(NASA-CR-163889) DISH STIRLING SOLAR RECEIVER PROGRAM Final Report (Fairchild Stratos Corp.) 174 p HC A08/MF A01 CSCL 10A

N81-16574

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STRATOS DIVISION

DOCUMENT NUMBER ER 79917-3

DISH STIRLING SOLAR RECEIVER PROGRAM

FINAL REPORT

CONTRACT NO. 955400

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This work was prepared for the Jet Propulsion Laboratory, California Institute of Technology, sponsored by the National Aeronautics and Space Administration under Contract No. NAS7-100.

15 December 1980

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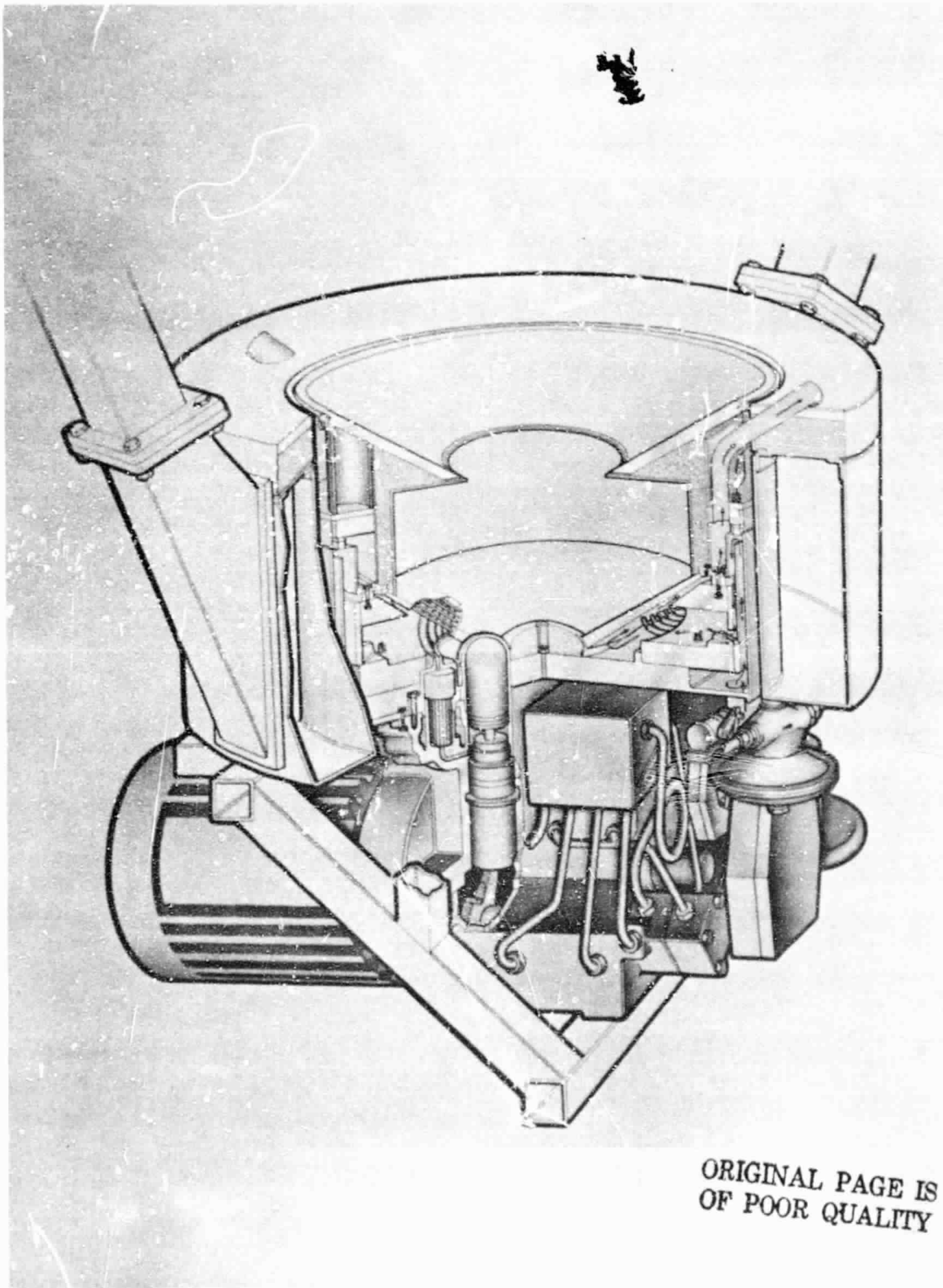

DSSR and P-40 Engine/Alternator

ABSTRACT

The Dish Stirling Solar Receiver (DSSR) Program has become a means by which a technology demonstration of a Dish Stirling solar thermal electric system can be accomplished earlier and at a much lower cost than previous planning had indicated. This achievement was brought about by employing unique technical solutions that allowed already existing hardware, with minimum modifications, to be integrated into a total system with a minimum of development.

The DSSR operates with a modified United Stirling P-40 engine/alternator and the JPL Test Bed Concentrator as a completely integrated solar thermal electric system, having a design output of 25 kWe. The system is augmented by fossil fuel combustion which ensures a continuous electrical output under all environmental conditions.

The projected technology demonstration can pave the way for early commercialization of distributed Dish Stirling solar electric systems. Technical and economic studies by government and industry in the United States and abroad identify the Dish Stirling solar electric system as the most appropriate, efficient and economical method for conversion of solar energy to electricity in applications when the electrical demand is 10 MWe and less. The decision of DOE and JPL to sponsor this significant technology demonstration can therefore be expected to pay a very high dividend.

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FOREWORD

This report describes the design and development effort of a fossil fuel combustion augmented Dish Stirling Solar Receiver (DSSR) which has been specifically designed to operate with a modified United Stirling P-40 engine/ alternator and the JPL Test Bed Concentrator as a completely integrated solar thermal electric system. This system has a design output of 25 kWe at an overall conversion efficiency (sunlight to electric output) of approximately 30 percent. The DSSR and P-40 engine/alternator as it will appear when mounted on the Test Bed Concentrator is illustrated in the frontispiece.

The principal feature of the DSSR is its ability to convert concentrated sunlight from a parabolic dish to heat, and to supply this heat directly, efficiently and uniformly to the Stirling engine hot end without the use of such intermediate heat transfer devices as heat pipes or thermal storage.

The fossil fuel combustion augmentation, which uses natural gas as fuel (but could be designed to use a variety of gaseous and liquid fuels) provides the capability to supplement the heat available from the sun with heat from another source on cloudy days or at night, so that the system can provide a continuous, reliable and predictable electrical output at all times. However, the available solar energy is always used first and then augmented with combustion heat, as necessary.

The capability of the system to provide a continuous electric output is considered essential in utility applications. This sytem can therefore provide an early demonstration to such potential users that solar thermal electric systems are practical and can meet the needs of a utility.

While an economic analysis to project the cost of electricity has not been a requirement of this contract, such analyses have been performed by Solar Energy Research Institute (SERI) and by others. Studies by the Solar Thermal Division of EXXON Enterprises showed that a hybrid Dish Stirling system can economically outperform a diesel generator set of comparable size. Studies by Messerschmitt-Bolkow-Blohm in West Germany show that the Dish Stirling system will economically outperform any other solar technology in the range of 10 to 100 kWe output.

At the outset of the DSSR program, the widely held belief, both in government and industry, was that the Dish Stirling technology, while promising, was an advanced technology, requiring many years of development and extensive funding before an actual demonstration of its potential high performance could be accomplished. Subsequent studies showed that the United Stirling P-40 engine, which has been subject to extensive development and testing by United Stirling both in-house and as part of the

FOREWORD (continued)

Automotive Stirling program sponsored by DOE, could be modified and used for an early demonstration of a full-up Dish Stirling solar thermal electric system. The necessary program and hardware elements to accomplish this full-up Dish Stirling system demonstration were subsequently funded and initiated by DOE through JPL and the system operational tests are now scheduled to begin during the early summer of 1981, ahead of or concurrent with similar tests using Rankine and Brayton systems. It will thus be possible to compare the merits of the Dish Stirling system with the Rankine and Brayton systems much earlier than previously believed possible to aid in the planning for early commercialization of the most promising and appropriate technology.

There have been no reportable items of new technology identified for this program. However, it is well to keep in mind that all basic elements of the system (i.e., the Test Bed Concentrator, the Dish Stirling Solar Receiver, the modified P-40 engine/alternator, and all associated controls) are designed to demonstrate the technology and are not designed for commercial mass production. The system will provide badly needed performance data and operational data, but is only partially useful in determining a future mass production cost of such a system. The technical approach and solutions for design of such a future system are inherent in this technology demonstration system hardware. As components are selected and the market requirements are identified, such future design activities will lead to simplification and specific design configuration to facilitate the mass production and assembly processes.

While the overall conversion efficiency of the present system is impressive, it is limited by the operating temperature capability of the metallic materials used. Conversion efficiencies as high as 40 percent (sunlight to electric output) are feasible in the future with the use of ceramic materials in the critical hot parts of the receiver, thus allowing the operating temperature to be increased. A study to determine the feasibility of a ceramic direct heated and fossil fuel combustion augmented Dish Stirling receiver has been performed and documented in Fairchild Report No. SOL-R034, dated 22 February 1980. The conclusion of this study was that such a receiver is feasible. Funding limitations have precluded initiating development of such a receiver at this time; however, it is recommended that such a program be initiated as soon as resources permit.

1.0 PROGRAM OVERVIEW

The program has been conducted in three basic phases in accordance with well established practices:

a. Preliminary Design

b. Detailed Design

c. Hardware Fabrication and Test

Formal Preliminary and Detailed Design Reviews were conducted by JPL at the conclusion of each of the first two phases to review the validity of the conclusions and results of each activity. Representatives of the JPL Engineering and Quality Assurance Departments observed significant fabrication and final assembly steps, as well as the acceptance tests prior to delivery.

Because of the evolving nature of the program, certain program elements, such as the P-40 design modification and combustor development testing, and final control system design, were separated from the main program. These elements were conducted separately by Fairchild and JPL in some cases, and jointly in some cases, as determined necessary for most efficient utilization of financial resources, facilities and manpower. The net result of this programming has been reduced program cost at the expense of some schedule slippage (three to four months) of the final system demonstration test, which will be performed at the JPL Point Focus Test Site (PFTS), Edwards Air Force Base near Lancaster, California. The greatest impact resulted from the delay in approval, issuing and completion of the United Stirling subcontract for the detail design of the P-40 engine modification which, when completed, necessitated extensive design changes in the receiver base plate, outer housing and fuel system to accommodate the engine mounting and lubrication system. This in turn delayed fabrication and delivery of the receiver.

The main program elements, as well as the separately conducted activities, are illustrated graphically in Figure 1-1.

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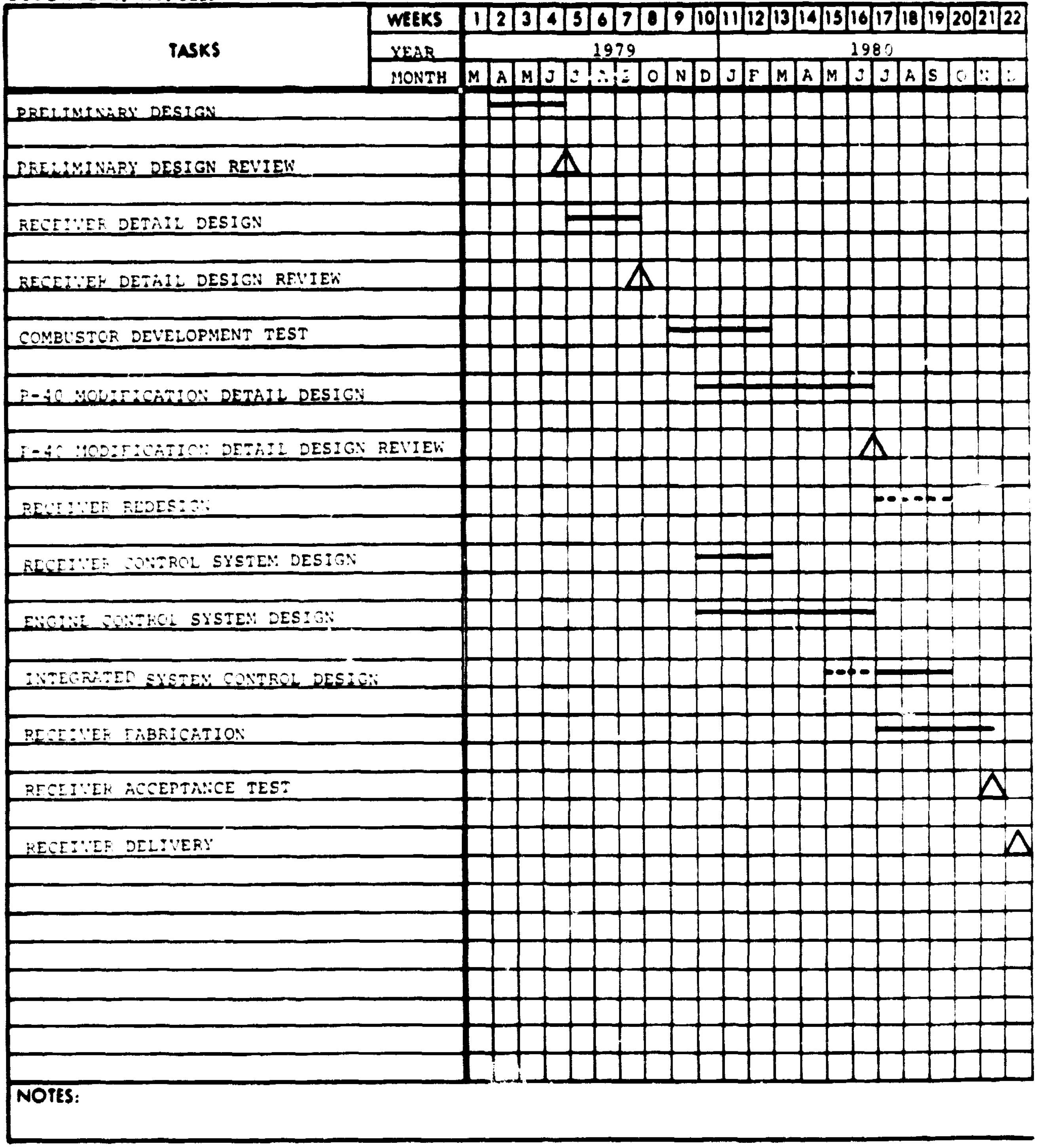
Figure 1-1. Program Elements and Milestones



1.0 PROGRAM OVERVIEW (continued)

The following subcontractors participated in this program:

- Georgia Institute of Technology (GIT)

  Optical, thermal and heat transfer analysis and design.

- Institute of Gas Technology (IGT)

  Combustion analysis and design.

- Solar Turbines International (STI)

  Receiver materials research and fabrication.

- United Stirling, Sweden (USS)

  P-40 engine integration and modification.

2.0 DESIGN FEATURES

2.1 Technical Baseline Definition

During the Preliminary Design Phase, alternative designs for Stirling engines and parabolic concentrators were evaluated to assess the impact on the receiver design. The alternatives considered were modified versions of the I-98 and P-40 Stirling engines and the Acurex 10-meter Advanced Concentrator, the General Electric 12-meter Low Cost Concentrator and the JPL 11-meter Test Bed Concentrator. In addition, the feasibility of incorporating fossil fuel combustion augmentation to achieve hybrid operation was analyzed and evaluated.

The conclusion reached was that the very high operating pressure required by the I-98 engine to achieve the output (25 kWe) associated with the smallest of the three candidate concentrators, the 10-meter Advanced Concentrator, would result in unacceptable short creep life of the heater tubes. Also the required heat transfer area of the receiver in the solar mode, as well as in the combustion mode, could not be attained with an acceptable degree of certainty.

On the other hand, the P-40 engine and the 10-meter Advanced Concentrator were found to be ideally matched and the relatively large heat transfer surface of the P-40 heater head, with some modification, could accommodate the required heat transfer in both the combustion mode and the solar mode.

Although the 11-meter Test Bed Concentrator and the 12-meter Low Cost Concentrator were too large, it was determined that some facets of the Test Bed Concentrator could be covered or removed, thus reducing the effective size of the concentrator to a suitable size. The 12-meter Low Cost Concentrator also has a short focal length and a relatively large slope error, which results in a wide flux pattern inside the receiver cavity; this is unsuitable for a direct-heated Stirling engine and, in addition, requires a large aperture, resulting in low thermal efficiency of the receiver.

The conclusion of the Preliminary Design activity was to proceed with a full-up dish Stirling solar thermal electric system, using a modified P-40 engine with a direct-driven induction alternator and the JPL Test Bed Concentrator with masked or removed facets to provide a suitably sized and configured concentrator. This configuration provided a narrow flux pattern inside the receiver cavity, suitable for a direct-heated Stirling engine, and a small diameter aperture, required for high thermal receiver efficiency.

2.1 Technical Baseline Definition (continued)

The fossil fuel combustion augmentation feature was also incorporated in the baseline design. While the 10-meter Advanced Concentrator was retained in the design specification as the baseline for the receiver design, the Test Bed Concentrator will be used for the demonstration test, since the 10-meter Advanced Concentrator will not be available at that time. The Test Bed Concentrator can, when suitably masked, closely simulate the performance projected for the 10-meter Advanced Concentrator, as illustrated in Figure 2-1.

The resulting baseline design specification was defined as shown in Table 2-I.

Table 2-I. Baseline Design - Dish Stirling Solar Receiver

Concentrator diameter, active (Advanced Concentrator Type)	10m
Focal plane distance/concentrator diameter (F/D)	0.6
Peak insolation (1 kW/m^2)	76.5 kW
Concentrator efficiency (clean)	0.83
Total concentrator error (slope plus pointing)	3 mr
Fossil fuel combustor design (peak input to helium)	70.0 kWt
Combustor turndown ratio	10:1
Allowable focal point mass:	
Design	1,350 kg
Test Bed Concentrator	1,500 lb
Peak engine pressure, helium (P-40)	2,500-3,000 psi
Working fluid temperature (helium)	1200°-1500°F

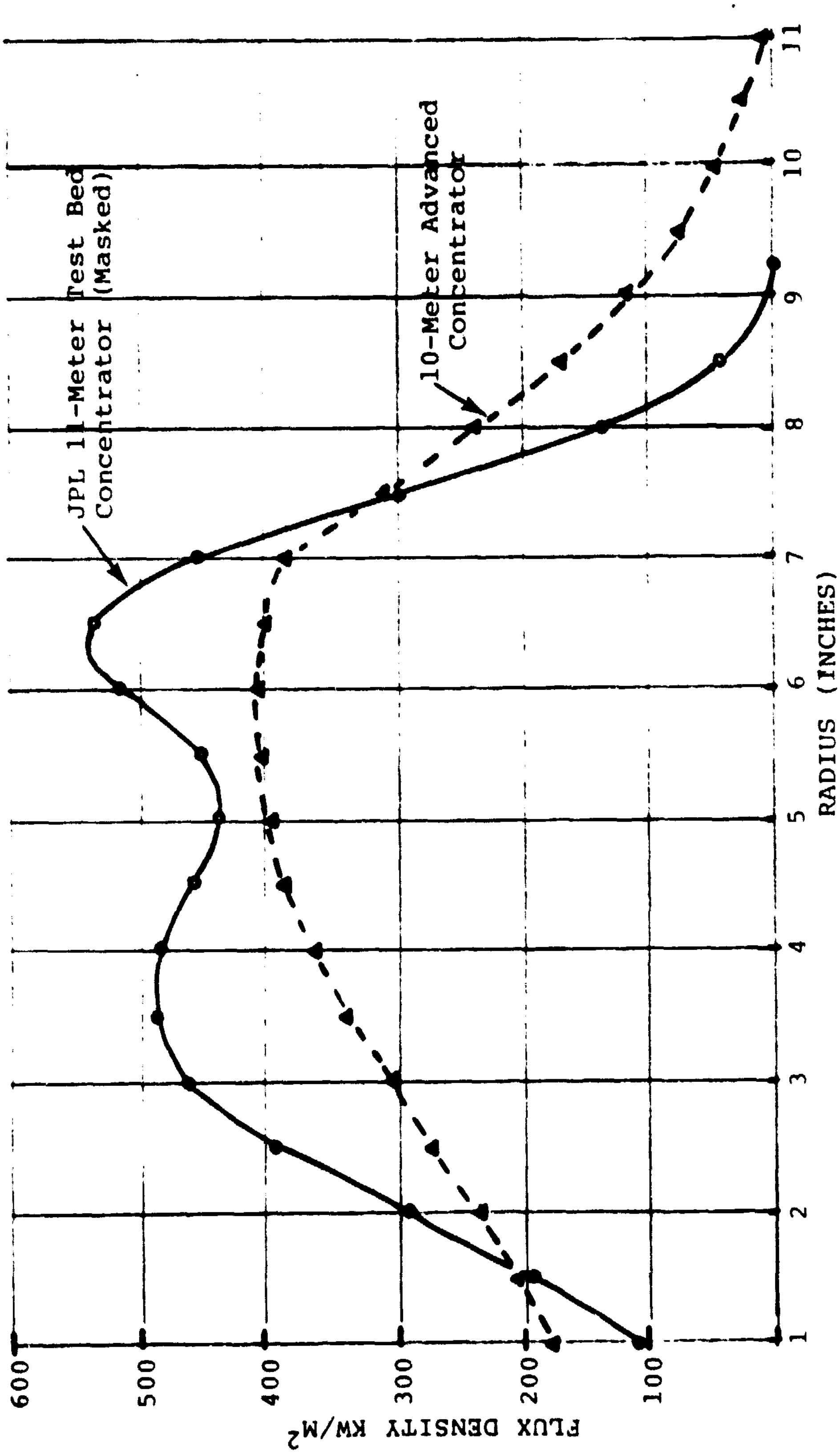


Figure 2-1. Comparison of Receiver Flux Patterns, Advanced and Test Bed Concentrator

2.1 Technical Baseline Definition (continued)

In addition, certain important design constraints were imposed on the receiver design by the P-40 engine.

- The total flow area of all heater tubes must be the same as the area of the standard P-40 heater head.
- The L/D (L = tube length, D = inside tube diameter) must be as close to 100:1 as possible.
- The orientation and location of cylinders and regenerators (including their offset in the horizontal plane, as shown in Figure 2-2) must remain unchanged.

2.2 Receiver Design

The basic design of the receiver and the analytical substantiation of its design and performance has been extensively documented in Fairchild Reports SOL-R025 and SOL-R040, dated September 20, 1979 and February 22, 1980, respectively. The general arrangement of the receiver is shown in Figure 2-3.

The receiver is divided into two sections: an upper section which contains the optical receiver cavity, covered by a conical ceramic aperture plate, and a lower section which contains the combustion system. The two cavities are separated by a conical receiver body made of copper encapsulated in Inconel 617 for oxidation protection and structural rigidity at elevated temperatures. Forty-eight equally spaced Inconel 617 engine heater tubes are embedded in the copper in such a manner that a near-uniform temperature is maintained around and along the heater tubes, despite the nonuniform solar flux impinging on the surface of the cone in the optical cavity. The embedded tubes are of sufficient length to transfer all thermal energy from the concentrator to the engine working fluid. Figures 2-4 and 2-5 show the excellent temperature distribution on the surface of the receiver cone and within the cavity at full solar flux with the engine working fluid at 1200°F and 1500°F, respectively. The receiver thermal efficiency has been calculated to be 87.5% and 82.5% at working fluid temperatures of 1200°F and 1500°F, respectively.

The engine heater tubes, which extend from the bottom surface of the receiver cone to the engine regenerators, are designed with Inconel-clad copper sleeves to provide the necessary heat transfer area in the combustion mode while uniform heater tube surface temperatures are maintained, which is essential for engine performance.

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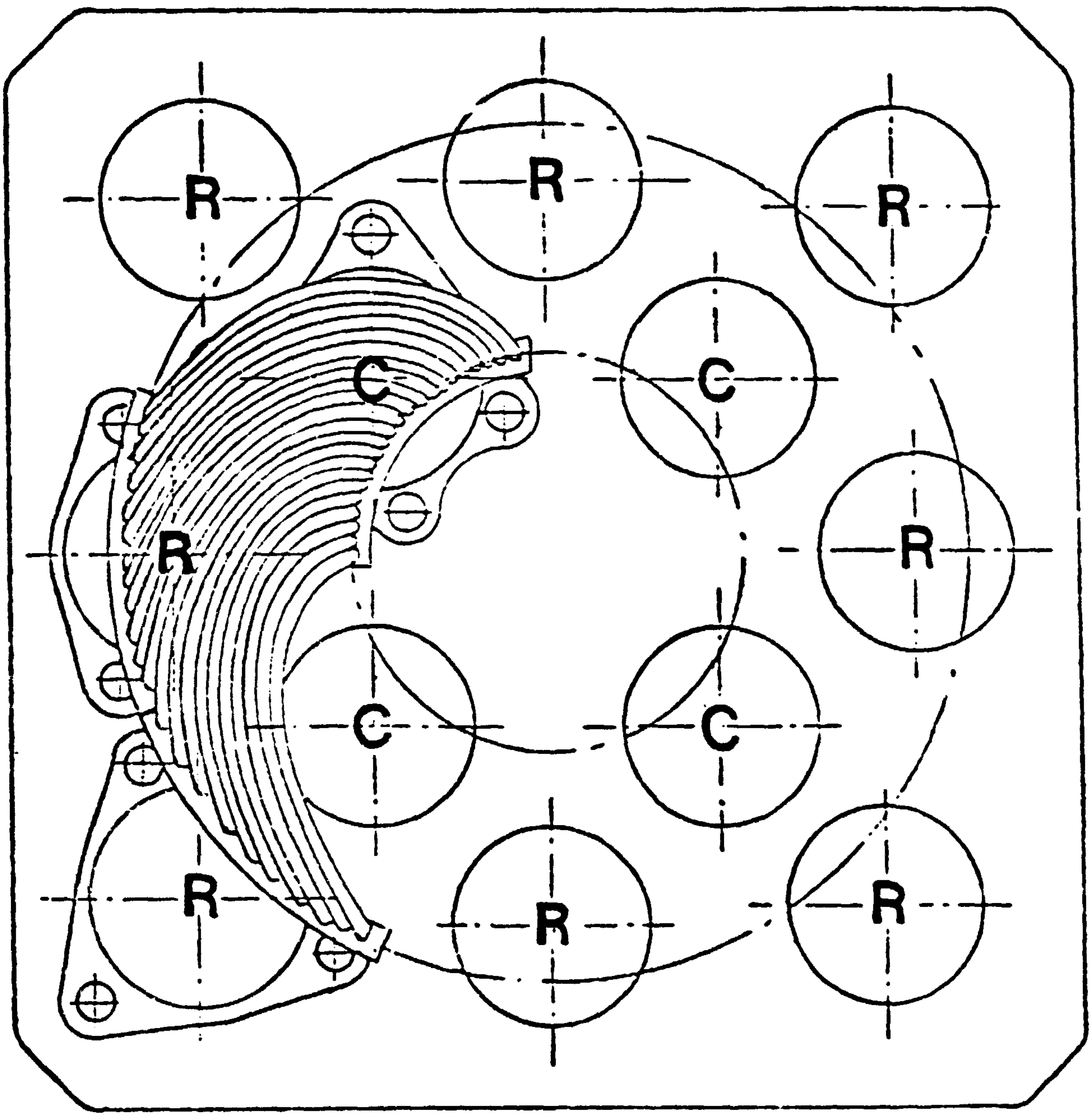
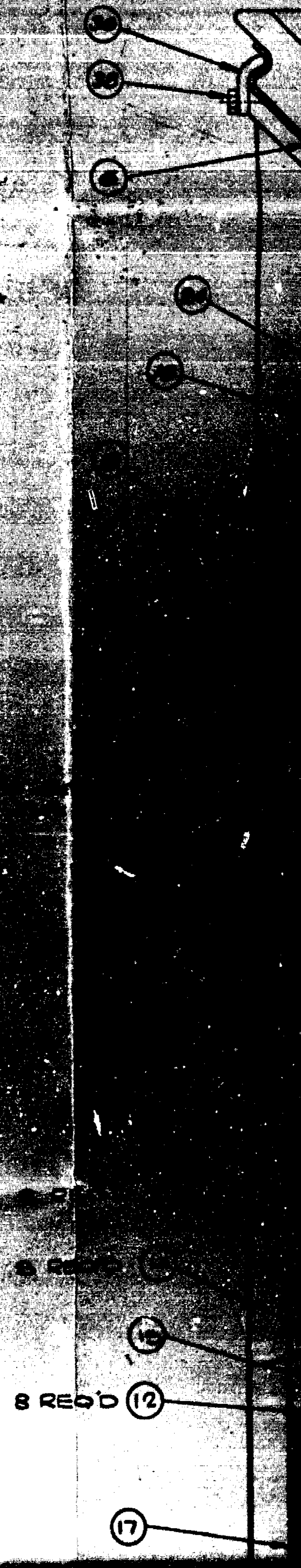
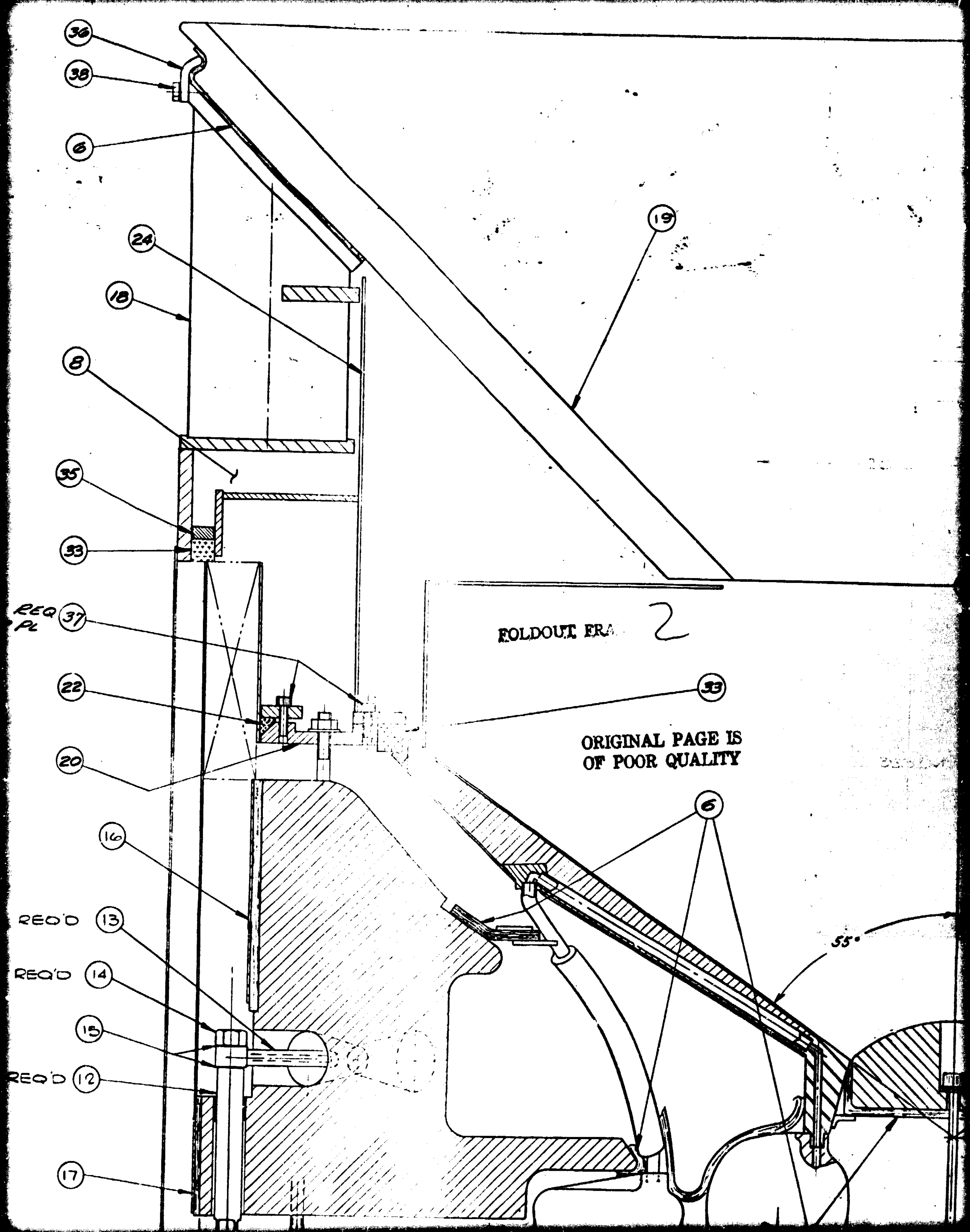


Figure 2-2. P-40 Cylinder and Regenerator Arrangement

TRIM LENGTH OF NOZZLE TO ACHIEVE
1.50 FROM NOZZLE END TO THROAT
OF MIXING CHAMBER





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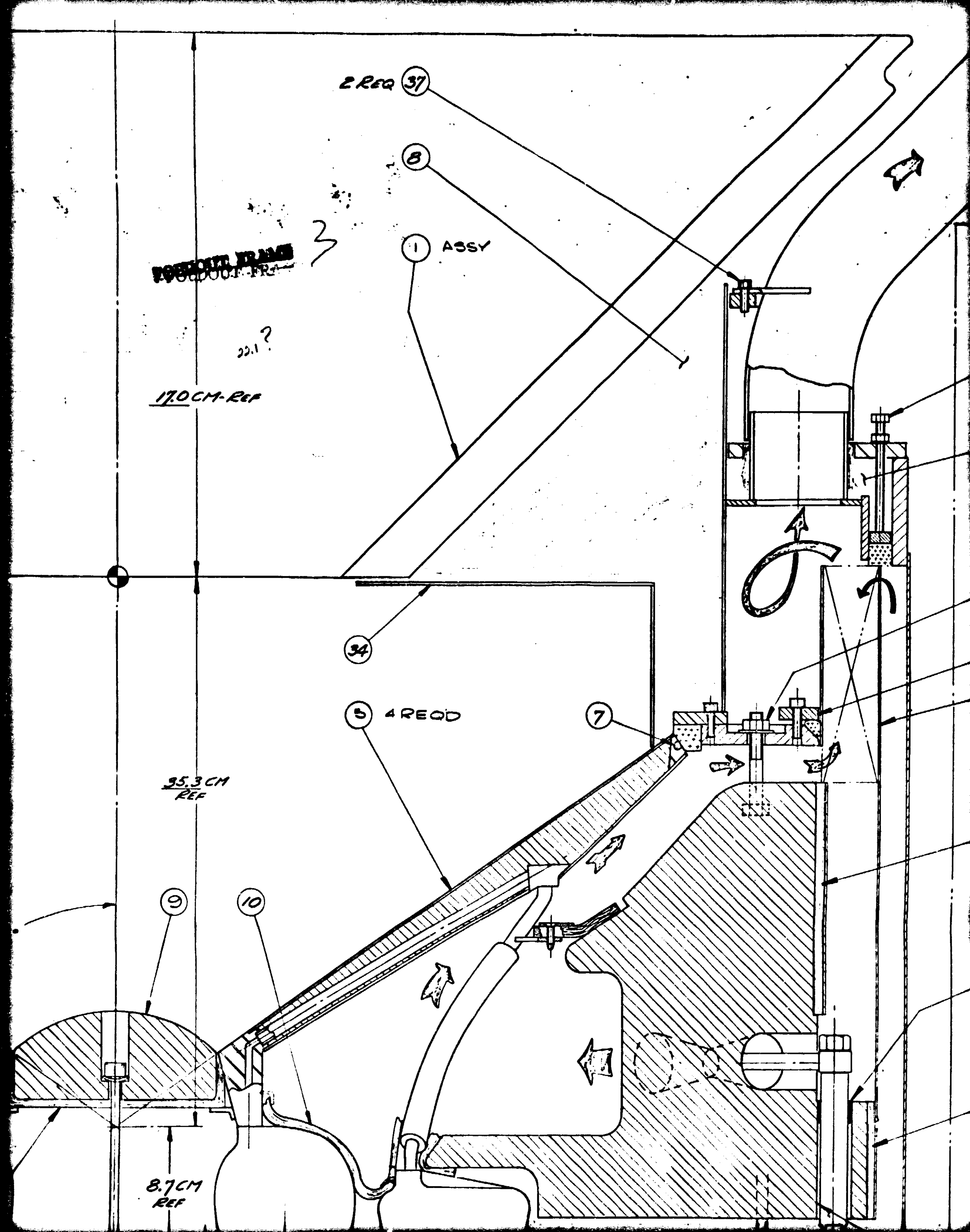

