General Electric
Buffalo Tube Plant.
Buffalo, N.Y.

CT DeGroat-EDP, Schen.
HJ Elias-BTP
FT Glastetter-BTP
HR Hemmings-Bldg. #6, Syrc.
WF Hopkins-Bldg. #6, Syrc.
JH Shepp-BTP
WM Perdziak-BTP
WS Munday-BTP
AN Reagan-Bldg. #6, Syrc.

April 18, 1955

Mr. W. L. Male

CONDITION OF D.P.I. BUGGY #17B

As per conversation with Mr. R. H. Henderson, this buggy was a chronic repeater. It was in and out of the shop several times for repairs and failed to produce good tubes.

CORRECTIVE MEASURES TO BE TAKEN

Removed the VMF-80 diffusion pump from the buggy and submerged it in a barrel of Pennetone formula M-423 Solvent. This pump remains in the solvent approximately 16 hours.

The next morning the pump was removed from the solvent. The outside of pump was rinsed and brushed clean of paint, etc. A rubber hose was placed on the hot water faucet and the other end of hose connected to a nipple on the ballast tank and a full stream of hot water was run through the pump until no contaminents could be observed coming from the pump. The first hot water rinse requires approximately 5 minutes.

The next procuedure was a hot water rinse in the opposite direction or flush into the intake of diffusion pump and exhaust through the ballast tank until water was clean (approximately 3 minutes).

Step Three, Screw a standard pipe cap on the end of the nipple attached to the ballast tank, fill pump about half full of water, plug the intake opening of the pump with the correct size rubber stopper. Aggitate the water back and forth by hand for approximately 5 minutes, pour water out of the pump and rinse with hot water.

Step Four, blow high pressure steam (40 lb. pressure) through the pump from the intake end for 4 minutes, blow steam through the pump from the ballast tank opening for the same length of time. Rinse again with hot water. Probably some substances will be noted.

Step Five, Blow the pump out with high pressure air until no visable moisture can be seen (estimate 5 minutes).

Step Six, pour 1 pint of acetone in the pump, stop up both ends and rock by hand back and forth for some three to five minutes. Empty the pump and blow air through for ten minutes. This pump is ready to be re-installed on the buggy.

While the diffusion pump is in the barrel of M-23 the 1405 Welch pump should be checked for optimum pressure.

How to determine whether a 1405 mechanical pump is in good operating condition.

Failure to obtin the desired operating pressure may be due to several causes, namely, inadequate pumping speed, presence of volatile contaminats in the pump and high vapor pressure of the pump lubricant, due either to the use of incorrect oil or to excessive contamination of the oil. If the lubricant is not at fault, a simple test will completely exonerate it. Connect a suitable vacuum gaage (thermocouple) in a closed system directly to the 1405 pump. If the pressure is equal to or below 10 microns in 2 minutes then the oil is not at fault. However, a satisfactory test does not completely exonerate the pump, since there is no proof that it has the required pumping speed at the desired operating pressure. Failure of the oil to meet the test would require an oil change.

RECOMMENDED METHOD FOR FLUSHING AND OIL CHANGE

Remove sweep connection from the intake side of pump. Remove exhaust vent cap, remove drain cap. Turn the pump on and drain the oil. While the oil is being drained place finger over the discharge opening occasionally and build up a pressure inside the pump. When the finger is removed the pressure is released through the oil trap, the vanes and reservoir and out the drain line. If there are any solids clinging in the vanes there is a good chance they will be dislodged and forced out of the pumps.

