FINAL REPORT

WELDING SPACE VACUUM TECHNOLOGY

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WELDING SPACE VACUUM TECHNOLOGY

This research effort was to determine the feasibility of gas metal arc (GMA) welding in a space environment vacuum system.

Our objective was to assist EH42 Division in putting together a vacuum system that could both attain desired pressure and be large enough to accommodate the GMA welding fixture apparatus (see Fig. 1). These effort were to be accomplished by using existing equipment in a redesigned mating configuration (vacuum system #1) of two separate systems. See Fig. 2 for schematic.

A larger system with greater pumping capabilities (vacuum system #2 shown in Fig. 3) was attained by EH42. This system is 4 feet in diameter and 8 feet long and, with the modifications made, could attain pressures down to 10^{-6} torr. It can also hold acceptable pressure for welding (10^{-3} - 10^{-4} torr) dependent upon gas flow input for the weld fixture.

The primary interest of NASA Weld Engineer (Ms. Russell) was for UAH to update the existing vacuum systems to provide the needed capability of holding acceptable vacuum pressures during the welding process. In order to accomplish this task, there were extensive modifications to both systems as well as equipment repair and update. In addition, the purchase of new equipment to meet the specific needs of welding in a vacuum environment was made, in part, upon UAH recommendations.

A major problem was that the existing welding apparatus had to be made compatible with a typical space environment. Some of the problems associated with the systems in accomplishing the objective were lubrication, electrical arcing, electrical cables, feed-thrus, wire feeds, gas and coolant lines, pressure measurement devices, T. V. monitors, thermocouples, and temperature controlled contamination

collection devices. Since some of the equipment available for use in the vacuum environment of the systems were not compatible from an outgassing standpoint, it was necessary to make certain modifications. In some instances acceptable vacuum stable materials were substituted to mitigate cross contamination of weld materials and reduce the gas load on the system pumping equipment.

There were three existing space environment simulation systems modified to accept necessary equipment to be used for the weld research. Modifications included the pumping systems, LN_2 traps for oil-type diffusion pumps, electronic control panels for fail-safe system operation, internal LN_2 cooled baffles to assist in contamination and pressure control. Both electromechanical and hand operated valves were designed into the systems for the purpose of mating the systems together for greater pumping speed and for isolation of pumps and/or instrumentation. Figure 4 illustrates the roughing/backing pumps and blowers.

A major accomplishment was the design and fabrication of the controller/annunciator for the 4' x 8' system. It contains many safety features such as thermocouple set point relays that will only allow inlet and exit gas and vacuum valves to be operated at pre-selected system pressures, and a fail safe mode for power interruptions and operator mistakes.

UAH feels that significant progress has been made in this research effort to weld in a vacuum environment. With continued efforts on greater pumping speeds for vacuum chambers and further studies on weld fixtures and gas inlet pressures, the NASA program will be successful.

