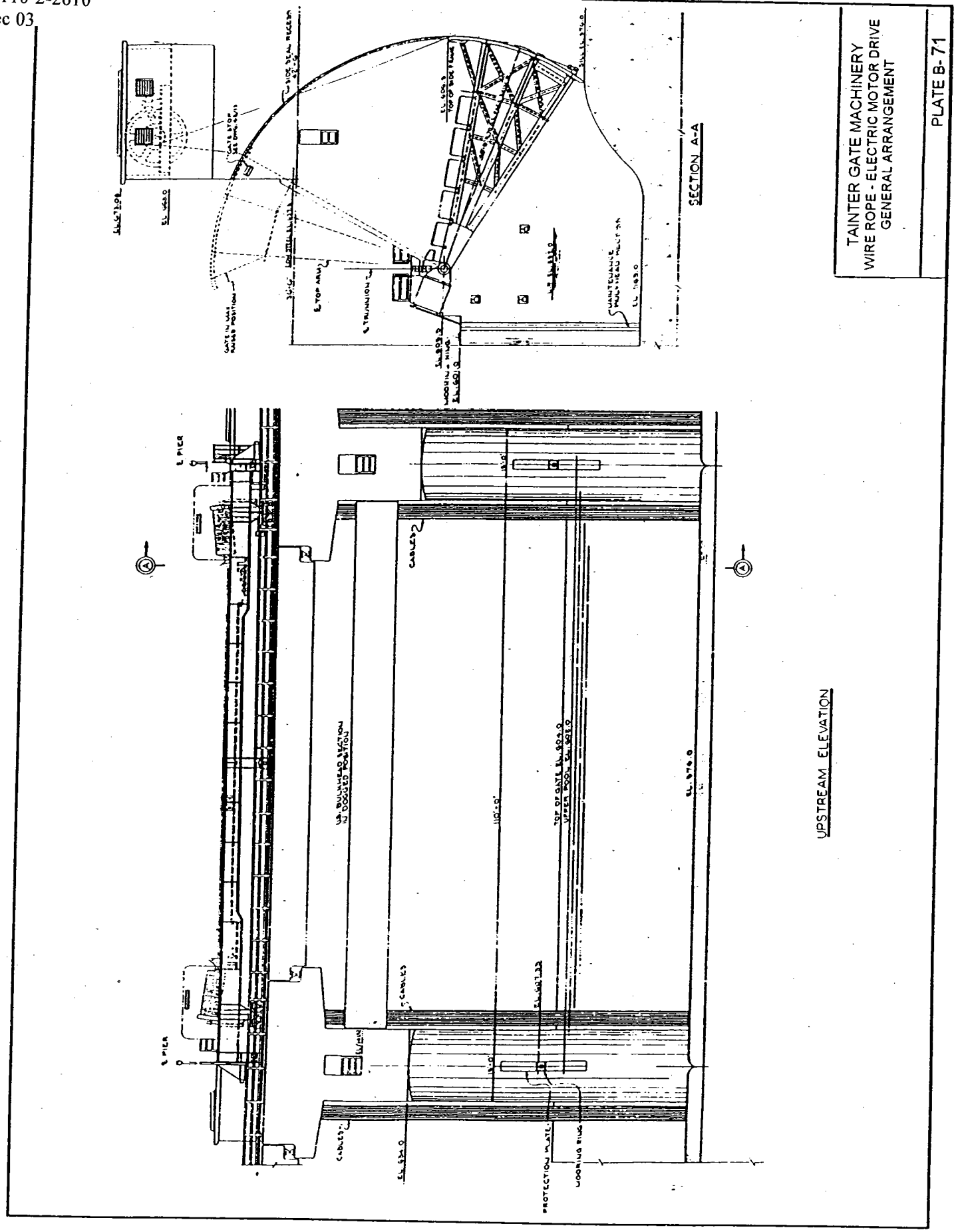
CULVERT TAINTER VALVE MACHINERY HOIST ELEVATION

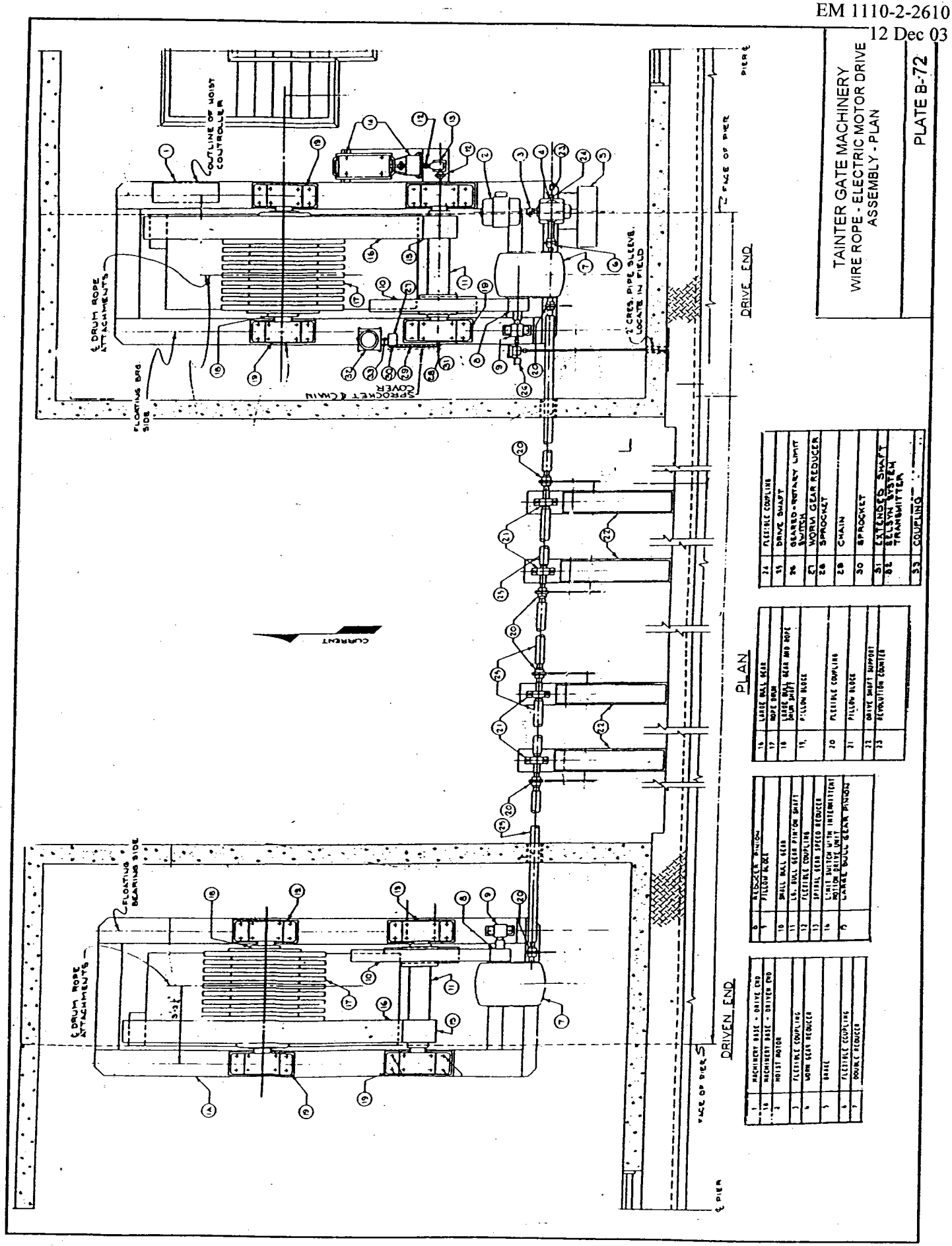
PLATE B-69

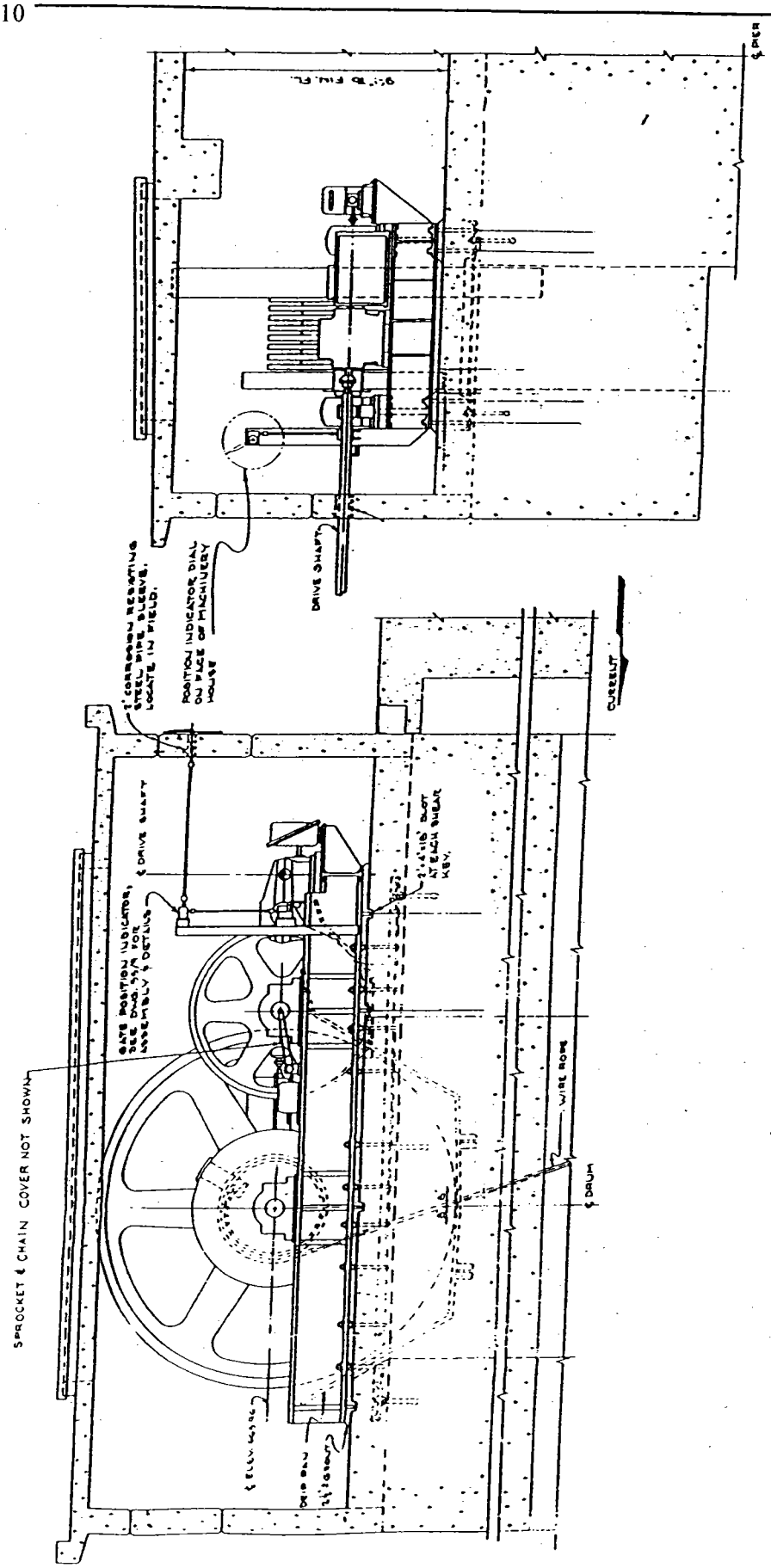


CULVERT TAINTER
VALVE MACHINERY
DIRECT-ACTING
HOIST ELEVATION

PLATE B-70

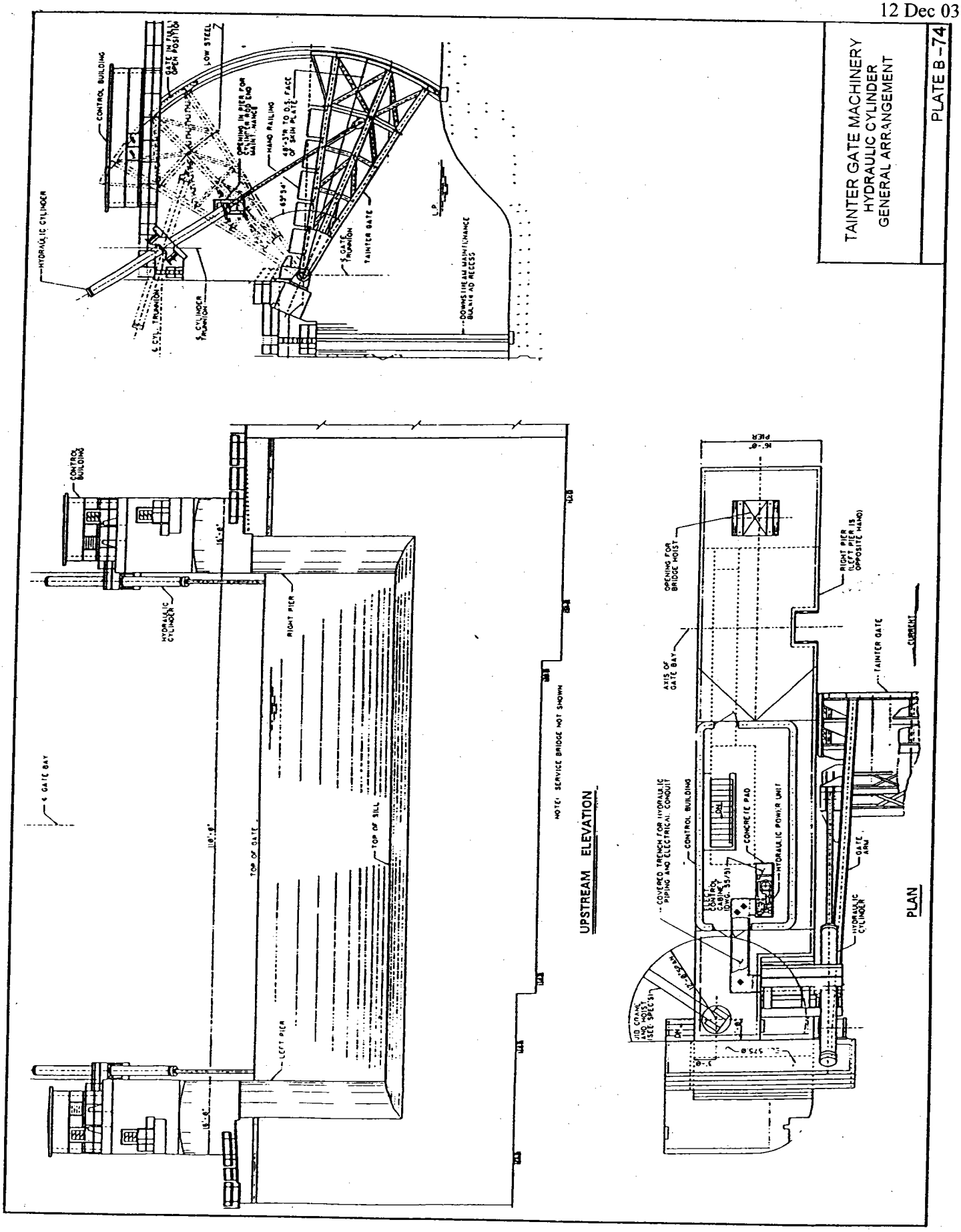

SECTION A-A
UPSTREAM ELEVATION
TAINTER GATE MACHINERY
WIRE ROPE - ELECTRIC MOTOR DRIVE
GENERAL ARRANGEMENT
PLATE B-71

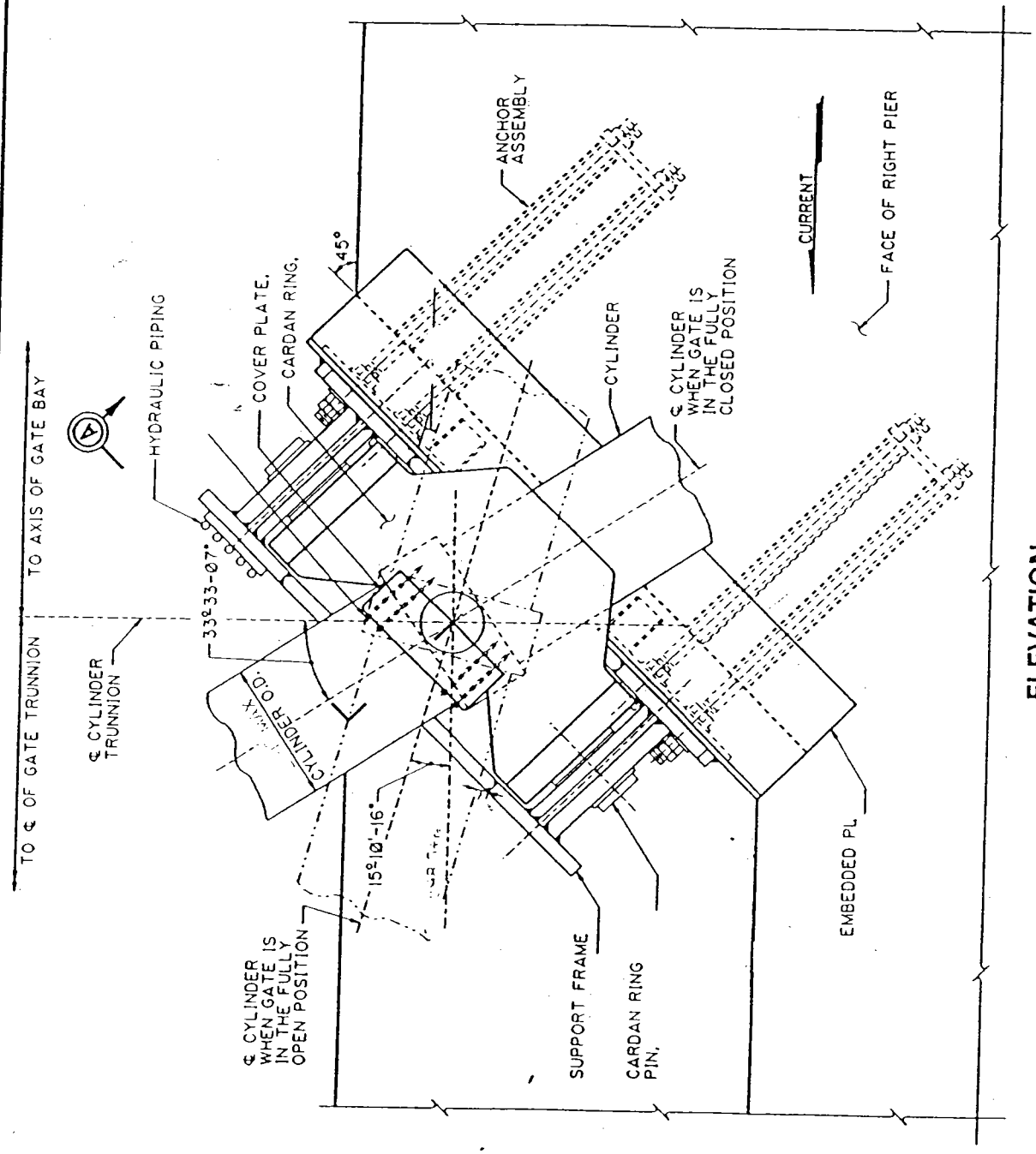

TAINTER GATE MACHINERY
