

BETHLEHEM PUMPING UNIT

ENGINEERING DATA

MODEL 160D-20S-64 WITH TYPE "C"  
ADJUSTABLE COUNTERBALANCE

MODEL: 160D-20S-6

"50" Series

Date: 4-19-56

Page: 3

Refer to MS-724

API PUMPING UNIT STROKE AND TORQUE FACTORS

POSITION OF CRANK DEGREES (1)	POSITION OF RODS (2)					TORQUE FACTOR (3) (4)				
	LENGTH OF STROKE - INCHES					LENGTH OF STROKE - INCHES				
	64	54	44	34	24	64	54	44	34	24
0	.004	.002	.002	.002	.001	-5.88	-4.20	-3.05	-2.13	-1.31
15	.005	.004	.004	.003	.003	5.83	5.11	4.12	3.26	2.22
30	.049	.053	.053	.053	.046	17.45	14.09	11.12	8.41	5.57
45	.141	.153	.138	.135	.127	27.05	21.60	17.08	12.54	8.41
60	.262	.257	.248	.244	.226	32.79	26.53	21.00	15.61	10.44
75	.397	.389	.376	.355	.350	34.38	28.22	22.60	17.12	11.73
90	.534	.524	.508	.499	.486	32.76	27.42	22.57	17.15	12.10
105	.655	.648	.640	.633	.612	28.83	24.92	20.66	16.32	11.57
120	.764	.756	.753	.743	.733	24.37	21.30	18.87	14.37	10.32
135	.849	.851	.854	.844	.835	19.62	17.10	14.55	11.70	8.50
150	.919	.924	.925	.922	.919	14.56	12.69	10.74	8.62	6.26
165	.966	.969	.973	.975	.971	9.54	7.99	6.52	5.24	3.74
180	.994	.998	.997	.997	.998	4.08	3.04	2.16	1.52	1.00
195	.999	.999	.998	.993	.991	-2.09	-2.47	-2.51	-2.15	-1.77
210	.977	.972	.972	.967	.960	-8.87	-8.13	-7.21	-6.00	-4.43
225	.924	.916	.913	.905	.895	-15.96	-14.09	-11.95	-9.55	-6.98
240	.845	.837	.828	.819	.804	-22.77	-19.59	-16.18	-12.74	-9.26
255	.743	.733	.721	.718	.697	-28.35	-23.97	-19.61	-15.15	-10.91
270	.622	.611	.602	.588	.571	-32.04	-26.87	-21.72	-16.78	-11.82
285	.489	.481	.470	.456	.439	-33.36	-27.78	-22.42	-17.21	-12.05
300	.358	.346	.339	.326	.312	-32.40	-27.00	-21.70	-16.38	-11.35
315	.232	.227	.216	.208	.191	-29.25	-24.00	-19.26	-14.31	-9.90
330	.128	.122	.131	.110	.104	-23.75	-19.25	-15.21	-11.24	-7.64
345	.049	.046	.044	.047	.037	-15.77	-12.61	-9.56	-7.32	-4.71

- (1) Position of crank is the angular displacement measured clockwise from the 12 o'clock position, viewed with the well head to the right.
- (2) Position is expressed as a fraction (percentage) of stroke above lowermost position.
- (3) Torque factor =  $\frac{T}{W}$  where T = torque on pumping-unit reducer due to polished rod load W.
- (4) Negative signs on torque factor indicate a clockwise torque on crankshaft.

$$\text{NET REDUCER TORQUE} = \overline{TF} (W-B) -M \sin \theta$$

Where  $\theta$  = Position of Crank Degrees (See Col. 1 above)

M = Maximum Moment of Counterbalance (See Page 4)

W = Measured Polish Rod Load (Lbs.) At Position Of Rods Corresponding to

B = Structural Unbalance = 650 Lbs.

$\overline{TF}$  = Torque Factor Corresponding to  $\theta$ .