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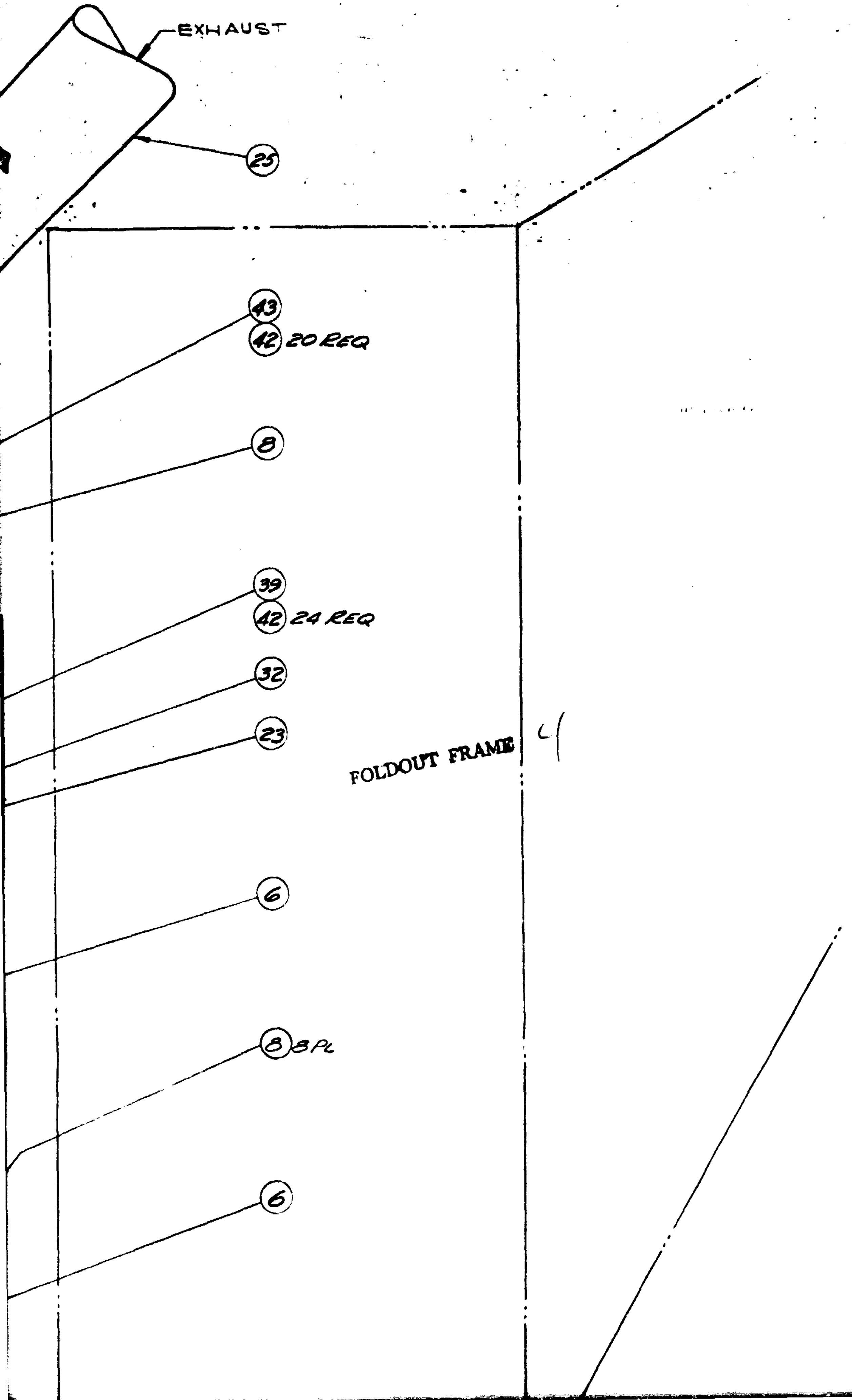

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				1		TUBE	79917087-3				68
				1		PIN	79917092-3				67
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	✓					TEST ASSY #2	-605	(SH. 4)			53
		✓				TEST ASSY #1	-603	(SH. 3)			52
			✓			PRIMARY SUB ASSY	-601	(SH. 2)			51
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				1		SCREW					49
						SCREW					48
						SCREW					47
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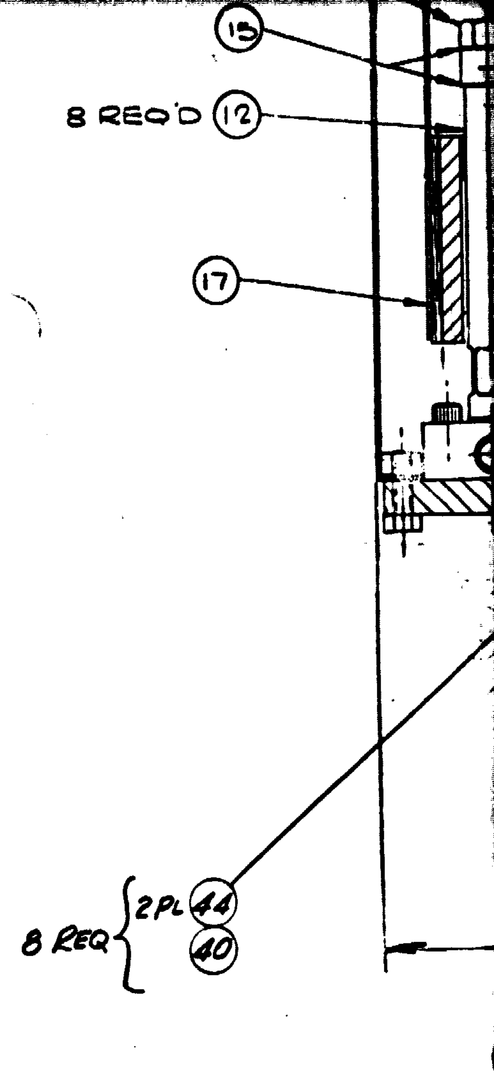

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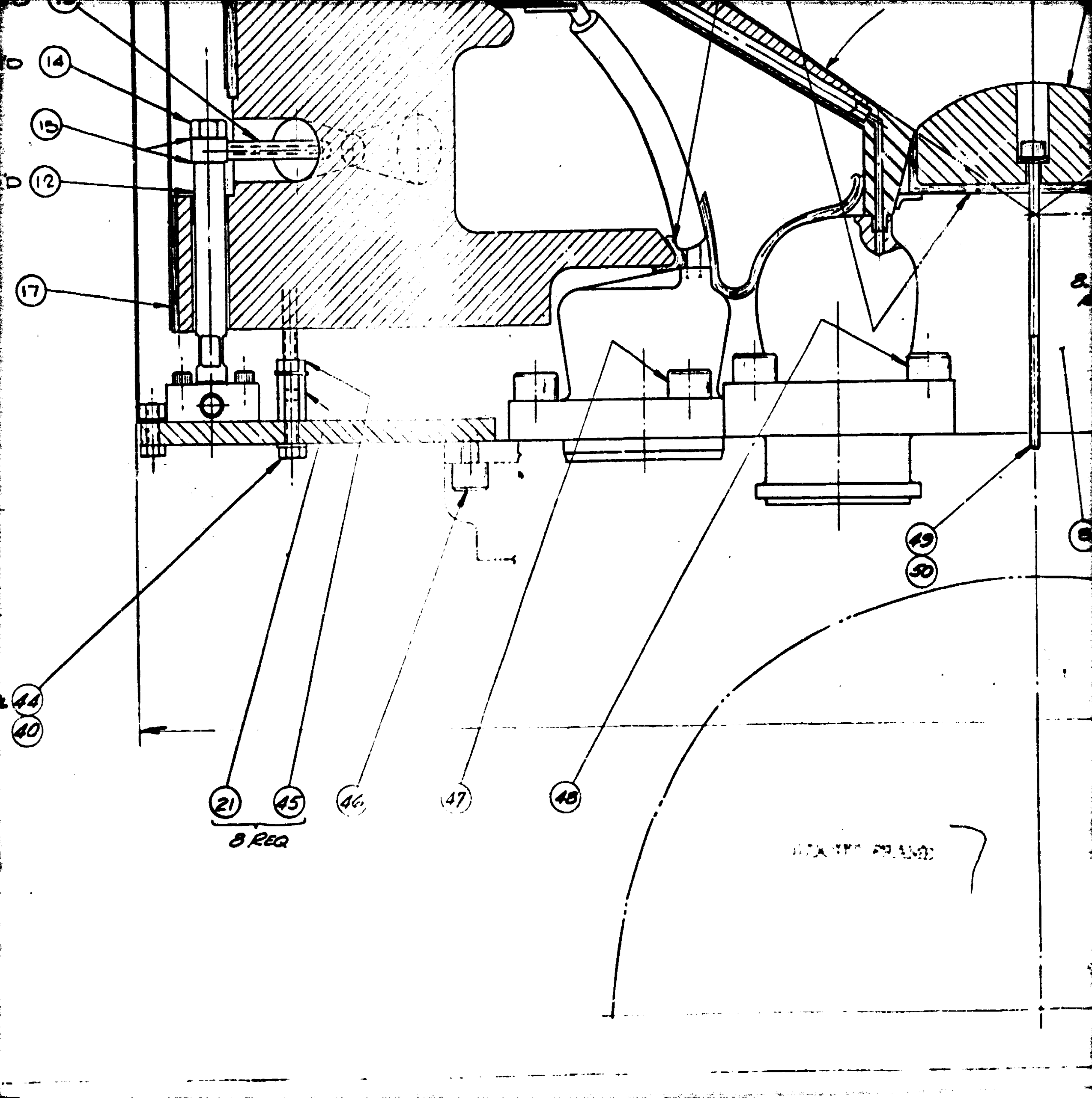
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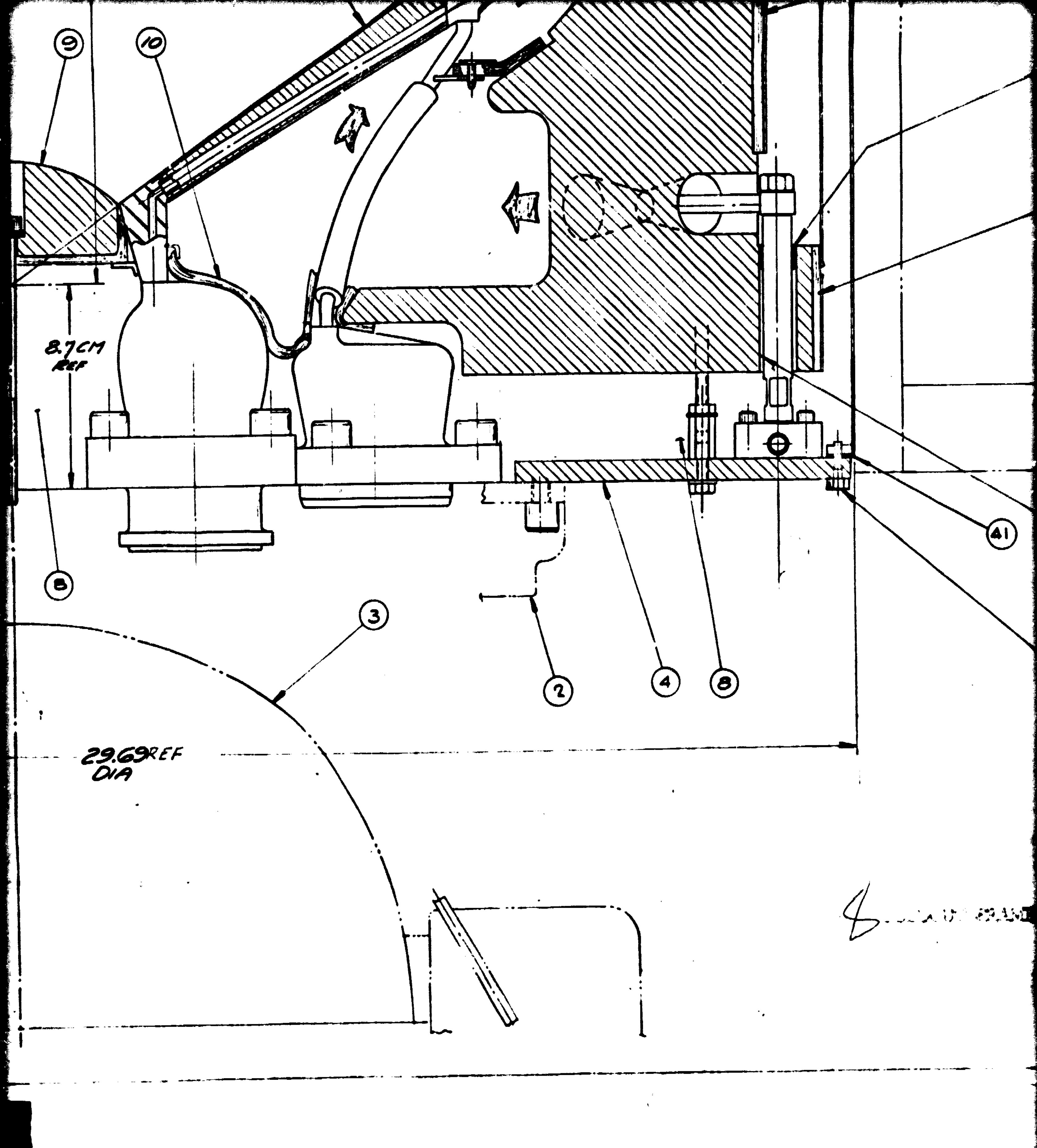
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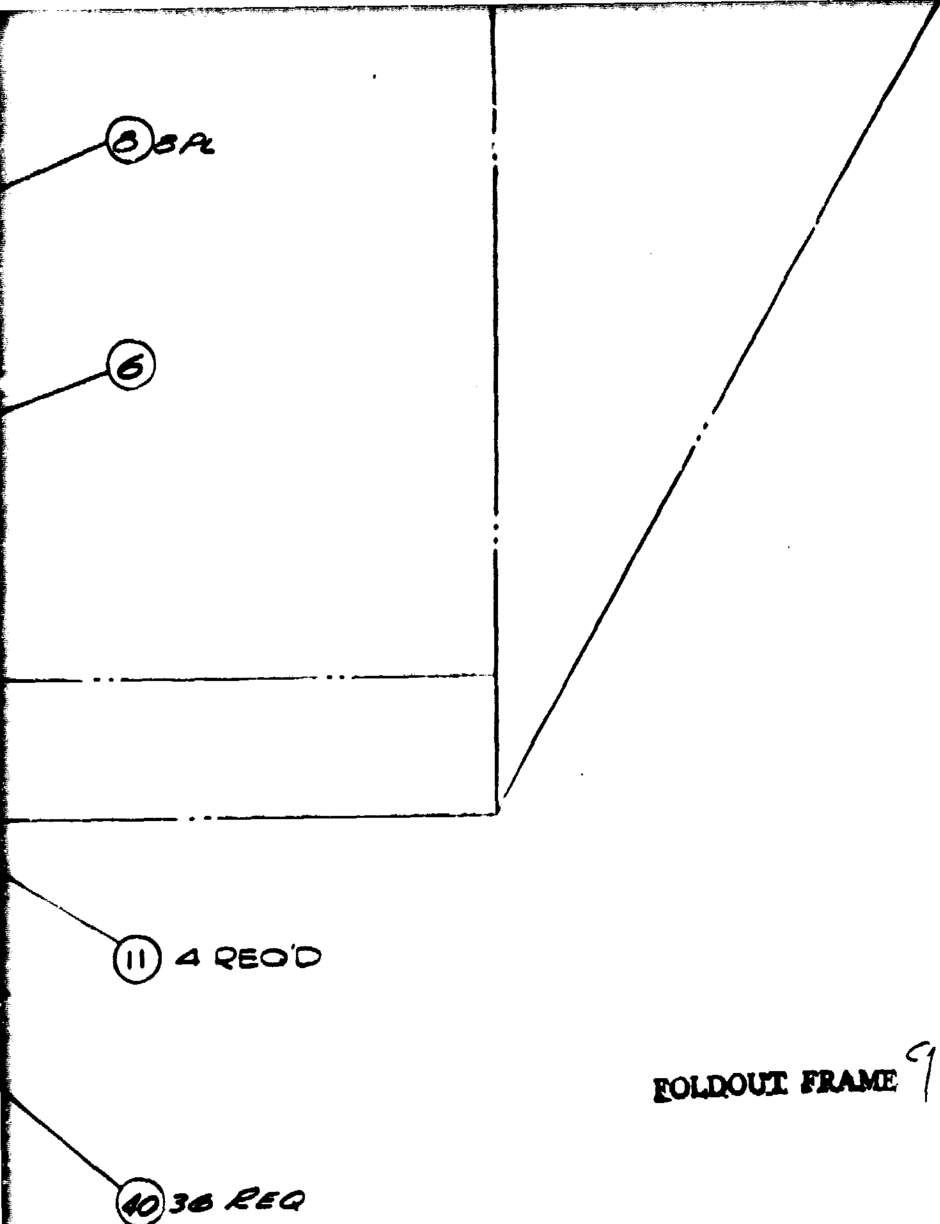

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QTY	NEXT ASSY	USED ON
APPLICATION		

EXCEPT AS SPECIFIED
A. DIM. ARE IN INCHES
B. DIM. APPLY AFTER PLATING
C. BREAK EDGES .005 .015R
D. INTERNAL CORNERS .015R MAX
E. CONCENTRICITIES .010 TIR
F. PARALLELISMS .010 IN./IN.
G. SQUARENESS .010 IN./IN.
H. ANGLES ± 0° 30'
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J. .X ± .1 .XX ± .03 .XXX ± .010
K. DIMENSIONS PER ANSI Y14.5
L. THREADS PER MIL-HNDBK-H 28
M. REMOVE ALL BURRS

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1	1	1	1	1		IGNITOR SYSTEM			FENWALL		28
1	1	1	1	1		LINKAGE	Q100B		HONEYWELL		27
1	1	1	1	1		BUTTERFLY VALVE	V51E		HONEYWELL		26
2	2			2		EXHAUST PIPE	79917068-501				25
1	1			1		EXH. MANI. ASSY	79917054-501				24
	1			1		PREHEATER ASSY	79917032-501				23
A/R	A/R			A/R		FIBER ROPE					22
8	8	8	8	8		STANDOFF	79917091-3				21
1	1	1	1	1		BOTTOM PLATE	79917048-3				20
				1		APERTURE PLATE	79917024-3				19
1	1			1		OUTER SHELL ASS'Y	79917062-501				18
1	1	1	1	1		BAND, LOWER	79917027-503				17
1	1	1	1	1		BAND, UPPER	79917027-501				16
A/R	A/R	A/R	A/R	A/R		SEAL, NOZZLE	79917022-3				15
8	8	8	8	8		PLUG, NOZZLE	79917030-3				14
8	8	8	8	8		FUEL JET	79917021-501				13
8	8	8	8	8		BASE, NOZZLE	79917020-3				12
4	4	4	4	4		REFRACTORY	79917019-3				11
				A/R		WET PACK					10
				1		PLUG, CENTER	79917018-3				9
A/R	A/R	A/R	A/R	A/R		INSULATION					8
1	1	1	1	1		RETAINER	79917047-3				7
A/R	A/R	A/R	A/R	A/R		FIBER PAPER					6
				4		QUADRANT ASSY	79917014-501				5
1	1	1	1	1		MOUNTING R ASSY	79917073-501				4
				1		ALTERNATOR			GENERAL ELECTRIC		3
				1		STIRLING ENG.	4-95-21		UNITED STIRLING		2
				✓		INSTALLED ASSY	-501				1

LIST OF MATERIALS OR PARTS LIST

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FOLDOUT FRAME 10

EXCEPT AS SPECIFIED
A. DIM. ARE IN INCHES
B. DIM. APPLY AFTER PLATING
C. BREAK EDGES .005 .015R
D. INTERNAL CORNERS .015R MAX
E. CONCENTRICITIES .010 TIR
F. PARALLELISMS .010 IN./IN.
G. SQUARENESS .010 IN./IN.
H. ANGLES ± 0° 30'
I. SURFACE TEXTURE PER ANSI B46.1
J. .X = ± .1 .XX = ± .03 .XXX = ± .010
K. DIMENSIONS PER ANSI Y14.5
L. THREADS PER MIL-HNDBK-H-28
M. REMOVE ALL BURRS

FINISH — HEAT TREAT —

QTY	NEXT ASSY	USED ON
	APPLICATION	

CONTRACT NO.
DR M0R3E 7/80
CHK
APPD
APPD
APPD
APPD
APPROVAL
APPROVAL

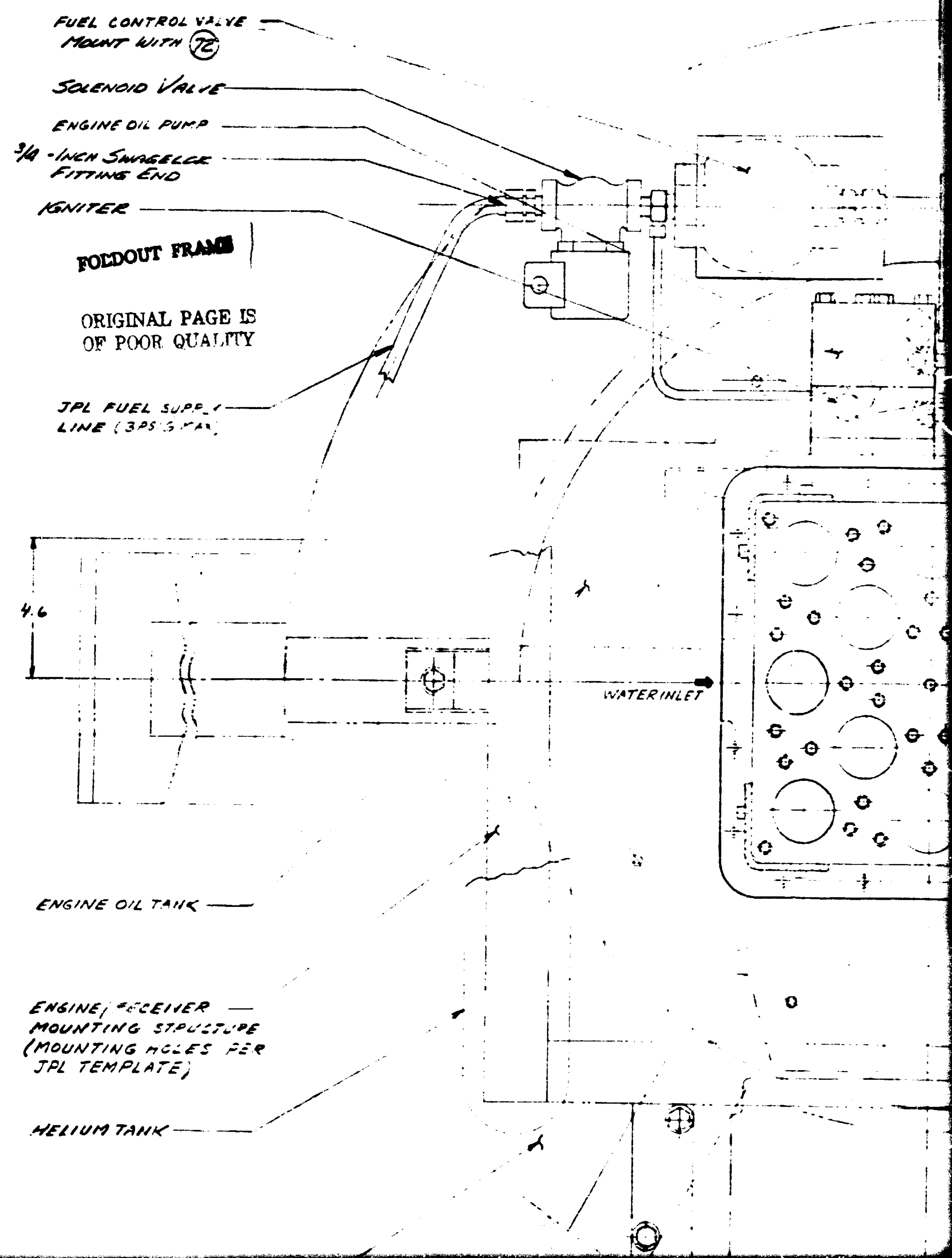
FAIRCHILD
STRATOS DIVISION

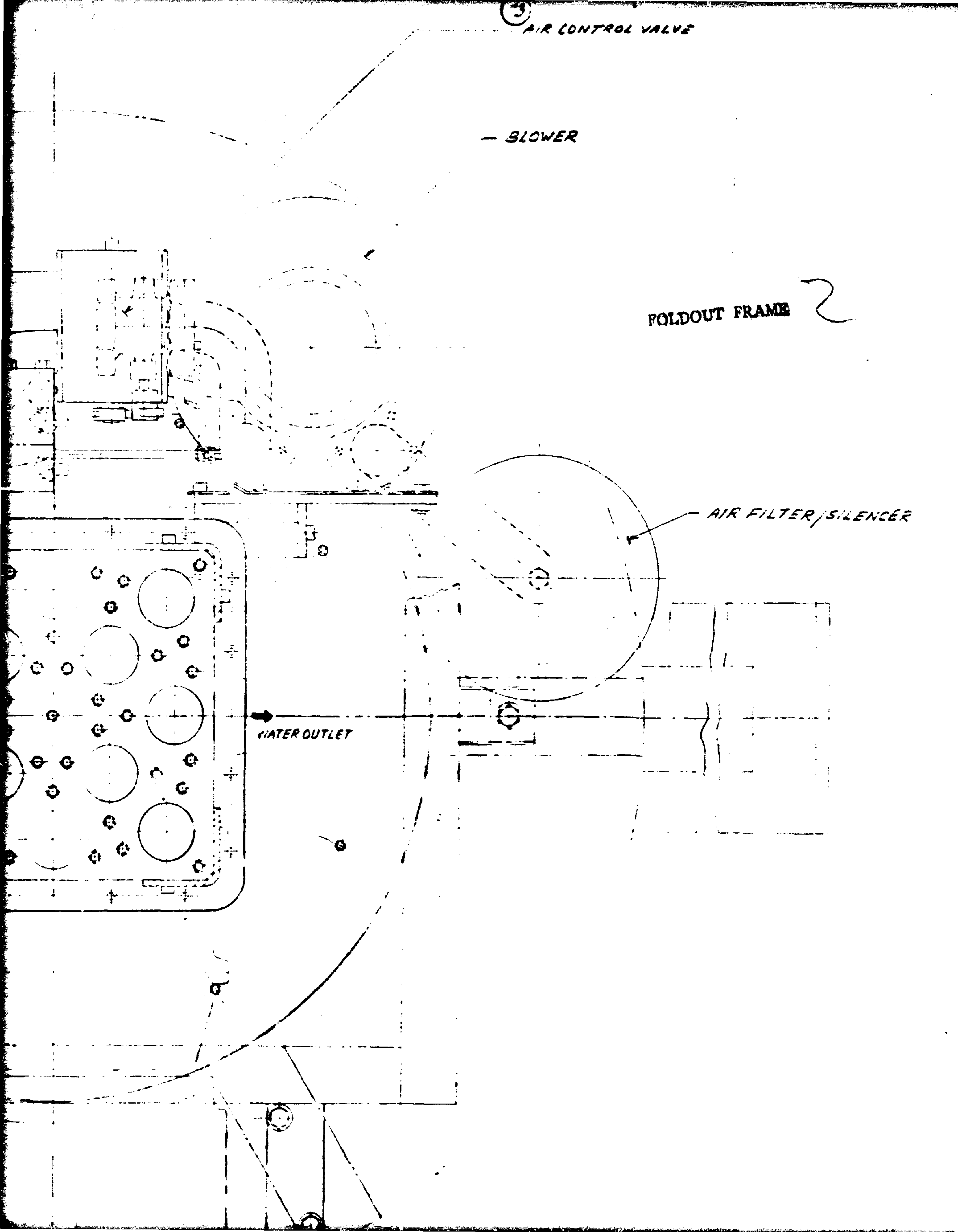
REV A

FINAL ASSY,
DISH STIRLING SOLAR
RECEIVER

SIZE	CODE IDENT NO.	DWG NO.
E	01359	79917001

SCALE SHEET 4


FUEL CONTROL VALVE
MOUNT WITH 72
SOLENOID VALVE
ENGINE OIL PUMP
3/4-INCH SWAGELOK
FITTING END
IGNITER
JPL FUEL SUPPLY
LINE (3PSIG MAX)
4.6
WATER INLET
ENGINE OIL TANK
ENGINE/ CEIVER
MOUNTING STRUCTURE
(MOUNTING HOLES ER
JPL TEMPLATE)
HELIUM TANK



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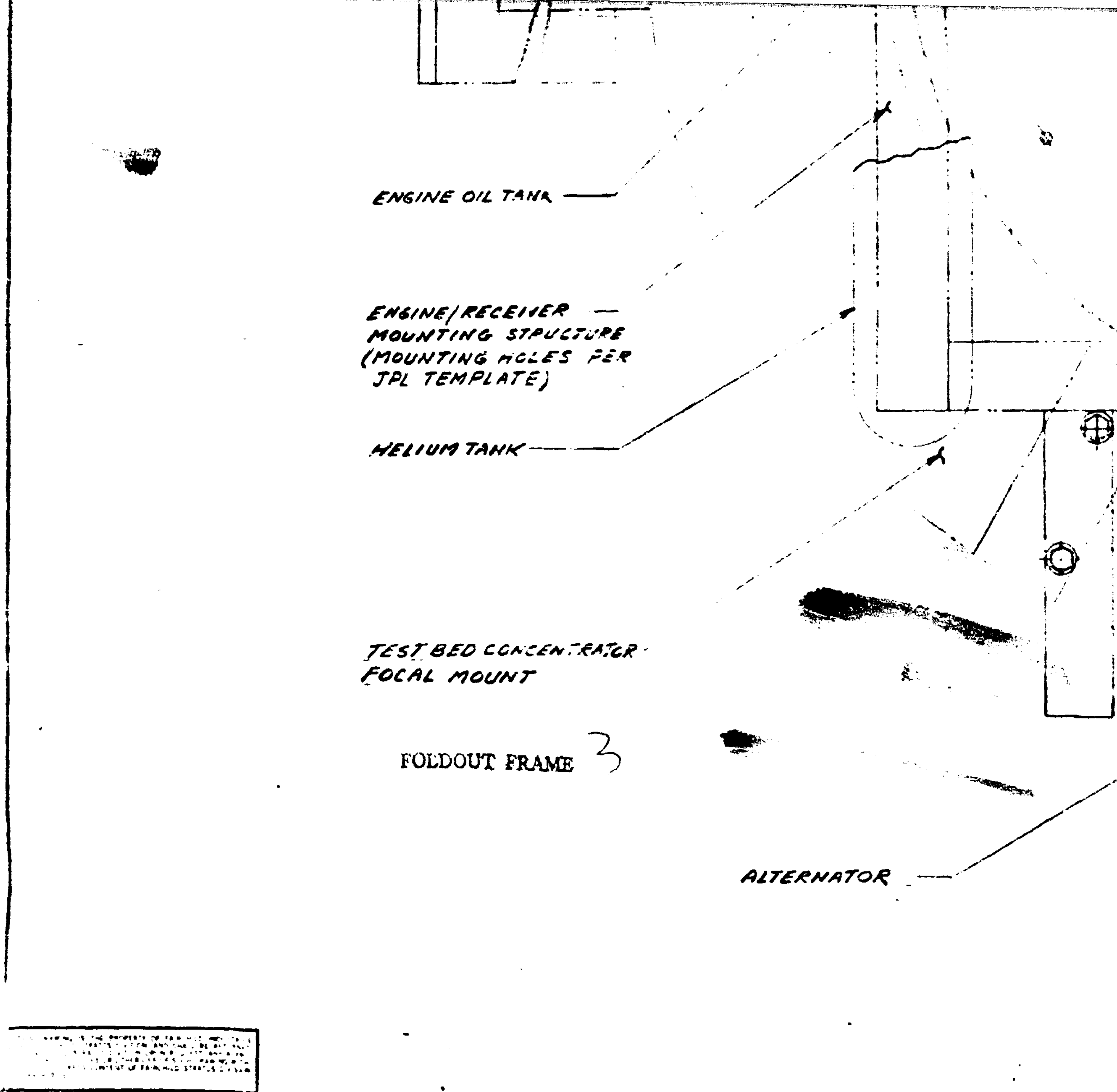

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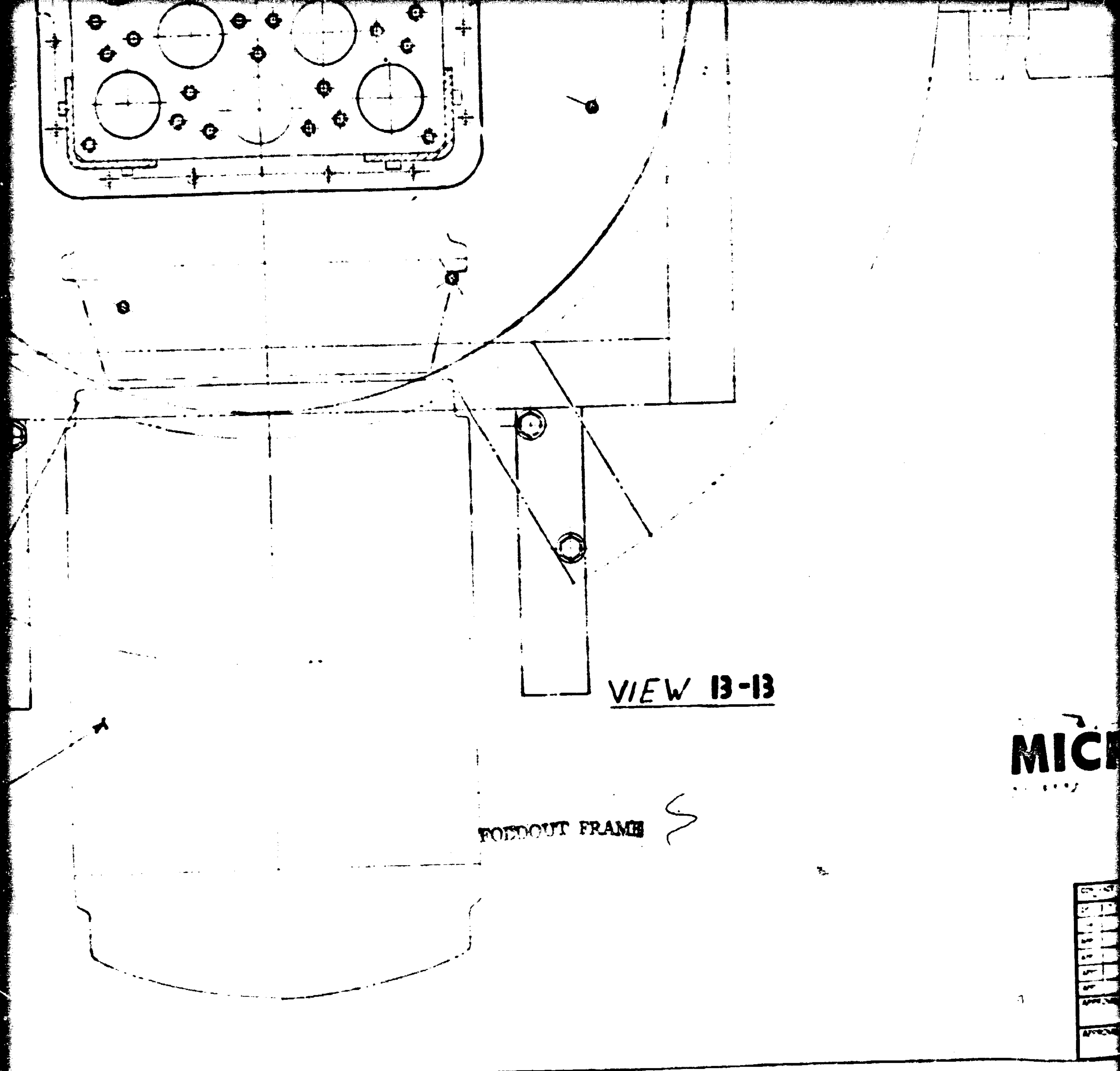