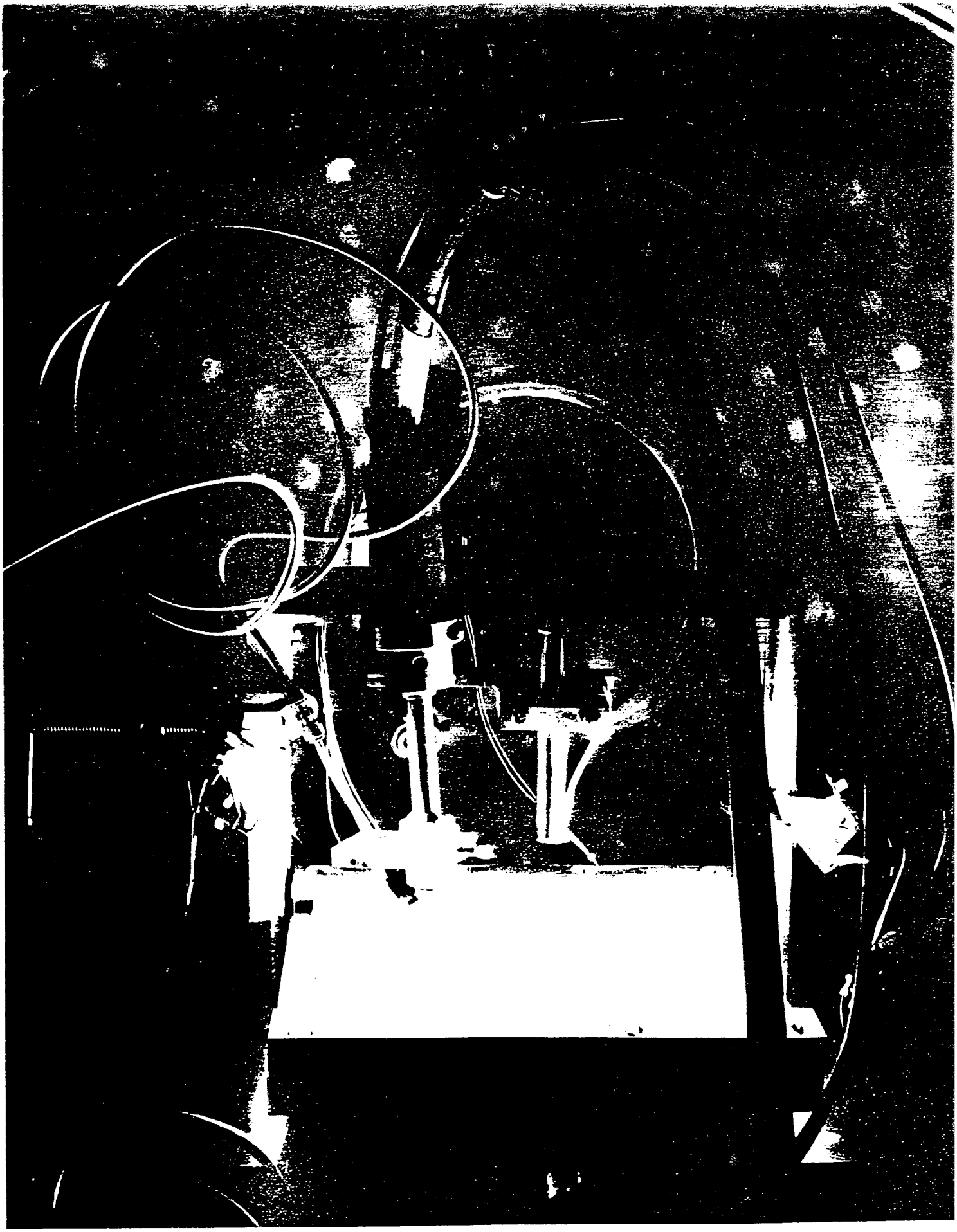

Figure 1. GMA weld fixture in 4' x 8' chamber

EH42 WELDING IN SPACE
PROPOSED VACUUM SYSTEM

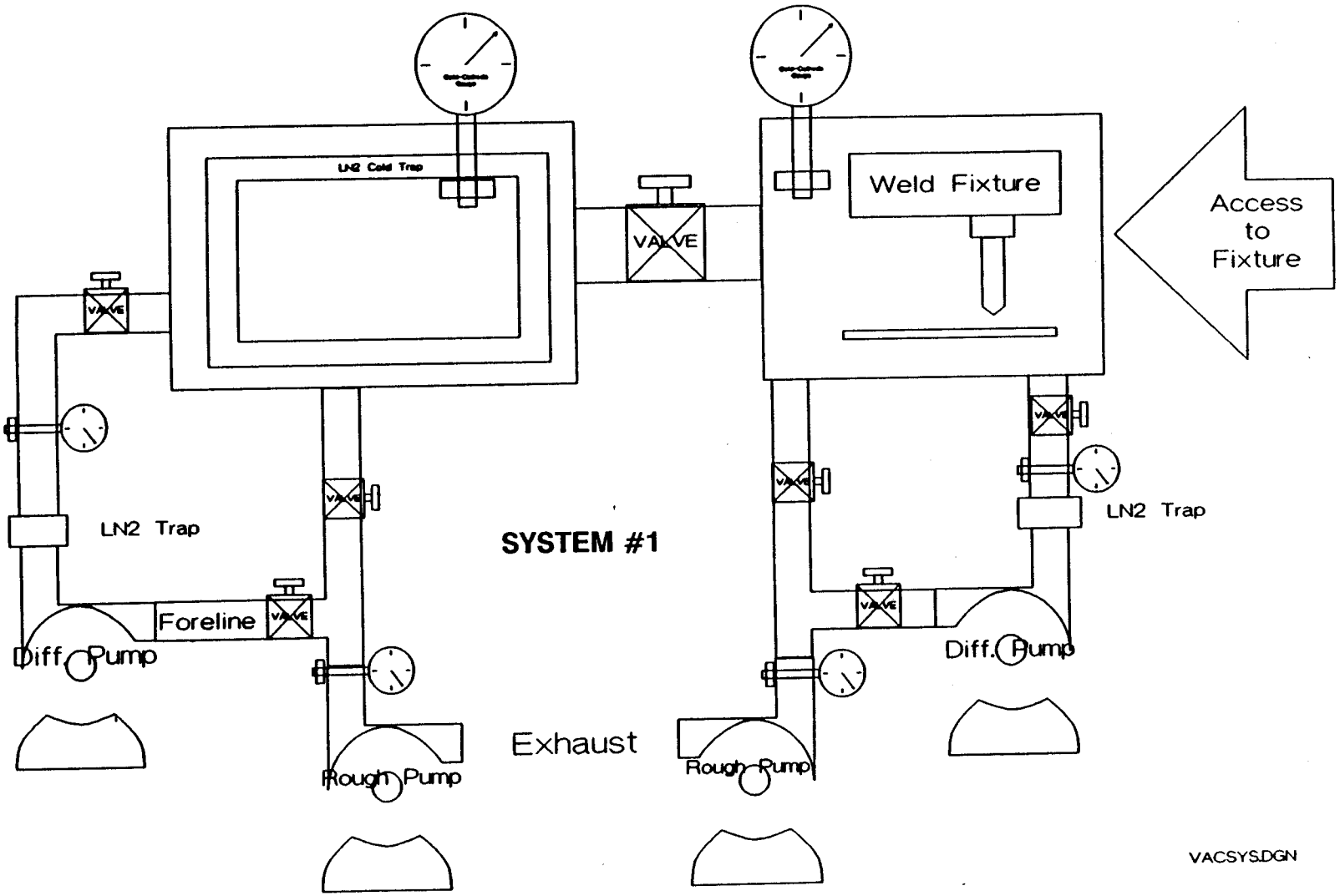