MODEL: 160D-20S-64

"50" Series

Date: 4-19-56

Page: 4

Refer to MS-724

BETHLEHEM PUMPING UNIT

ENGINEERING DATA

MODEL 160D-20S-64 WITH TYPE "C"

ADJUSTABLE COUNTERBALANCE

API RATING FORM FOR CRANK COUNTERBALANCE

DESCRIPTION	TOTAL WEIGHT LBS.	POSITION OF COUNTERWEIGHTS (1)	MAXIMUM (2) MOMENT ABOUT CRANKSHAFT INCH POUNDS
Heavy Counterweight Assembly - "With" Filler Weights Includes the Following: 2 - Cranks - 17337 2 - Right Face Counterweights - 17339-A 2 - Left Face Counterweights - 17338-A 2 - Left Rear Counterweights - 17340 2 - Right Rear Counterweights - 17341 8 - Filler Weights - 17342 Plus Necessary Bolts Etc.	13,200	0	-12,800
		1	36,500
		2	85,800
		3	135,100
		4	184,400
		5	233,700
		6	283,000
		7	332,300
		8	381,600
		9	430,900
		10	480,200
Standard Counterweight Assembly - "Without" Filler Weights Includes the Following: 2 - Cranks - 17337 2 - Right Face Counterweights - 17339-A 2 - Left Face Counterweights - 17338-A 2 - Left Rear Counterweights - 17340 2 - Right Rear Counterweights - 17341 Plus Necessary Bolts Etc.	10,170	0	28,300
		1	61,080
		2	93,860
		3	126,640
		4	159,420
		5	192,200
		6	224,980
		7	257,760
		8	290,540
		9	323,320
		10	356,100
Light Counterweight Assembly With "Face Weights" and "Rear Clamps" Includes the Following: 2 - Cranks - 17337 2 - Right Face Counterweights - 17339-A 2 - Left Face Counterweights - 17338-A 2 - Counterweight Clamps - 18247 2 - Counterweight Clamps - 18264 Plus Necessary Bolts Etc.	8,170	0	48,840
		1	70,640
		2	92,440
		3	114,240
		4	136,040
		5	157,840
		6	179,640
		7	201,440
		8	223,240
		9	245,040
		10	266,840

(1) Pointers on all Counterweight Assemblies must be set to indicated number on crank to give Moment shown.

(2) Moments are given for horizontal position (90 and 270 degrees) only.

COUNTERBALANCE EFFECT AT POLISH ROD WITH #7478-B CRANKS

STRUCTURE UNBALANCE OF 900# INCLUDED BELOW

	<u>With #78 Main &amp; Filler Weights</u>		<u>With #68 Main &amp; Filler Weights</u>	
	<u>Pounds</u>		<u>Pounds</u>	
	<u>CBE</u> <u>@</u> <u>.74" Stroke</u>	<u>Actual Weight</u> <u>of</u> <u>Counterweights</u>	<u>CBE</u> <u>@</u> <u>.74" Stroke</u>	<u>Actual Weight</u> <u>of</u> <u>Counterweights</u>
Crank Only	5,850		5,850	
Crank Plus 1 Main Weight	7,170	795	7,090	735
Crank Plus 2 Main Weights	8,500	1,590	8,340	1,470
Crank Plus 3 Main Weights	9,820	2,385	9,580	2,205
Crank Plus 4 Main Weights	11,140	3,180	10,820	2,940
Crank Plus 4 Main Weights and 1 Filler Weight	11,810	3,585	11,310	3,238
" " 4 " " 2 " "	12,480	3,990	11,810	3,536
" " 4 " " 3 " "	13,140	4,395	12,300	3,834
" " 4 " " 4 " "	13,810	4,800	12,790	4,132
" " 4 " " 5 " "	14,480	5,205	13,280	4,430
" " 4 " " 6 " "	15,140	5,610	13,780	4,728
" " 4 " " 7 " "	15,810	6,015	14,270	5,026
" " 4 " " 8 " "	16,470	6,420	14,760	5,324
" " 4 " " 9 " "	17,140	6,825	15,260	5,622
" " 4 " " 10 " "	17,810	7,230	15,750	5,920
" " 4 " " 11 " "	18,470	7,635	16,250	6,218
" " 4 " " 12 " "	19,140	8,040	16,740	6,516
" " 4 " " 13 " "	19,810	8,445	17,230	6,814
" " 4 " " 14 " "	20,480	8,850	17,720	7,112