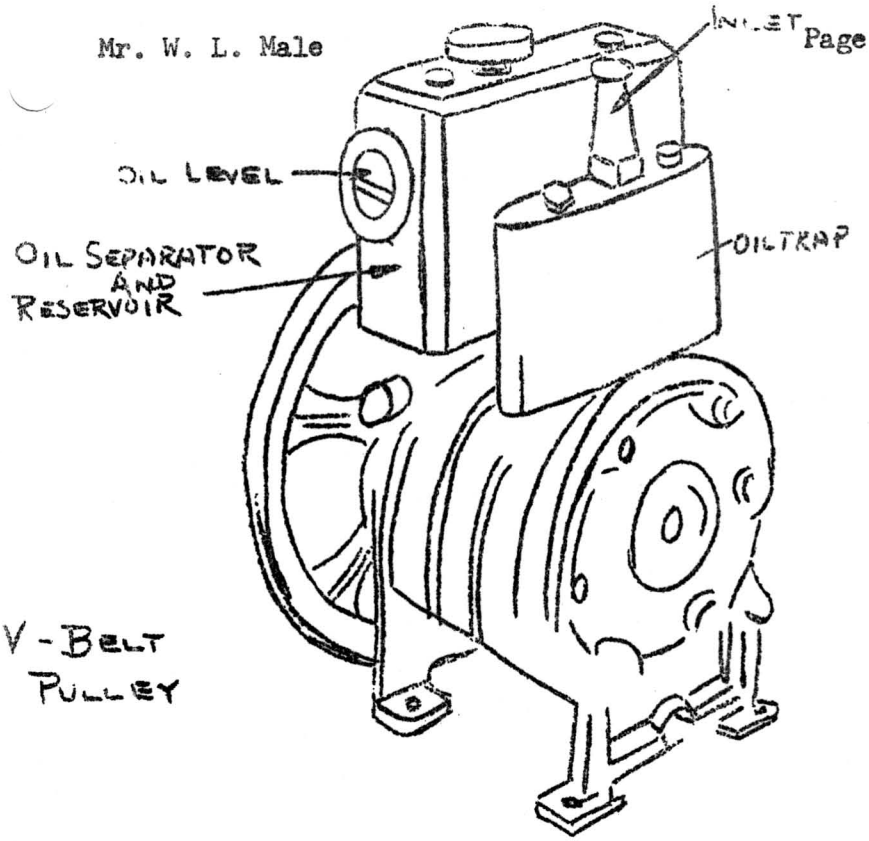
The method of filling the pump may be open for some discussion but I would recommend putting the oil in from the inlet side rather than the reservoir. The oil will flow through the vanes into opening between the cylinder walls and the rotar and in the reservoir.

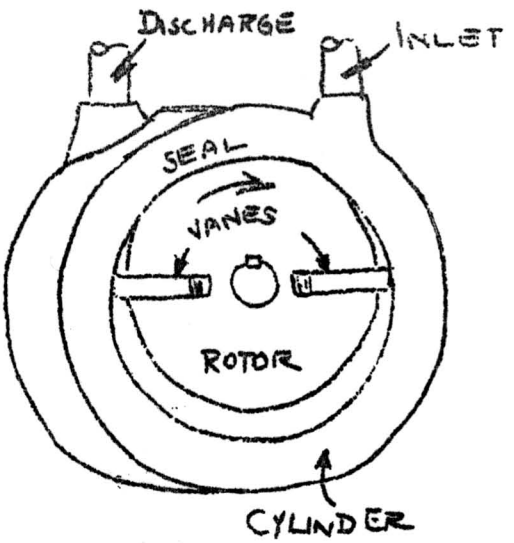
It may require the second oil change if the desired pressure is not obtained.

It can be detected by listening, that a good pump working with a load (21" tube) being evacuated has a distinct pinging sound while a pump that has been run for a number of years seems to run quiter may be defective, worn parts, etc. Most likely this pump should be returned to the manufacturer for reconditioning.

From atmosphere to 5 microns reading with a thermocouple gauge in a closed system should be obtained if the 1405 is in excellent condition.

It may be helpful to briefly describe the operation of a 1405 Welch two-stage vacuum pump.