Figure 2. Mating configuration of System #1 and System #2

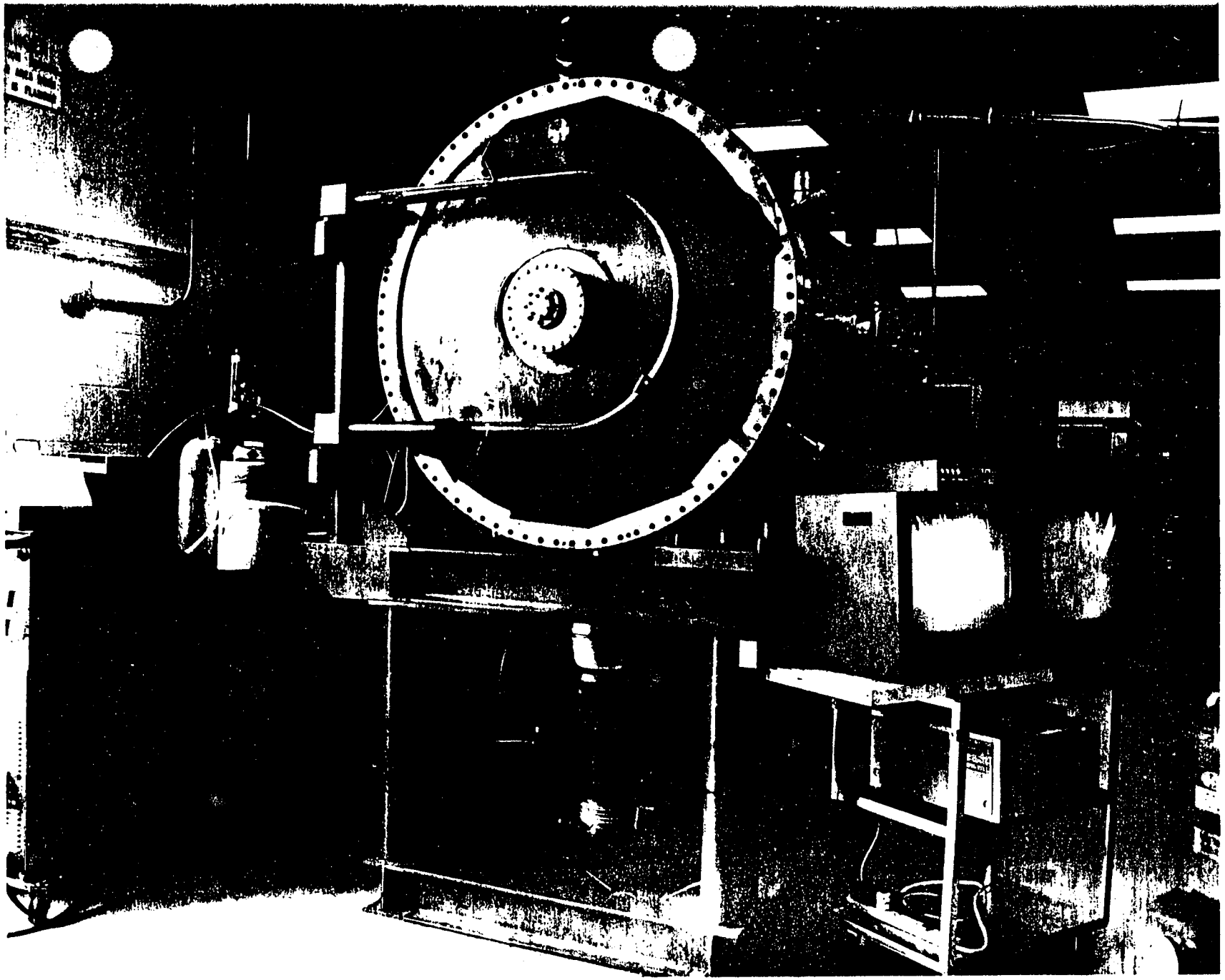

Figure 3. System #2 — 4'x8' space simulation chamber