WIRE ROPE - ELECTRIC MOTOR DRIVE
ASSEMBLY - PLAN
PLATE B-72
PLAN
DRIVE END
DRIVEN END
CURRENT
OUTLINE OF HOIST CONTROLLER
℄ DRUM ROPE ATTACHMENTS
FLOATING BRG. SIDE
SPROCKET & CHAIN COVER
2" CRES. PIPE SLEEVE. LOCATE IN FIELD
FACE OF PIER
PIER ℄
FLOATING BEARING SIDE
1 MACHINERY BASE - DRIVE END
18 MACHINERY BASE - DRIVEN END
2 HOIST MOTOR
3 FLEXIBLE COUPLING
4 WORM GEAR REDUCER
5 BRAKE
6 FLEXIBLE COUPLING
7 DOUBLE REDUCER
8 REDUCER PINION
9 PILLOW BLOCK
10 SMALL BULL GEAR
11 LG. BULL GEAR PINION SHAFT
12 FLEXIBLE COUPLING
13 SPIRAL GEAR SPEED REDUCER
14 LIMIT SWITCH WITH INTERMITTENT MOTION DRIVE UNIT
15 LARGE BULL GEAR PINION
16 LARGE BULL GEAR
17 ROPE DRUM
18 LARGE BULL GEAR AND ROPE DRUM SHAFT
19 PILLOW BLOCK
20 FLEXIBLE COUPLING
21 PILLOW BLOCK
22 DRIVE SHAFT SUPPORT
23 REVOLUTION COUNTER
24 FLEXIBLE COUPLING
25 DRIVE SHAFT
26 GEARED-ROTARY LIMIT SWITCH
27 WORM GEAR REDUCER
28 SPROCKET
29 CHAIN
30 SPROCKET
31 EXTENDED SHAFT
32 SELSYN SYSTEM TRANSMITTER
33 COUPLING