The sliding vanes (right hand figure) are kept in contact with the cylinder walls by means of a spring (not shown) in the rotar slots. In the rotar positions shown, air is entering the increasing space behind the right hand vane through a port in the cylinder wall, while air compressed to slightly above atmospheric pressure is being forced out of the decreasing space ahead of the left hand vane through a ball check valve (not shown) in the discharge passage. At the same time, the air trapped in the crescent-shaped space between the vanes is being swept around toward the discharge port.

A portion of the cylinder at the top is machined to the same radius as the eccentrically placed rotar to provide a long minimum-clearance sealing the area between inlet and discharge sides of the pump. It is essential that a film of lubricating oil be maintained in this and other close clearance areas between moving parts in order to seal against leakage and, thus, achieve the desired vacuum. If this seal is slightly loose it is possible under a load to have a slight leak between inlet and discharge.

Oil from the reservoir (left hand figure) is supplied to the sleeve type shaft bearings of the pump through drilled passages (not shown). It is drawn by a vacuum into the bearings and thence into the pump interior. Oil films for the lubrication and sealing of moving parts are continually replenished by the rotation of the pump. Excess oil is discharged along with air into the oil separator. Here, it separates from the air and is reused over and over again.

The No.--1405 pump has two stages of the type illustrated at the right and are mounted on the same shaft and connected in series.

After the diffusion pump on Buggy No. 17B was cleaned and re-mounted and a factory reconditioned 1405 mechanical pump was installed (1405 properly degassed) all lines tested for leaks, the cyclicvalve was closed to the diffusion pump and thermocouple gauge placed in the parts the following readings were obtained. Welch Dual-Seal oil was put into the pump. Silicone #702 in the diffusion pump.

MIN.	MICRONS ROUGHING	MIN.	MICRONS ROUGHING
1	11	12	4.9
2	8	13	4.8
3	7	14	4.8
4	6	15	4.75
5	6	16	4.75
6	5.5	17	4.75
7	5.25	18	4.5
8	5.1	19	4.5
9	5.	20	4.5
10	5.	21	4.5
11	4.9	22	4.5

With a FP-62 I gauge tube in the port diffusion pump on backed by a 1405 an optimum vacuum reading of .02 microns was obtained. The port was opened to air and the first reading was taken. This diffusion pump was degassed for 14 hours prior to the following reading, opened to air and Reading #2 taken.

MIN.	MICRONS	#2 READING	MIN.	MICRONS
1	.36	.3	11	
2	.15	.11	12	.02
3	.09	.07	13	
4	.06	.05	14	.018
5	.05	.04	15	
6	.04	.038	16	.017
7	.038		17	
8	.032		18	.014
9	.024		19	
10	.021		20	.01

A clear 21" bulb with a p iece of standard size tubulation fused in the side opposite the button and a gun sealed in was placed in the port. Approximately 12" from the forepressure pump a thermocouple tube was installed and a thermocouple gauge was connected to the above mentioned tubulation. The following readings were obtained with the 1405 pump (only) in operation:

MIN.	MICRON READINGS AT TUBE		MICRON FORE-PRESSURE READINGS
1	5/9/55		
2	new sweep. Rec. tulch. Chanel line.		
3			
4			
5			
6	500+		
7	400-		
8	500-		
9	200+		
10	150	450	300
11	125	350	210
12	85	300	150
13	65	250	115
14	50	200	90
15	42	152	72
16	35	140	60
17	29	115	50
18	22	100	43

MIN.	MICRON READINGS AT TUBE	MICRON FORE-PRESSURE READINGS
19	19	
20	80 16	38
21	75	34
22	60	28
23	52	25
24	50	23
25	45	22
26	42	20
27	38	18
28	34	18
29	30	17
30	29	16
31	25	15

The following readings were obtained with the 21" tube as above except an I gauge was connected to the 21" tube and the buggy was operated with both the VMF-80 and backed by a 1405 Welch Pump:

MIN.	MICRON AT TUBE	MIN.	MICRON AT TUBE
27	10	60	.156
28	7.5	61	Degas
29	5.0	62	"
30	3.3	63	"
31	2.5	64	"
32	1.8	65	.15
33	1.0	66	.145
34	.8	67	.14
35	.62	68	.13
36	.52	69	.125
37	.44	70	—
38	.37	71	.12
39	.32	72	.118
40	.28	73	.11
41	.26	74	.11
42	.24	75	.108
43	.23	76	.105
44	.22	77	.103
45	.21	78	.102
46	.2	79	.101
47	.195	80	.1
48	.19	81	.1
49	.18	82	.099
50	.175	83	.098
51	.17	84	.097
52	.175	85	.097
53	.16	86	.097
54	.158	87	—
55	.158	88	—
56	.158	89	—
57	.157	90	—
58	.157		
59	.157		

This #17B D.P.I. Buggy was placed on #1 inline exhaust machine at 2:00 p.m. April 7, 1955. After the buggy was run through the machine one revolution to heat the diffusion pump and degas, a 21" black inside paint tube was placed on same for a test run. A thermocouple gauge was connected to the sweep approximately 12" from the back up pump to indicate if there would be any rise in pressure when the tube entered No. 1 Zone before the diffusion pump was turned on. At this time the VMF-80 pump was being turned on five positions in No. 1 Zone or twenty minutes after the tube was loaded. The index speed of #1 exhaust is 60 seconds.

It is noted according to the following pressure readings that a sharp rise in pressure takes place in 18 minutes which represents 3 positions in the Hot Zone without the VMF-80 being turned on. When the trigger switch was pressed in position #20 the 100 micron reading substantiates the fact that the fore-pressure is out of range for sufficient backup for the VMF-80 pump. It is also noted that at least 16 minutes of pumping time was lost.

MIN.	1405 PUMP AT FORE-PRESSURE	MIN.	1405 PUMP AT FORE-PRESSURE
8	450	32	110
9	300	33	100
10	155	34	81
11	140	35	75
12	105	36	62
13	85	37	55
14	70	38	48
15	60	39	42
16	53	40	40
17	53	41	39
18	62	42	39
19	80	43	39
20	100	44	38
21	145	45	34
22	125	46	29
23	125	47	25
24	140	48	20
25	150	49	18
26	150	50	15
27	150	51	13
28	150	52	12
29	150	53	12
30	150	54	11
31	140		

The pumps evidently recovered the out gasing. The first tubes exhausted on #17B has gas readings as follows:

.08	.10
.10	.12
.12	.10
.11	.08
.08	.12
Short	.10
.10	.11
NL	.08
.10	.06
.14	

The 1405 pump was running at a speed of 360 RPM. 1/3 HP, 220V ac motor, 3 phase, current reading 1.1 amps.

Buggy #96C was taken to the maintenance shop. The operating condition was the same as No. 17B.

The same precedure was followed in cleaning the VMF-80 and a factory reconditioned 1405 mechanical pump was installed. One change was made on this particular buggy. The 1/2" sweep from the fore-pressure pump to the cyclic valve was increased to 3/4" for this reason. In general vacuum connecting lines should be as short and as large in diameter as practicable. In no case should the vacuum line to a mechanical pump be smaller than the connection provided at the pump, and larger diameter pipe or tubing should be used where long lines are required.

The 1405 pump was running at a speed of 525 RPM., 1/3 hp, 3 phase motor. Current reading 2.0 amps which is .8 amps overloaded.

The following test was made with the roughing pump only. 21" clear bulb in the port. A thermocouple gauge connected to the tubulation on side of the bulb and a thermocouple gauge connected to the back up pump.

MIN.	MICRON READING AT BULB	READING AT 1405 PUMP
9	400	150
10	225	95
11	160	68
12	125	50
13	100	39
14	80	32
15	65	29
16	82	24
17	45	19
18	38	21
19	33	16
20	30	13
21	27	13
22	24	11
23	22	11
24	20	
25	19	
26	17	
27	16	
28	14	
29	13	10
30	13	9.5

This rest was run with a 21" clear bulb in theport a thermocouple gauge connected to the tubulation on the side of bulb and a thermocouple gauge connected to the sweep at the backup pump. The VMF-80 was turned on---operation in 17 minutes.