COUNTERBALANCE EFFECT AT POLISH ROD WITH #7478-B CRANKS

STRUCTURE UNBALANCE OF 500# INCLUDED BELOW

	<u>With #78 Main &amp; Filler Weights</u>		<u>With #68 Main &amp; Filler Weights</u>	
	Pounds		Pounds	
	<u>CBE @ 86" Stroke</u>	<u>Actual Weight of Counterweights</u>	<u>CBE @ 86" Stroke</u>	<u>Actual Weight of Counterweights</u>
Crank Only	4,780		4,780	
Crank Plus 1 Main Weight	5,920	795	5,860	735
Crank Plus 2 Main Weights	7,070	1,590	6,930	1,470
Crank Plus 3 Main Weights	8,210	2,385	8,010	2,205
Crank Plus 4 Main Weights	9,350	3,180	9,080	2,940
Crank Plus 4 Main Weights and 1 Filler Weight	9,930	3,585	9,510	3,238
" " 4 " " " 2 " "	10,510	3,990	9,930	3,536
" " 4 " " " 3 " "	11,080	4,395	10,360	3,834
" " 4 " " " 4 " "	11,660	4,800	10,780	4,132
" " 4 " " " 5 " "	12,240	5,205	11,210	4,430
" " 4 " " " 6 " "	12,810	5,610	11,640	4,728
" " 4 " " " 7 " "	13,390	6,015	12,060	5,026
" " 4 " " " 8 " "	13,960	6,420	12,490	5,324
" " 4 " " " 9 " "	14,540	6,825	12,920	5,622
" " 4 " " " 10 " "	15,120	7,230	13,350	5,920
" " 4 " " " 11 " "	15,690	7,635	13,770	6,218
" " 4 " " " 12 " "	16,270	8,040	14,200	6,516
" " 4 " " " 13 " "	16,850	8,445	14,630	6,814
" " 4 " " " 14 " "	17,430	8,850	15,060	7,112

THE HISTORY OF THE UNITED STATES

CHAPTER I

The history of the United States is a story of a young nation that grew from a small group of colonies to a powerful world superpower. It is a story of struggle, of triumph, and of the pursuit of the American dream. The story begins with the first European settlers who came to North America in search of a better life. They found a land of vast natural resources and a people who were determined to build a new society. The story continues through the years of colonial struggle, the American Revolution, and the formation of the United States. It is a story of a nation that has always been a land of opportunity, a land where anyone can make their own destiny. The story ends with the United States as a global leader, a nation that has shaped the world and continues to shape the future.



COUNTERBALANCE EFFECT AT POLISH ROD WITH #8495-B CRANKS

STRUCTURE UNBALANCE OF 1000# INCLUDED BELOW

	<u>With #95 Main &amp; Filler Weights</u>		<u>With #78 Main &amp; Filler Weights</u>	
	Pounds		Pounds	
	<u>CBE</u> <u>@</u> <u>86" Stroke</u>	<u>Actual Weight</u> <u>of</u> <u>Counterweights</u>	<u>CBE</u> <u>@</u> <u>86" Stroke</u>	<u>Actual Weight</u> <u>of</u> <u>Counterweights</u>
Cranks Only	8,730		8,730	
Cranks Plus 1 Main Weight	10,890	1,170	10,200	795
Cranks Plus 2 Main Weights	13,060	2,340	11,670	1,590
Cranks Plus 3 Main Weights	15,220	3,510	13,140	2,385
Cranks Plus 4 Main Weights	17,380	4,680	14,610	3,180
Cranks Plus 4 Main Weights and 1 Filler Weight	18,280	5,175	15,350	3,585
" " 4 " " " 2 Filler Weights	19,190	5,670	16,090	3,990
" " 4 " " " 3 " "	20,090	6,165	16,840	4,395
" " 4 " " " 4 " "	20,990	6,600	17,580	4,800
" " 4 " " " 5 " "	21,900	7,155	18,320	5,205
" " 4 " " " 6 " "	22,800	7,650	19,070	5,610
" " 4 " " " 7 " "	23,710	8,145	19,810	6,015
" " 4 " " " 8 " "	24,610	8,640	20,550	6,420
" " 4 " " " 9 " "	25,510	9,135	21,290	6,825
" " 4 " " " 10 " "	26,420	9,630	22,030	7,230
" " 4 " " " 11 " "	27,320	10,125	22,770	7,635
" " 4 " " " 12 " "	28,220	10,620	23,510	8,040
" " 4 " " " 13 " "			24,250	8,445
" " 4 " " " 14 " "			24,990	8,850