TAINTER GATE MACHINERY
WIRE ROPE - ELECTRIC MOTOR DRIVE
ASSEMBLY - ELEVATIONS

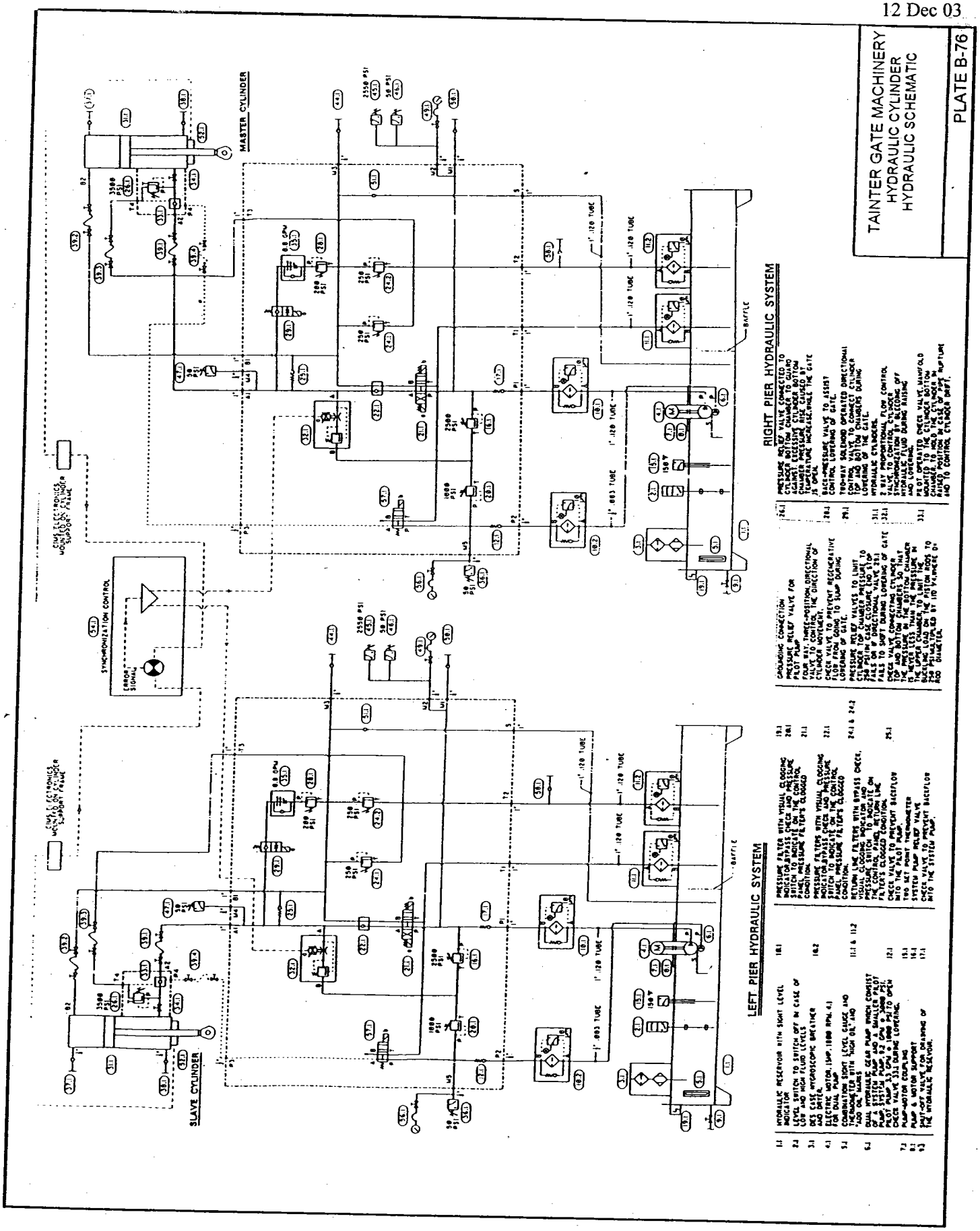
PLATE B- 73

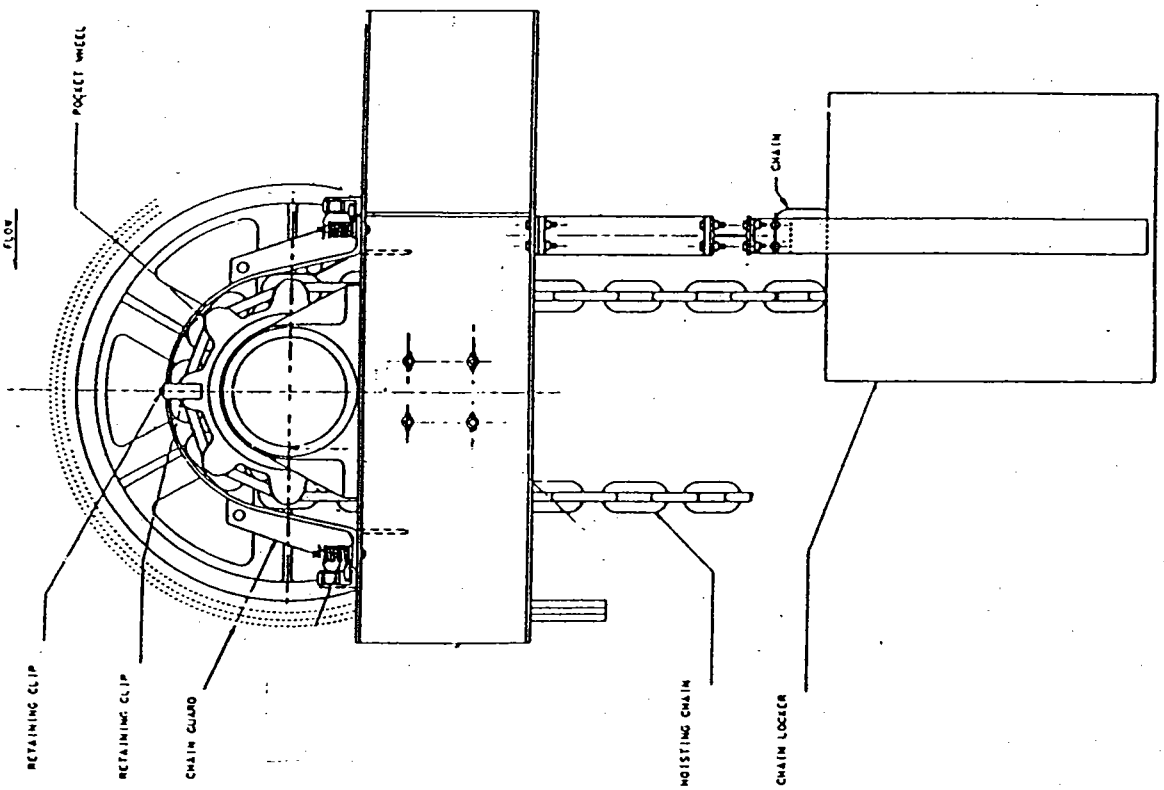

TAINTER GATE MACHINERY
HYDRAULIC CYLINDER
GENERAL ARRANGEMENT
PLATE B-74
HYDRAULIC CYLINDER
CONTROL BUILDING
GATE IN FULL OPEN POSITION
LOW STEEL
HAND RAILING
TAINTER GATE
DOWNSTREAM MAINTENANCE BULKHEAD RECESS
UPSTREAM ELEVATION
RIGHT PIER
LEFT PIER
TOP OF GATE
TOP OF SILL
NOTE: SERVICE BRIDGE NOT SHOWN
PLAN
OPENING FOR BRIDGE HOIST
RIGHT PIER (LEFT PIER IS OPPOSITE HAND)
AXIS OF GATE BAY
TAINTER GATE
CURRENT
CONCRETE PAD
HYDRAULIC POWER UNIT
CONTROL BUILDING
COVERED TRENCH FOR HYDRAULIC PIPING AND ELECTRICAL CONDUIT
GATE ARM
HYDRAULIC CYLINDER