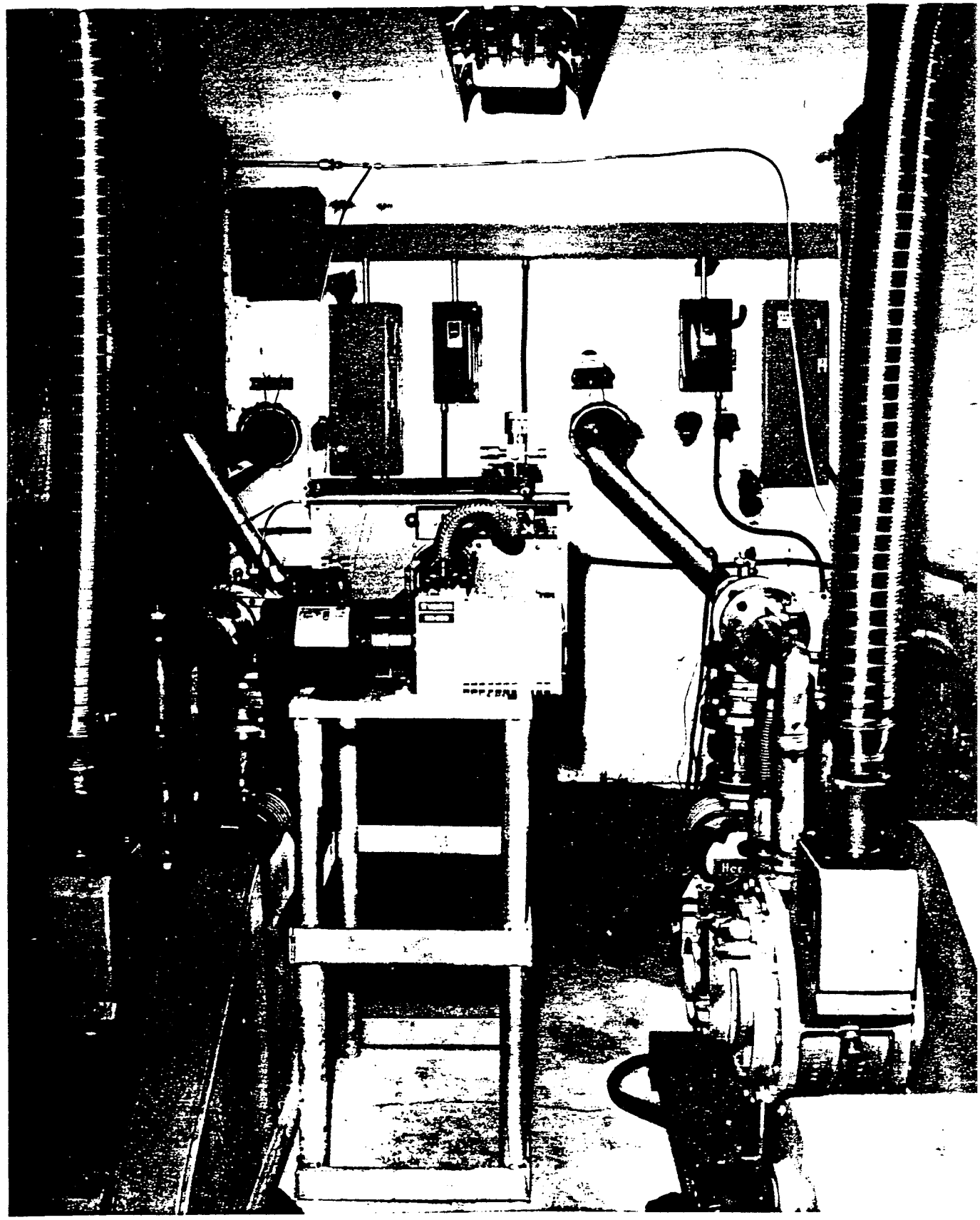

Figure 4. Roughing/backing pumps and blowers

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