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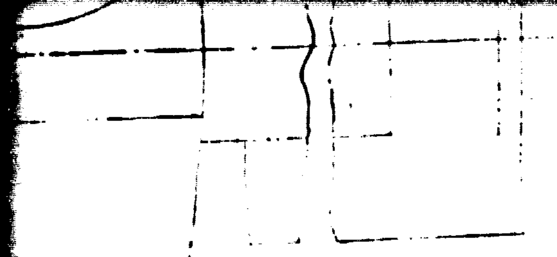

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SHEET 2

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FAIRCHILD

STRATOS DIVISION

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HASLUND	1-20-

FINAL ASS[illegible] AND TEST ASSY AND DELIVERABLE ASSY-DISH [illegible]RLING [illegible] AR RECEIVER

SIZE	CODE IDENT NO	DWG NO.
E	01359	7CC 7001

SCALE [illegible]

SHEET 2 [illegible]

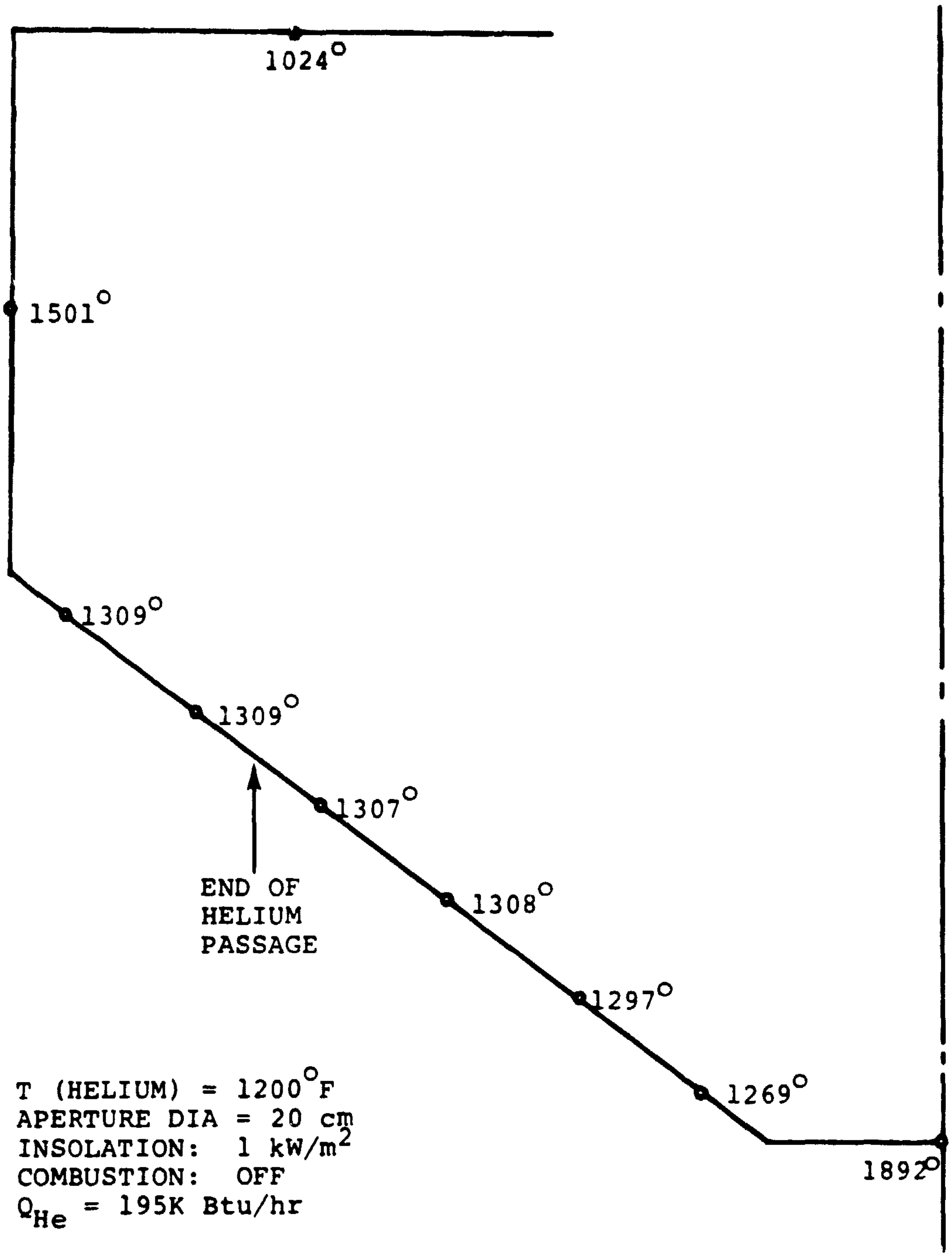

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Figure 2-4. Cavity Surface Temperature Distribution (1200°F)

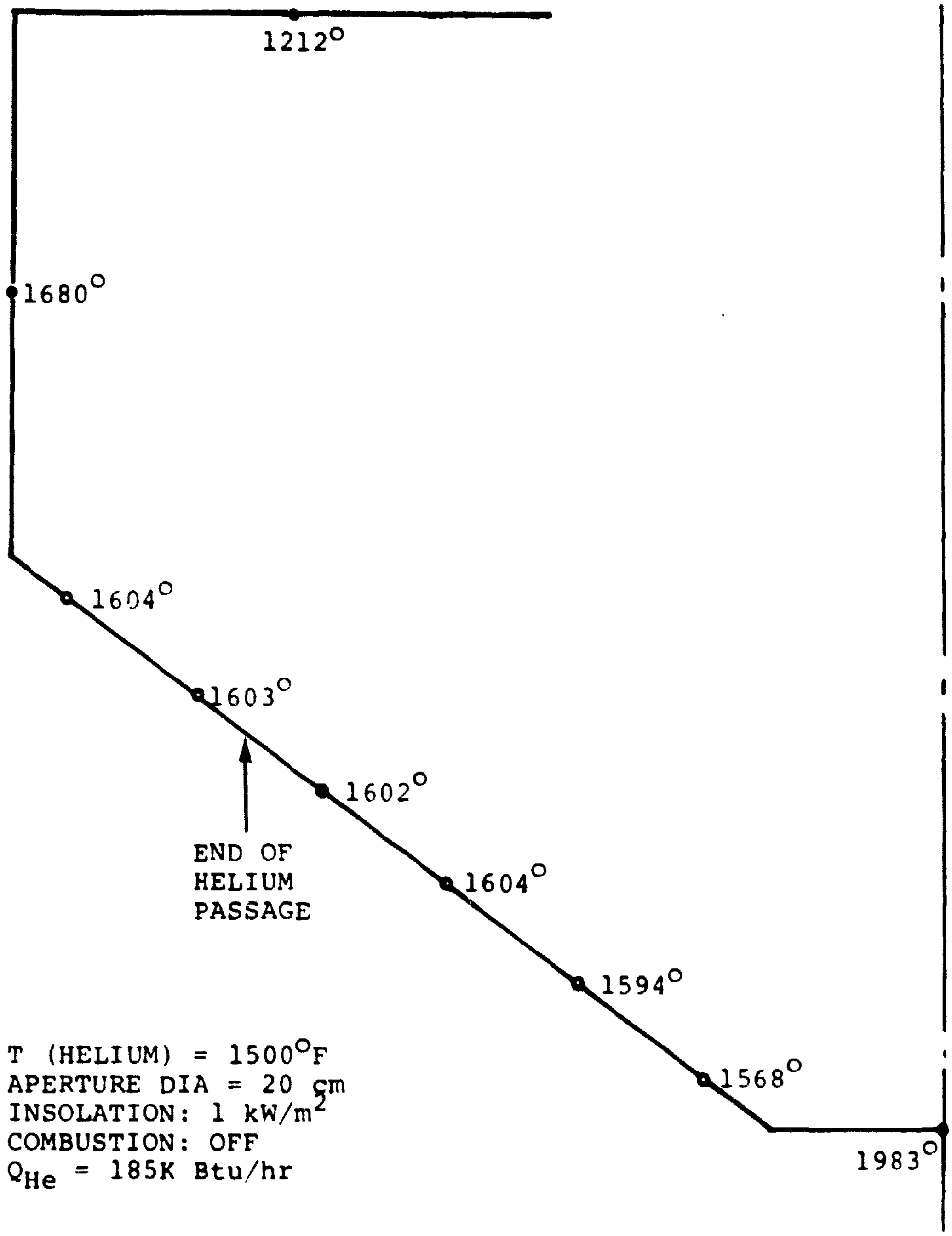

Figure 2-5. Cavity Surface Temperature Distribution (1500°F)

2.2 Receiver Design (continued)

In the hybrid mode, the heater tube embedded in the receiver cone is primarily heated by the solar flux and, to a lesser degree, by combustion gases sweeping under the cone. The heater tubes extending from the underside of the receiver cone are heated entirely by combustion gases. Thermocouples attached to these tubes sense the engine working gas temperature indirectly and provide signal inputs to the combustion system to increase or decrease the firing rate, as required to maintain a given heater tube temperature. In this way, full utilization of all available solar heat is assured and combustion heat is only supplied as necessary to provide constant heat input to the engine. This arrangement also allows the receiver to be thermally stabilized with the engine running prior to focusing on the sun and after detracking, which will minimize thermal stresses and thermal shock, and benefit the receiver life.

The combustion chamber is designed with eight venturi-type mixing nozzles (shown in Figure 2-6) firing tangentially into the annular combustion chamber, as shown in Figure 2-7. The nozzles are arranged so that a high velocity rotating flow field is maintained in the combustion chamber, providing sufficient residence time to complete combustion while at the same time providing uniform combustion gas temperatures upstream of the heater tubes exposed to the combustion chamber. Ignition and flame safety is provided by a Fenwal spark igniter and flame sensing subsystem. The mixing venturies and fuel nozzles are sized to provide turndown capability in excess of 10 to 1. (Turndowns in excess of 20 to 1 have been demonstrated in the combustion test rig.)

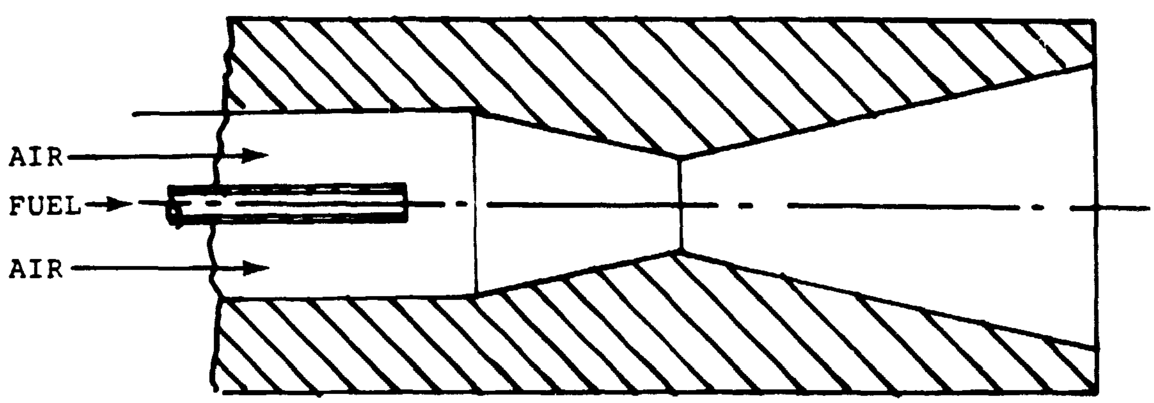

Figure 2-6. Venturi Mixer Configuration

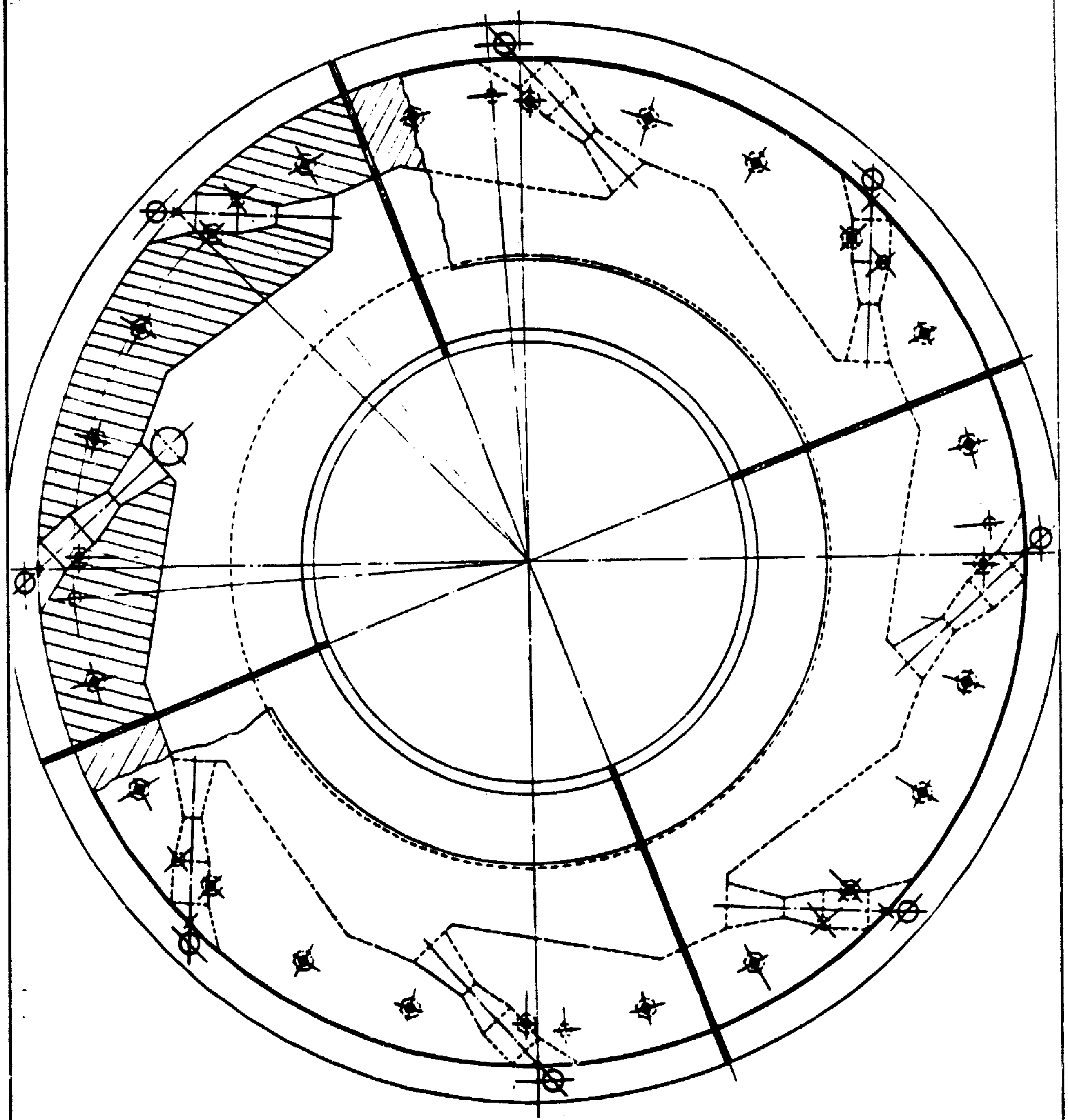

Figure 2-7. Refractory Combustion Chamber

2.2 Receiver Design (continued)

A combustion air preheater of annular configuration (shown in Figure 2-8) is located above the combustion chamber around the outer edge of the receiver cone and is designed to preheat the combustion air up to a temperature of 1400°F. The cold combustion air (from the external electric-motor-driven constant speed blower) is introduced at the bottom of the receiver housing and flows in an annulus between the inside of the receiver housing and the preheater and combustion chamber to the top of the preheater. This flow pattern assures cooling of the outer receiver housing by the air in a way that the structural integrity of the receiver housing and the surrounding focal mount is maintained, while heat loss from the receiver is minimized. Particular care has been taken in the design to incorporate flexible Fiberfrax seals at critical locations to minimize thermal stresses and facilitate thermal expansion and contraction.

Two exhaust pipes in the front of the receiver, extending from an exhaust manifold behind the conical aperture, direct the exhaust away from the receiver mount and bipod in areas that will not be traversed by the "fireball" during focusing and defocusing of the concentrator. The orientation of the exhaust pipes relative to the bipod struts is shown in Figure 2-9.

The external configuration of the receiver is shown in Figure 2-10, which also shows the arrangement of the combustion air blower, fuel and air controls. The combustion air blower, a Siemens unit of the side channel type, as illustrated in Figure 2-11, is driven by a 1.15-hp single-phase, 50/60-Hz, 115-volt electric motor. This type of blower was selected for its high head and low flow characteristics. A commercial air filter (with replaceable filter cartridge) and silencer are installed on the blower intake. The air and fuel control valves are of the Honeywell electrically operated industrial type, which have been modified at Fairchild to provide the desired control capability and characteristics.

The air control valve control capability is assisted by a spring-loaded butterfly plate inside the blower manifold, as shown in Figure 2-12.

A complete list of all detail and assembly drawings is included in Appendix A. Manufacturers' product data sheets and operating instructions for the pertinent commercial components are included in Appendix B.

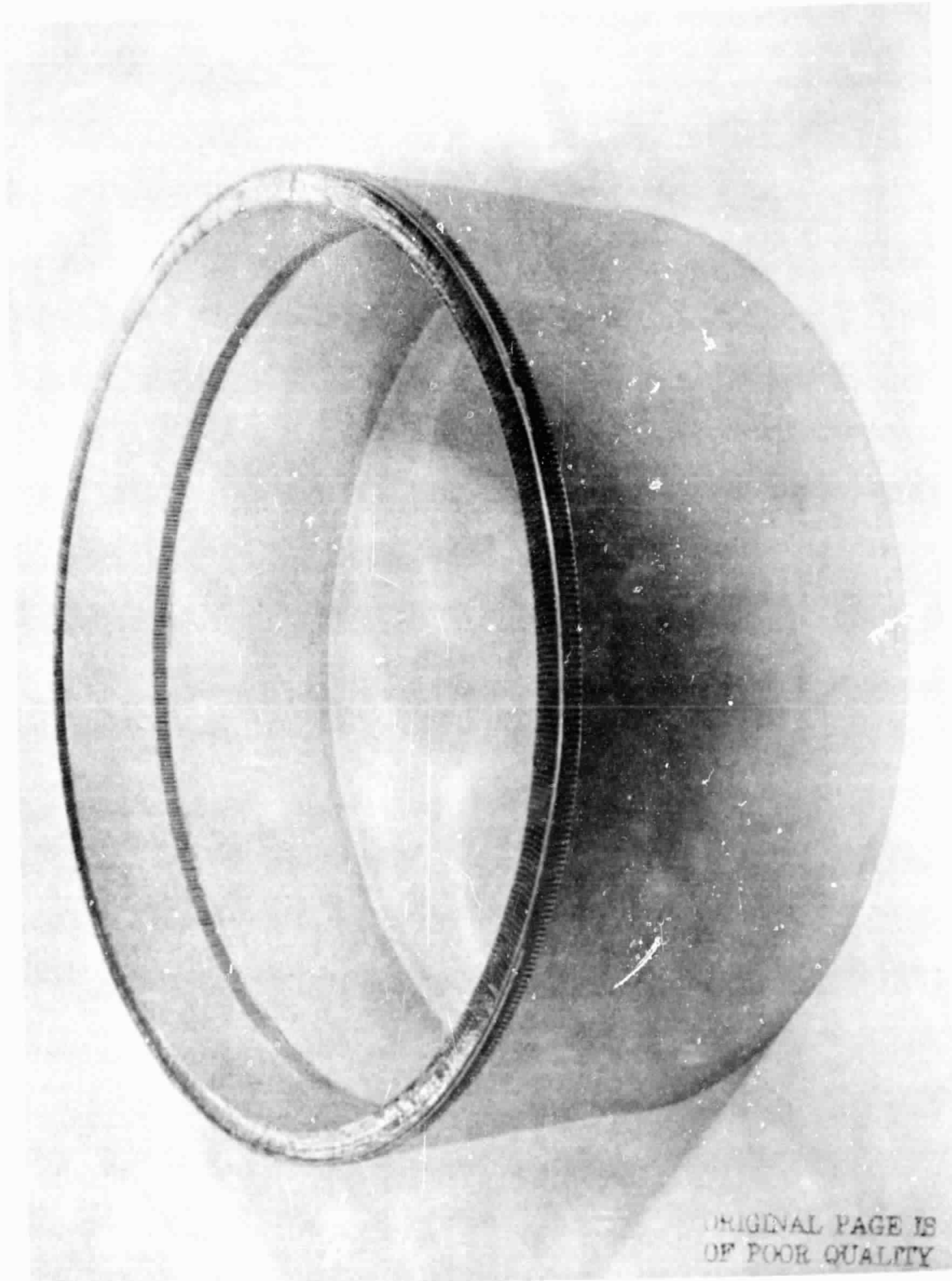

Figure 2-8. Combustion Air Preheater

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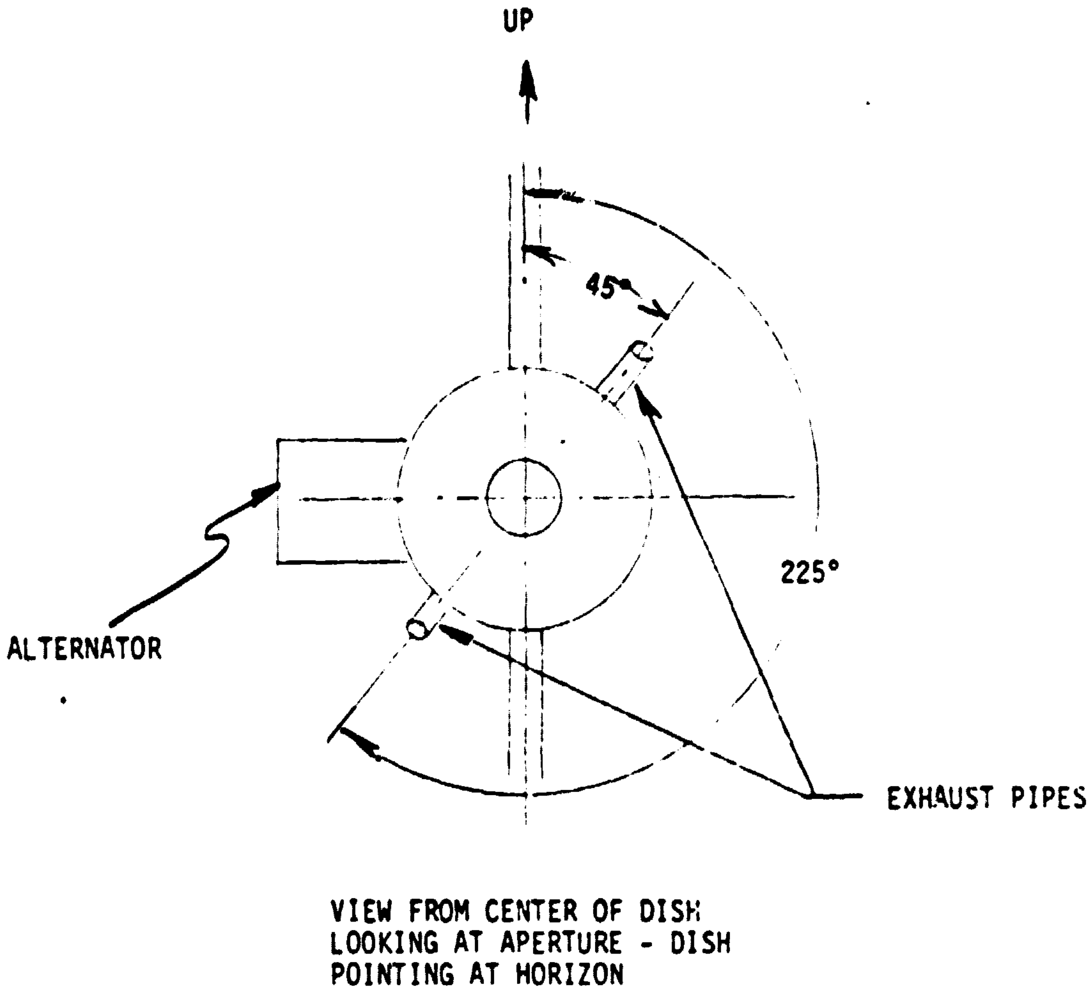

Figure 2-9. Exhaust Pipe Location

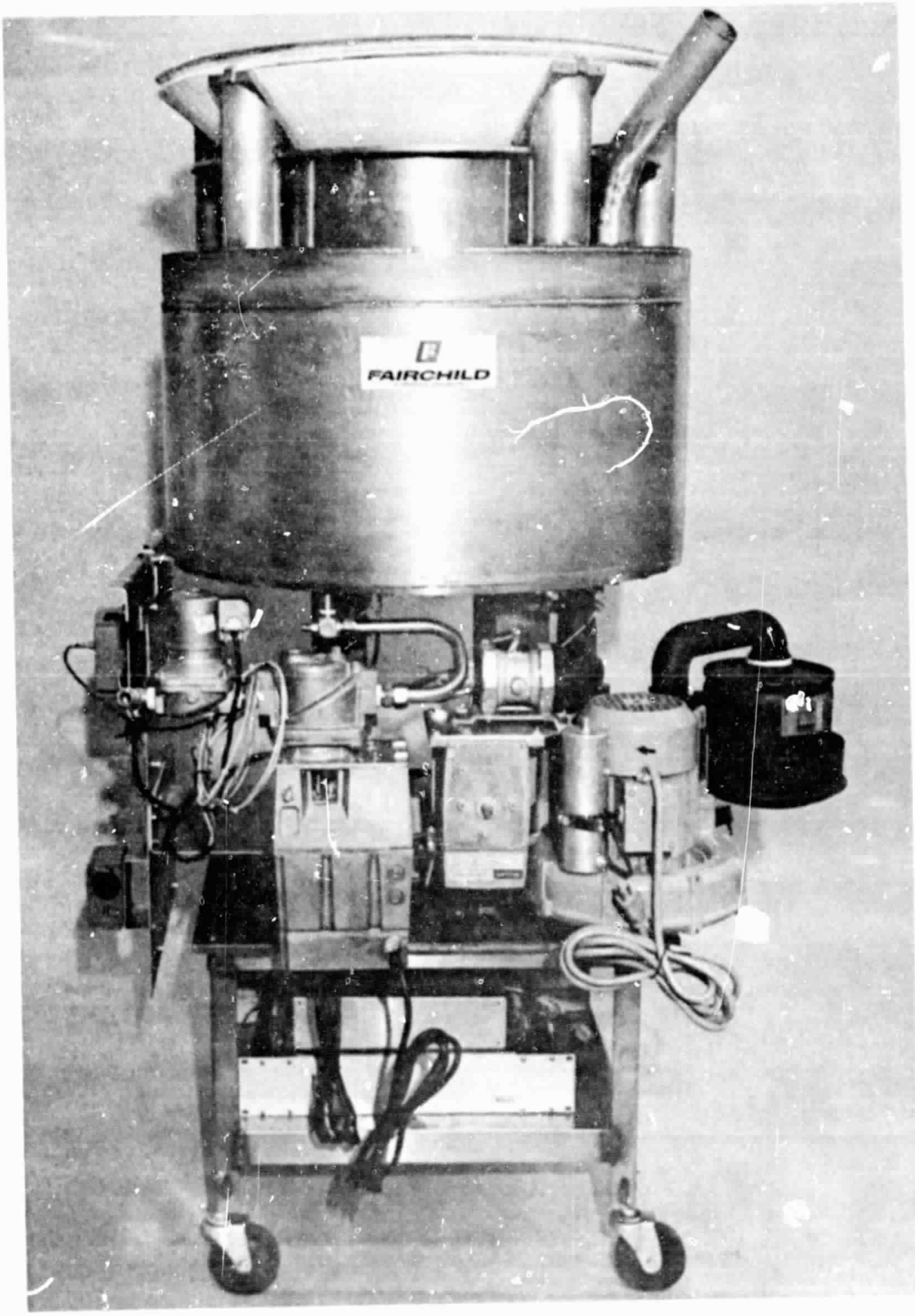

Figure 2-10. Receiver, External Configuration

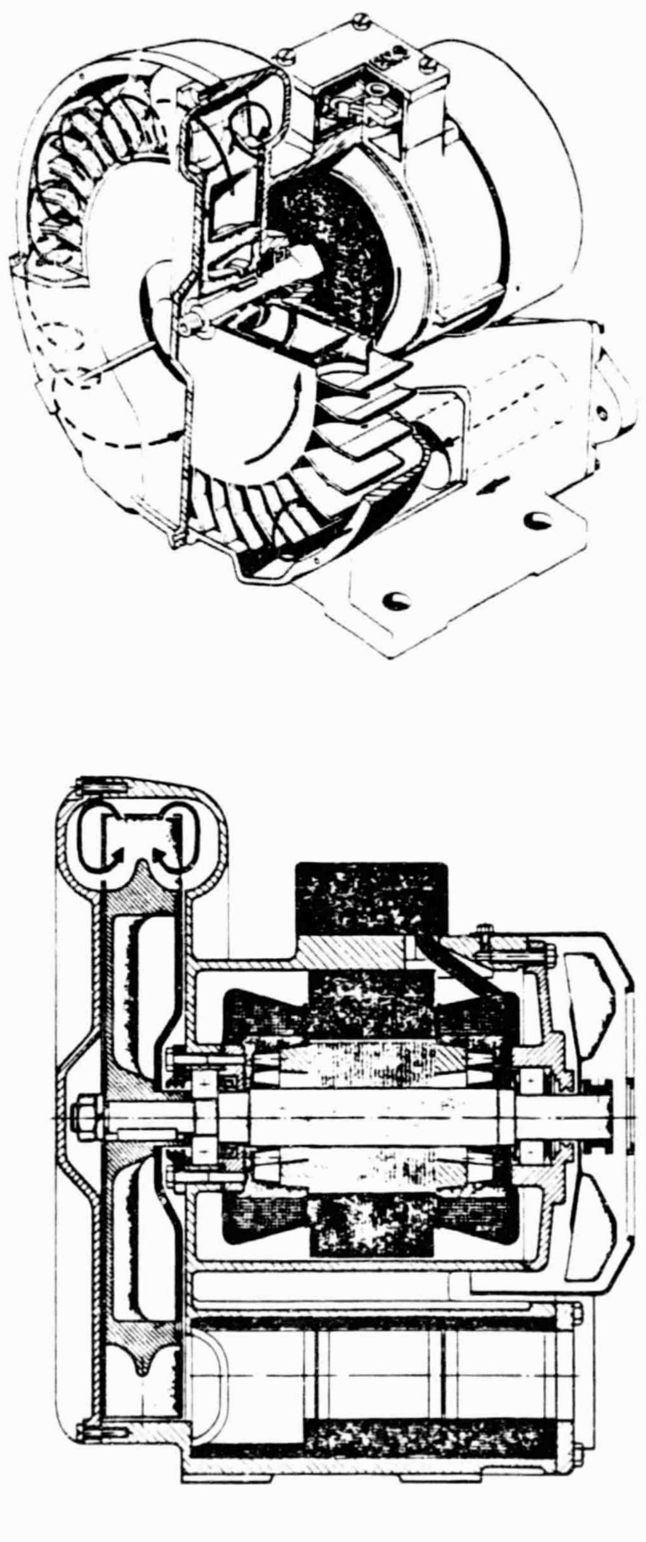

Figure 2-11. Combustion Air Blower

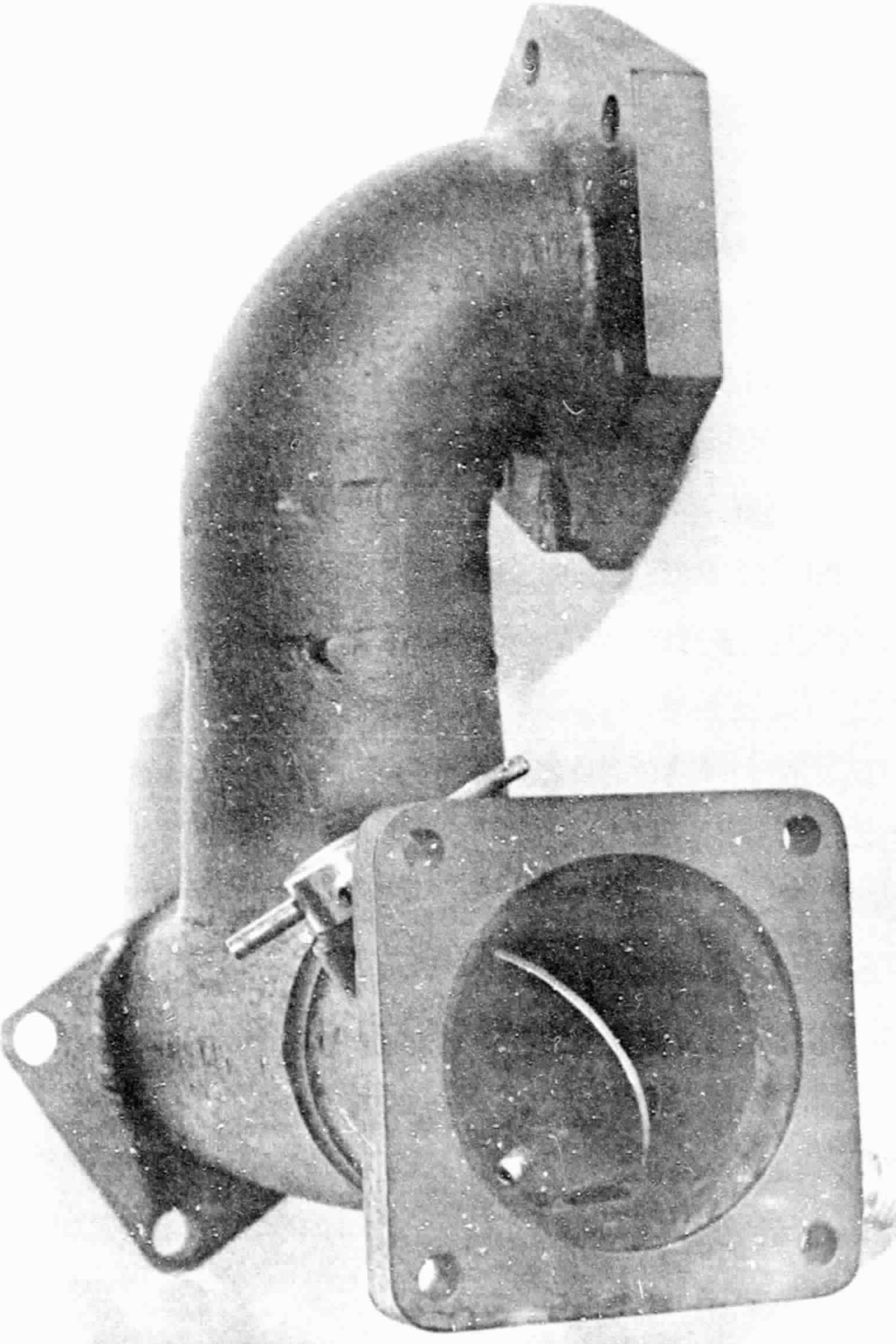

Figure 2-12. Air Control Valve

2.3 P-40 Engine Modification

The modification to the P-40 engine has been thoroughly documented by United Stirling in a separately prepared report and set of drawings provided at the Design Review in July 1980. The Executive Summary of this report, which includes drawings of the general arrangement and projected performance data, is reproduced on the following pages.