TAINTER GATE MACHINERY
HYDRAULIC CYLINDER
MOUNTING ARRANGEMENT

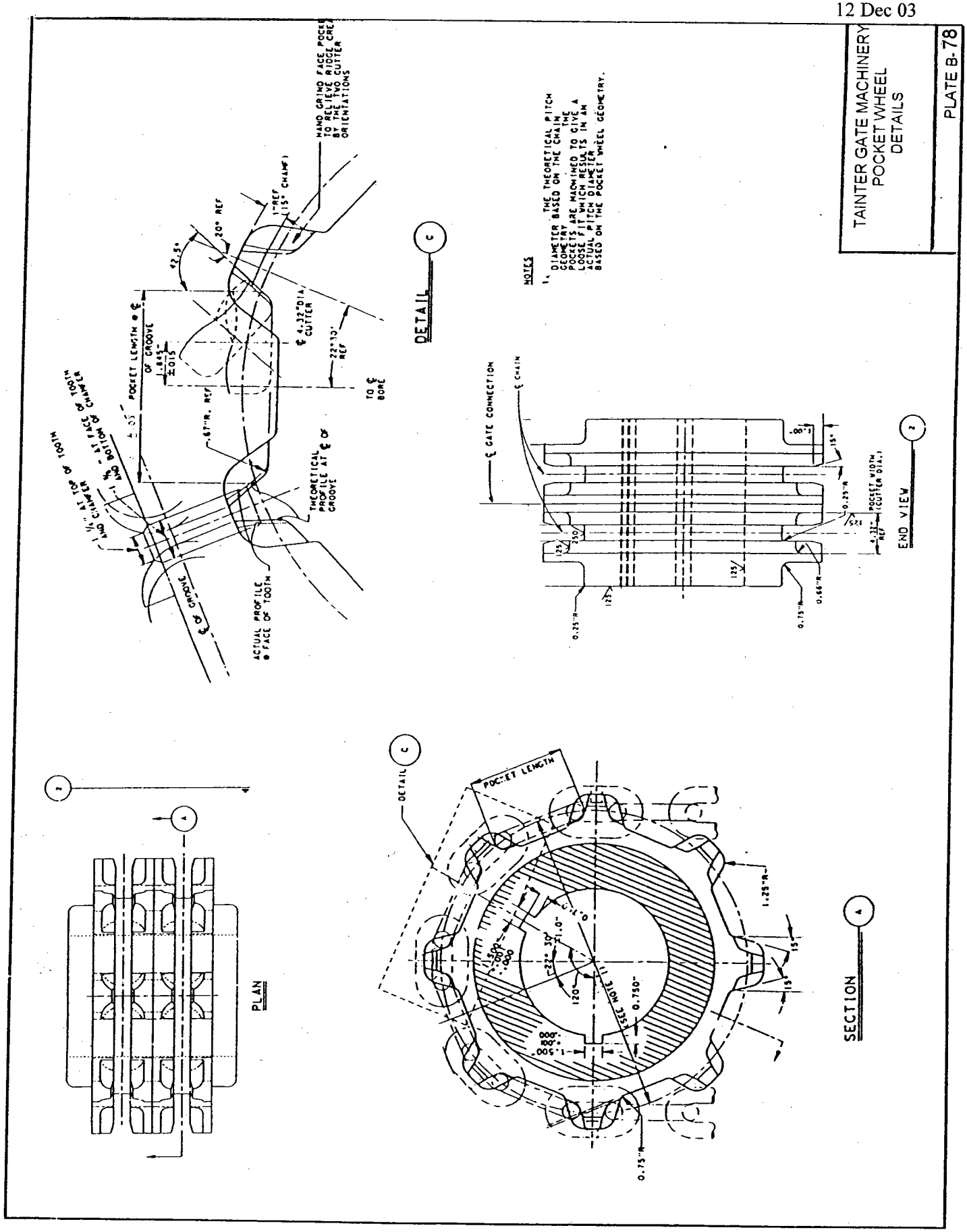
PLATE B-75

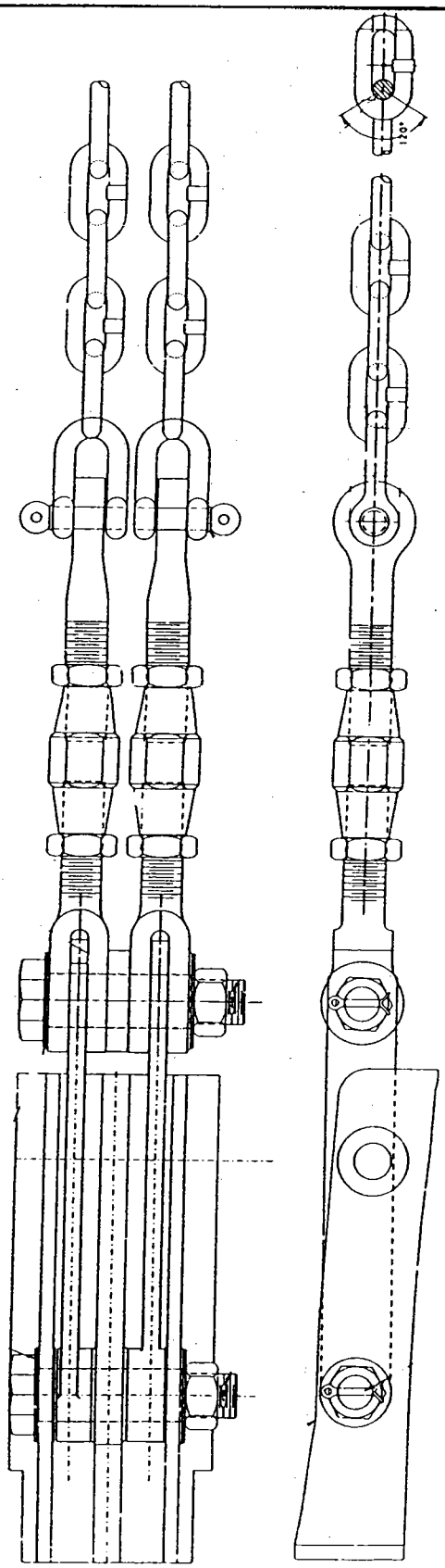

TAINTER GATE MACHINERY
HYDRAULIC CYLINDER
HYDRAULIC SCHEMATIC
PLATE B-76
MASTER CYLINDER
SLAVE CYLINDER
SYNCHRONIZATION CONTROL
ERROR SIGNAL
RIGHT PIER HYDRAULIC SYSTEM
LEFT PIER HYDRAULIC SYSTEM
BAFFLE



TAINTER GATE MACHINERY
POCKET WHEEL
ELEVATION

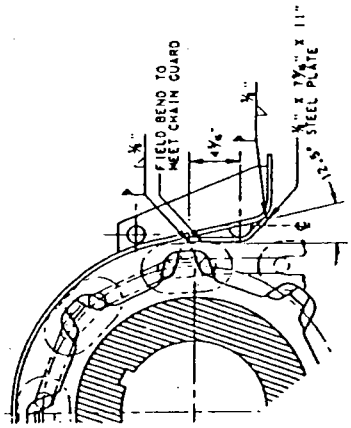
PLATE B-77


TAINTER GATE MACHINERY
POCKET WHEEL
DETAILS
PLATE B-78
NOTES
1. THE THEORETICAL PITCH DIAMETER BASED ON THE CHAIN GEOMETRY. THE POCKETS ARE MACHINED TO GIVE A LOOSE FIT WHICH RESULTS IN AN ACTUAL PITCH DIAMETER BASED ON THE POCKET WHEEL GEOMETRY.
DETAIL C
END VIEW
PLAN
SECTION A
POCKET LENGTH
ACTUAL PROFILE @ FACE OF TOOTH
THEORETICAL PROFILE AT ℄ OF GROOVE
℄ OF GROOVE
℄ GATE CONNECTION
℄ CHAIN
POCKET WIDTH (CUTTER DIA.)
HAND GRIND FACE POCKET TO RELIEVE RIDGE CREAT BY THE TWO CUTTER ORIENTATIONS
TO ℄ BORE
℄ 4.32" DIA CUTTER
SEE NOTE 11