MIN.	MICRONS AT BULB	MICRONS AT 1405 PUMP
14	80	35
15	65	30
16	55	27
17	38	28
18	25	50
19	19	25
20	13	22
21	10	19
22	8	17
23	6	17
24	5	17
25	4.5	17
26	4.	15
27	2.5	14
28	2.25	14
29	2	14
30	2	15
31	2	15
32	1.75	15
33	1.75	15
34	1.75	15

It is interesting to compare the test of roughing time and pressure readings obtained between the buggy No. 17C with a 1/2" sweep and buggy No. 96C with the sweep increased to 3/4". On Buggy #17C the bulb pressure was 200 microns in 14 minutes. Pressure on No. 96C in 14 minutes was 80 microns.

This test was performed with an I gauge connected to the tubulation on side of a 21" clear bulb and a thermocouple gauge connected to the back up pump.

MIN.	MICRONS AT TUBE	MICRONS AT 1405 PUMP
14		35
15		30
16		26
17	VMF-80-ON	20
18		28
19		22
20		18
21		15
22		14
23		13
24	6.0	12
25	4.0	12
26	2.0	11
27	1.6	—
28	1.2	—

Continued:

MIN.	MICRONS AT TUBE	MICRONS AT 1405 PUMP
29	.7	---
30	.46	---
31	.36	---
32	.29	---
33	.24	---
34	.20	---
35	.18	---
36	.16	---
37	.15	---
38	.14	---
39	.13	---
40	.125	---
41	.12	---
42	.115	---
43	.11	11
44	.105	
45	.102	
46	.10	
47	.1	
48	.1	
49	.16	
50	.14	
51	.12	
52	.11	
53	.1	
54	.099	
55	.097	
56	.09	
57	.085	
58	.082	
59	.079	
60	.075	
61	.073	
62	.073	
63	.073	Degas 30 seconds
64		
65		
66		
67		
68		
69	.09	
70	.08	
71	.076	
72	.072	
73	.068	
74	.064	
75	.062	

Buggy #96C was put on #1 inline exhaust machine April 14, 1955. A 21" black tube was placed in the port for an exhaust test. A thermocouple gauge was connected to the sweep near the back up pump. The fore pump was kicked on in 14 minutes which points to some very interesting results. No. 14 position is two positions out of the No. 1 Zone:

MIN.	MICRONS PRESSURE AT BACK-UP PUMP
11	88
14	48
15	40
16	50
17	43
18	47
19	58
20	72
21	82
22	82
23	79
24	79
25	81
26	89
27	87
28	81
29	78
30	72
31	70
32	65
33	60
34	52
35	49
36	49
37	43
38	40

This test was followed all the way through the exhaust cycle. Fore-pressure through gas check was 16 microns.

The following gas readings were obtained on the first six tubes exhausted on No. 96C buggy, .12 - .12 - .12 - .10 - .08 - .06. Dual-seal oil in 1405 pump and Socony Vacuum oil in diffusion pump. I was assisted in this work by Messrs. Fred Glastetter and Walter Perdziak.

After analyzing the results of these tests I have some recommendations for your consideration:

1) Clean diffusion pumps as soon as possible and replace 1405 mechanical pumps with factory reconditioned pumps as necessary.

2) Maintain a regular schedule for cleaning diffusion pumps at least once each year (VMF-80).

3) Flush 1405 pumps as prescribed occasionally (once each month).

4) Provide for sufficient roughing time so fine pump can be turned on outside the oven.

5) Design and install 3/4" sweeps with the least restriction in the back up line.

6) Purchase more modern equipment for vacuum tests.

7) Provide a procedure for testing each barrel of vacuum oil.

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