MASTER

EXTERNAL TRANSMITTAL AUTHORIZED

OAK RIDGE NATIONAL LABORATORY

Operated by

UNION CARBIDE NUCLEAR COMPANY
Division of Union Carbide Corporation Post Office Box X
Oak Ridge, Tennessee

R-9441

ORNL
CENTRAL FILES NUMBER

59-6-75

DATE:

COPY NO.

SUBJECT: Edwards F903 - Oil Diffusion Pump.

TO:

FROM: C.E. Normand

NOTICE

This document contains information of a preliminary nature and was prepared primarily for internal use at the Oak Ridge National Laboratory. It is subject to revision or correction and therefore does not represent a final report. The information is not to be abstracted, reprinted or otherwise given public dissemination without the approval of the ORNL patent branch, Legal and Information Control Department.

RELEASE APPROVED
BY PATENT BRANCH1-18-61
DATE

SIGNATURE

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

EDWARDS F903

OIL DIFFUSION PUMP

C. E. Norman

This pump, and its water cooled baffle-valve, is from Edwards High Vacuum Ltd., Crawley, England. The pump has a 9 in. diameter barrel, three pumping stages and a cooled cap ("guard ring") covering the top jet assembly. The rated pumping speed for air is 1500 L/sec unbaffled and 900 L/sec. with the baffle-valve. The rated operating power with Apiezon-c fluid is 2250 watts. At this power the limiting fore pressure is said to be 350 μ , and the ultimate vacuum less than 5×10^{-7} mm Hg.

Tests were carried out over an extended range of operating powers, with and without the baffle-valve, and with both Apiezon-c and Convoil-20 pump fluids. Observed performance did not differ substantially from that claimed by the manufacturer.

1. Operating power. This pump operates satisfactorily over an exceptionally wide power range. Between 1500 and 2750 watts there is little change in pumping speed, and almost no change in base pressure or in steadiness of pressure. The limiting fore pressure does increase by a factor of four over this power range, but is adequate for most purposes even at the lower power limit.

At powers less than 1500 watts, performance is definitely marginal: limiting fore pressure is reduced, base pressure rises, and pumping becomes quite unsteady. There seems to be little to gain by operating at powers above 2750 watts, except in pumping hydrogen. Here even higher power is advantageous. In normal service an operating power of 2250 watts - or even a few hundred watts less - appears to be a reasonable choice.

2. Pumping Speed. Pumping speed curves for air, with and without baffle, and at several operating powers, are shown in Fig. 1. There is no clear dependence of speed on power over the power range covered in these measurements. Simple averaging yields speeds of 1320 L/sec unbaffled and 710 L/sec with the baffle-valve -- a speed reduction by the baffle of 46%.

Pumping speed curves for hydrogen are given in Fig. 2. Here there is a clear dependence of speed on power up to the highest power applied (3250 watts). The ratio of hydrogen speed to air speed (baffled) ranges from 1.25 at 1600 watts to 1.70 at 3250 watts. The unbaffled pumping speed for hydrogen was not determined; however, the ratio of unbaffled speed to baffled speed for hydrogen could hardly be less than this ratio for air (1.87). It is, therefore, safe to say that the unbaffled speed for hydrogen is not less than 2250 L/sec at 3250 watts operating power.

3. Limiting Fore Pressure. The fore pressure characteristics of this pump are unusually good. The fore pressure limit ranges from 180μ at 1500 watts input up to 550μ at 2750 watts. Base pressure is unaffected by rising fore pressure up to the critical value at which breakdown of pumping occurs. This excellent fore pressure performance is presumably due to the third (high pressure) stage being an ejector jet rather than the more conventional diffusion jet across a narrow annular aperture. Limiting fore pressure is plotted as a function of power input in Fig. 3. The corresponding curve for the MCF-1400 pump is also shown for comparison.

4. Base Pressure. Base pressures of 3.0 to 3.5×10^{-7} mm were consistently obtained with this pump. The slight variation of base pressure over the operating power range is also plotted in Fig. 3.

5. Pressure Variations. Over the recommended range of operating power (1500 to 2750 watts), and with the base pressure at about 4×10^{-7} mm, the base pressure varies almost continuously, but through quite narrow limits; i.e., by less than $\pm 0.1 \times 10^{-7}$ mm. At higher or lower power the variations become less regular and greater in amplitude.

6. Oil Back Streaming. As a means of reducing oil backstreaming, this pump is equipped (optionally) with a "guard ring". This device consists of a conical cap covering the top jet assembly, and cooled by conduction through the support frame to the water cooled side walls of the pump. Throughout our tests, the guard ring has been used. The following rates of backstreaming were observed for the pump operating at about 2000 watts power, and with Apiezon-c fluid. Without the baffle-valve backstreaming was at the rate of 0.2 to 0.4 cc/hr. With the baffle-valve backstreaming was less than .003 cc/hr.

7. Comparison of F903 and MCF-1400 Pumps. A comparison of these two pumps seems worthwhile in as much as they are of approximately the same size and capacity, and since the latter pump has been widely used in this division. Various characteristics of these two pumps are listed for easy comparison in Table I.

TABLE I

		EDWARDS F-903	CEC MCF-1400
Barrel Diameter	(in.)	9	10
Height	(in.)	27	36
Pumping Stages		2 Diffusion 1 Ejector	3 Diffusion
Normal Power	(Watts)	2250	2950
Speed at 10^{-5} mm Hg (L/sec)	Air - Baffled	910	
	Air - Unbaffled	1320	1170
	H ₂ - Baffled	1200	
	H ₂ - Unbaffled	> 2250	2400
Limiting Fore Pressure (μ) at Normal Power		400	100
Base Pressure	(mm)	$3.0-3.5 \times 10^{-7}$	$\sim 6.5 \times 10^{-7}$
Backstreaming v. cool cap-no baffle (cc/hr.)		~ 0.30	.125
Ratio:	$\frac{\text{Speed (Air)}}{\text{Aperture}}$ L/sec./in ²	20.8	14.9
Ratio:	$\frac{\text{Speed}}{\text{Power}}$ L/sec/watts	.587	.397

8. Summary. The Edwards F-903 pump with "guard ring" is a better than average pump in all respects. It has good pumping speed both for air and hydrogen, and its fore pressure characteristics are outstanding. Good base pressures are attained both with and without the baffle and using either Apiezon-c or Convoil-20. Pressure variations are small over a wide range of operating powers.

Fig. 1. Baffled and Unbaffled Pumping Speed for Air.

Fig. 2. Baffled Pumping Speed for Hydrogen.

Fig. 3. Limiting Static Fore Pressure vs Power Input.

9-6