0. EXECUTIVE SUMMARY

0.1 Introduction

This report summarizes work executed on behalv of the US Department of Energy Solar Thermal Branch Distributed Receiver Program. Its purpose was to investigate changes to the existing P-40 Stirling engine required to match and operate this engine with a solar insolation receiver mounted at the focus of a parabolic collector. While the collector is tracking the sun, the engine assumes an inclination varying between 90° and 180° relative to its normal upright position. This requires extensive changes to the lubrication system of the engine and to some extent also to the engine cooling system.

0.2 Lubrication

The changes of the lubrication system involve replacing the internal oil pump by an external pump and the existing oil sump by a separate oil tank. The engine and the tank are connected by nine drainage lines. Two of these, which carry a major part of the oil flow, are routed to a separate scavenge pump, which assures that no oil accumulates inside the engine and interferes with the movements of the cross heads. The remaining lines, one of which drains the working gas compressor, work by gravity forces only. As these lines carry a much smaller flow, there is ample capacity. The main oil pump and the scavenge pump are stacked on the front of the engine and driven by an extension of one of the two crank-shafts.

Figure 0:1, which is a free hand sketch of the drive unit with its external connections to the tank, gives a general idea of the arrangement. The large loop in the suction line from the tank to the main pump is intented to assure oil flow to the bearings immediately after cranking when the engine has started.

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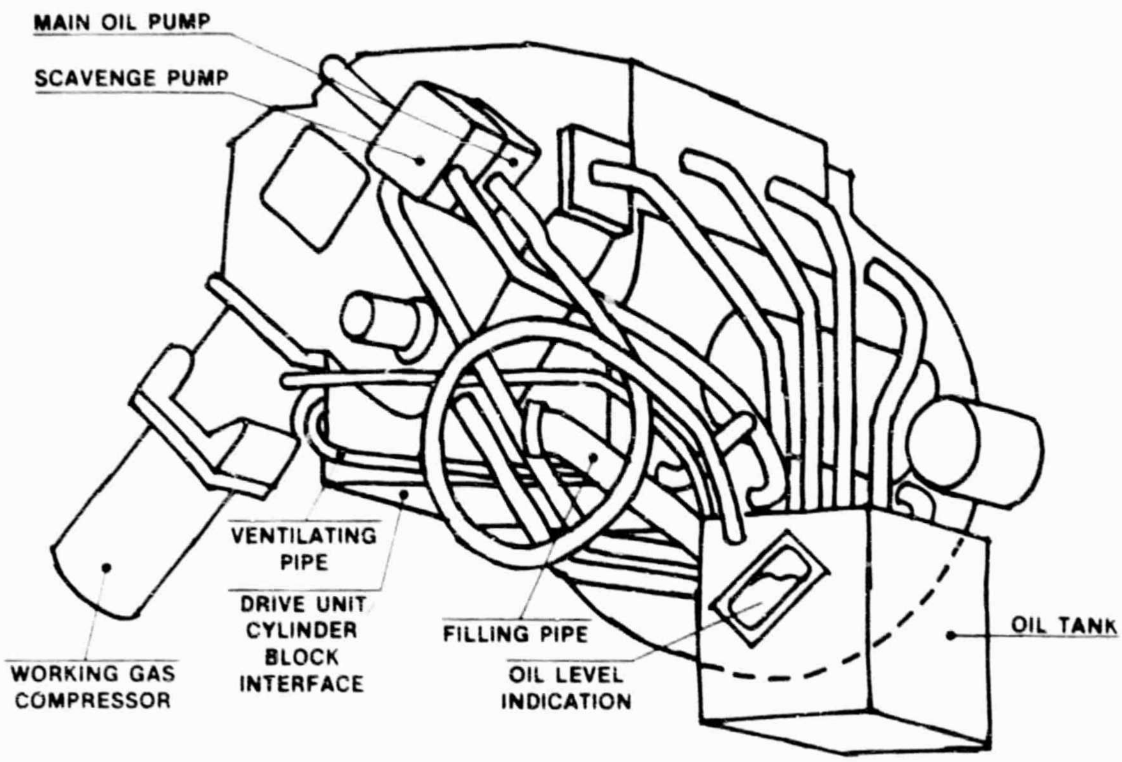

Fig 0:1 Principle Sketch Showing Arrangement of Oil Drainage Pipes.

A further purpose of the work was to show how the engine may be interfaced with a GE alternator type No 193B4014 AD, a hybrid receiver, which was designed by Fairchild Stratos Division and is currently being manufactured, and a Test Bed Concentrator, which already exists at Jet Propulsion Laboratory's Test Facility on Edwards Air Force Base near Lancaster, California.

0.3 Mechanical Interfaces

Engine and alternator are interfaced using a specially designed intercasing, containing a Lavrub coupling. This coupling is capable of absorbing minor misalignment of all kinds and damps torsional vibrations.

The engine and alternator are supported in a main frame by six flexible mounts. Four of these are connected to the engine by individual brackets. The two legs on each side of the alternator are joined with a beam and the remaining flexible mounts are centrally located on these beams. The flexible element in the mount consists of two concentric cylinders with the annular space between filled with rubber.

The receiver is supported entirely by the engine and replaces the standard combustion system and heater of the P-40 engine. Standard P-40 cylinder and regenerator tops are brazed to the receiver cone, and the whole assembly bolted to the cylinder block in the normal way. The bolt holes, by which the standard external heat system is fastened to the engine, are now used to keep the receiver casing and the natural gas combustion system in position. Some of the receiver auxiliaries are mounted on one of the engine brackets inside the flexible mounts to prevent relative motions between receiver and auxiliaries.

The main frame, finally, is bolted to the Test Bed Concentrator mounting ring at four locations. This main frame is rigid enough to distribute the load uniformly inside the mounting ring and prevent distortion of the ring itself. Figures 0:2 and 0:3 pictures the layout of the complete system.

0.4 Control Interfaces

The interfacing of the engine electronic control unit with the system electronic control unit has been treated in detail.

The power output of the engine is controlled by varying the internal gas pressure of the engine. In this application the power output is held constant by manually setting the gas pressure at a fixed level and keeping the temperature of the receiver constant. This is done by a separate temperature control system which controls the firing rate of the natural gas combustion system so that the total amount of heat absorbed from solar insolation and hot combustion products remains constant. This temperature control system is part of the receiver package.

The most complicated part of the control is the start-up sequence. In a simplified way the engine related part of the sequence may be described as follows. Note that the engine is always started in the combustion only mode, i.e. with the concentrator not tracking the sun.

- Prepare engine for start with working gas pressure at low level (4.5 MPa) and cooling water pump in operation.
- Fire combustion system at 50% of full load.
- Simultaneously with firing the combustion system start cranking the engine by connecting alternator to grid. To prevent excessive bearing loads the time to speed the engine up to 1800 rpm is limited to 3-5 seconds by use of starting resistors.
- When the receiver tube temperature has reached 700^{o} C, which should take about one minute, the engine is ready for full power operation. The combustion control system is now switched to constant temperature control and the engine working gas pressure raised to a level determined by the preset power output.

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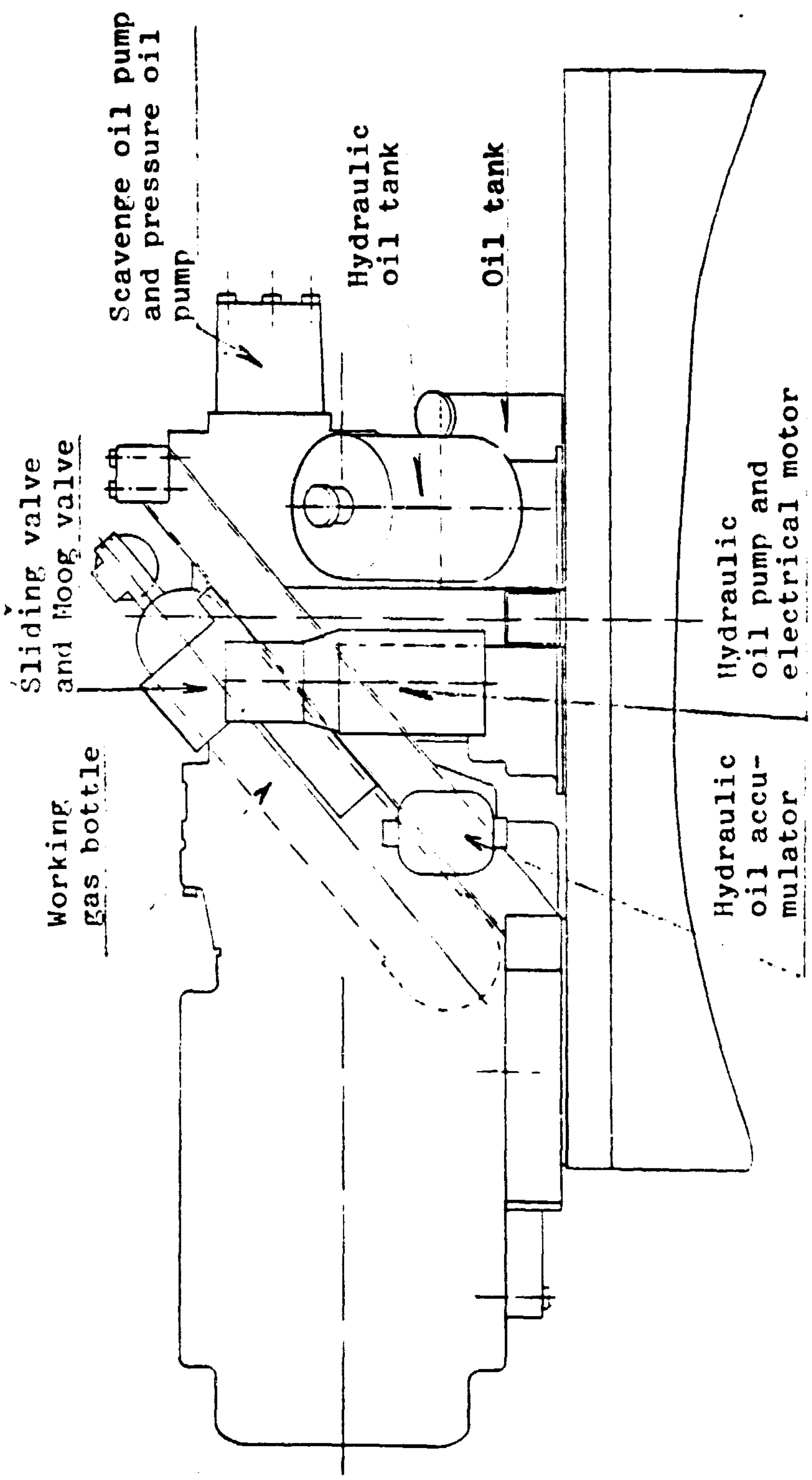

Figure 0:2 Side View of Complete System

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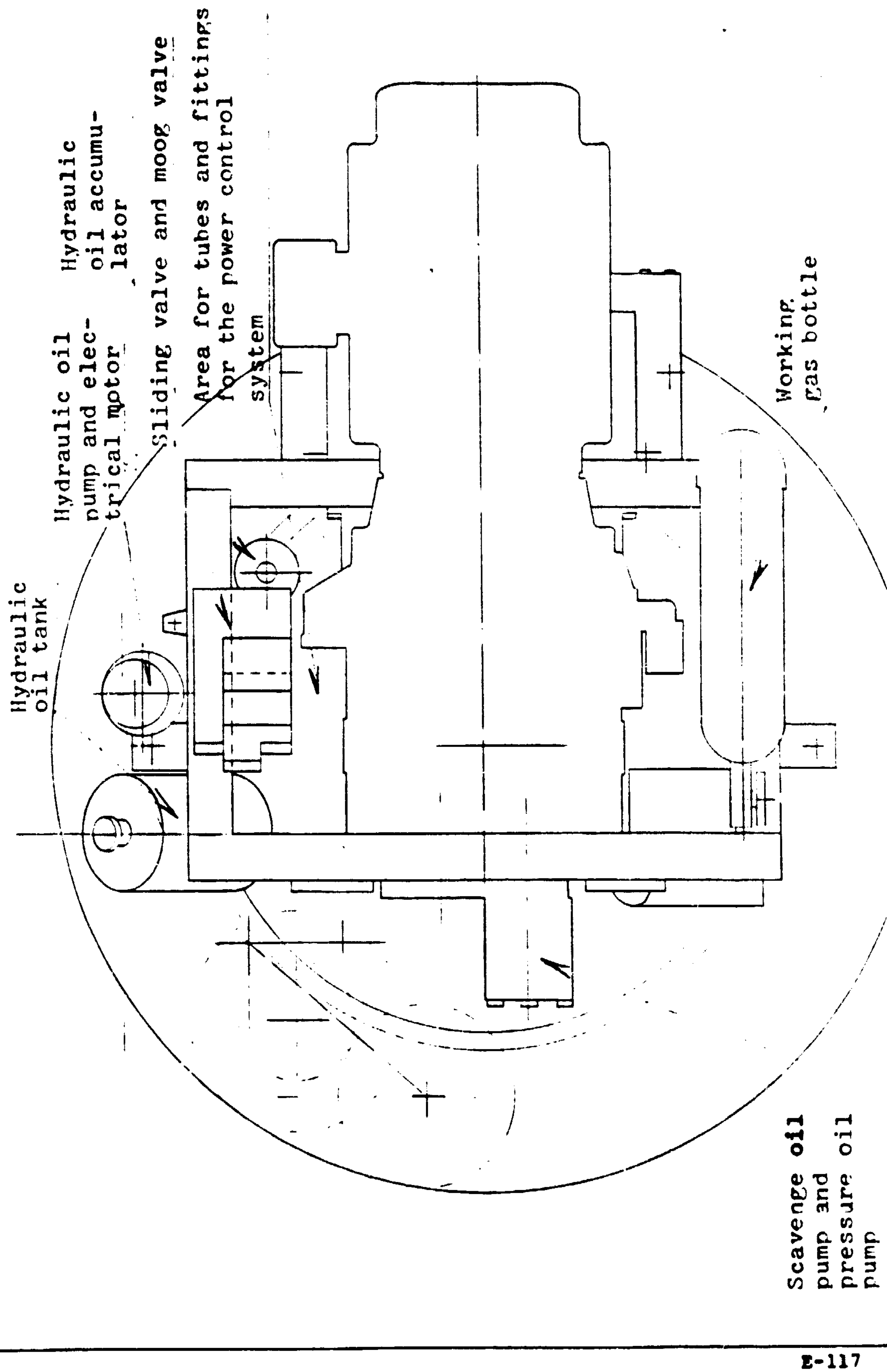

Figure 0:3 Top View of Complete System

- The concentrator may now start tracking the sun. The start up sequence is illustrated in figure 0:4.

Any stop sequence, both normal and emergency, is initiated, by turning the concentrator away from the sun and shutting off fuel supply. The normal stop routine continues as follows.

- Reduce working gas pressure to low level. When engine ceases to produce power, disconnect engine from grid.
- After a predetermined soaking time (10 minutes) or when cooling water temperature has dropped to a safe level, the cooling water pump may be switched off.

The output power from the engine may be reduced almost instantaneously by short-circuiting the engine, i.e. interconnecting the four normally independent Stirling cycles in the engine. The same heat flux is drawn from the receiver but more heat is now rejected to the cooling water. This feature is used e.g. to protect the engine from overspeeding should the grid suddenly be disconnected. As this maximum speed is of the order of 5-6000 rpm the short-circuiting function is useful to protect the alternator. The same function is capable of forcing the engine to a complete stop within a few seconds after disconnection from grid in an emergency.

The necessary control signals to and from the engine electronics are summarized in figure 0:5. This figure also contains a recommended set of engine related indication lamps and continuous displays for the instrument panel.

0.5 Performance

As the Stirling cycle computer codes have been extensively calibrated and validated against numerous laboratory tests with several individual P-40 engines and because the gas passages in the hybrid receiver are reasonably similar to the passages in the

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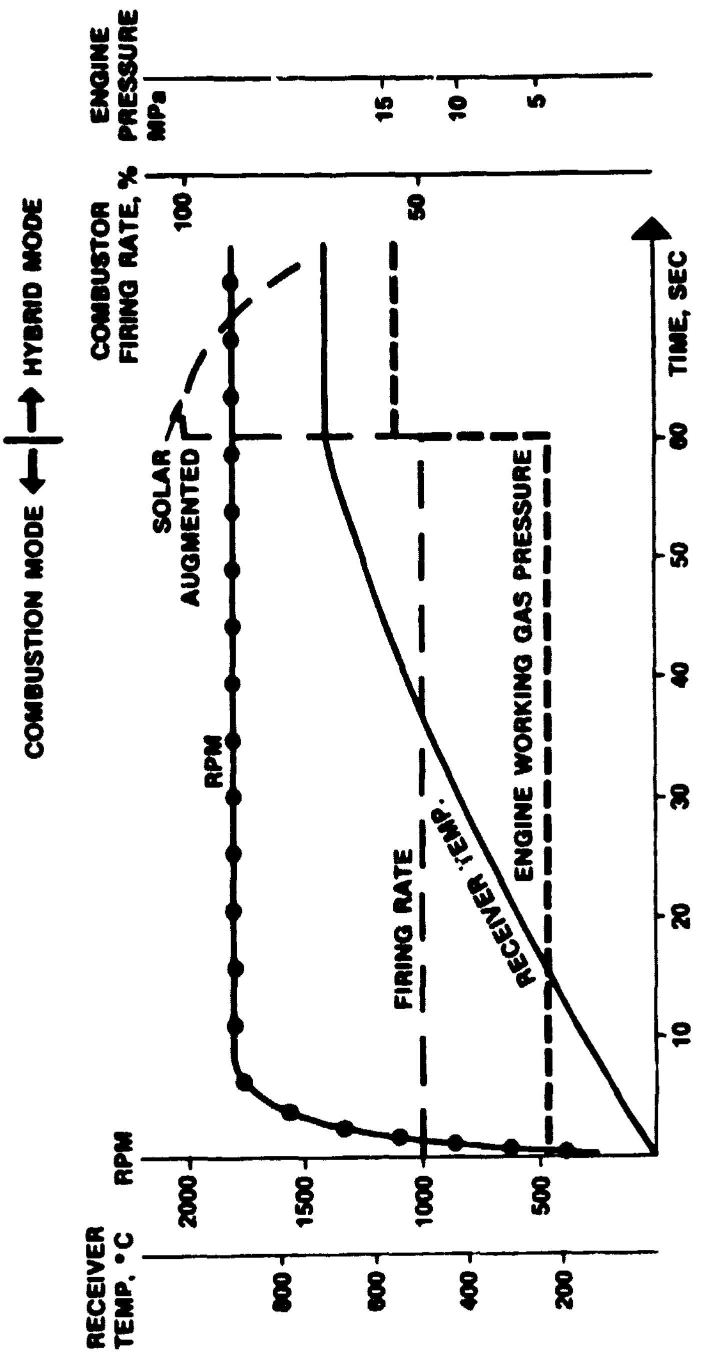

Figure 0:4 Start-Up Sequence

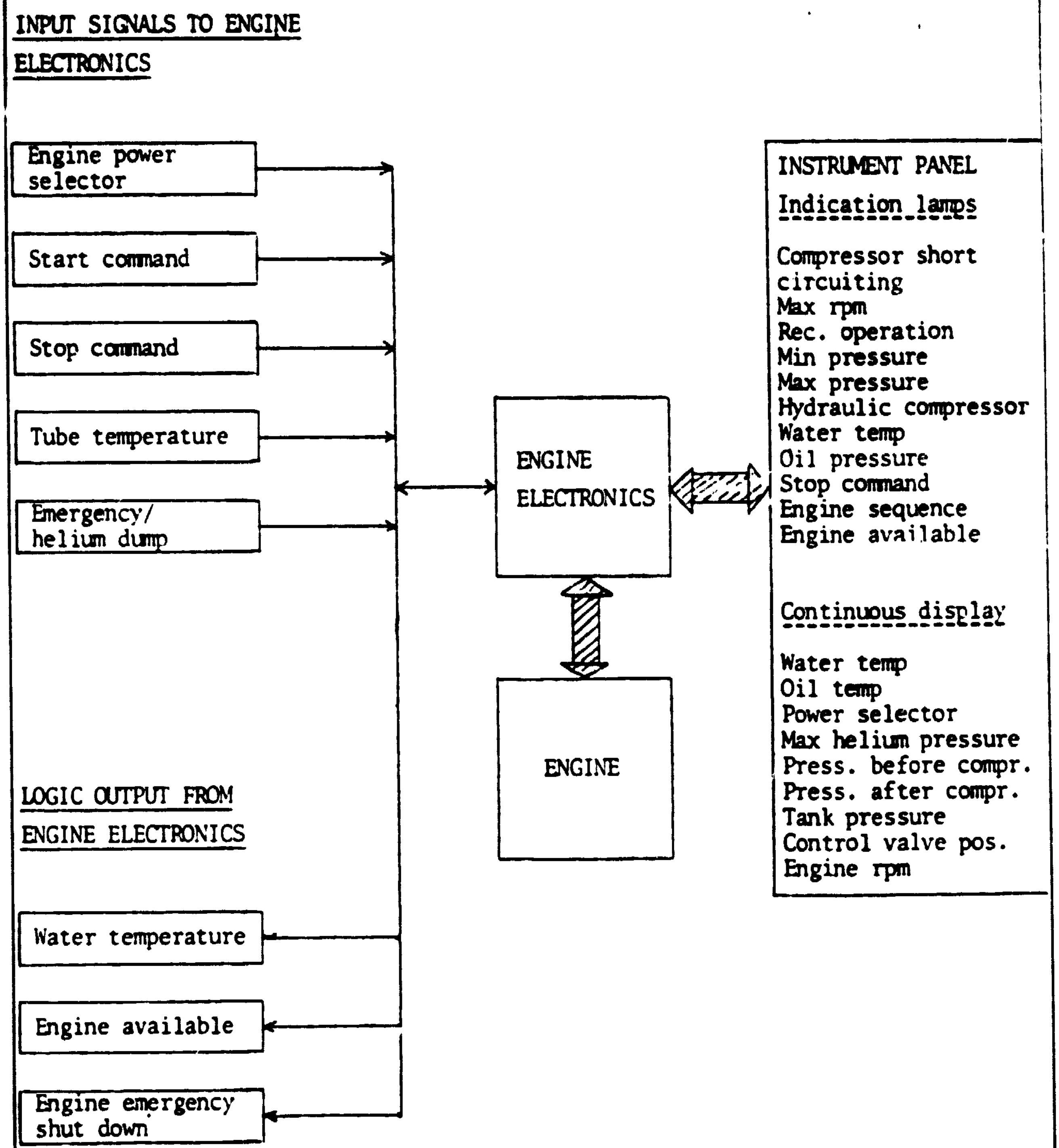

Fig 0:5 Engine Electronic Control Unit Input and Output Signals.

standard P-40 heater it is possible to predict the performance of the solar engine with reasonable accuracy. Power and efficiency curves are given in figure 0:6.

The nominal efficiency at 15 MPa working gas pressure and 710° C heater tube outer wall temperature is 35% as expressed by the ratio of engine shaft power to heat absorbed by the working gas. Shaft power is 22.5 kW. This is 1.5 percent units (or about 4%) and 2 kW lower respectively than consistently predicted for a P-40 with a standard heater. This small discrepancy is due to the fact that the receiver had to be designed for an existing engine and an existing concentrator and that the hybrid mode requires the heater tubes in the receiver to be capable of absorbing solar as well as combustion gas heat.

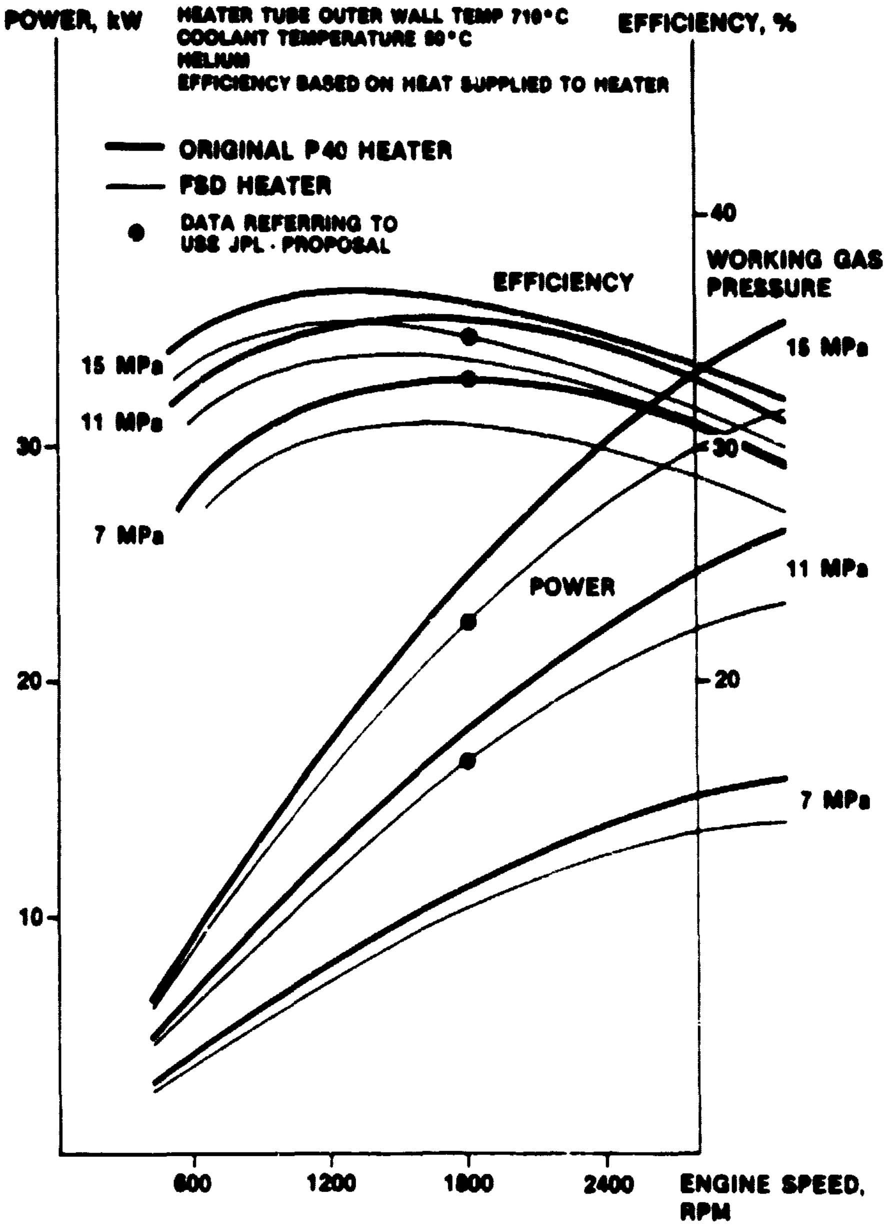

Fig 0:6 Power and Efficiency versus Engine Speed for Original P40 Heater and P40 with FSD Receiver.

3.0 COMBUSTOR DEVELOPMENT TEST PROGRAM

During the Detailed Design Phase, a combustor development test program was established to verify the combustor and receiver heat transfer design. The results and conclusions of this test program are presented in this section of the final report.

A detailed extensive report on this activity, which was conducted jointly by Fairchild and JPL, with the assistance of the Institute of Gas Technology in Chicago and CMC in Malmo, Sweden, and which was remarkably successful, will be published by JPL at a future date. Illustrations of the general arrangement of the test setup and key components are presented in Figures 3-1 through 3-4.

The DSSR Combustor Test Program has verified the feasibility of the combustor design for the prototype receiver. A summary of combustor performance is presented in Tables 3-I and 3-II for preheated 10% excess combustion air; Table 3-III shows combustor performance with nonpreheated combustion air.

Combustion is stable over the range of operating conditions from 10% to 100% (of design maximum fuel and air input) for an air/fuel (natural gas) ratio of 18.876 (10% excess air). This stability also applies to operating conditions where there is no combustion air preheat. Measured combustion efficiencies are approximately 1 at 10% excess air and over the same range of operating conditions. Thus, it appears that the DSSR combustor may be operated at a constant air/fuel ratio over the complete range of anticipated operating conditions without adversely affecting combustion efficiency or stability. Cold start ignition has also been successfully demonstrated at 10% design maximum input.

Measured combustion gas (flame) temperatures are less than the predicted temperature of 3600°F, which was calculated assuming 20% (flame) heat losses. Thus, combustor heat losses are apparently greater than 20%, which may be caused by (a) convective heat transfer to the refractory and thence to the surroundings or (b) losses associated with system air leakages.