HOISTING CHAIN

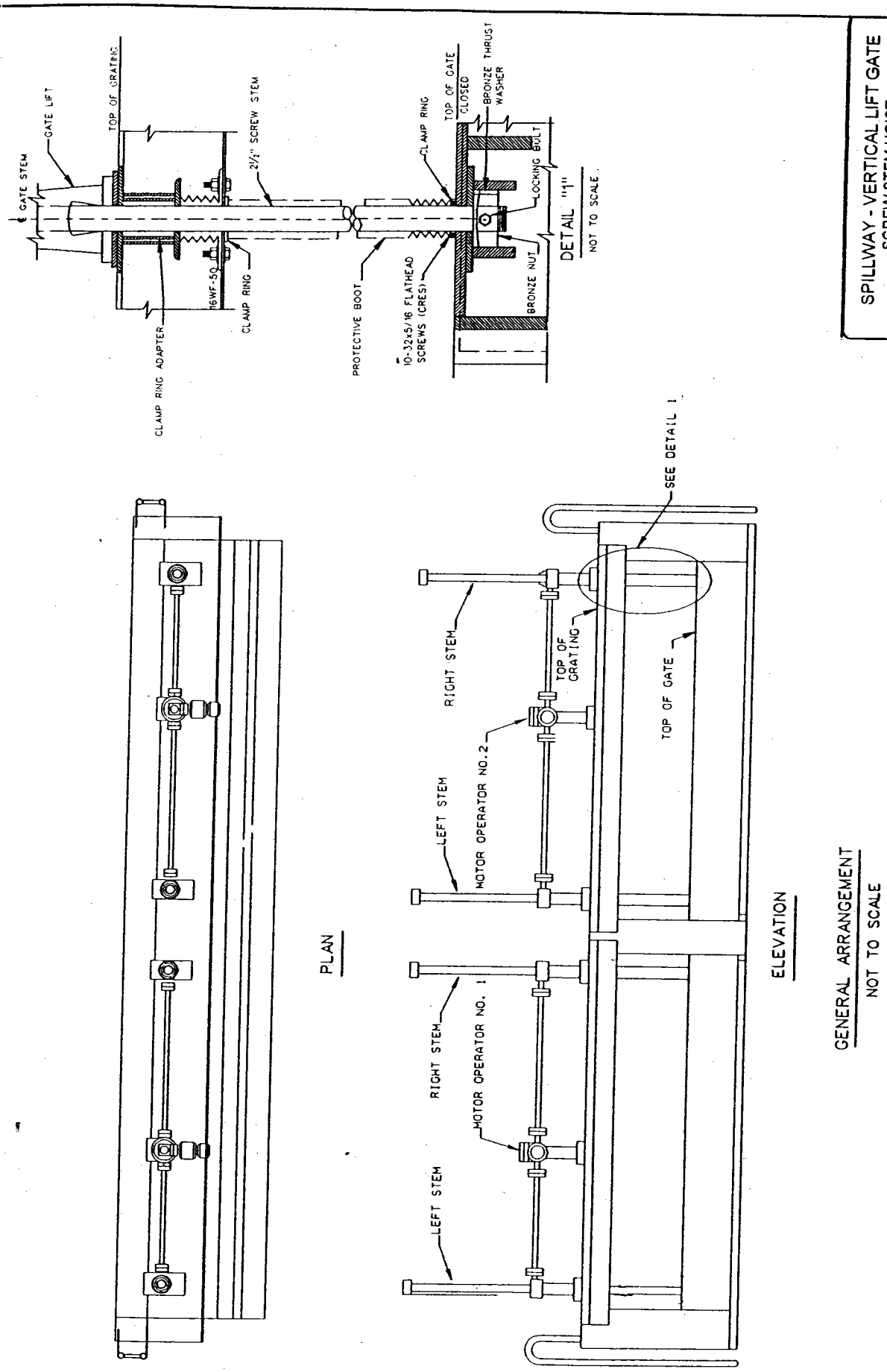
GATE CONNECTION ASSEMBLY



CHAIN GUIDE PLATE

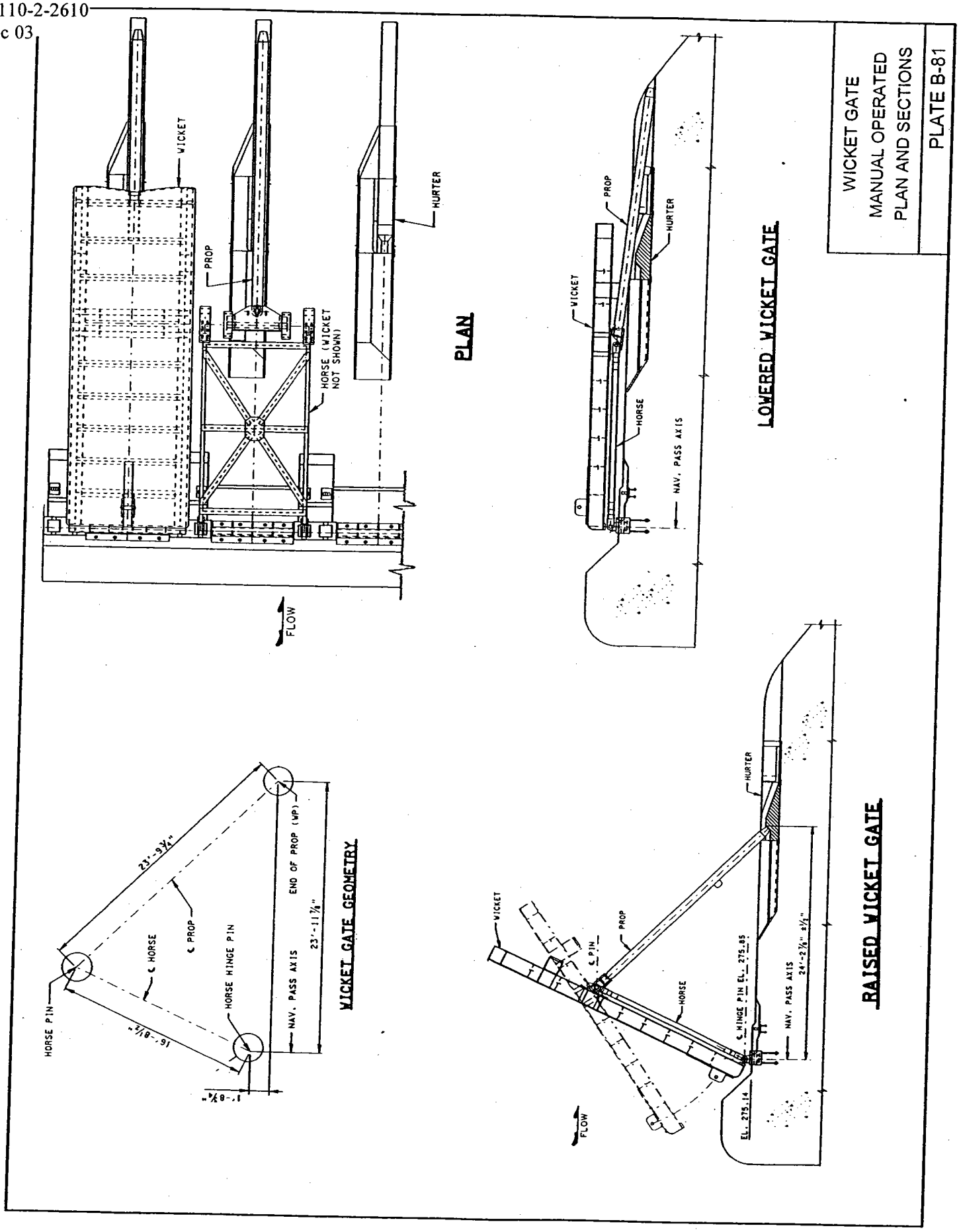
TAINTER GATE MACHINERY
POCKET WHEEL
GATE CONNECTION & DETAILS

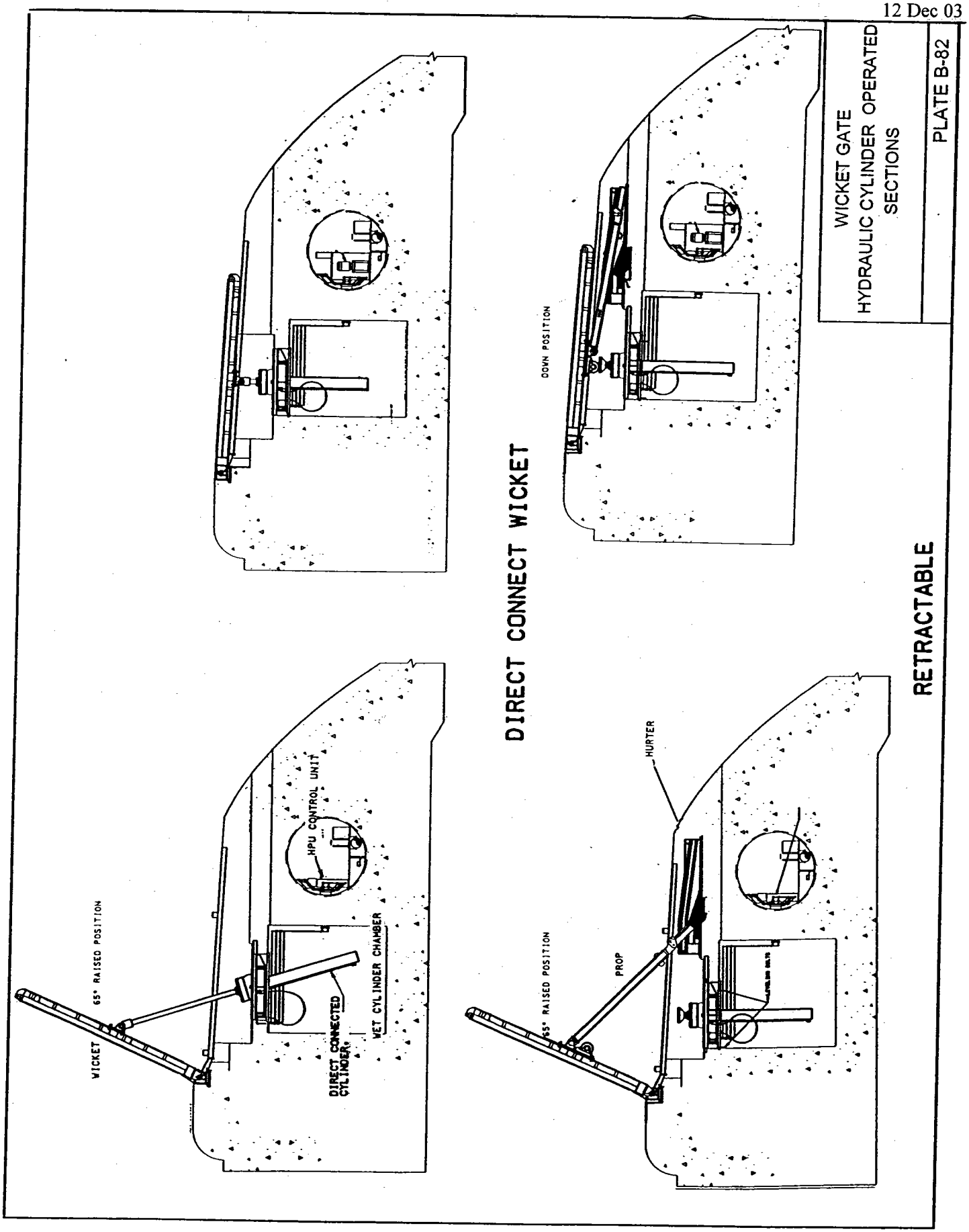
PLATE B- 79

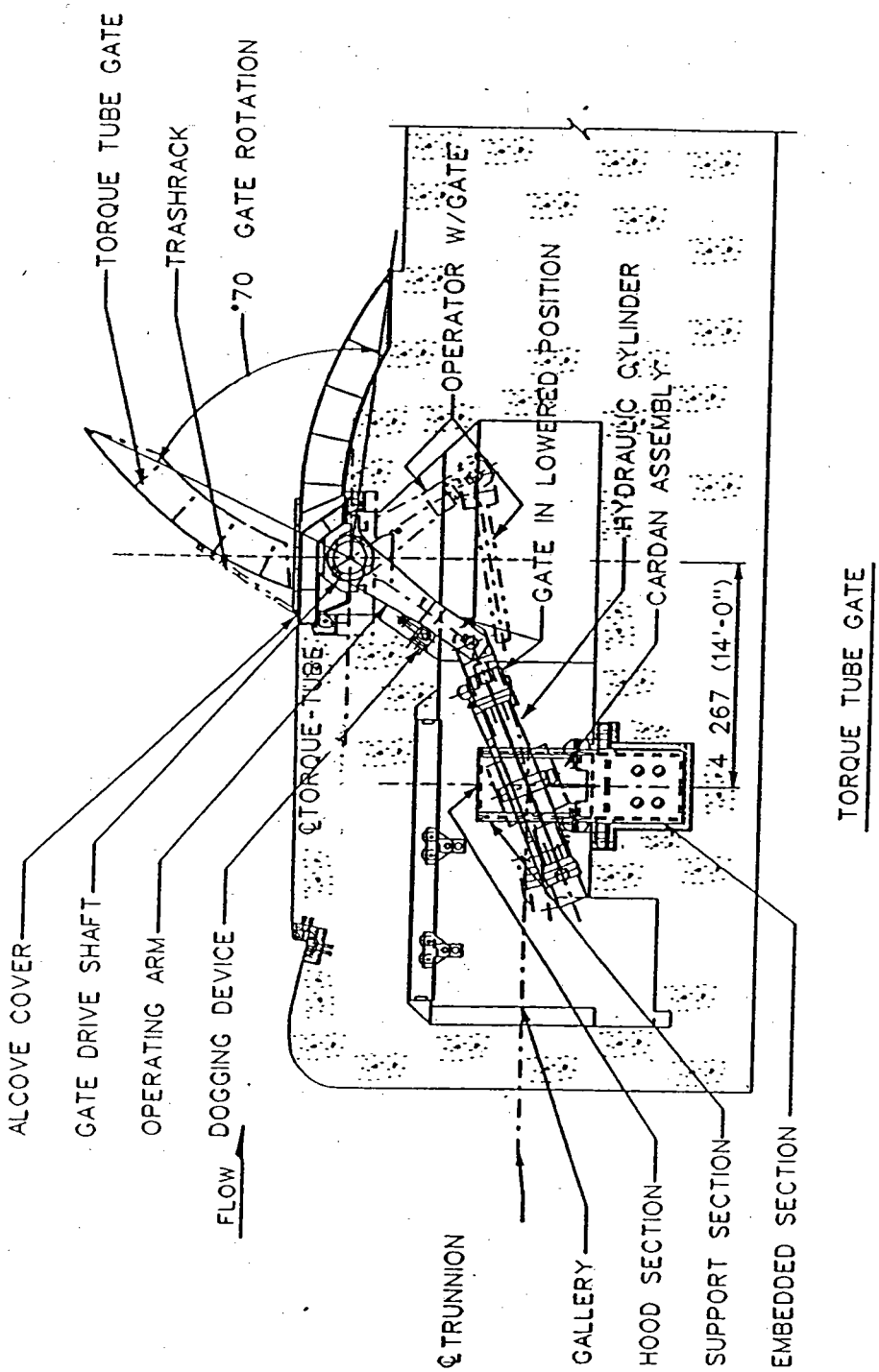


SPILLWAY - VERTICAL LIFT GATE
SCREW STEM HOIST
GENERAL ARRANGEMENT

PLATE B-80

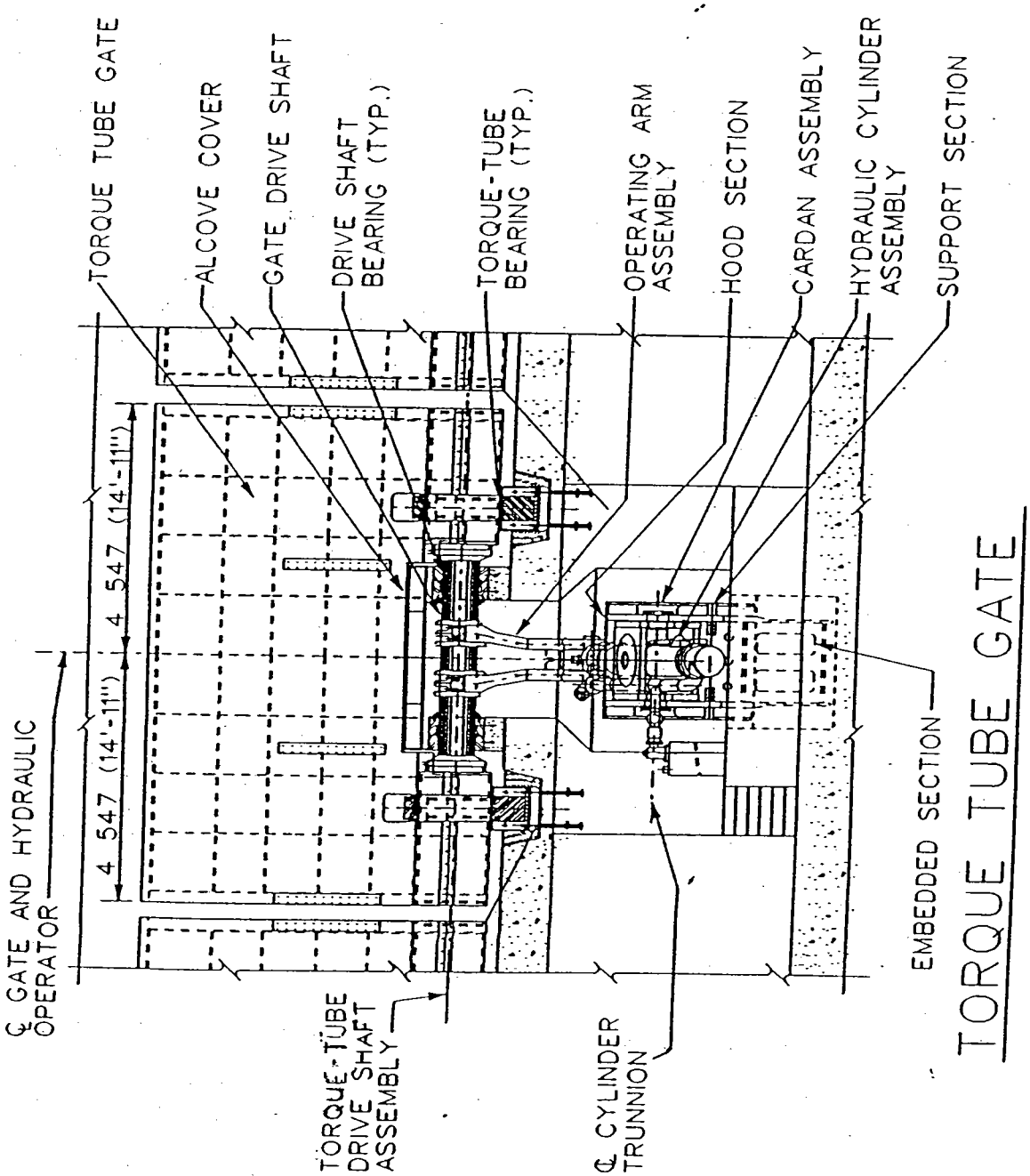

WICKET
PROP
HORSE (WICKET NOT SHOWN)
HURTER
FLOW
PLAN
WICKET
PROP
HURTER
HORSE
NAV. PASS AXIS
LOWERED WICKET GATE
HORSE PIN
23'-9¾"
16'-8½"
1'-8¾"
℄ PROP
℄ HORSE
HORSE HINGE PIN
NAV. PASS AXIS
23'-11⅞"
END OF PROP (WP)
WICKET GATE GEOMETRY
WICKET
℄ PIN
PROP
HORSE
HURTER
℄ HINGE PIN EL. 275.85
NAV. PASS AXIS
24'-2⅞" ±½"
EL. 275.14
FLOW
RAISED WICKET GATE
WICKET GATE
MANUAL OPERATED
PLAN AND SECTIONS
PLATE B-81


WICKET GATE
HYDRAULIC CYLINDER OPERATED
SECTIONS
PLATE B-82
DOWN POSITION
DIRECT CONNECT WICKET
RETRACTABLE
HURTER
PROP
65° RAISED POSITION
WICKET
65° RAISED POSITION
HPU CONTROL UNIT
DIRECT CONNECTED CYLINDER
VET CYLINDER CHAMBER