COUNTERBALANCE EFFECT AT POLISH ROD WITH #8495-B CRANKS

STRUCTURE UNBALANCE OF 1000# INCLUDED BELOW

	<u>With #68 Main &amp; Filler Weights</u>	
	<u>Pounds</u>	
	<u>CBE</u> <u>@</u> <u>86" Stroke</u>	<u>Actual Weight</u> <u>of</u> <u>Counterweights</u>
Cranks Only	8,730	
Cranks Plus 1 Main Weight	10,110	735
Cranks Plus 2 Main Weights	11,480	1,470
Cranks Plus 3 Main Weights	12,860	2,205
Cranks Plus 4 Main Weights	14,230	2,940
Cranks Plus 4 Main Weights and 1 Filler Weight	14,780	3,238
" " " " " " 2 " "	15,330	3,536
" " " " " " 3 " "	15,880	3,834
" " " " " " 4 " "	16,430	4,132
" " " " " " 5 " "	16,980	4,430
" " " " " " 6 " "	17,530	4,728
" " " " " " 7 " "	18,080	5,026
" " " " " " 8 " "	18,630	5,324
" " " " " " 9 " "	19,180	5,622
" " " " " " 10 " "	19,730	5,920
" " " " " " 11 " "	20,280	6,218
" " " " " " 12 " "	20,830	6,516
" " " " " " 13 " "	21,380	6,814
" " " " " " 14 " "	21,930	7,112



COUNTERBALANCE EFFECT AT POLISH ROD WITH #8495-B CRANKS

STRUCTURE UNBALANCE OF 700# INCLUDED BELOW

	<u>With #95 Main &amp; Filler Weights</u>		<u>With #78 Main &amp; Filler Weights</u>	
	<u>Pounds</u>		<u>Pounds</u>	
	<u>CBE</u> <u>@</u> <u>100" Stroke</u>	<u>Actual Weight</u> <u>of</u> <u>Counterweights</u>	<u>CBE</u> <u>@</u> <u>100" Stroke</u>	<u>Actual Weight</u> <u>of</u> <u>Counterweights</u>
Cranks Only	7,350		7,350	
Cranks Plus 1 Main Weight	9,210	1,170	8,620	795
Cranks Plus 2 Main Weights	11,070	2,340	9,880	1,590
Cranks Plus 3 Main Weights	12,930	3,510	11,150	2,385
Cranks Plus 4 Main Weights	14,790	4,680	12,410	3,180
Cranks Plus 4 Main Weights and 1 Filler Weight	15,570	5,175	13,050	3,585
" " 4 " " " 2 Filler Weights	16,350	5,670	13,690	3,990
" " 4 " " " 3 " "	17,120	6,165	14,330	4,395
" " 4 " " " 4 " "	17,900	6,600	14,970	4,800
" " 4 " " " 5 " "	18,680	7,155	15,610	5,205
" " 4 " " " 6 " "	19,460	7,650	16,250	5,610
" " 4 " " " 7 " "	20,230	8,145	16,880	6,015
" " 4 " " " 8 " "	21,010	8,640	17,520	6,420
" " 4 " " " 9 " "	21,790	9,135	18,160	6,825
" " 4 " " " 10 " "	22,570	9,630	18,800	7,230
" " 4 " " " 11 " "	23,340	10,125	19,430	7,635
" " 4 " " " 12 " "	24,120	10,620	20,070	8,040
" " 4 " " " 13 " "	24,900	11,115	20,710	8,445
" " 4 " " " 14 " "	25,680	11,610	21,350	8,850

COUNTERBALANCE EFFECT AT POLISH ROD WITH #8495-B CRANKS  
 STRUCTURE UNBALANCE OF 700# INCLUDED BELOW

	With #68 Main & Filler Weights	
	Pounds	
	CBE @ 100' Stroke	Actual Weight of Counterweights
Crank Only	7,350	
Crank Plus 1 Main Weight	8,830	735
Crank Plus 2 Main Weights	9,720	1,470
Crank Plus 3 Main Weights	10,900	2,205
Crank Plus 4 Main Weights	12,080	2,940
Crank Plus 4 Main Weights and 1 Filler Weight	12,550	3,238
" " " " " " 2 " "	13,030	3,536
" " " " " " 3 " "	13,500	3,834
" " " " " " 4 " "	13,970	4,132
" " " " " " 5 " "	14,450	4,430
" " " " " " 6 " "	14,920	4,728
" " " " " " 7 " "	15,400	5,026
" " " " " " 8 " "	15,870	5,324
" " " " " " 9 " "	16,340	5,622
" " " " " " 10 " "	16,820	5,920
" " " " " " 11 " "	17,290	6,218
" " " " " " 12 " "	17,760	6,516
" " " " " " 13 " "	18,230	6,814
" " " " " " 14 " "	18,700	7,112