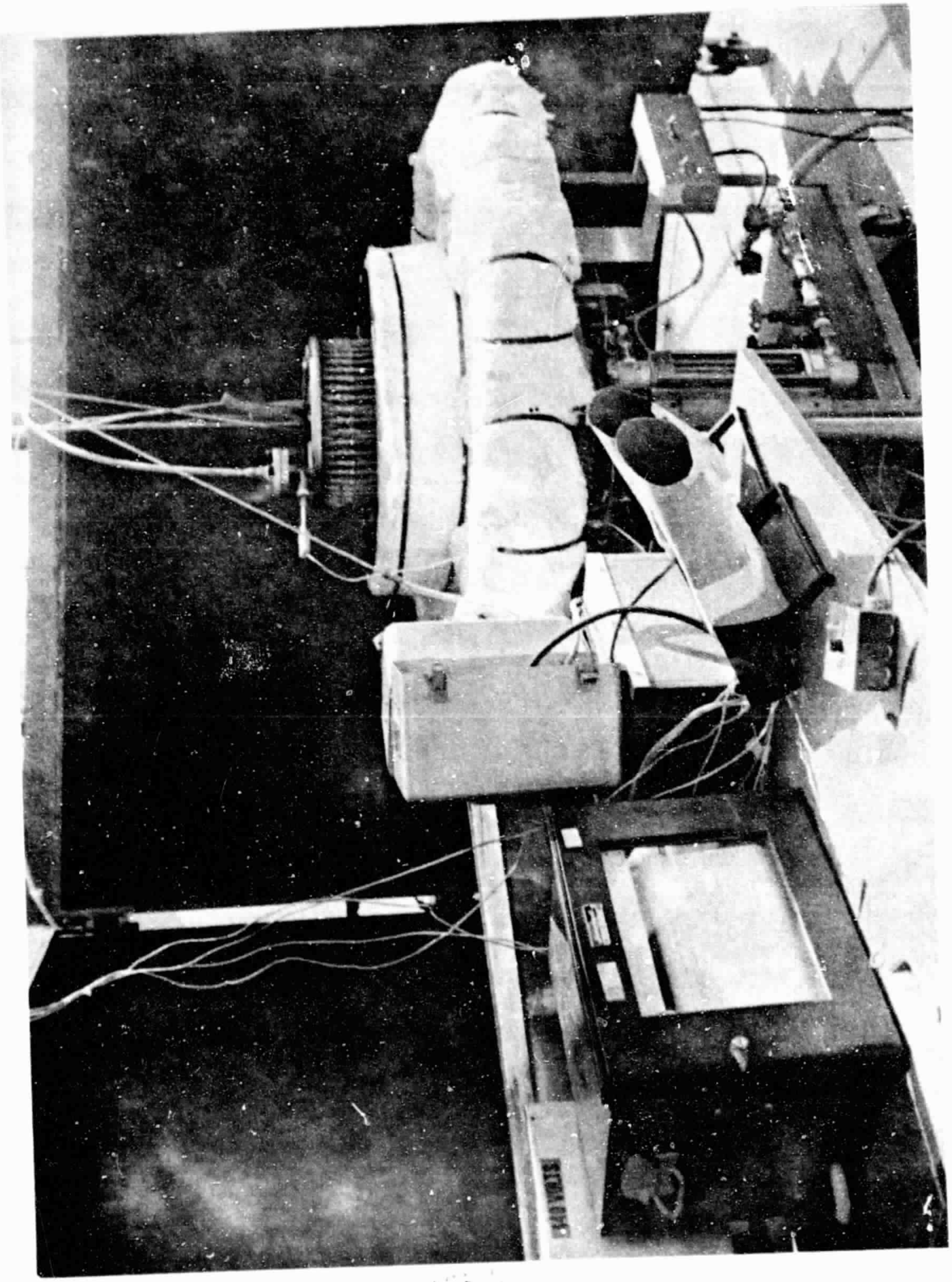

Figure 3-1. Combustion Test Setup

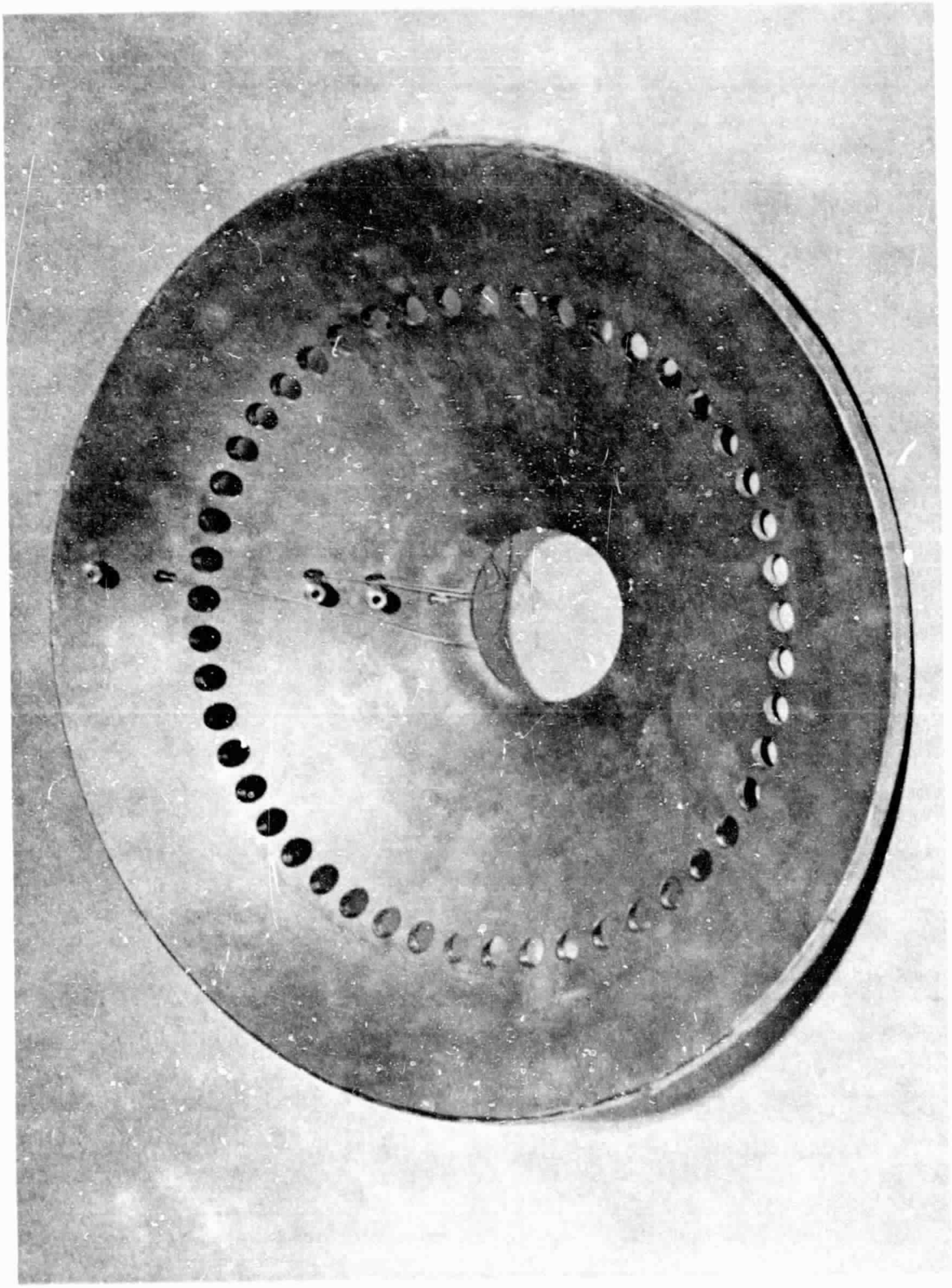

Figure 3-2. Receiver Cone - Test Rig

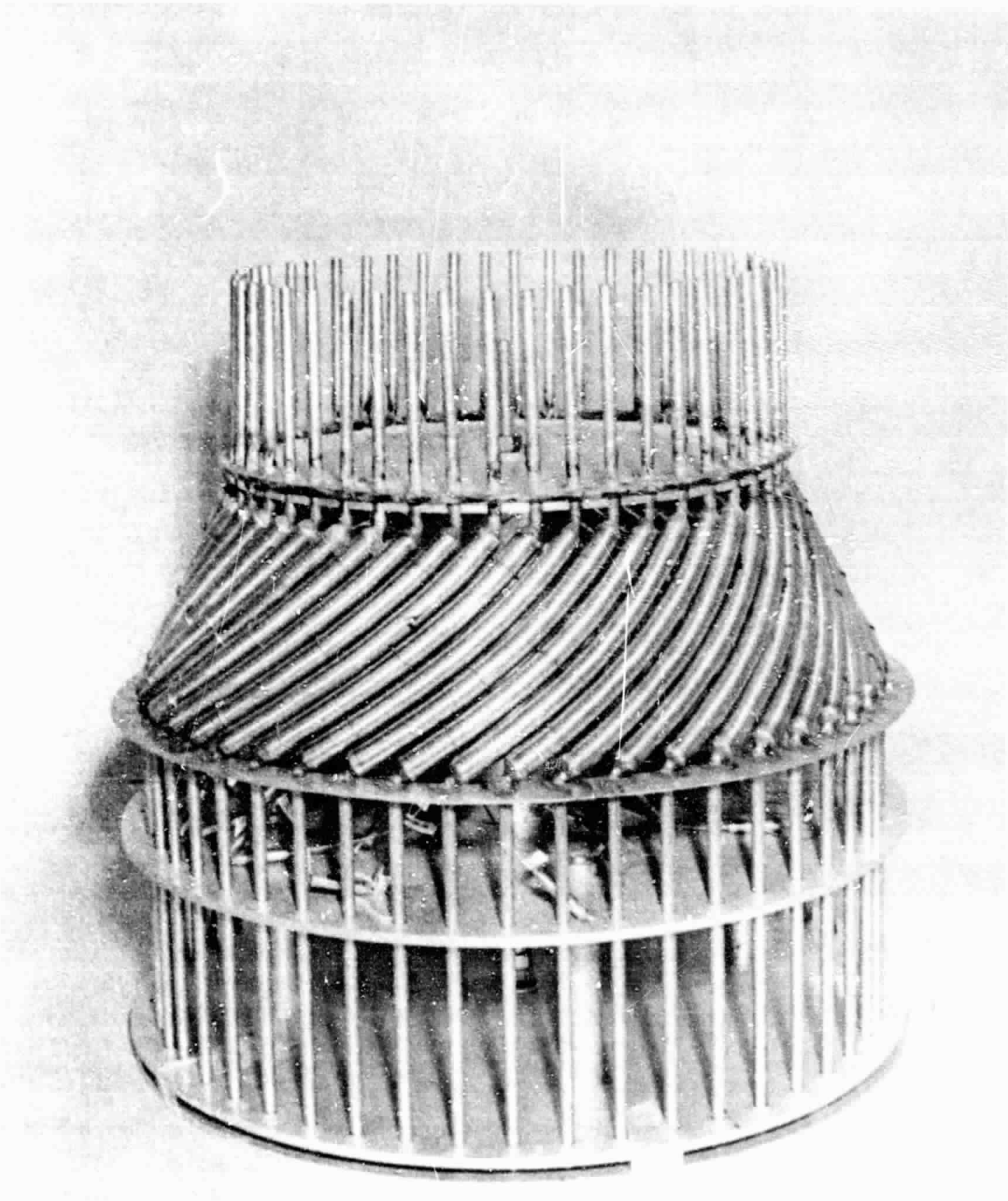

Figure 3-3. Heat Exchanger - Test Rig

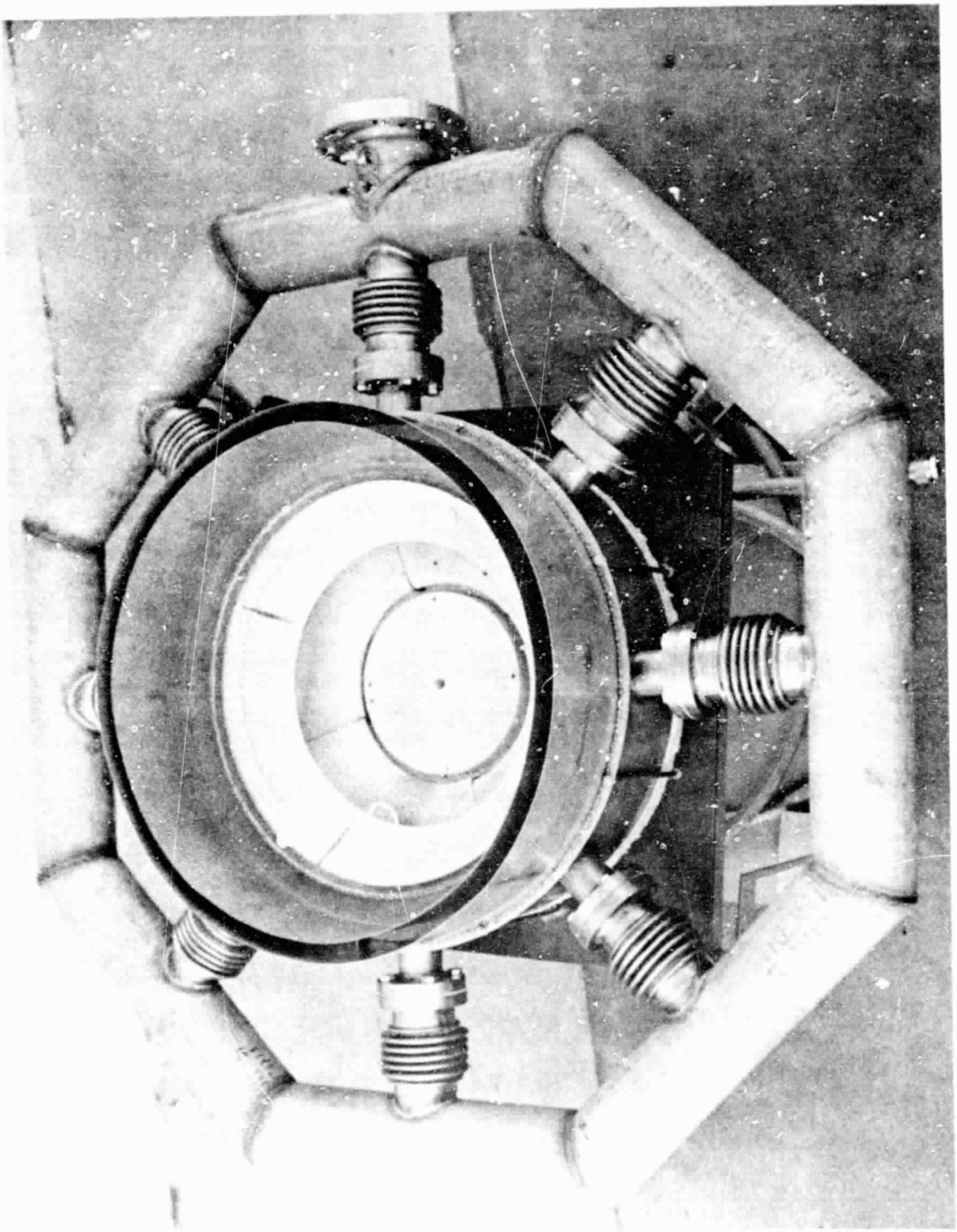

Figure 3-4. Air Distribution Manifold and Combustion Chamber - Test Rig

Table 3-I. DSSR Combustor Performance, 1000°F Air Preheat

Operating level (%*)	T_A (°F)	$\dot{Q}_W$ (kW)	$\dot{Q}_F$ (kW)	$\dot{Q}_T$ (kW)	$\bar{h}$ $\left(\frac{Btu}{ft^2 \cdot hr \cdot F}\right)$	T_C (°F)	T_P (°F)	T_{T_M} (°F)
10	1008	18.5	13.7	17.0	9.1	2210	441	190
20.1	1008	25.1	27.6	34.4	11.6	2403	592	240
30	1007	35.6	41.3	51.0	16.0	2557	734	340
40	1014	45.5	55.0	68.0	20.0	2699	875	430
50.4	1004	46.9	69.5	85.8	21.2	2684	865	480
63	1004	57.4	86.8	107.2	25.3	2817	976	550
71.6	996	66.0	98.6	121.8	28.9	2894	1088	615
82.5	993	73.3	113.6	140.6	32.1	2940	1207	660
92	893	78.5	126.6	151.5	35.0	2970	1274	730

*Percent of predicted fuel input required with 10% excess air preheated to 1400°F for 66.5 kW input to Stirling engine.

NOMENCLATURE

T_A = temperature of preheated combustion air

$\dot{Q}_W$ = total heat transfer rate to water

$\dot{Q}_F$ = total fuel heat input

$\dot{Q}_T$ = total heat input

$\bar{h}$ = overall heat transfer coefficient to heater tubes

T_C = combustion gas (flame) temperature

T_P = flue gas temperature

T_{T_M} = surface temperature at midpoint of heater tube

Table 3-II. DSSR Combustor Performance, 1400°F Air Preheat

Operating level (%*)	T_A (°F)	$\dot{Q}_W$ (kW)	$\dot{Q}_F$ (kW)	$\dot{Q}_T$ (kW)	$\bar{h}$ $\left(\frac{Btu}{ft^2 \cdot hr \cdot F}\right)$	T_C (°F)	T_P (°F)	T_{TM} (°F)
13	1400	18.7	19.0	25.3	9.0	2283	488	200
30.4	1400	36.6	44.2	59.0	16.1	2621	780	350
40.8	1400	45.9	58.1	78.0	20.2	2699	875	430
50.4	1300	51.9	73.4	96.0	22.6	2795	878	500

*Percent of predicted fuel input required with 10% excess air preheated to 1400°F for 66.5 kW input to Stirling engine.

NOMENCLATURE

T_A = temperature of preheated combustion air

$\dot{Q}_W$ = total heat transfer rate to water

$\dot{Q}_F$ = total fuel heat input

$\dot{Q}_T$ = total heat input

$\bar{h}$ = overall heat transfer coefficient to heater tubes

T_C = combustion gas (flame) temperature

T_P = flue gas temperature

T_{TM} = surface temperature at midpoint of heater tube

Table 3-III. DSSR Combustor Performance, No Air Preheat

Operating level (%*)	$\dot{Q}_W$ (kW)	$\dot{Q}_F$ (kW)	$\dot{Q}_T$ (kW)	$\bar{h}$ $\left(\frac{Btu}{ft^2 \cdot hr \cdot F}\right)$	T_C (°F)	T_P (°F)	T_{T_M} (°F)
10	15.1	14.5	14.5	8.1	2062	455	200
20	19.9	29.2	29.2	10.5	2140	524	240
31.5	28.3	45.9	45.9	14.2	2302	675	310
41.2	35.4	60.0	60.0	17.2	2446	806	390
50.4**	32.6	73.4	73.4	16.3	2418	655	420
61.3**	39.7	89.1	89.1	19.6	2517	799	490
71.2	46.9	103.6	103.6	22.9	2596	908	550
81.5	53.5	118.5	118.5	26.0	2657	1006	600
91.7	61.9	133.3	133.3	30.7	2683	1095	670
102	67.8	148.6	148.6	33.8	2704	1157	700

*Percent of predicted fuel input required with 10% excess air preheated to 1400°F for 66.5 kW input to Stirling engine.

**11.75% excess air.

NOMENCLATURE

$\dot{Q}_W$ = total heat transfer rate to water

$\dot{Q}_F$ = total fuel heat input

$\dot{Q}_T$ = total heat input

$\bar{h}$ = overall heat transfer coefficient to heater tubes

T_C = combustion gas (flame) temperature

T_P = flue gas temperature

T_{T_M} = surface temperature at midpoint of heater tube

3.1 Recommendations

Estimated system air leakage rates are between 15 and 40% of total input for the combustor test rig. Final prototype design and assembly should provide for a substantial reduction in system leakage, thus ensuring correct fuel/air mixtures and optimization of combustion gas temperatures. Also, flue gas analysis will be necessary in order to maintain specified fuel/air mixtures in the prototype unless these system leakages are eliminated.

The maximum pressure drop measured through the combustor test rig was 7 inches water column.

There is a potential problem with noise generated by the combustor. In the original design configuration, the noise levels generated during combustor testing were extremely high. Noise levels were subsequently reduced to an "acceptable" level by raising the heater plate 1/2 inch above the original design position. However, when the plate was again lowered 3/8 inch (from the highest position), the noise level increased to the previous unacceptable levels. Thus, it is evident that the noise is sensitive to the plate location and to the geometry and fluid mechanics of the system. It is therefore recommended that the receiver combustor system be tested in as complete a configuration as practicable to ensure acceptable operation (in terms of noise level) prior to shipment to United Stirling.

Instrumentation necessary to monitor combustor operation in the final prototype should include: combustion gas temperature (1); preheated combustion air temperature (1); tube wall temperatures (4); flue gas temperatures before and after the preheater (2); receiver cone temperatures (4); and flue gas analysis.

3.2 Heat Transfer Analysis

Maximum heat transfer to the water was approximately 80 kW, which corresponds to an overall heat transfer coefficient (to the tubes) of 35 Btu/ft^2-hr-°F, as shown in Table 3-I. For hot tube walls (1900°F), as will be the case in the P-40 engine, and for combustion gas temperatures of 3000°F, the resulting heat transfer to the working fluid would be approximately 47.5 kW maximum (h = 43.1 Btu/ft^2-hr-°F). If combustion gas temperatures are subsequently increased to 3600°F, then heat transfer to the P-40 working fluid could be increased to approximately 74.7 kW maximum (h = 43.9 Btu/ft^2-hr-°F), thus meeting (or exceeding) design specifications. A more detailed analysis of heat transfer characteristics follows for tests with preheated air.

3.2 Heat Transfer Analysis (continued)

Figure 3-5 presents overall heat transfer data for the combustor tube bank at four air preheat temperatures. The Nusselt number is plotted versus the Reynolds number referenced to the velocity in the minimum free area between tubes. The single data point taken from Ward and Jewad's[1] data is for closely spaced tubes in a single row with a blockage ratio d/s = 0.923; in comparison, the blockage ratio for the DSSR tube bank is 0.928. These data show apparent enhanced heat transfer characteristics for the present heat exchanger tube bank when compared to similar data for a perpendicular row of straight tubes.

Figures 3-7 and 3-8 represent average heat transfer coefficients along the tube length, as determined by the measurements shown in Figure 3-6. In general, the data show variations in heat transfer coefficient along the length of the tube with a peak near the middle of the tube. This variation tends to be more evident at lower Reynolds numbers, while being less, if at all, evident at the highest Reynolds numbers. That is, as the Reynolds number increases, heat transfer becomes more uniform along the tube length. Insofar as variations around the circumference of the tube bank are concerned, slight variations were observed. While there are not enough data for a detailed analysis, it appears that such variations are not operationally significant.

---

(1) Ward, J. and Jewad, M. A., "Local and Average Heat Transfers Associated with a Single Row of Closely-Spaced Tubes in Cross Flow," Heat Transfer, 1978, Volume 4, National Research Council of Canada, Toronto, pp. 273-278, 1978.

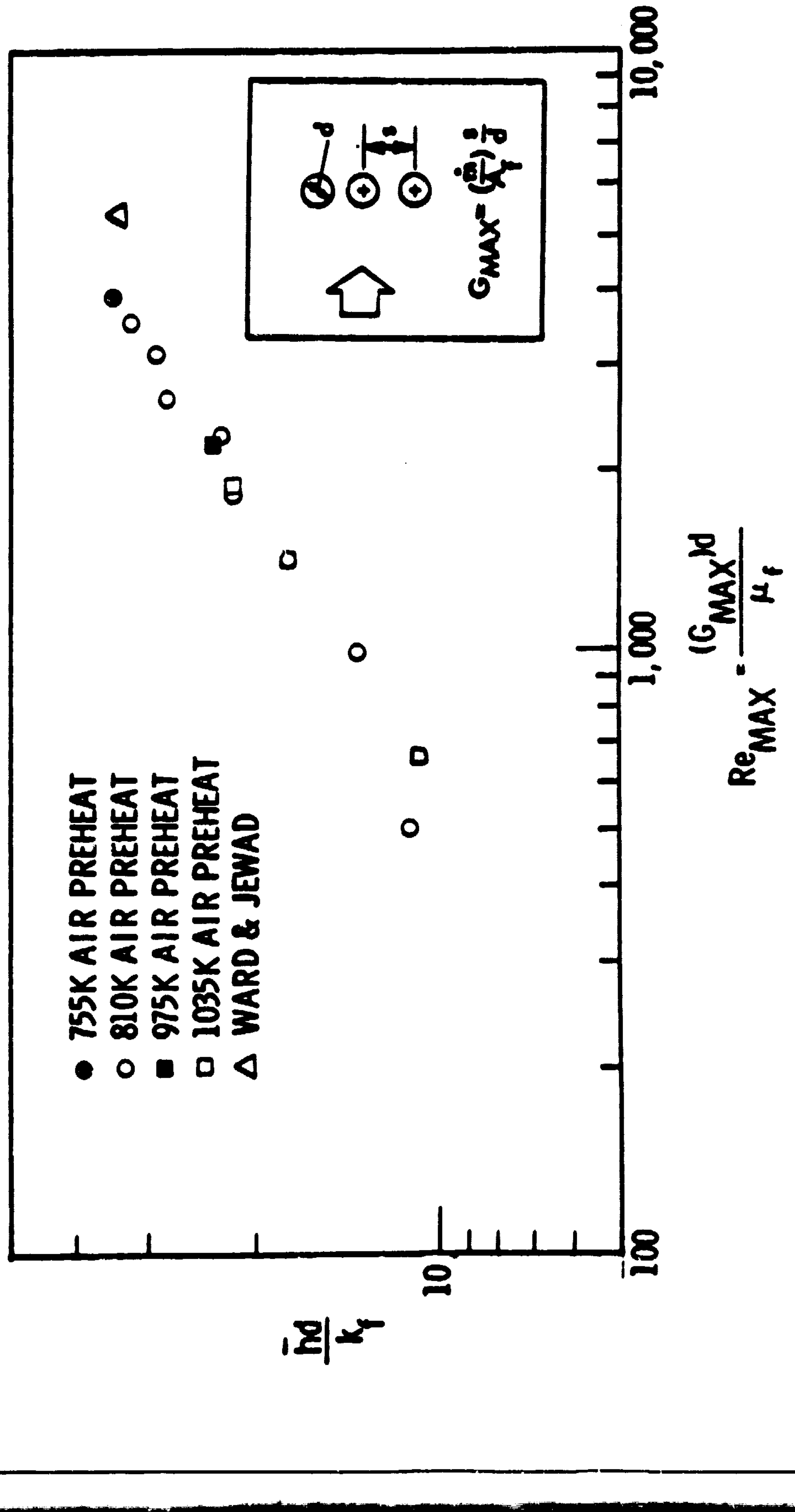

Figure 3-5. DSSR Combustor: Overall Heat Transfer Coefficients

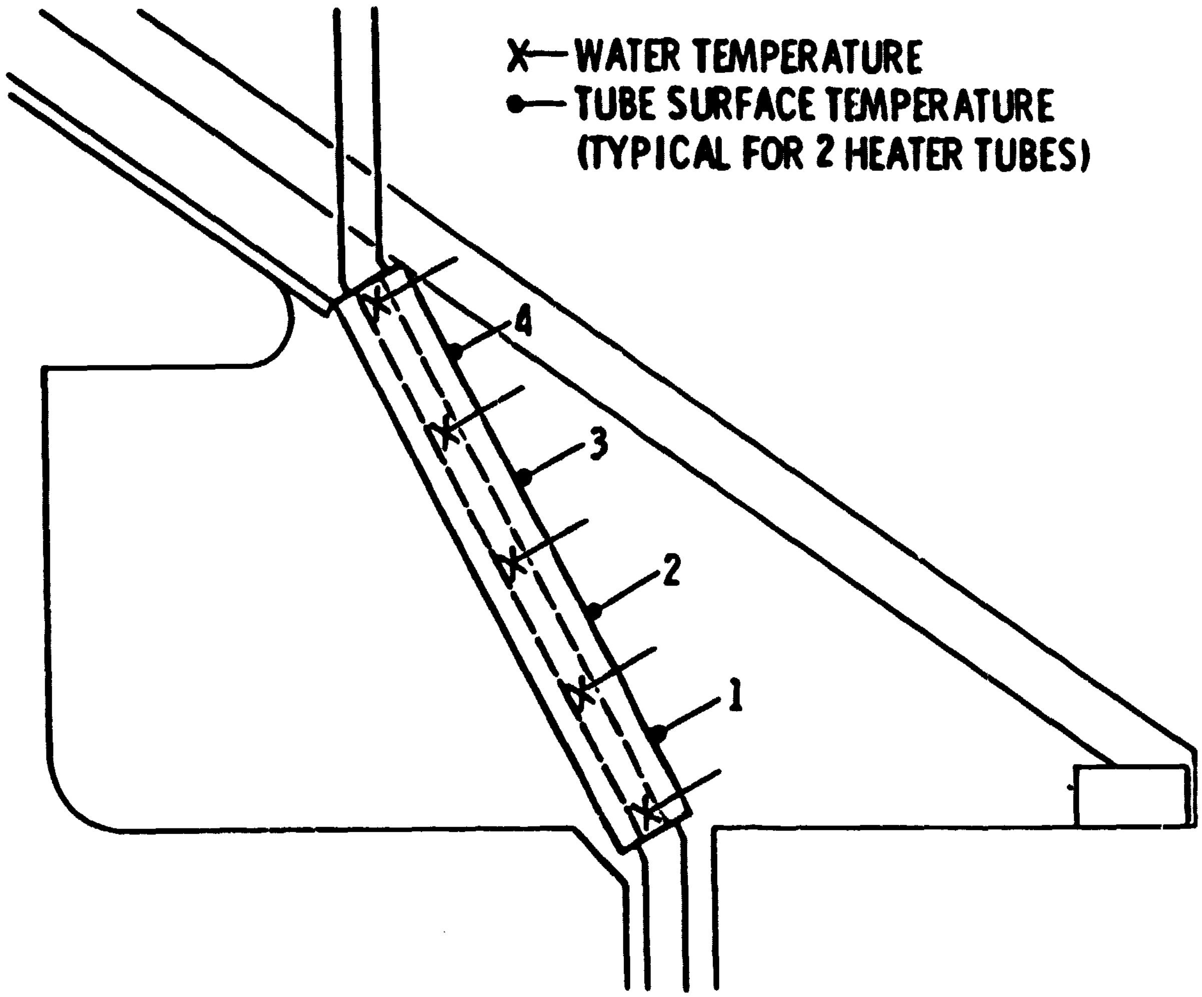

Figure 3-6. DSSR Combustor, Heater Tube Instrumentation

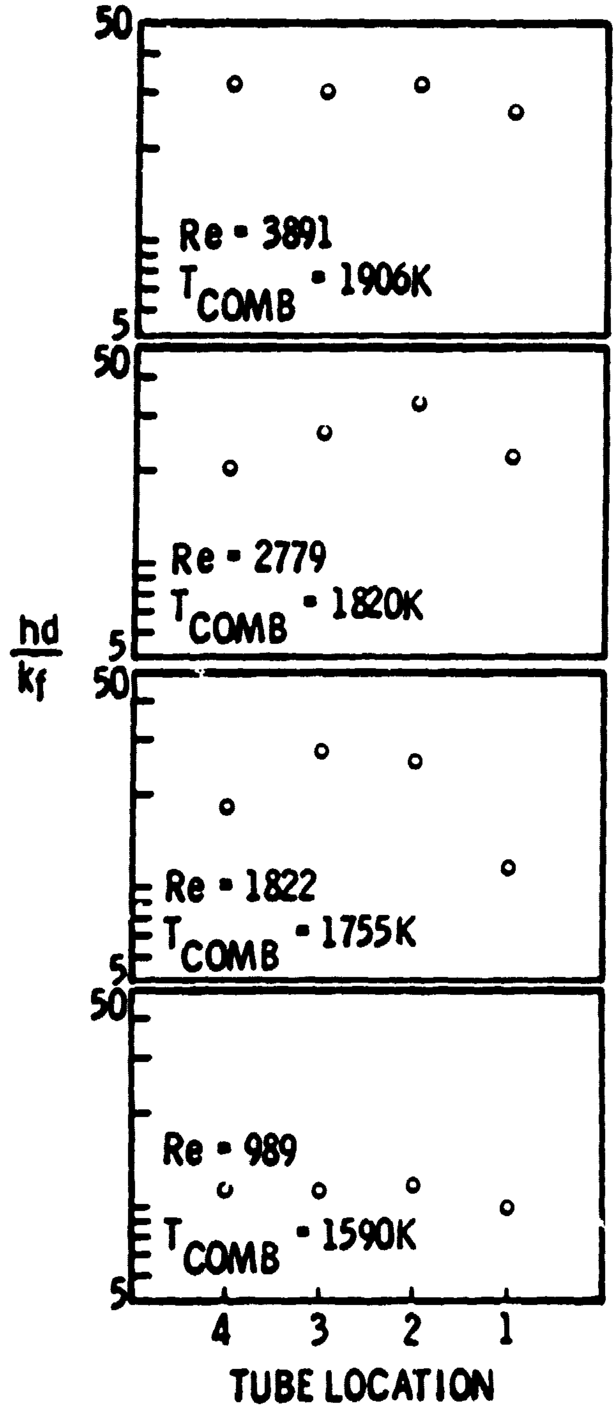

Figure 3-7. DSSR Combustor: Heat Transfer Coefficients Along the Tube Length (810K Air Preheat)

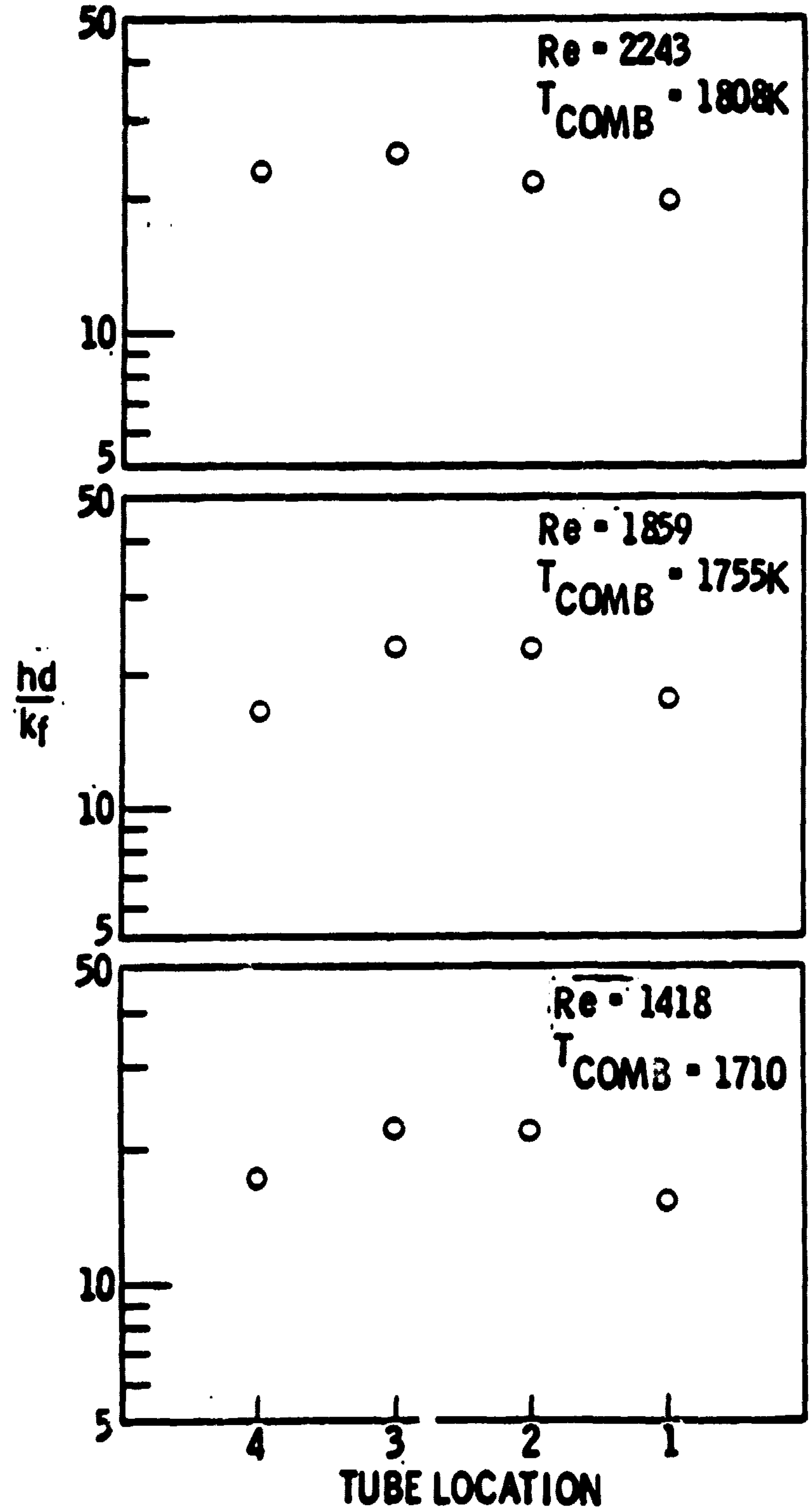

Figure 3-8. DSSR Combustor: Heat Transfer Along the Tube Length (1000°K Air Preheat)

4.0 END ITEM ACCEPTANCE TEST

An end item acceptance test was successfully conducted in accordance with the requirements of the contract; the tests were observed by JPL technical and quality assurance representatives. The data produced during the test, a description of the test operations and a schematic arrangement of the test setup and equipment are documented in Fairchild Test Report ER 79917-2, which is attached as Appendix C to this report.

5.0 POTENTIAL PROBLEM AREAS

Potential technical problem areas are discussed in this section in order to facilitate early planning for their solution and, if possible, to preclude their occurrence.

5.1 Aperture Plate

Tests with other receivers at JPL have resulted in aperture fracture. The aperture plate on the DSSR is presently a single-piece slip-cast fused quartz cone. A segmented aperture plate made of zirconium oxide has been proposed by Corning; this alternate should be pursued. A water-cooled metallic aperture plate is also a viable alternative.

5.2 Refractory Combustion Chamber

Frequent handling of the rather heavy and somewhat bulky combustion chamber will be required at the PFTS, as well as at United Stirling. Accidental damage from handling could cause several months delay in the remaining phases of the program. Spare combustion chamber parts should be considered.

5.3 Combustion Air Plenum

While conservatively designed, the possibility of air maldistribution exists and could cause local overheating of the preheater. Installation of thermocouples in the exhaust manifold section above the preheater is recommended for monitoring of the preheater to avoid overheating and possible damage.

5.4 Receiver Body Quadrants

Installation of the receiver body quadrants must be carefully executed by skilled technicians to avoid binding of the cylinder and regenerator pilot sleeves in the engine block. Detailed installation and removal procedures and special tools, as necessary, should be developed and verified prior to actual assembly operations.

FAIRCHILD
STRATOS DIVISION
1800 ROSECRANS AVENUE
MANHATTAN BEACH, CALIF. 90266

APPENDIX A

DRAWING LIST

DISH STIRLING SOLAR RECEIVER

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1800 ROSECRANS AVENUE
MANHATTAN BEACH, CALIF. 90266

DRAWING LIST

Drawing No.	Title
79917001	Dish Stirling Solar Receiver, Final Assembly (4 sheets)
79917011	Tube Assembly, Heater
79917012	Cylinder, Stirling Engine
79917013	Regenerator, Stirling Engine
79917014	Quadrant Assembly
79917015	Mounting Plate, Receiver
79917018	Plug, Center
79917019	Refractory Assembly
79917020	Base, Nozzle
79917021	Nozzle, Fuel
79917022	Seal, Fuel Nozzle
79917024	Plate, Aperture
79917027	Band, Assembly, Refractory Clamping
79917030	Plug, Fuel Nozzle
79917032	Preheater Assembly
79917033	Manifold, Tube - Quadrant Assembly
79917034	Manifold, Center
79917035	Filler, Tube Slot, Outer
79917036	Skin, Front
79917037	Skin, Bottom Rear
79917038	Skin, Top Rear
79917039	Filler, Tube Slot, Inner
79917040	Strip, End

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DRAWING LIST (continued)

Drawing No.	Title
79917041	Quadrant, Section
79917042	Strip, Outer
79917044	Heater Tube Set
79917045	Plug, Manifold
79917046	Assembly Instruction
79917047	Ring, Retainer
79917048	Plate, Bottom Combustion Manifold
79917049	Flange, Exhaust Manifold
79917052	Ring, Gland
79917053	Inner Housing
79917054	Manifold Assembly, Exhaust
79917055	Ring, Transition
79917056	Tube, Support
79917057	Cap, Tube
79917058	Ring, Mounting
79917059	Shell
79917060	Ring, Tube Support
79917061	Ring, Central
79917062	Outer Shell Assembly
79917063	Fixture, Mounting
79917064	Top, Plate
79917065	Leg Assembly
79917066	Bottom Plate
79917067	Bracket

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DRAWING LIST (continued)

Drawing No.	Title
79917068	Exhaust Pipe Assembly
79917070	Air Plenum Test
79917071	Air Baffle
79917072	Compression Ring
79917073	Base Plate Assembly, Receiver
79917074	Base, Fuel Manifold
79917075	Tube, Manifold, Fuel
79917077	Block, Support, Combustion Chamber
79917078	Manifold Assembly, Air Blower
79917079	Manifold - Air Filter
79917080	Flange
79917081	Air Control Valve
79917082	Flange
79917083	Flange
79917084	Gasket, Bottom Plate
79917085	Clamp, Aperture Plate
79917086	Port, Pressure Tap, Receiver
79917087	Tube, Valve to Bottom Plate
79917088	Fitting, Tube - Bottom Plate
79917089	Bracket, Blower Mounting
79917090	Bracket, Fuel Valve
79917091	Standoff, Adjustable
79917092	Pin

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DRAWING LIST (continued)

Drawing No.	Title
79917093	Shaft
79917094	Butterfly
79917095	Bushing
79917096	Gasket
79917097	Gasket
79917098	Gasket
79917099	Shield, Tube

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APPENDIX B

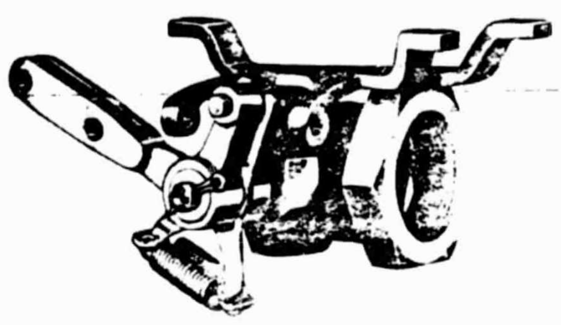
MANUFACTURERS' DATA

DISH STIRLING SOLAR RECEIVER

BUTTERFLY VALVE

The V51E Butterfly Valve is used to provide variable control of natural, manufactured, or LP gas, or air. It is driven by a firing rate motor such as the M941, which may be mounted directly on the valve or close to it. Since the V51E does not provide tight close off, it is not suitable for use as a safety shutoff valve on a gas burner.