HINGED CREST GATE
TORQUE TUBE GATE-ELEVATION

PLATE B - 83



HINGED CREST GATE
TORQUE TUBE GATE - PLAN

PLATE B-84

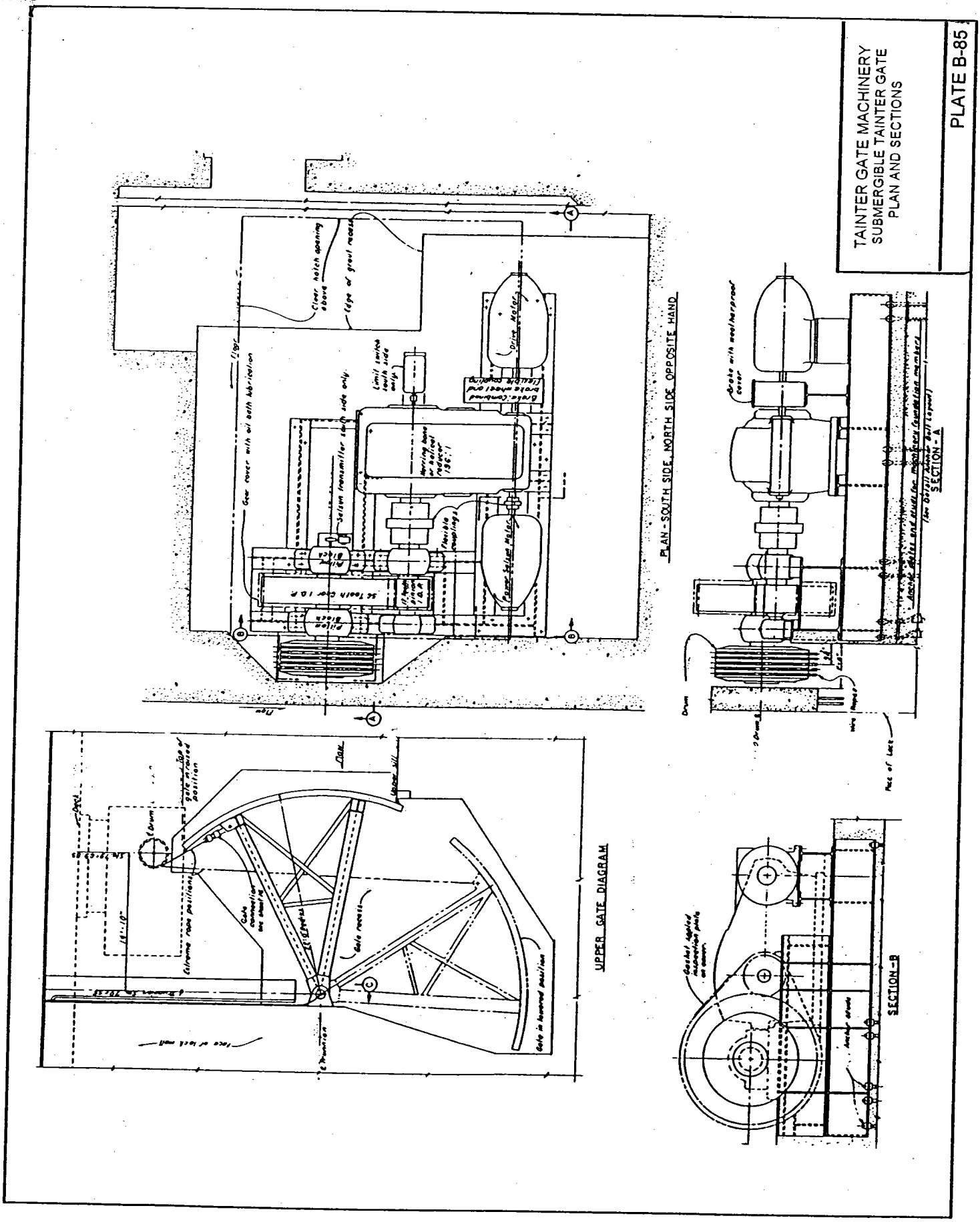
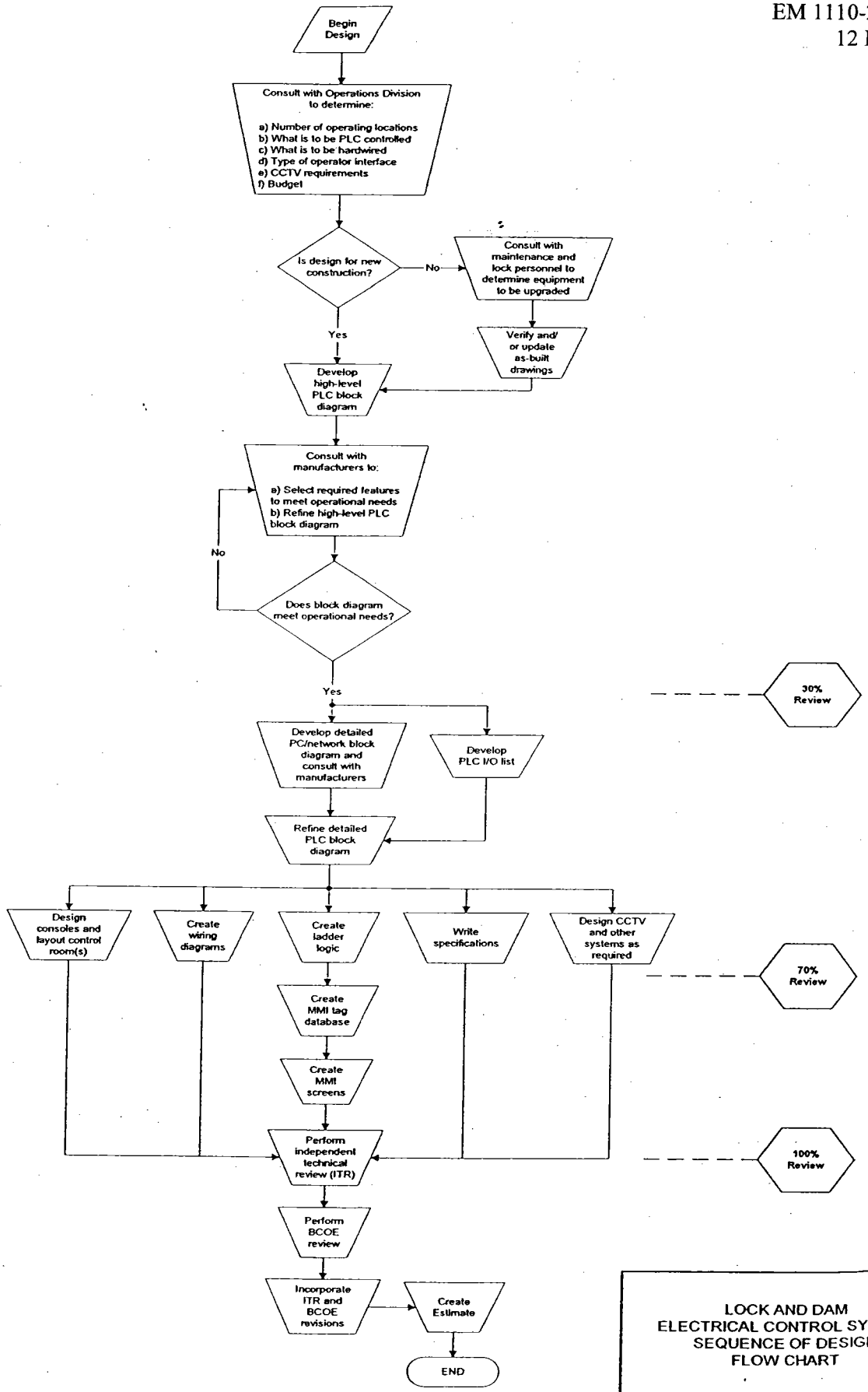


PLATE B-85
TAINTER GATE MACHINERY
SUBMERGIBLE TAINTER GATE
PLAN AND SECTIONS
PLAN - SOUTH SIDE, NORTH SIDE OPPOSITE HAND
SECTION - A
SECTION - B
UPPER GATE DIAGRAM



LOCK AND DAM
ELECTRICAL CONTROL SYSTEM
SEQUENCE OF DESIGN
FLOW CHART

PLATE B-86