COUNTERBALANCE EFFECT AT POLISH ROD WITH #8495-B CRANKS

STRUCTURE UNBALANCE OF 200# INCLUDED BELOW

	<u>With #95 Main &amp; Filler Weights</u>		<u>With #78 Main &amp; Filler Weights</u>	
	<u>Pounds</u>		<u>Pounds</u>	
	<u>CBE</u> <u>@</u> <u>120" Stroke</u>	<u>Actual Weight</u> <u>of</u> <u>Counterweights</u>	<u>CBE</u> <u>@</u> <u>120" Stroke</u>	<u>Actual Weight</u> <u>of</u> <u>Counterweights</u>
Cranks Only	5,740		5,740	
Cranks Plus 1 Main Weight	7,290	1,170	6,790	795
Cranks Plus 2 Main Weights	8,840	2,340	7,850	1,590
Cranks Plus 3 Main Weights	10,380	3,510	8,900	2,385
Cranks Plus 4 Main Weights	11,930	4,680	9,950	3,180
Cranks Plus 4 Main Weights and 1 Filler Weight	12,580	5,175	10,480	3,585
" " 4 " " " 2 " "	13,230	5,670	11,020	3,990
" " 4 " " " 3 " "	13,870	6,165	11,547	4,395
" " 4 " " " 4 " "	14,520	6,600	12,080	4,800
" " 4 " " " 5 " "	15,170	7,155	12,610	5,205
" " 4 " " " 6 " "	15,820	7,650	13,140	5,610
" " 4 " " " 7 " "	16,440	8,145	13,670	6,015
" " 4 " " " 8 " "	17,110	8,640	14,200	6,420
" " 4 " " " 9 " "	17,760	9,135	14,730	6,825
" " 4 " " " 10 " "	18,410	9,630	15,270	7,230
" " 4 " " " 11 " "	19,050	10,125	15,800	7,635
" " 4 " " " 12 " "	19,700	10,620	16,330	8,040
" " 4 " " " 13 " "	20,350	11,115	16,860	8,445
" " 4 " " " 14 " "	21,000	11,610	17,390	8,850
	(Over)			

BETHLEHEM API UNIT - 456-256-120  
 456-213-120  
 320-256-120  
 320-213-120

COUNTERBALANCE EFFECT AT POLISH ROD WITH #8495-B CRANKS

STRUCTURE UNBALANCE OF 200# INCLUDED BELOW

	<u>With #68 Main &amp; Filler Weights</u>	
	<u>CBE</u>	<u>Actual Weight</u>
	<u>@</u>	<u>of</u>
	<u>120" Stroke</u>	<u>Counterweights</u>
Cranks Only	5,740	
Cranks Plus 1 Main Weight	6,520	735
Cranks Plus 2 Main Weights	7,580	1,470
Cranks Plus 3 Main Weights	8,630	2,205
Cranks Plus 4 Main Weights	9,680	2,940
Cranks Plus 4 Main Weights and 1 Filler Weight	10,080	3,238
" " " " " " 2 " "	10,470	3,536
" " " " " " 3 " "	10,870	3,834
" " " " " " 4 " "	11,260	4,132
" " " " " " 5 " "	11,650	4,430
" " " " " " 6 " "	12,050	4,728
" " " " " " 7 " "	12,440	5,026
" " " " " " 8 " "	12,830	5,324
" " " " " " 9 " "	13,230	5,622
" " " " " " 10 " "	13,620	5,920
" " " " " " 11 " "	14,020	6,218
" " " " " " 12 " "	14,410	6,516
" " " " " " 13 " "	14,810	6,814
" " " " " " 14 " "	15,200	7,112