Butterfly valves have high flow capacity and relatively constant relationship between flow volume and angle of valve opening. Therefore, this assembly is especially adaptable to commercial and industrial installations where large amounts of gas must be closely controlled.



- ☐ Variety of valve sizes, drive motors, and linkages make the V51E adaptable to most modulating jobs.
- ☐ Rugged cast aluminum body provides durability and maintenance-free operation.
- ☐ Compatible with Modutrol motor and Q100A or B Linkage, Actionator motor and Q100C Linkage, and Type 03 Air-O-Motor pneumatic actuator and Q524A Linkage.
- ☐ The valve mechanism is equipped with strain release springs.
- ☐ The valve (with the appropriate linkage) is suitable for electric or pneumatic operators.
- ☐ Valve may be used with manufacturer's own linkage and drive motor.

V51E

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OF POOR QUALITY

Residential Div. Form Number 60-2102-1 2-76

SPECIFICATIONS

MODEL: V51E Butterfly Valve.

MEDIUM CONTROLLED: Gas or air.

FLOW CAPACITIES: See below.

SIZES: 1-1/2, 2, 2-1/2, 3, and 4 inches.

PATTERN: Straight-through.

BODY MATERIAL: Aluminum.

FINISH: Aluminum.

MAXIMUM INLET PRESSURE: 5 psig.

AMBIENT TEMPERATURE RANGE: 32 F to 140 F.

DIMENSIONS: See Figure 2.

ACCESSORIES:

1. Stop screws for stop bracket (2 required), no. 80697BC.
2. Stop screw locking nuts (2 required), no. 22355.

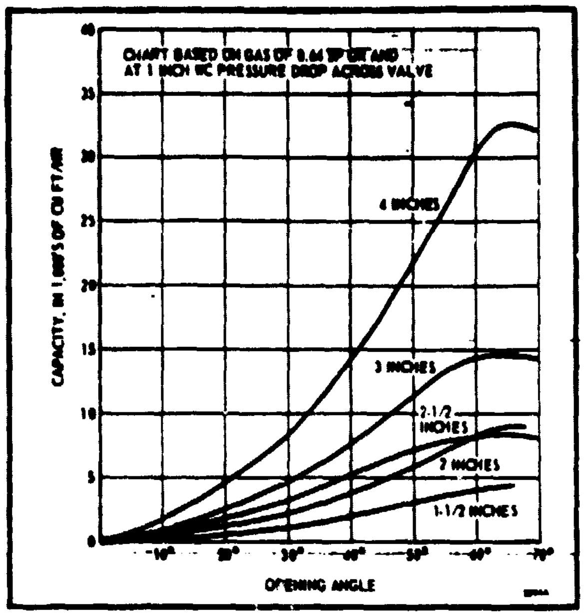
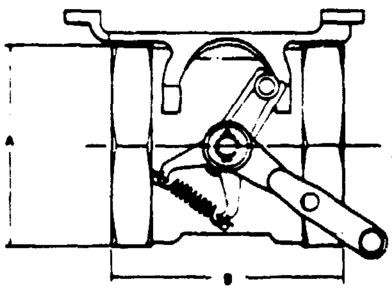


FIG. 1—FLOW CAPACITIES OF V51E VALVES.



Valve Size	Dimensions A	B	C	D
1-1/2	2-11/16	3-1/16	4-7/8	1-5/8
2	3-3/16	3-7/16	4-7/8	1-5/8
2-1/2	3-5/8	4-11/16	4-7/8	1-5/16
3	4-1/16	4-1/4	5-3/16	1-5/8
4	5-3/16	5-5/16	5-11/16	1-3/4

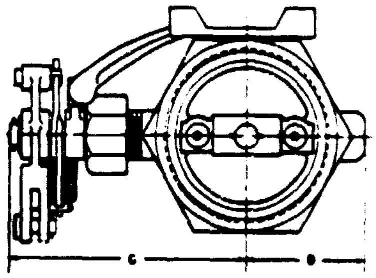


FIG. 2—APPROXIMATE DIMENSIONS (IN INCHES) OF V51E ASSEMBLY.

(continued on page 3)

ORDERING INFORMATION

WHEN ORDERING REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING SPECIFICATION NUMBER, OR . . .

SPECIFY—
1. VALVE MODEL.
2. VALVE SIZE (1-1/2, 2, 2-1/2, 3, 4 INCHES).
3. ACCESSORIES.
4. BAG ASSEMBLIES FOR INSTALLING AND ADAPTING THE ELECTRIC MOTORS TO THE V51E VALVE.
5. ORDER MOTOR AND LINKAGE SEPARATELY. REFER TO APPLICABLE SPECIFICATION SHEETS.

ORDER FROM—
1. YOUR USUAL SOURCE; OR
2. HONEYWELL
1885 DOUGLAS DRIVE NORTH
MINNEAPOLIS, MINNESOTA 55422
(IN CANADA—HONEYWELL CONTROLS LIMITE
740 ELLESMERE ROAD
SCARBOROUGH, ONTARIO
INTERNATIONAL SALES AND SERVICE
IN ALL PRINCIPAL CITIES OF THE W

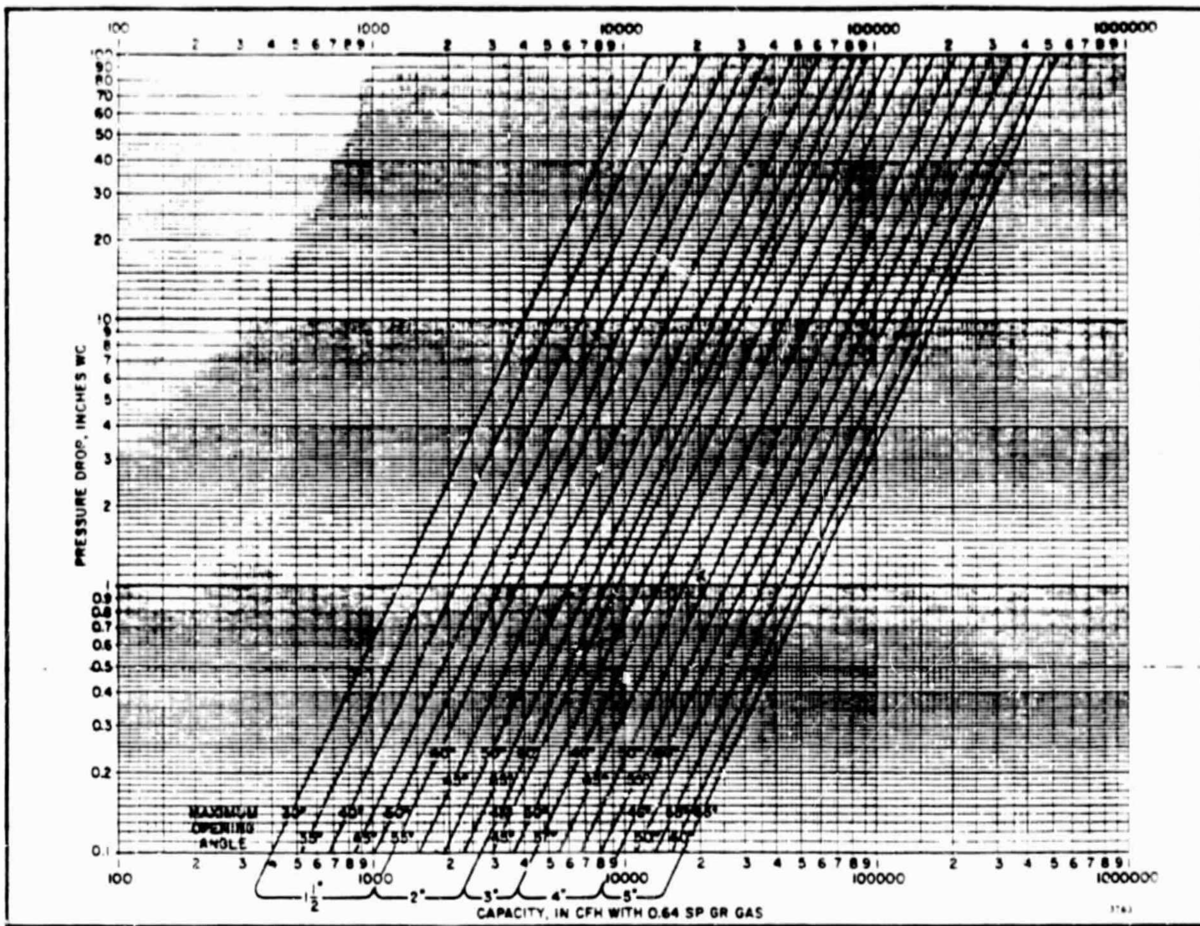


FIG. 3—PRESSURE DROP VERSUS CAPACITY FOR V51E. MAXIMUM OPENING ANGLES SHOWN ARE USED AS TRIAL SETTINGS WHEN ADJUSTING VALVES FOR HIGH FIRE.

INSTALLATION

MOUNTING

Electric motorized valves of this type should not be installed in poorly ventilated pits or confined spaces when they are to control the flow of combustible gases. The valve body may be installed in any position, provided the motor shaft is horizontal. Allow sufficient clearance for assembling the motor and linkage, packing the valve, and general servicing. See Fig. 2 for approximate installation dimensions.

PIPING

The valve body may be piped either by screwing directly to the pipe or by using close nipples and companion flanges. The pipes must be in exact alignment to avoid distorting the valve body. Ream and clean pipes carefully, and apply pipe dope to the male threads only. Leave the first two threads free of dope.

INSTALLING ELECTRIC MOTOR AND Q100A LINKAGE ON V51E (SEE FIG. 4):

Any special parts, nuts, or screws needed are furnished in bag assemblies. Install the motor and linkages as follows:

1. Mount plate on stop bracket with three No. 10 screws and lock washers.
2. Mount motor on plate with four 1/4 in. screws, lock washers, and nuts.
3. Remove motor crank arm assembly from motor and discard it.

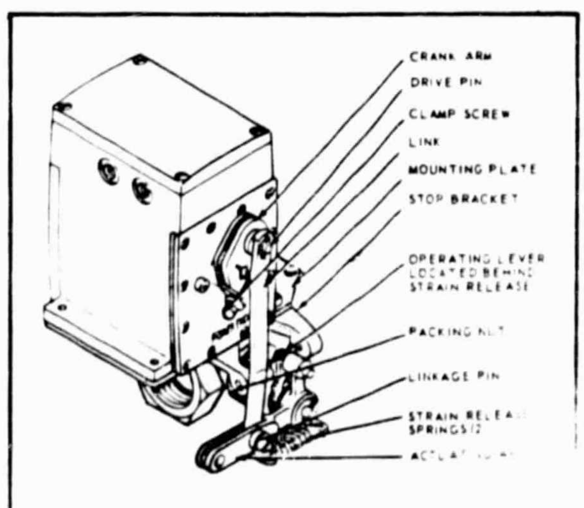


FIG. 4—TYPICAL COMBINATION OF V... MOTOR, AND Q100A LINKAGE ASSEMBLY.

4. Install the special crank-arm in position shown. With crank-arm tight against shoulder of shaft, tighten clamp screw securely.

5. One end of link measures 1-1/4 in. from end to bend. Slip this end over drive pin. Place washer on drive pin. Insert cotter pin in drive pin. Spread cotter pin ends.

6. Slip the other end of link into the forked end of actuating arm and insert the linkage pin moving the arm as necessary. Insert cotter pin in linkage pin. Spread cotter pin ends.

INSTALLING MODUTROL MOTOR AND Q100B LINKAGE ON V51E (SEE FIG. 5):

Special parts needed for the basic assembly are furnished in bag assemblies. Special linkages for the valve arm to operate dampers, auxiliary valves, or other equipment can be provided by the burner manufacturer or installer. Install the motor and linkage on the valve as follows:

1. Mount plate on stop bracket with three No. 10 screws and lock washers.

2. Mount motor on plate with 1/4 in. screws, lock washers, and nuts.

3. Make sure the motor is in the "closed" position (the position assumed when red and white terminals on motor are shorted together). Install motor crank arm and tighten clamp screw securely.

4. Install valve actuating arm as shown in Fig. 5, and adjust as desired.

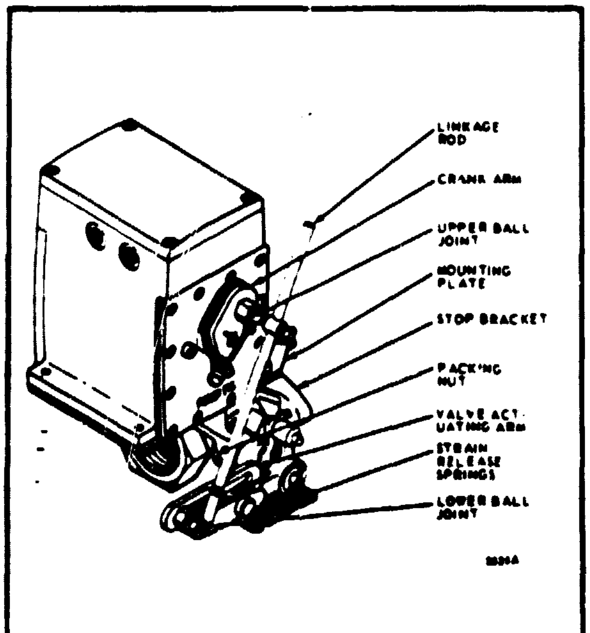


FIG. 5—TYPICAL COMBINATION OF V51E, MODUTROL MOTOR, AND Q100B LINKAGE ASSEMBLY.

INSTALLING ACTIONATOR MOTOR AND Q100C LINKAGE ON V51E (SEE FIG. 6):

1. Mount plate on stop bracket with three No. 10 screws and lock washers.

2. Mount motor on plate with 4-1/4 in. hex head screws and lock washers.

3. Install the crank arm in the position shown. With the crank-arm tight against the shoulder of the shaft, tighten the clamp screw securely.

4. One end of the link measures 1-3/4 in. from the end to the bend. Slip this end of the link into the forked end of the arm and insert the linkage pin, moving the arm as necessary. Insert cotter pin in linkage pin. Spread the cotter pin ends.

5. Insert the drive pin into the other end of the link and place a washer on the drive pin. Insert the drive pin into the crank arm and secure the pin with a nut and locking washer.

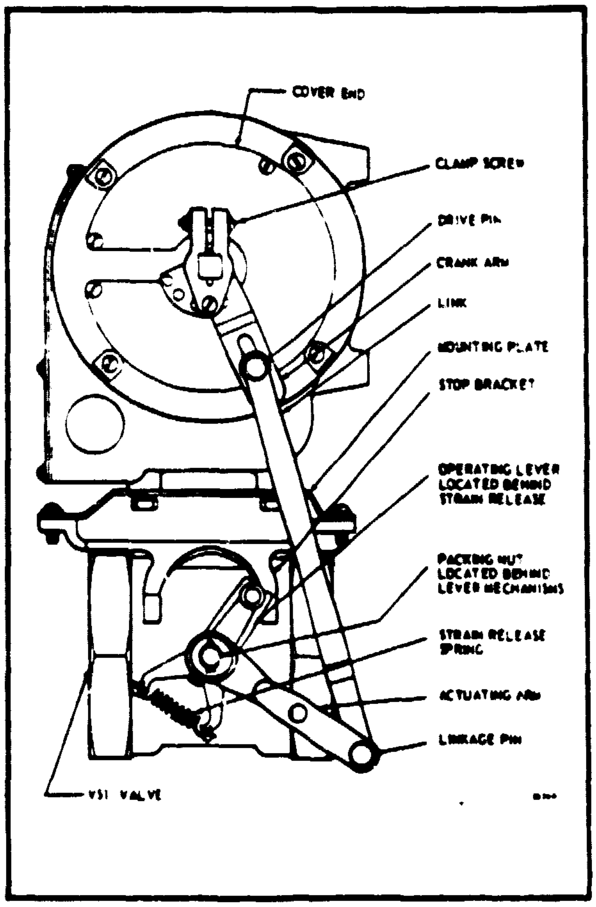


FIG. 6—TYPICAL COMBINATION OF V51E, ACTIONATOR MOTOR, AND Q100C LINKAGE ASSEMBLY.

WIRING

Wiring diagrams are packed with the m[illegible] wiring must comply with applicable cod[illegible] ances.

INSTALLING TYPE 03 AIR-O-MOTOR PNEUMATIC ACTUATOR AND O524A LINKAGE ON V51E (SEE FIGS. 7, 8, 9).

If the V51 valve is intended to provide normally open, direct operation (valve open when pneumatic pressure off), the actuating arm points to the right, as in Fig. 7. For a normally closed system, the arm projects to the left as in Fig. 8. If it is necessary to field-convert the valve, remove only the cotter pia, washer and arm. Reverse the arm and re-install.

1. Remove the 4 round-head machine screws and washers holding the stop bracket to the valve hex at each end. Do not remove stop bracket.

2. Position the adapter plate over stop bracket so that adapter plate holes match the stop bracket holes.

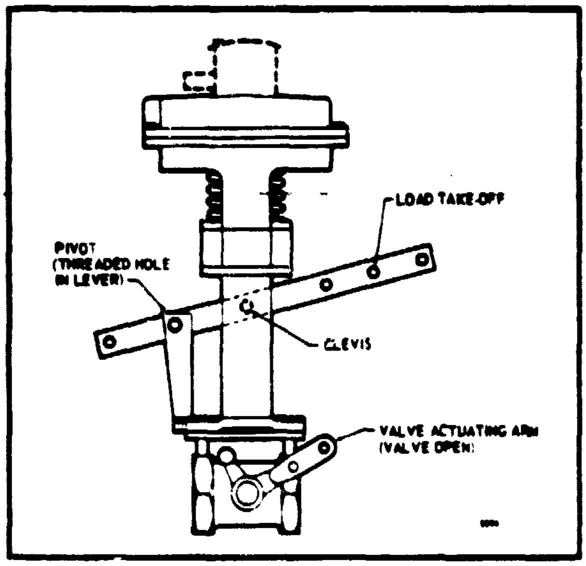


FIG. 7—RECOMMENDED "POWER OFF" POSITIONS OF MOTOR LEVER AND VALVE ARM FOR NORMALLY OPEN OPERATION.

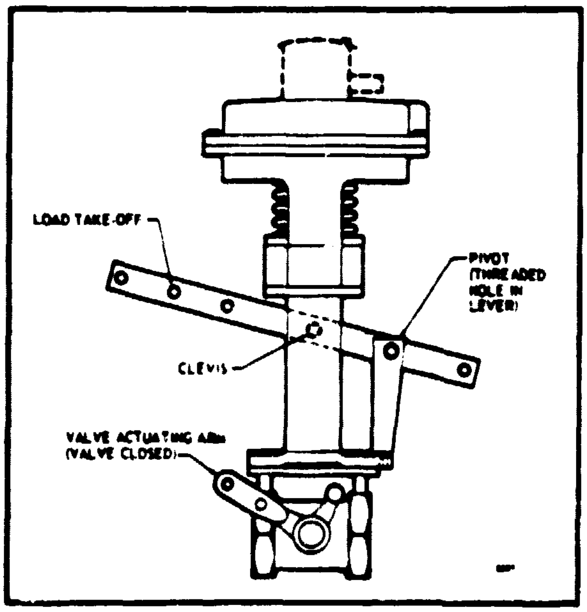


FIG. 8—RECOMMENDED ARRANGEMENT FOR NORMALLY CLOSED OPERATION.

3. Insert the flat head screws supplied with the linkage assembly through plate, spacers, and stop bracket and into each hex. Tighten securely. The spacers prevent contact of adapter plate and stop bracket. See Fig. 9.

4. Mount the lever arm (13-3/4 inches) supplied with the motor so that the load take-off holes will be at the same end of the valve as the valve actuating arm.
NOTE: Both motor lever and valve arm could be installed 180 degrees from the positions shown in Figs. 7 and 8, if more convenient. Use bushing hole at the clevis.

5. Use the four large cap screws supplied with the linkage assembly to secure motor to the adapter plate.

6. Add the ball joint assembly and push rod as shown in Fig. 10.

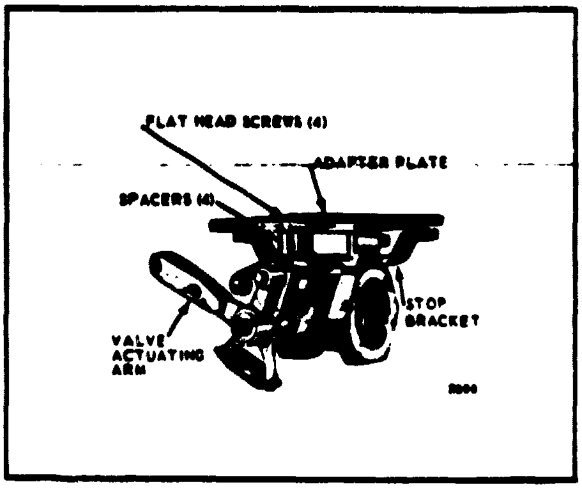


FIG. 9—RELATIONSHIP OF PARTS IN V51E.

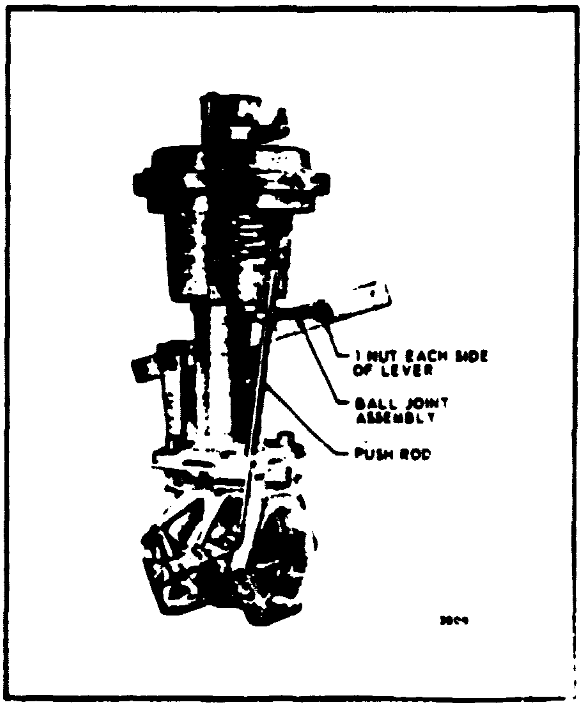


FIG. 10—TYPICAL COMBINATION OF V51[illegible] PNEUMATIC ACTUATOR, AND O524[illegible]

ADJUSTING AND CHECKOUT

MODUTROL MOTOR WITH Q100A LINKAGE AND V51E (SEE FIG. 4):

MINIMUM FLOW ADJUSTMENT

With motor in closed position, loosen the lock nut on the stop screw. Turn this screw in against the operating lever until desired minimum flow position is obtained. If full-closed is the minimum position desired, back the screw out until its end is flush with stop bracket. Tighten the lock nut.

MAXIMUM FLOW ADJUSTMENT

With motor in open position, loosen the lock nut on stop screw. Turn this screw in against operating lever until desired maximum flow adjustment is obtained. If fully open is the maximum position desired, back screw out until its threaded end is flush with stop bracket. Tighten lock nut.

MODUTROL MOTOR WITH Q100B LINKAGE AND V51E (SEE FIG. 5).

1. Loosen Allen-head setscrews in upper ball joint to allow linkage rod to slide freely. Loosen lower ball joint so that it will slide freely in the actuating arm slot.
2. Short the motor terminals red to white to drive the motor closed.
3. Hold valve butterfly open at the desired low-fire position and tighten the lower ball joint hand tight against the outer end of the actuating arm slot. Tighten screw in the upper ball joint enough to provide some friction on the rod, but not enough to prevent it from sliding if the valve hits its stop.
4. Short the motor terminals red to blue. As motor drives open, note the valve travel. Reset the lower ball joint to give the proper high-fire valve position.

NOTE: When the lower ball joint is moved, the upper ball joint usually must be readjusted if the valve is to keep the same low-fire position.

ACTIONATOR MOTOR WITH Q100C LINKAGE AND V51E (SEE FIG. 6):

MINIMUM FLOW ADJUSTMENTS

Using the motor, drive the valve to the closed position. Loosen the lock nut on the stop screw. Turn this screw in against the operating lever until the desired minimum flow position is obtained. If full closed is the minimum position desired, back the screw out until its threaded end is flush with the stop bracket. Tighten the lock nut.

MAXIMUM FLOW ADJUSTMENT

Using motor, drive valve to the open position. Loosen the lock nut on stop screw. Turn this screw in against the operating lever until the desired maximum flow adjustment is obtained. If full open is the maximum position desired, back the screw out until its threaded end is flush with the stop bracket. Tighten lock nut.

MAINTENANCE OF THE V51E:

PACKING THE VALVE

The packing nut should be tightened with the fingers only, just enough to prevent leakage and to provide a slight friction against the valve stem. Do not use wrench or pliers.

NOTE: The stem packing should last indefinitely. The valve is designed so that it should not require repacking in the field. If repacking should be necessary, we recommend returning the valve body for factory repair.

LUBRICATION

Place a few drops of SAE 20 or heavier oil on linkage bearings whenever required. The motor needs no lubrication in the field.

MECHANICAL LINKAGES

Mechanical linkages may be devised to operate dampers or other valves in unison or sequence with this assembly. In no case should the combined load of the valve, damper, and linkage exceed the rated load limit of the motor for its timing. See applicable motor sheets.

CHECKOUT

Cycle the burner twice through high fire and low fire while observing the actuating arm for smooth operation and watching the burner flame level for proper regulation of gas or air. Make certain the actuator arm does not hang up while the drive motor is in operation.

For detailed operation of drive motor and linkage refer to applicable sheet furnished with the device.

ITT GENERAL CONTROLS
801 ALLEN AVE., GLENDALE, CALIF. 91201

K3 SERIES (BALANCED DIAPHRAGM) SOLENOID GAS VALVES

INSTALLATION AND SERVICE

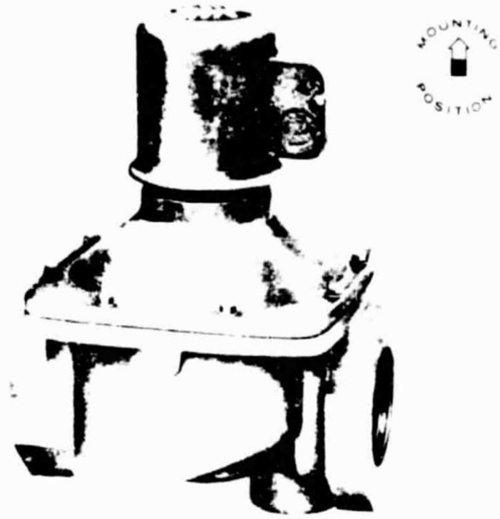


Fig. · Typical K·

DESCRIPTION

K3 Series Balanced Diaphragm Solenoid valves provide on-off control for domestic and industrial furnaces, boilers, conversion burners and similar units using thermostats, limit controls, or similar control devices. The valve uses a balanced diaphragm for high operating pressure with low electrical power consumption. Suitable for use with all gases, K3 valves are available in a variety of sizes, capacities and pressures.

USE ONLY WITH NATURAL, MIXED, MANUFACTURED OR LP GASES, INCLUDING HIGH SULFUR, SCRUBBED COKE, AND SCRUBBED AND DRIED SEWER GASES.

Solenoid covers feature a junction box which rotates 360° to facilitate wiring.

OPERATION

Energized coil lifts the iron plunger enough to open the "pilot" valve. Gas then bleeds from the area above the diaphragm faster than it can be replaced. Pressure above diaphragm is now the same as pressure below seat disc. A balanced or unloaded condition exists. The solenoid coil lifts the complete interior assembly to full open position. When solenoid is de-energized, pressure recovers above diaphragm. Weight of interior assembly and gas pressure across seat disc hold valve closed.

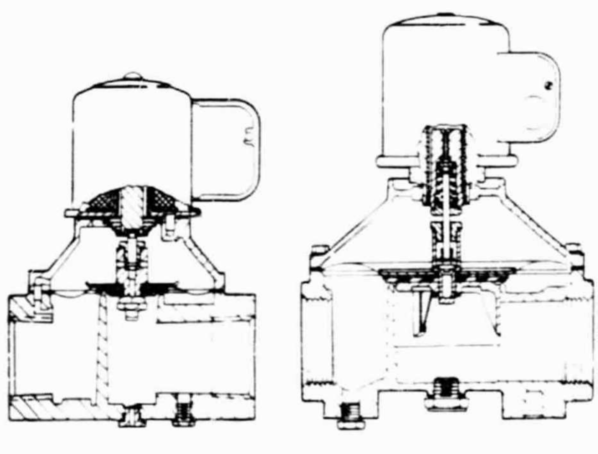


Fig. 1. Cross Sectional Views

SPECIFICATIONS

Valve should be used within specified operating ranges as indicated on valve nameplate and in complete catalog number. (i.e., Min./Max. psi, Volts, Hertz, Max. Media Temp. @ °F Ambient, Cv Factor, etc.).

INSTALLATION

CAUTION

1. **This valve should be installed by a qualified serviceman.**
2. **Turn off gas supply before installing valve.**
3. **All piping must meet applicable local codes and ordinances and the National Fuel Gas Code (ANSI Z23:1/NFPA No. 54).**
4. **All wiring must meet applicable electrical codes and ordinances. Installations in Canada require the use of rigid metal conduit to ground the electrical enclosure of this valve when rated over 30 volts.**
5. **Check out the complete system after installing the valve.**

1. Make certain gas pressure is within valve rating.
2. Check name plate on solenoid for correct voltage.
3. Blow out dirt or foreign matter from all pipes.
4. Use pipe dope sparingly on male pipe threads only.
5. DO NOT use solenoid for handling or turning valve on pipe. Use wrench on body flat at port being connected.

6. Valve must be on horizontal line with solenoid vertical and with flow according to arrow on body.
7. Make all wiring connections clean and tight with limit and safety controls connected in hot side of line voltage circuits.

MANUAL OPENING DEVICE (OLDER MODELS)

WARNING

Use of manual opening device nullifies effect of all safety controls used with valve. Never use device when valve is installed on current powered equipment. Before using manual opening device, make certain current failure is not result of limit or safety control operation. Make certain device is released on solenoid valves before automatic control operation is resumed.

SERVICE

WARNING

Disassembly, reassembly or internal adjustment without factory test may result in hazardous condition. If control does not operate properly after following the INSTALLATION and SERVICE instructions, complete control must be replaced by qualified person.

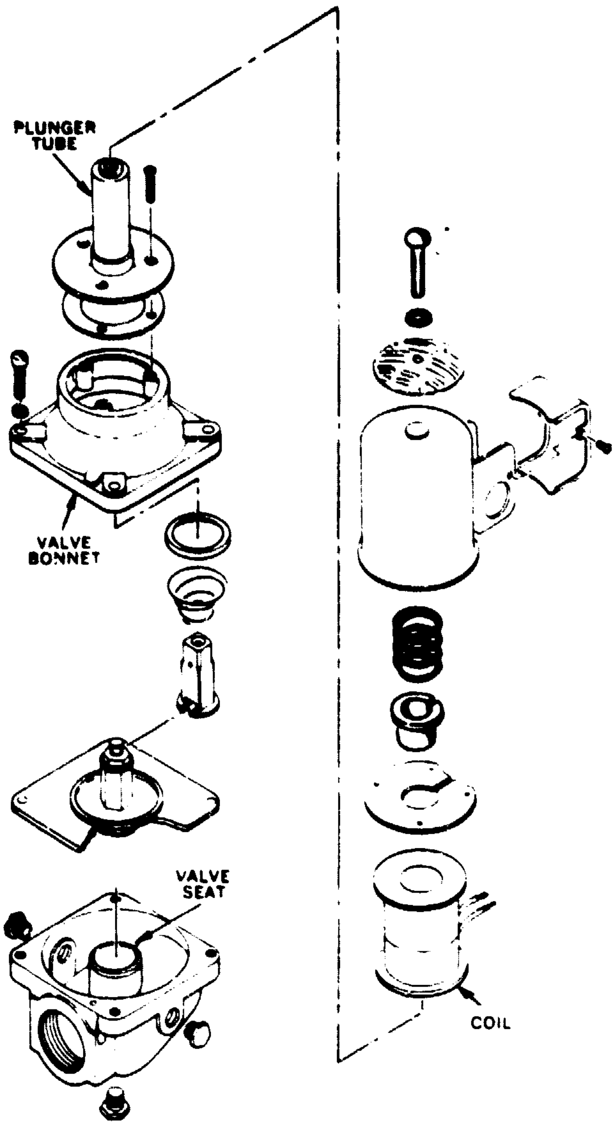
These valves will operate for years without trouble. However, foreign matter between the valve seat and seat disc can cause leakage. Excessive temperature will also cause coil burnout.

To clean the valve seat and seat disc, remove the valve bonnet with the attached solenoid. Do not disassemble the solenoid.

COIL REPLACEMENT

Turn off the electric power to the solenoid. Disconnect the coil leads. It is not necessary to remove the valve from the pipe line.

Disassemble the solenoid, taking care to note the exact order of placement and quantity of parts as incorrect reassembly can cause coil burnout. At all times take care not to nick, dent or damage the plunger tube.



EXPLODED VIEW OF TYPICAL K3A BALANCED DIAPHRAGM VALVE

SERVICE SUGGESTIONS

TROUBLE	POSSIBLE CAUSE	REMEDY
Valve fails to open	Thermostat, safety or limit controls inoperative. Blown fuses, short in wiring or wrong voltage	Check all contacts and circuit wiring. Repair or replace controls where needed
	Solenoid coil shortened, burned out or wrong voltage	Replace with solenoid coil of correct voltage
	Bent or damaged solenoid plunger tube	Replace plunger and plunger tube assembly
	Dirt, pipe compound or other foreign substance restricting operation of valve	Disassemble and clean valve disc, guides and seat with solvent
Valve fails to close	Manual opening device holding valve open	Turn back until valve shuts off
	Bent or damaged solenoid plunger tube	Replace plunger and plunger tube assembly
	Short circuit with limit controls in ground side of circuit	Remove cause of short and wire controls in hot side of circuit
	Dirt, pipe, chips or other substance on valve seat	Disassemble and clean valve disc, guides and seat with solvent

Honeywell

M941 STROKE ADJUSTMENT

IMPORTANT

This motor is set for a 160 degree stroke. It may be adjusted for a 90 degree stroke by changing the settings of both the limit arms, and the terminal in the wiring compartment.

1. Run m- -idstroke and disconnect power. Remove c- -uxiliary end. Remove switch cams, if pr- see Fig. 1). Be careful not to lose the two was- and spring. Loosen the two locking screws on limit arm assembly (see Fig. 2).

IMPORTANT

DO NOT loosen the set screw on the limit arm hub.

2. Push both limit arms down as far as they will go. Tighten the locking screws.

3. Change terminal in wiring compartment to "90 degrees" (see Fig. 1). Loosen screws labeled 160 and 90 degrees. Move spade terminal on end of lead from 160 to 90 degree screw terminal. Tighten screws.

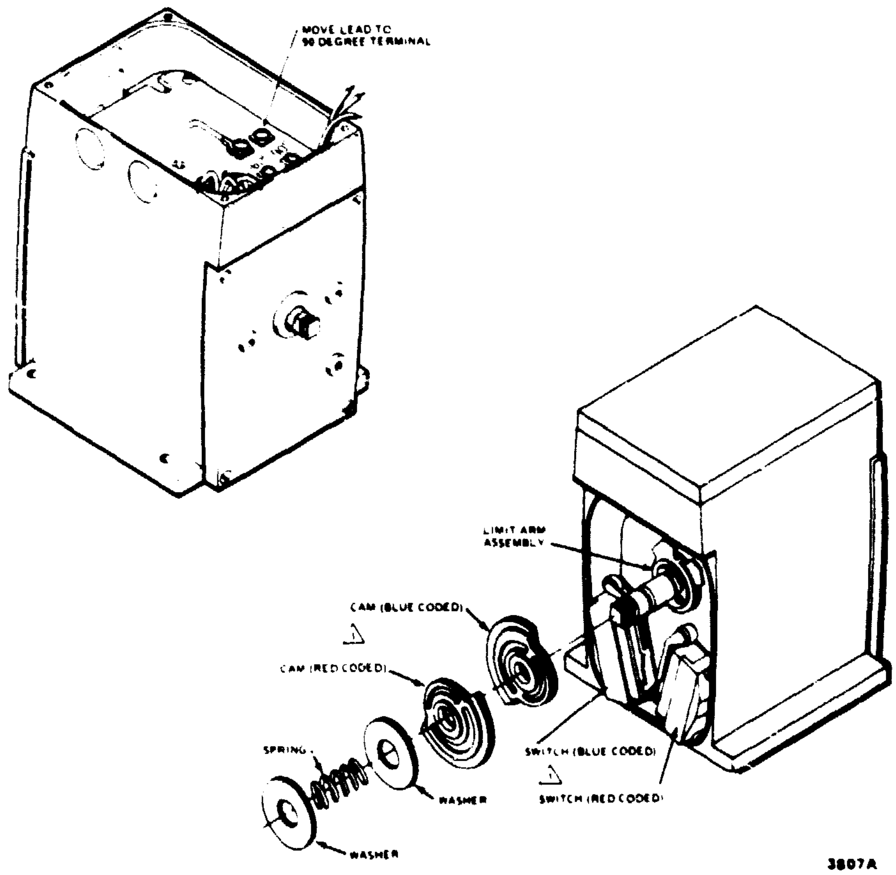


Fig. 1—Terminal connection; cam assembly.

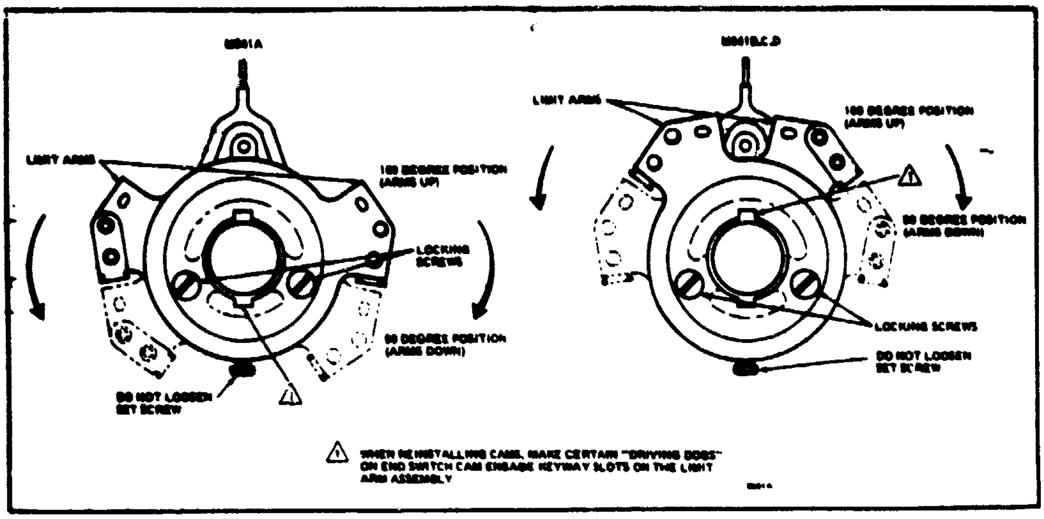


FIG. 2—Limit arm assembly.

REASSEMBLY

1. Replace the switch cams—blue coded cam first; then red coded cam. Cams should be installed so that color code spot is adjacent to the associated cam follower.

2. Replace the washers and spring in the correct sequence shown in Fig. 1.

3. Replace the cover. Do not allow the washers to become caught in the shaft slots.

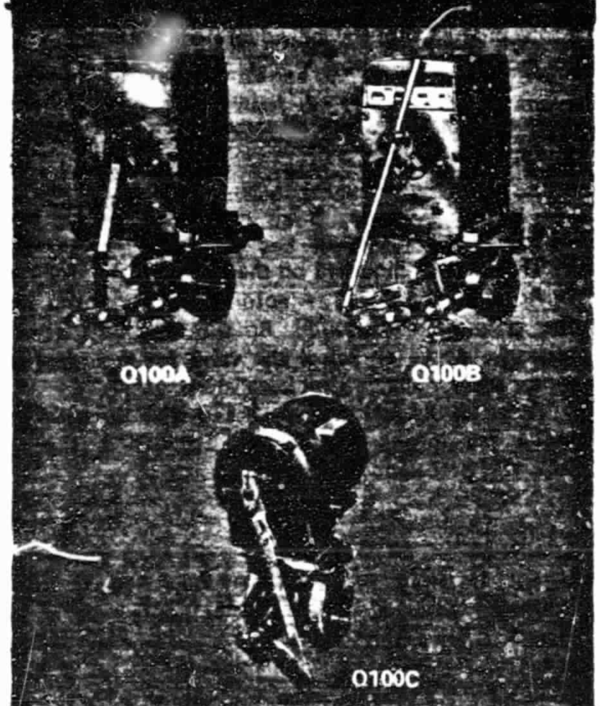
REFER TO INSTRUCTION SHEET, 60-2111, FOR ADDITIONAL INSTALLATION INFORMATION.

Honeywell

THE Q100A,B,C ARE LINKAGES FOR COUPLING V51B,E BUTTERFLY VALVES TO MODUTROL MOTORS OR ACTIONATOR MOTORS. THE LINKAGES MAY BE USED WITH VALVES OF ANY SIZE. STRAIN RELEASE AND STOP BRACKET ARE NOT INCLUDED WITH THE LINKAGES.

- ☐ Q100A links V51B and Modutrol motors.
- ☐ Q100B links V51E and 90 degree stroke Modutrol motors only.
- ☐ Q100C links V51E and Actionator motors.
- ☐ Adaptable to all V51 valves.
- ☐ May be used with Modutrol or Actionator motors.
- ☐ Easily mounted.
- ☐ Compact lightweight unit is easy to handle and requires little space on the installation.

LINKAGES



Q100A,B,C

Residential Div Form Number 60-2135-2

E.K.
REV. 8-75

SPECIFICATIONS

MODELS:

Q100A Linkage, for use with V51B and Modutrol motors.

Q100B Linkage, for use with V51E and 90 degree stroke Modutrol motors only. Linkage is adjustable to fit all sizes of motors.

Q100C Linkage, for use with V51E and Actionator motors. Linkage includes adapter bracket.

MOUNTING MEANS: One end connects to power crankarm of the motor and the other end connects to the actuating lever on the valve.

TEMPERATURE RATING: Limited only by temperature rating of motor and valve.

ACCESSORIES: Strain release and stop bracket may be ordered with the individual Modutrol or Actionator motors.

DIMENSIONS:

MODEL NUMBER	USED WITH	VALVE SIZE (IN.)	LENGTH OF LINKAGE[a] ROD (IN.)
Q100A	V51B	1-1/2 or 2	6-3/16
		2-1/2 or 3	6-5/8
		4	7-1/4
		5 or 6	8-15/32
Q100B	V51E	All sizes	10-3/4
Q100C	V51E	1-1/2 or 2	8-1/8
		1-1/2 or 3	8-1/2
		4	9-1/8
		5 or 6	9-5/16

[a]Connecting holes for pins are 5/16 inch in diameter and 1/4 inch from each end of the rod

INSTALLATION

LOCATION

The Q100 is mounted on the gear end of a Modutrol or Actionator motor. The motor must be installed with the crankshaft horizontal. Be sure to allow enough clearance above or below the valve for mounting the motor and for service after installation.

Refer to the instructions packed with the valve and motor for information on the installation. Use the following procedures to install the linkages.

CONNECTING MODUTROL MOTOR AND V51B VALVE USING Q100A LINKAGE (SEE FIG. 1)

Special parts, nuts, and screws needed are in the furnished bag assemblies. Install the motor and linkage as follows (see Fig. 1):

1. Mount plate on stop bracket with 3 No. 10 screws.

2. Mount motor on plate with 3 1/4 inch screws, lock washers, and nuts.

3. Install the special crankarm in position shown. With crankarm tight against shoulder of shaft, tighten clamp screw securely.

4. One end of link measures 1-1/4 inch from end to bend. Slip this end over drive pin. Place washer on drive pin. Insert cotter pin in drive pin. Spread cotter pin ends.

5. Slip the other end of link into the forked end of arm and insert the pin, moving the arm as necessary. Insert cotter pin in pin. Spread cotter pin ends.

(continued on page 3)

ORDERING INFORMATION

WHEN ORDERING REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING SPECIFICATION NUMBER, OR ...

SPECIFY–

1. **LINKAGE MODEL NUMBER.**
2. **V51 VALVE SIZE.**

ORDER FROM–

1. **YOUR USUAL SOURCE, OR**
2. **HONEYWELL**
   1885 DOUGLAS DRIVE
   MINNEAPOLIS, MINNESOTA 55422
   (IN CANADA–HONEYWELL CONTROLS LIMITED
   740 ELLESMERE ROAD
   SCARBOROUGH, ONTARIO)
   INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

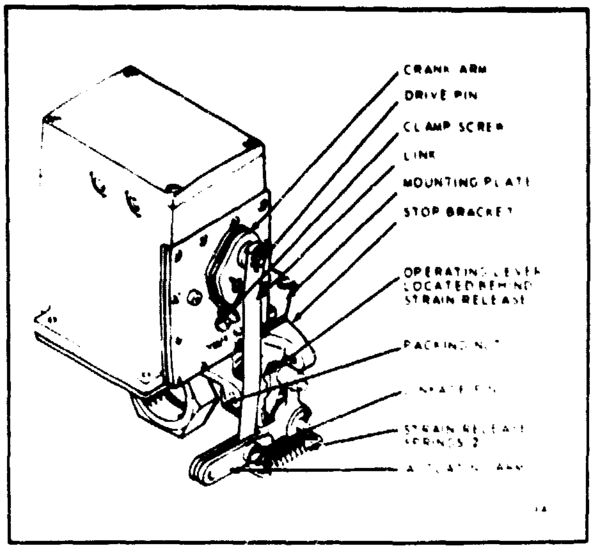


FIG. 1—Q100A LINKAGE ASSEMBLY.

CONNECTING MODUTROL MOTOR AND V51E VALVE USING Q100B LINKAGE (SEE FIG. 2)

The Q100B and V51E must be used with a 90 degree stroke Modutrol motor.

Special parts needed for the basic assembly are furnished in bag assemblies. For adapting Q100B linkage to operate dampers, auxiliary valves, or other equipment, see burner manufacturer's instructions. Install the motor and linkage on the valve as follows (refer to Fig. 2):

1. Mount plate on stop bracket with 3 No. 10 screws and lock washers.
2. Mount motor on plate with four 1/4 inch screws, lock washers, and nuts.

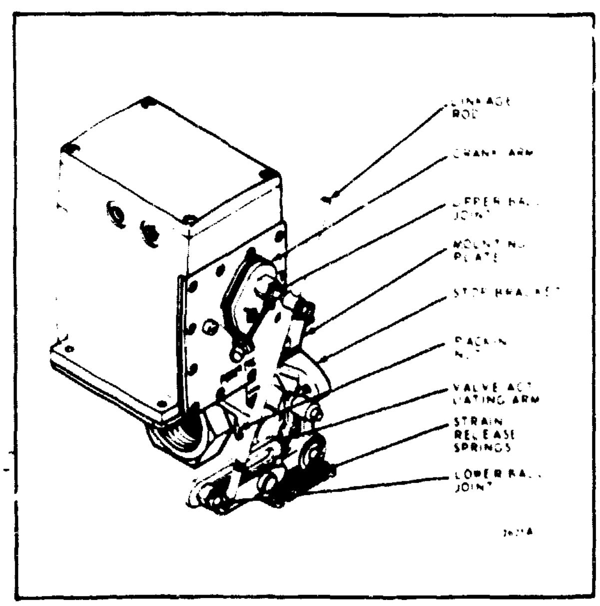


FIG. 2—Q100B LINKAGE ASSEMBLY.

3. Make sure the motor is in the "closed" position (the position assumed when motor terminals are shorted Red-to-White). Install motor crankarm and tighten clamp screw securely.
4. Install valve actuating arm as shown in Fig. 2 and adjust as desired.

CONNECTING ACTIONATOR MOTOR AND V51E VALVE USING Q100C LINKAGE (SEE FIG. 3)

1. Mount plate on stop bracket with 3 No. 10 screws and lock washers.
2. Mount motor on plate with four 1/4 inch hex head screws and lock washers.
3. Install the crankarm in the position shown. With the crankarm tight against the shoulder of the shaft, tighten the clamp screw securely.
4. One end of the link measures 1-3/4 inch from the end to the bend. Slip this end of the link into the forked end of the arm and insert the pin moving the arm as necessary. Insert cotter pin in pin. Spread the cotter pin ends.
5. Insert the drive pin into the other end of the link and place a washer on the drive pin. Insert the drive pin into the crankarm and secure the pin with a nut and locking washer.

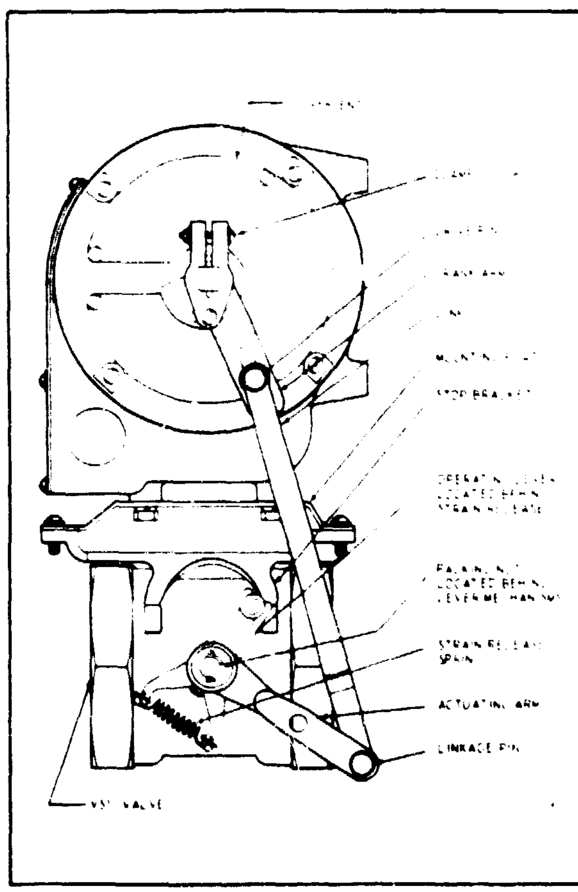


FIG. 3—Q100C LINKAGE ASSEMBLY.

ADJUSTMENTS

Q100B

1. Loosen Allen head setscrews in upper ball joint to allow linkage rod to slide freely. Loosen lower ball joint so that it will slide freely in the actuating arm slot.
2. Short the motor terminals Red-to-White to drive the motor closed.
3. Hold valve disc open at the desired low-fire position and tighten the lower ball joint hand tight against the outer end of the actuating arm slot. Tighten Allen head screws in the upper ball joint to provide some friction on the rod, but not enough to prevent it from sliding if the valve hits its stop.
4. Short the motor terminals Red-to-Blue. As motor drives open, note the valve travel. Reset the lower ball joint to give the proper high-fire valve position.

NOTE: When the lower ball joint is moved, the upper ball joint usually must be readjusted if the valve is to keep the same low-fire position.

Adjustments at the lower and upper ball joints enable the installer to set the valve for any span of travel and for any minimum and maximum setting without loss of motor positions.

Q100A,C
MINIMUM FLOW ADJUSTMENT

Using the motor, drive the valve to the closed position. Loosen the lock nut on the stop screw. Turn this screw in against the operating lever, until the desired minimum flow position is obtained. If full closed is the minimum position desired, back the screw out until its inner end is flush with the stop bracket. Tighten the lock nut.

MAXIMUM FLOW ADJUSTMENT

Using the motor, drive the valve to the open position. Loosen the lock nut on the stop screw. Turn this screw in against the operating lever until the desired maximum flow adjustment is obtained. If full-open is the maximum position desired, back the screw out until its inner end is flush with the stop bracket. Tighten the lock nut.

SERVICE AND CHECKOUT

Operate the system to make sure valve, motor, and linkage assembly function as intended. See the instructions packed with the motor and valve for more specific checkout procedures. Place a few drops of SAE20 or heavier oil on the linkage bearings whenever required.

HONEYWELL MINNEAPOLIS MINN 55408 INTERNATIONAL Sales Offices in all principal cities of the world Manufacturing in Australia Canada Finland France Germany Japan Mexico Netherlands Spain Taiwan United Kingdom U S A
PRINTED IN U S A

Honeywell

MODUTROL MOTOR

THE M941 IS A REVERSING, PROPORTIONAL MODUTROL MOTOR USED TO DRIVE VALVES, DAMPERS, OR AUXILIARY EQUIPMENT. IT IS ADAPTABLE TO COMMERCIAL OR INDUSTRIAL (OIL OR GAS) BURNER SYSTEMS.

- ☐ M941A,C, and D have a heavy-duty, vibration-resistant balance relay.
- ☐ M941B requires an R9107 external balance relay.
- ☐ M941C has 1 cam-adjusted MICRO SWITCH spdt auxiliary switch.
- ☐ M941D has 2 cam-adjusted MICRO SWITCH spdt auxiliary switches.
- ☐ Auxiliary switch differential is fixed on M941C, adjustable on M941D.
- ☐ M941C,D available with auxiliary switches factory adjusted for low or high fire switching.
- ☐ Motor stroke is field adjustable to 90 or 160 degrees.
- ☐ All models require 24V power supply.
- ☐ Die-cast aluminum case.
- ☐ Direct drive feedback potentiometer.
- ☐ Interchangeable with other modulating motors. Use existing accessories.
- ☐ Accessories include weatherproofing kit and cover-mounted transformer.

M941A-D

Residential Div. Form Number 60-2111 3

J.A.
REV. 7-75 (.032)

SPECIFICATIONS

MODELS: The M941 is a reversible, proportioning motor with feedback potentiometer. For additional model characteristics refer to the table below.

MODEL	TIMING (SECONDS)	BALANCE RELAY	INTERNAL AUXILIARY SWITCH
M941A	7-1/2 or 15 15 or 30 30 or 60 60 or 120	Internal balance relay	-
M941B	30 or 60	Requires R9107 externally mounted balance relay	-
M941C	15 or 30 30 or 60	Internal balance relay	Spdt[a]
M941D	15 or 30 30 or 60	Internal balance relay	Spdt(2)[a]

[a]Models available with factory-set make and break switch position.

ELECTRICAL RATING: 24 volts, 50/60 Hz.
POWER CONSUMPTION:

M941A,C,D–21 VA.
M941B–17 VA.

CRANKSHAFT: Double ended, 3/8 inch square.
STROKE: Dual–90 and 160 degrees (field adjustable).

TORQUE (in pound-inches):

TIMING (NOMINAL) 160 DEGREE STROKE	TIMING (NOMINAL) 90 DEGREE STROKE	NORMAL RUNNING TORQUE	BREAKAWAY TORQUE[a]
15 sec.	7.5 sec.	37	75
30 sec.	15.0 sec.	75	150
1,2,4 min.	1/2,1,2 min.	150	300

[a]The maximum torque available to overcome occasional large loads such as a seized damper or valve. MUST NOT BE USED CONTINUOUSLY AT THIS RATING.

DEAD WEIGHT LOAD ON SHAFT:
Power End–200 pounds maximum.
Auxiliary End–100 pounds maximum
AMBIENT TEMPERATURE RATINGS:
Maximum–125 F [54 C].
Minimum–minus 40 F [minus 40 C].
DIMENSIONS: See Fig. 1.
AUXILIARY SWITCH RATING (amps):
M941C

	120V AC	240V AC
Full Load	7.2	3.6
Locked Rotor	43.2	21.6

M941D

	120V AC	240V AC	277V AC
Full Load	5.8	2.9	-
Locked Rotor	34.8	17.4	-
Resistive	11.0	11.0	11.0

SWITCH OPERATING POINT: Field adjustable
SWITCH DIFFERENTIAL:
M941C–Fixed, 10 angular degrees.
M941D–Field adjustable.
UNDERWRITERS' LABORATORIES, INC. LISTED: M941C and D only. File No. E4436, Guide No. XAPX.
NOTE: Only line voltage models and those with auxiliary switches require Underwriters' Laboratories, Inc. listing.

(continued on page 3)

ORDERING INFORMATION

WHEN ORDERING REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING SPECIFICATION NUMBER, OR ...

SPECIFY–
1. MODEL NUMBER, TRADELINE IF DESIRED.
2. VOLTAGE AND FREQUENCY.
3. TIMING.
4. ACCESSORIES, IF DESIRED.

ORDER FROM–
1. YOUR USUAL SOURCE, OR
2. HONEYWELL
1885 DOUGLAS DRIVE NORTH
MINNEAPOLIS, MINNESOTA 55422
(IN CANADA–HONEYWELL CONTROLS LIMITED
740 ELLESMERE ROAD
SCARBOROUGH, ONTARIO)
INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

ACCESSORIES:

DHE-94 Explosion-proof Housing–encloses motor for use in explosive atmospheres. Not for use with Q601 and Q455 Linkages. Order separately from Crouse-Hinds Co. Requires Honeywell 7617DM Coupling.

Cover-transformers–die-cast aluminum cover with built-in transformer.
- Part No. 130810A-120V ac; 60 Hz.
- Part No. 130810B-120/208/240V ac; 60 Hz.
- Part No. 130810C-220V ac; 50 Hz.
- Part No. 130810D-208/240V ac; 60 Hz.
- Part No. 130810E-208V ac, 60 Hz.
- Part No. 130810F-240V ac; 60 Hz.

Q607 Auxiliary Switch–controls auxiliary equipment as a function of motor position.

Q605 Damper Linkage–connects motor to damper; includes motor crank arm.

Q601 Linkage–connects motor to water or steam valve.

Q618 Linkage–connects Modutrol motor to water or steam valve.

Q100 Linkage–connects Modutrol motor to butterfly valve.

R9107A–external balancing relay.

7640JS Weatherproofing Kit–weatherproofs the Modutrol Motor.

7616BR Motor Crank Arm–included with Q605 but not with motor.

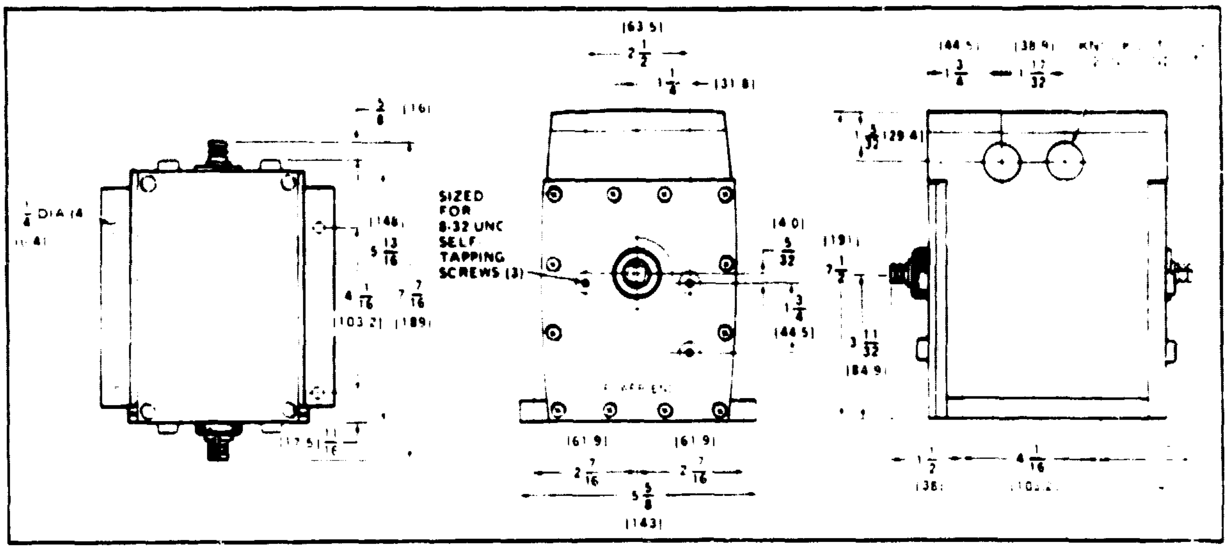


FIG. 1–APPROXIMATE DIMENSIONS OF M941 MOTORS IN INCHES (MILLIMETERS SHOWN IN BRACKETS)

INSTALLATION

CAUTION
1. **Installer must be a trained, experienced serviceman.**
2. **Disconnect power supply before beginning installation.**
3. **Do not attempt to turn the motor shaft by hand or with a wrench. Damage to the gear train will result.**
4. **Always conduct a thorough checkout when installation is complete.**

LOCATION

Install the Modutrol motor in any location except where acid fumes or other deteriorating vapors might attack the metal parts, or in atmospheres of escaping gas or other explosive vapors. Motors are rated for ambient temperatures between minus 40 and 125 F. If located outdoors, use weatherproofing kit; see Accessories section.

Allow enough clearance for installing accessories and servicing the motor when selecting a location. See Fig. 1.

MOUNTING

Always install the motor with the crankshaft horizontal. Mounting flanges extending from the bottom of the motor housing are drilled for 1/4 inch machine screws or bolts.

All M941 motors are shipped from the factory in the closed position, which is the limit of counterclockwise rotation as viewed from the power end of the motor.

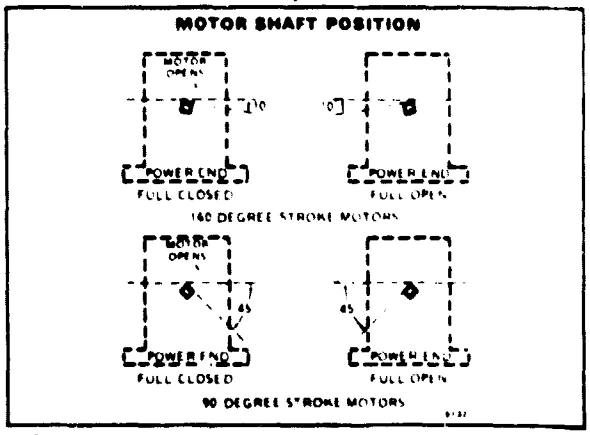


FIG. 2–MOTOR SHAFT POSITION AT ROTATIONAL LIMITS (AS VIEWED FROM THE POWER END OF THE MOTOR).

INSTALLING LINKAGES

The motor comes without a crank arm. The motor arm is included in the Q605 Linkage or may be ordered separately (see Accessories).

For detailed instructions on the assembly of specific linkages, refer to the instruction sheet packed with each linkage.

In general, however, check the following points of operation when installing a motor and linkage.

1. Linkages for valves and louver type dampers should be adjusted so that the damper or valve moves through only the maximum required distance when the motor moves through its full stroke.
2. With modulating control, maximum damper opening should be no more than 60 degrees. Little additional airflow is provided beyond this point.
3. The motor must be stopped at the end of its stroke by the limit switch and must not be stalled by the damper or valve. The motor will be damaged if it is not permitted to complete its full stroke.
4. Do not exceed the motor ratings in any installation.

WIRING

CAUTION
Disconnect power supply before wiring to prevent electrical shock or equipment damage.

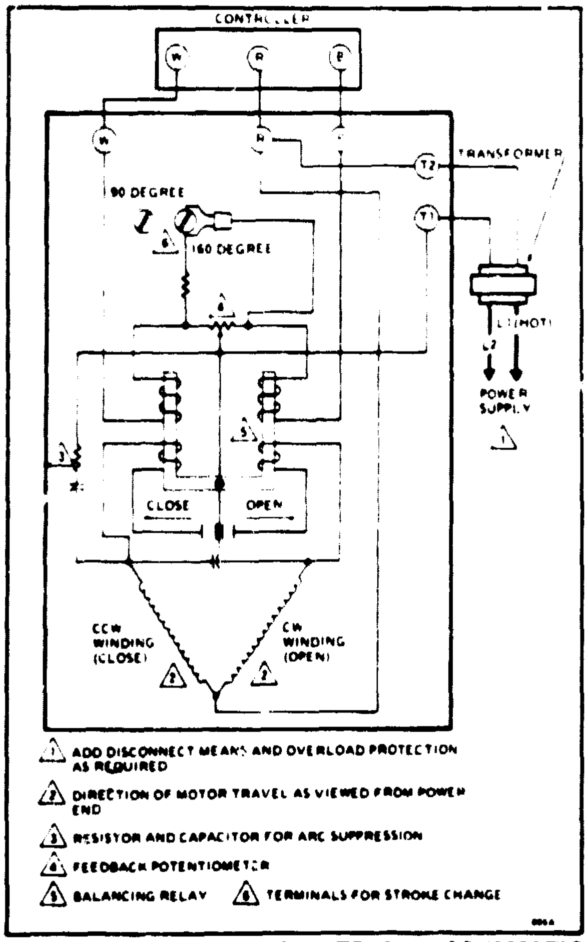


FIG. 3—M941A,C, AND D INTERNAL SCHEMATIC AND BASIC EXTERNAL CONNECTIONS.

All wiring must agree with applicable codes, ordinances, and regulations.

Make sure that the voltage and frequency stamped on the motor correspond to the characteristics of the power supply.

Figs. 3 and 4 show internal schematics and basic connections to the M941 motors.

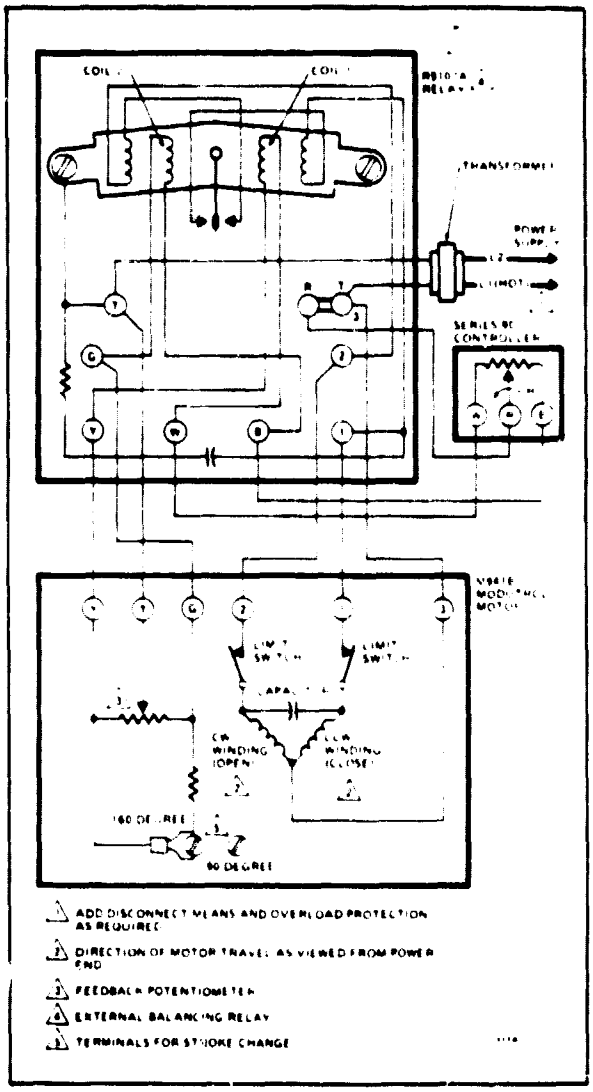


FIG. 4—M941B INTERNAL SCHEMATIC AND CONNECTIONS TO R9107A RELAY.

AUXILIARY SWITCH CONNECTIONS

CAUTION
Disconnect all power supplies to de-energize the auxiliary switches before servicing.

M941C

The M941C has 1 internal auxiliary switch. The switch wires are color-coded as follows: solid yellow-normally closed (N.C.), solid red-common (COM.), solid blue-normally open (N.O.). Refer to Fig. 5.

M941D

The M941D has 2 internal auxiliary switches which may be used to prove low fire and high fire positions (see Fig. 4).

1. To prove low fire, use red (common) and yellow wires connected to left switch. This switch makes red to yellow and breaks red to blue as motor closes.

2. Wires connected to the right switch are black with colored tracers. To prove high fire, use red tracer (common) and blue tracer wires. The right switch makes red tracer to blue tracer and breaks red tracer to yellow tracer as motor opens.

Color coding and switching action are tabulated below to aid the installer.

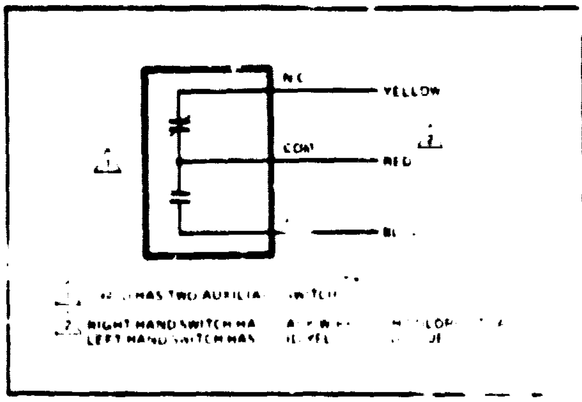


FIG. 5—AUXILIARY SWITCH CONNECTIONS

SWITCH/CAM COLOR-CODING

SWITCH LOCATION[a]	CAM ASSEMBLY LOCATION[a]	SWITCH/CAM COLOR CODE	SWITCH WIRES[b] COLOR	DESIGNATION
Left	Inner	Blue Dot	Solid Yellow	Normally Closed (N.C.)
			Solid Red	Common (COM.)
			Solid Blue	Normally Open (N.O.)
Right	Outer	Red Dot	Yellow Tracer	Normally Closed (N.C.)
			Red Tracer	Common (COM.)
			Blue Tracer	Normally Open (N.O.)

[a]Viewed from auxiliary end of motor

[b]See Fig. 5

SWITCHING ACTION

SWITCH LOCATION[a]	NORMAL FUNCTION	MAKES	BREAKS	CAM POSITION[b]	MOTOR POSITION
Left	Proves Low Fire Position	Red to Yellow	Red to Blue	Operational Cam Lobe in Contact with Cam Roller	Closing
Right	Proves High Fire Position	Red Tracer to Blue Tracer	Red Tracer to Yellow Tracer	Operational Cam Lobe in Contact with Cam Roller	Opening

[a]Viewed from auxiliary end of motor

[b]See Figs. 6, 10, and 11.

SETTINGS AND ADJUSTMENTS

STROKE ADJUSTMENT

Changing the position of the limit arms that actuate the limit switches adjusts the motor stroke. Use the following procedure to adjust the stroke to 90 or 160 degrees.

Step 1—Run the motor to approximately midstroke. Stop the motor by removing power to it. Remove the auxiliary end cover from the motor by taking out the 4 screws securing it. Be careful not to lose the washers (2) and spring on the motor shaft (M941C and D). Remove the switch cam assemblies (M941C, 1; M941D, 2; M941A and B have no switch cams).

Step 2—Loosen the 2 locking screws on the limit arm hub. (See Fig. 6.)

IMPORTANT

DO NOT loosen the set screw on the limit arm hub.

Set the arms at either extreme of their travel. With both arms up, the stroke will be 160 degrees; with both arms down, the stroke will be 90 degrees. Move them to the desired position. Tighten the locking screws.

Step 3—In the wiring compartment, connect lead to proper terminal (90 or 160 degrees).

CAUTION

Both limit arms and lead must be set for the same stroke (90 or 160 degrees) or the motor will not operate properly.

Step 4 Replace switch cam assemblies (M941C, 1; M941D, 2) and make certain colored dot on cam matches the switch it drives (inner cam assembly and left switch – blue dots; outer cam assembly and right switch – red dots). Make certain the driving dogs on the cams engage the keyway slots on the limit arm assembly. Replace the spring and washers (2) and the auxiliary end cover, using the 4 screws removed in Step 1.

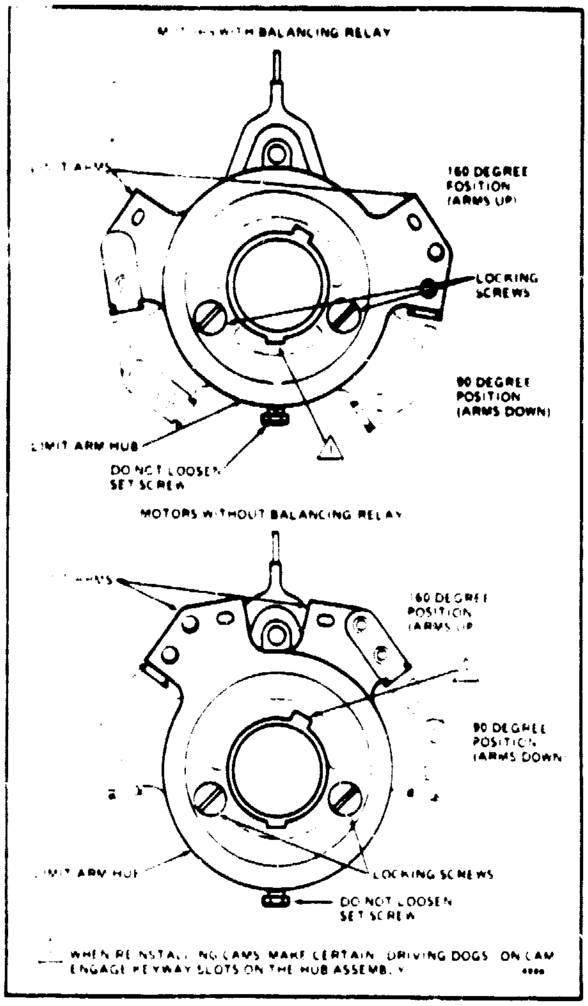


FIG. 6–CHANGE THE POSITIONS OF THE LIMIT ARMS TO ADJUST THE MOTOR STROKE.

AUXILIARY SWITCH ADJUSTMENT

(M941C,D only)

The auxiliary switches in the M941 are operated by cams on the motor shaft. Each switch is operated by a separate set of cams, the left switch and cams are color-coded blue, and the right switch and cams are color-coded red. The switch makes red to blue when its cam roller moves to the upper level of the operational cam and makes red to yellow when the cam roller moves to the lower level. The differential cam provides an intermediate level. On the M941C the differential is fixed at 10 angular degrees; on the M941D the differential cam can be adjusted to change the differential between the switch make and break points.

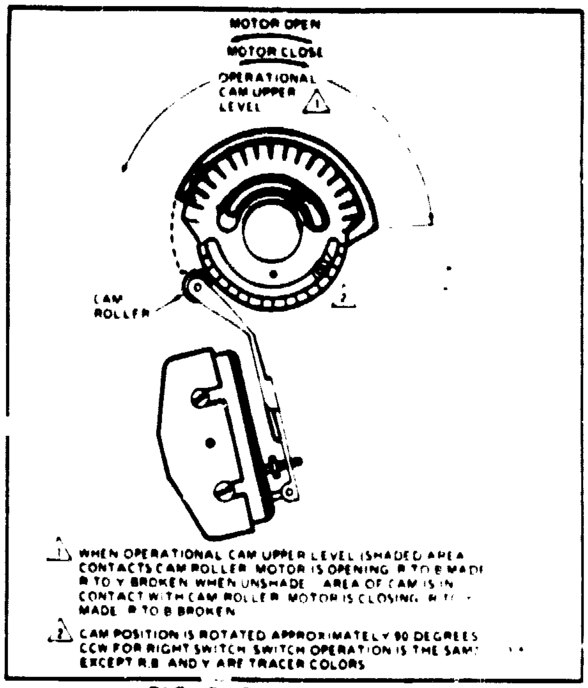


FIG. 7–CAM OPERATION.

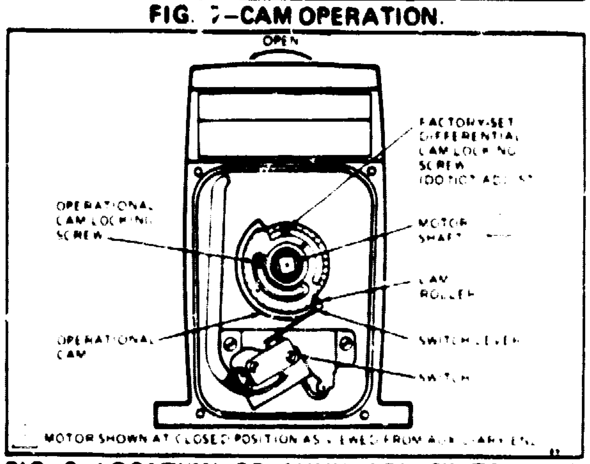


FIG. 8–LOCATION OF AUXILIARY SWITCH AND CAM ASSEMBLY IN THE M941C.

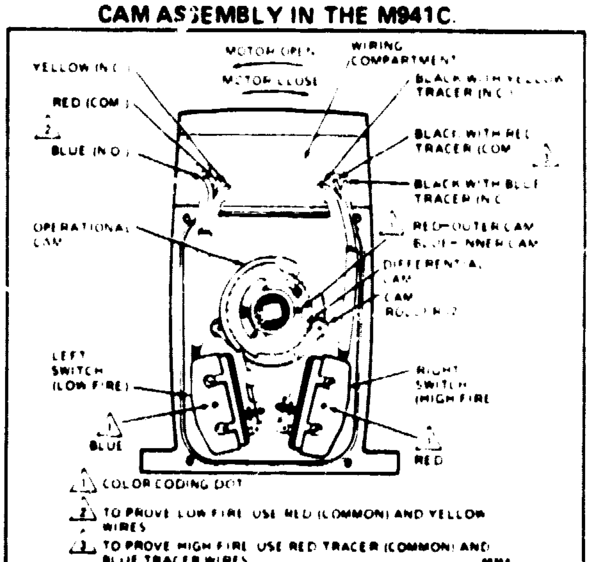


FIG. 9–LOCATION OF AUXILIARY SWITCH AND CAM ASSEMBLY IN THE M941D.

CAUTION
Disconnect all power supplies to de-energize the auxiliary switches before proceeding.

APPROXIMATE ADJUSTMENT

(Does not require running the motor.)

1. Motor must be in the full closed position.
2. Remove auxiliary end cover by removing the 4 screws securing it to the motor.
3. Remove spring and washers on motor shaft.
4. Push back right cam roller and remove outer cam. Note color-coding dots.
5. Adjust left switch (inner cam) first. See Fig. 10

CAUTION
On the M941C, do not attempt to adjust the differential cam or to loosen the differential cam locking screw. The differential on this model is factory set and cannot be field adjusted.

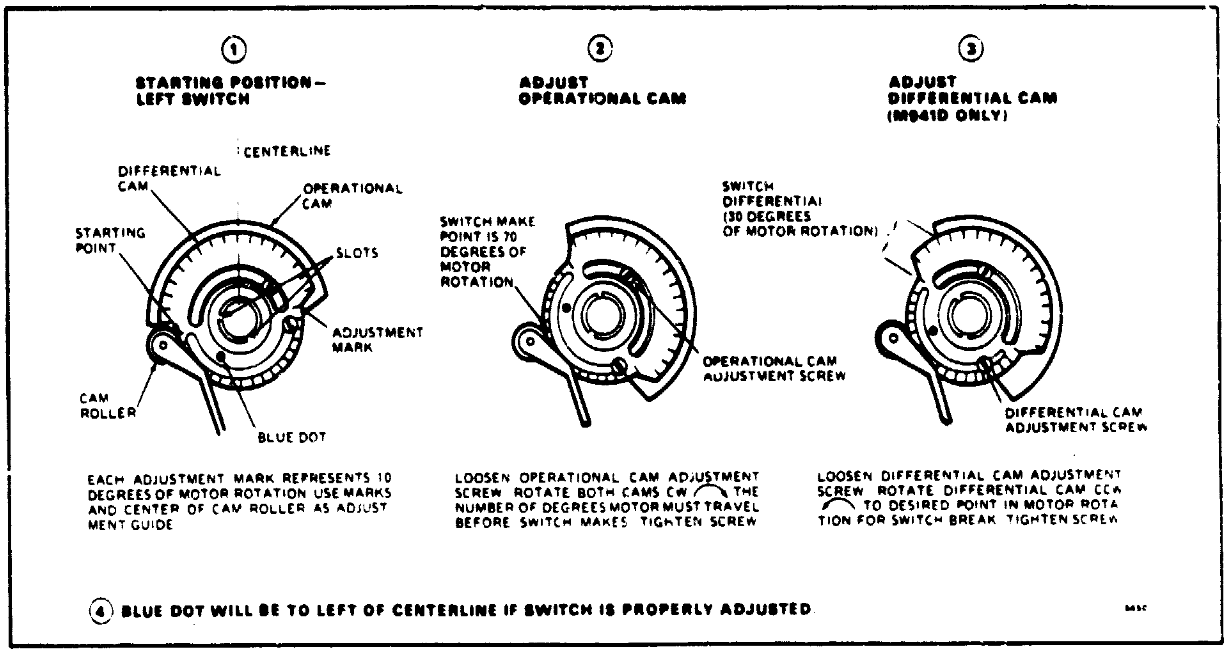


FIG. 10—ADJUST MAKE AND BREAK POINTS OF LEFT AUXILIARY SWITCH.

6. On the M941D, put right switch cams on motor shaft and adjust right switch. See Fig. 11.

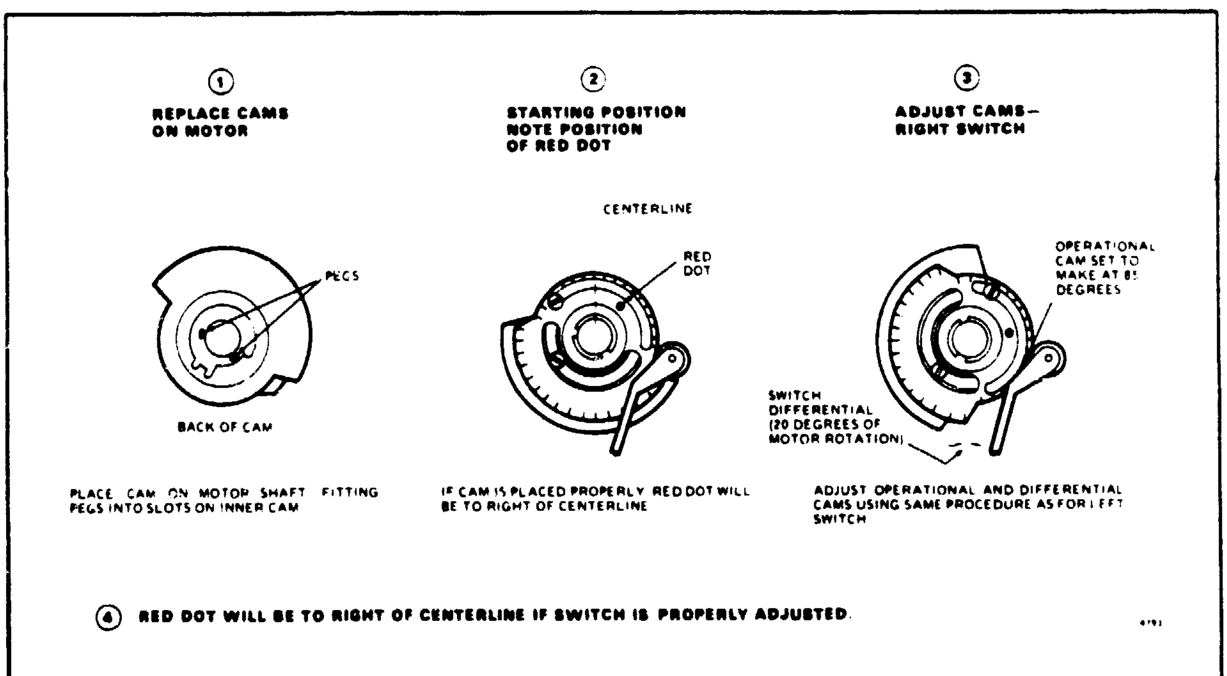


FIG. 11—ADJUST MAKE AND BREAK POINTS OF RIGHT AUXILIARY SWITCH (M941D ONLY).

C - 2

7. After switches are adjusted, replace spring and washers on motor shaft and replace the auxiliary end cover.

EXACT ADJUSTMENT

(Requires running the motor.)

Connect a manual potentiometer to the motor in place of the regular controller and run the motor to the desired position for switch make. Set the operational cam so the cam roller is on the outer corner of the upper level of the operational cam, and tighten the operational cam locking screw. On the M941D, run the motor back to desired switch break point and set differential cam. DO NOT ATTEMPT TO ADJUST THE DIFFERENTIAL CAM ON THE M941C.

CAUTION

Do not attempt to turn the motor shaft by hand or with a wrench as damage to the gear train will result.

OPERATION

SERIES 90 CIRCUIT

The 2 potentiometers, one in the controller and one in the motor, along with the balance relay form a bridge circuit. As long as the value of the controlled medium remains at the controller set point, the circuit is balanced (equal current flowing through each half of the balancing relay), and the motor does not run.

When the value of the controlled medium changes, the potentiometer wiper in the controller is moved. This unbalances the circuit and more current flows through one-half of the balancing relay. The relay closes and the motor runs in the direction necessary to correct the change in temperature or pressure. As the motor runs, the feedback potentiometer moves to rebalance the circuit and stop the motor.

CHECKOUT

After installation and linkage adjustment, check the entire motor and control hookup to prove that-

- the motor operates the damper or valve properly.
- the motor responds properly to the controller.

Inspect the motor, linkage and valve or damper to see that all mechanical connections are correct and secure. In damper installations, the push rod should not extend more than a few inches past the ball joints. Check to see that there is adequate clearance for the linkage to move through its stroke without binding or striking other objects.

M941 motors are shipped in the fully closed position (the limit of counterclockwise rotation as viewed from the power end of the motor).

To check operation of motors with integral balance relay, jumper R1 to W1 to close, or R1 to B1 to open, the motor. Check operation of motors without integral balance relay by jumpering appropriate terminals on the remote balance relay.

HONEYWELL MINNEAPOLIS MINN 55408 INTERNATIONAL Sales Offices in all principal cities of the world Manufacturing in Australia Canada Finland France Germany Japan Mexico Netherlands Spain Taiwan United Kingdom U S A

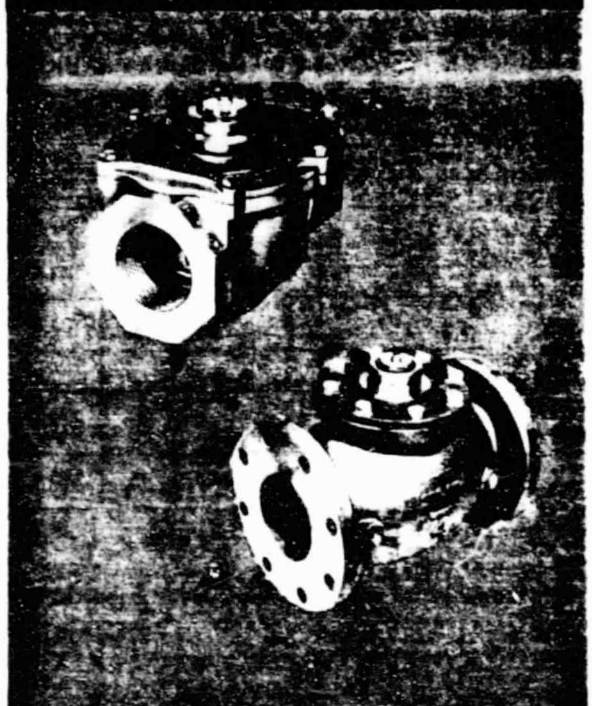
PRINTED IN U S A

Honeywell

THE V5055 GAS VALVES ARE USED WITH THE V4055, V4062, AND V9055 FLUID POWER ACTUATORS TO CONTROL GAS FLOW TO COMMERCIAL AND INDUSTRIAL BURNERS. THEY MAY BE USED WITH NATURAL OR LP GASES.

- V5055 single-seated, normally closed valves are suitable for service requiring tight shutoff.
- V5055A,C,D,E valves are for On-Off service.
- V5055B valve has a characterized guide to provide slow opening, Hi-Lo-Off, or Modulating service.
- V5055C and E valves have 2 seals to provide a valve seal overtravel interlock (valve-closed indication).
- V5055D and E valves are for high pressure applications.
- Threaded connections for 7 pipe sizes from 3/4 to 3 in. NPT (or parallel BSP); V5055A, B,C are also available in a 4 in. size with flange connections.
- Standard–1/4 in. NPT or parallel BSP upstream tap and plug. Optional–1/8 in. NPT downstream tap and plug; additional 1/2 in. NPT upstream tap and plug.
- Valve body rating of 75 psi [517.1 kPa]; body passes burst test of Underwriters Laboratories Inc.
- Yellow "SHUT" indicator right on the valve stem represents an accurate indication of the actual position of the valve disc.
- Unpainted, die-cast aluminum body.

INDUSTRIAL GAS VALVES



V5055

Form Number 60-2307-5

J.B.
REV. 11-79 (.13)

SPECIFICATIONS

IMPORTANT

THE SPECIFICATIONS GIVEN IN THIS PUBLICATION DO NOT INCLUDE NORMAL MANUFACTURING TOLERANCES. THEREFORE, THIS UNIT MAY NOT MATCH THE LISTED SPECIFICATIONS EXACTLY. ALSO, THIS PRODUCT IS TESTED AND CALIBRATED UNDER CLOSELY CONTROLLED CONDITIONS, AND SOME MINOR DIFFERENCES IN PERFORMANCE CAN BE EXPECTED IF THOSE CONDITIONS ARE CHANGED.

MODELS:

V5055A Industrial Gas Valve for On-Off service.

V5055B Industrial Gas Valve with characterized guide for slow opening, Hi-Lo-Off, or Modulating service.

V5055C - Same as V5055A, but with 2 seals to provide a valve seal overtravel interlock (valve-closed indication).

V5055D - Same as V5055A, but for high pressure applications.

V5055E - Same as V5055C (with valve-closed indication feature), but for high pressure applications.

TYPE OF GAS: Natural or LP (liquefied petroleum) only.

PIPE SIZE (in.): 3/4, 1, 1-1/4, 1-1/2, 2, 2-1/2, 3, and 4 (only V5055A,B,C available in 4 in. size).

PIPE THREADS: NPT (National Pipe Threads) or parallel BSP (British Standard Pipe Threads - equivalent to ISO R7 and DIN 2999) available on inlet and outlet of 3/4 to 3 in. valves; 4 in. valves have flange connections.

PRESSURE RATINGS: See Table I.

TABLE I - PRESSURE RATINGS OF VALVE-ACTUATOR COMBINATIONS

VALVE	ACTUATOR											
	V4055A,D[c]				V4055B,E[c]				V4062, V9055[c]			
	DIFF.[a]		CLOSE-OFF[b]		DIFF.[a]		CLOSE-OFF[b]		DIFF.[a]		CLOSE-OFF[b]	
	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa
V5055A,C 3/4 to 3 in.	5	34.5	15	103.4	15	103.4	15	103.4	5	34.5	15	103.4
V5055A,C 4 in.	3	20.7	15	103.4	5	34.5	15	103.4	3	20.7	15	103.4
V5055B 3/4 to 3 in.	5	34.5	15	103.4	15	103.4	15	103.4	5	34.5	15	103.4
V5055B 4 in.	3	20.7	15	103.4	5	34.5	15	103.4	3	20.7	15	103.4
V5055D,E 3/4, 1, 1-1/4, 1-1/2 in.	5	34.5	75	517.1	25	172.4	75	517.1	5	34.5	75	517.1
V5055D,F 2, 2-1/2, 3 in.	5	34.5	45	310.3	15	103.4	45	310.3	5	34.5	45	310.3

[a] Maximum operating pressure differential.

[b] Maximum close-off pressure without seat leakage. This is the maximum allowable pressure drop to which a valve may be subjected while fully closed, and is independent of the valve body rating.

[c] Use a V4055D, V4055E, V4062D, or V9055D (with valve-closed indication switch) with a V5055C or E (with double seal) for a Valve Seal Overtravel Interlock.

(continued on next page)

ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALER OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY—

1. **Order number.**
2. **Pipe size.**
3. **NPT or parallel BSP threads (except for 4 in. models with flanges).**
4. **Optional additional tapping and plug—1/8 in. downstream and/or 1/2 in. upstream.**
5. **Replacement parts, if desired.**

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. **YOUR LOCAL HONEYWELL RESIDENTIAL GROUP SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY).**
2. **RESIDENTIAL GROUP CUSTOMER SERVICE**
   HONEYWELL INC., 1885 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422 (612) 542-7500

   (IN CANADA—HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9) INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

VALVE BODY RATING: 75 psi [517.1 kPa]; body passes burst test of Underwriters Laboratories Inc.

VALVE CAPACITIES: A.G.A. ratings at 1 in. [0.25 kPa] pressure drop; based on gas with specific gravity of 0.64. (See Fig. 1 for other pressure drops.)

VALVE SIZE (in.)	A.G.A. RATED CAPACITY	
	cfh	m^3/hr
3/4	665	18.8
1	960	27.2
1-1/4	1406	39.8
1-1/2	1717	48.6
2	3620	102.5
2-1/2	4250	120.3
3	5230	148.1
4 (V5055A)	10200	288.8
4 (V5055B,C)	9180	259.9

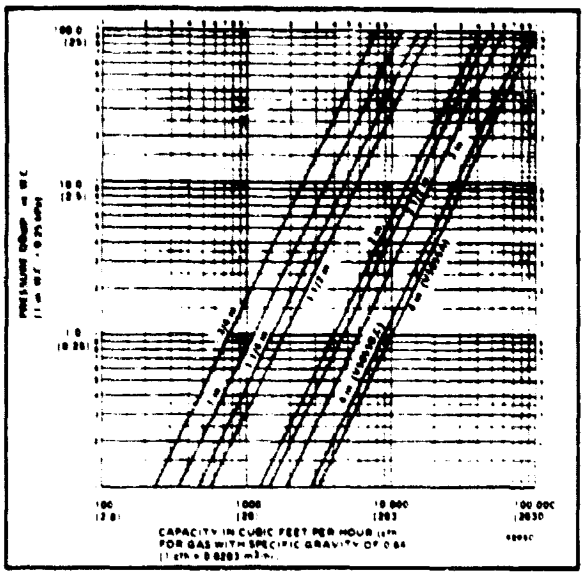


FIG. 1—FLOW CURVES FOR V5055 VALVES.

UPSTREAM TAPPING AND PLUG: 1/4 in. NPT or parallel BSP is standard; additional 1/2 in. NPT is optional.

DOWNSTREAM TAPPING AND PLUG (optional): 1/8 in. NPT.

AMBIENT OPERATING TEMPERATURE RATING: Minus 40 F to plus 150 F [minus 40 C to plus 66 C]; (to plus 125 F [52 C] when used with a V9055).

MATERIAL: Die-cast aluminum.

MOUNTING MEANS: Mounts directly in the gas supply line.

DIMENSIONS: See Fig. 2 and 3.

WEIGHT:

3/4, 1, 1-1/4, 1-1/2 in. valve	- 4 lb [1.8 kg].
2 in. valve	- 8 lb [3.6 kg].
2-1/2, 3 in. valve	-11 lb [5.0 kg].
4 in. valve	-28 lb [12.7 kg].

REPLACEMENT PARTS:

Replacement seal assembly—includes valve seal, bonnet seal, and tube of lubricant.

133393A for 3/4, 1, 1-1/4, and 1-1/2 in. valves.
133392A for 2, 2-1/2, and 3 in. valves.
137253A for 4 in. valves.

Replacement bonnet assembly—includes complete bonnet assembly, plus the required replacement seal assembly.

VALVE MODEL	VALVE SIZE (in.)	REPLACEMENT BONNET ASSEMBLY
V5055A (On-Off)	3/4,1,1-1/4,1-1/2	133398AA
	2,2-1/2,3	133417AA
	4	136911AA
V5055B (Characterized Guide)	3/4,1,1-1/4 1-1/2	133398BA
	2,2-1/2,3	133417BA
	4	136911BA
V5055C (Valve-Closed Indicator)	3/4,1,1-1/4,1-1/2	137338AA
	2,2-1/2,3	133964AA
	4	136911CA
V5055D (High Pressure, On-Off)	3/4,1,1-1/4,1-1/2	136308AA
	2,2-1/2,3	136307AA
V5055E (High Pressure, Valve-Closed Indicator)	3/4,1,1-1/4,1-1/2	136308BA
	2,2-1/2,3	136307BA

APPROVALS: The following combinations of V5055 Valves (3/4 through 4 in.) and V4055, V4062, and V9055 Fluid Power Actuators are approved by these agencies.

UNDERWRITERS LABORATORIES INC. LISTED (File No. MH1639, Guide No. YIOZ):
V4055A,B,D,E/V5055A,B,C,D,E
V4062/V5055A,B,C,E
V9055/V5055A,B,C,E

INDUSTRIAL RISK INSURERS (FORMERLY F.I.A.) APPROVABLE:
V4055A,B,D,E/V5055A,B,C,D,E
V4062/V5055A,B,C,E
V9055/V5055A,B,C,E

FACTORY MUTUAL APPROVED (Report Nos. 20698, 20835, 21172, and 24061) AND AMERICAN GAS ASSOCIATION DESIGN CERTIFIED (Certificate Nos. F-273.001, F-273.101, and F-273.201):

V4055A/V5055A,B	V4055E/V5055E
V4055B/V5055D	V4062/V5055B,C
V4055D/V5055C	V9055/V5055B,C

CANADIAN GAS ASSOCIATION CERTIFIED (Report No. 1029-SSV-4098; 60 Hz actuator models only):
V4055A,B,D,E/V5055A,B,C,D,E
V4062/V5055B
V9055/V5055B

(continued on next page)

BRITISH GAS CORPORATION AND DUTCH GAS INSTITUTE APPROVED:

V4055 or V4062 with V5055A1129, -A1137, -A1145, -A1152, -A1160, -A1178, -B1168, -B1176, -B1184, -B1192, -B1200, -B1218, -B1317, -B1325, and -B1333.

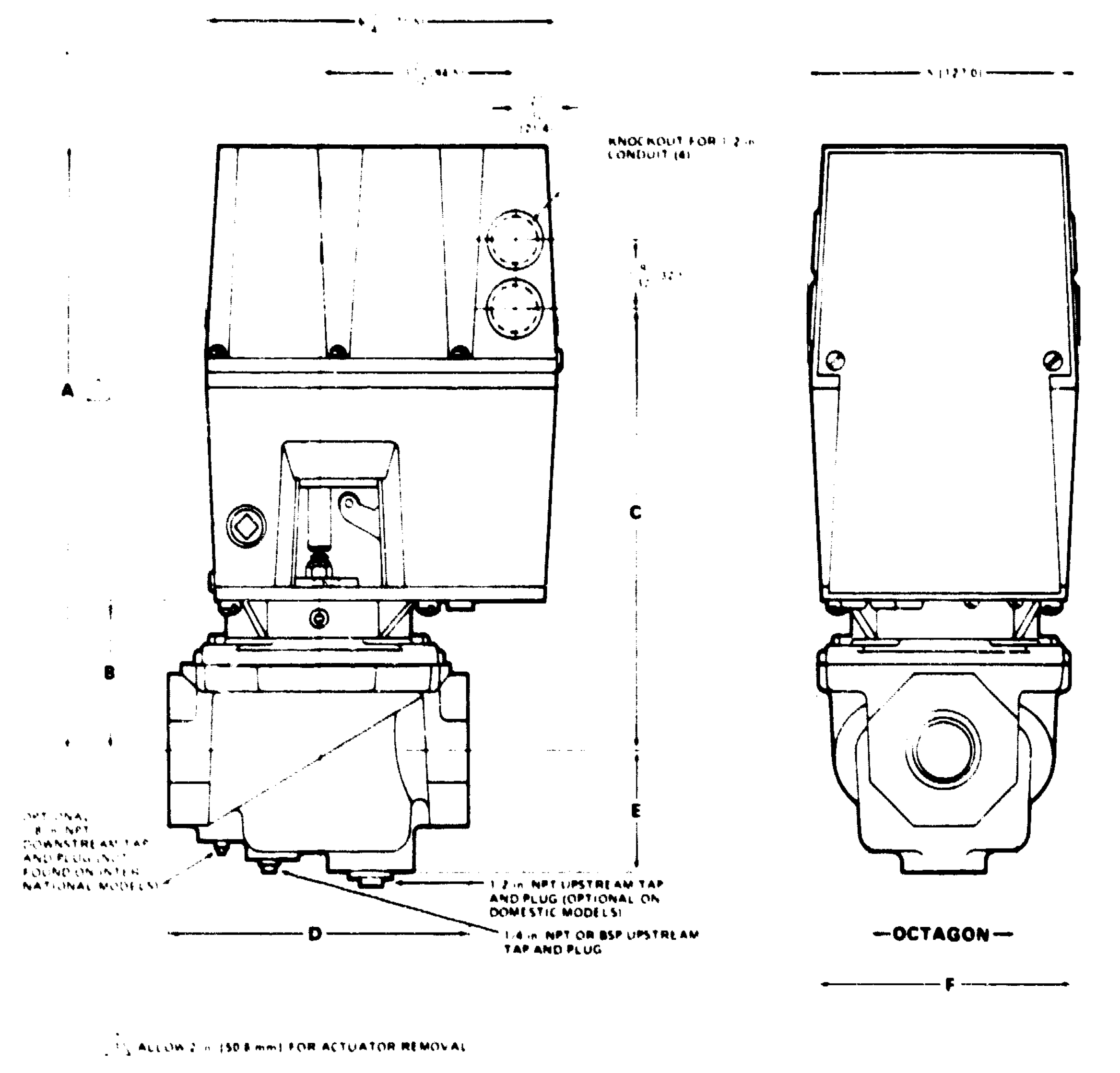
V4055D or V4062D with V5055C1216, -C1224, and -C1232.

AUSTRALIAN GAS ASSOCIATION APPROVED:

V5055B1242, -B1259, -B1267, -B1275, -B1283, -B1291, and -B1309.

DIN-DVGW APPROVED (GERMANY):

V5055A1129, -A1137, -A1145, -A1152, -A1160, -A1178, -A1236, -B1168, -B1176, -B1184, -B1192, -B1200, -B1218, and -B1226.



ALLOW 2 in (50.8 mm) FOR ACTUATOR REMOVAL

VALVE SIZE	DIM A		DIM B		DIM C		DIM D		DIM E		DIM F		OCTAGON	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
3/4 in	11 1/8	282.6	2 3/4	69.9	8 3/16	208.0	5 3/4	146.1	2 1/4	57.2	4 13/16	122.2	2 13/16	71.4
1 in	11 1/8	282.6	2 3/4	69.9	8 3/16	208.0	5 3/4	146.1	2 1/4	57.2	4 13/16	122.2	2 13/16	71.4
1 1/4 in	11 1/8	282.6	2 3/4	69.9	8 3/16	208.0	5 3/4	146.1	2 1/4	57.2	4 13/16	122.2	2 13/16	71.4
1 1/2 in	11 1/8	282.6	2 3/4	69.9	8 3/16	208.0	5 3/4	146.1	2 1/4	57.2	4 13/16	122.2	2 13/16	71.4
2 in	11 1/4	285.8	2 7/8	73.0	8 5/16	211.1	8 3/8	212.7	2 15/16	74.6	[illegible]	102.9	3 1/2	88.9
2 1/2 in	11 3/4	298.5	3 3/8	85.7	8 13/16	223.8	9 1/4	235.0	2 3/4	69.9	[illegible]	102.9	4 1/2	114.3
3 in	11 3/4	298.5	3 3/8	85.7	8 13/16	223.8	9 1/4	235.0	2 3/4	69.9	[illegible]	102.9	4 1/2	114.3

FIG. 2–APPROXIMATE DIMENSIONS OF THE 3/4 THROUGH 3 in. V5055 VALVES WITH VALVE ACTUATOR, IN in. [mm IN BRACKETS].

GAS VALVE SIZING

1. Check the burner nameplate for (a) the type of gas used, and (b) the gas flow capacity. The capacity will be listed in Btuh (Btu's per hour) or in cfh (cubic feet per hour).
2. Call the gas utility for information on (a) the specific gravity (sp gr) and (b) Btu per cubic feet (Btu/cu ft) for type of gas used.
3. Find the capacity in cfh. If the capacity is listed in Btuh, convert to cfh by the following formula.

$$\text{Capacity in cfh} = \frac{\text{Btuh (from burner nameplate)}}{\text{Btu/cu ft (from gas utility)}}$$

4. For gases with specific gravities other than 0.64, multiply the burner cfh by the proper conversion factor shown below.

TYPE OF GAS	sp gr (average)	MULTIPLY cfh BY
LP–Propane	1.53	1.55
LP–Butane	1.98	1.76

5. Use the corrected capacity in cfh when determining the gas valve size on Fig. 1.
6. Determine the maximum pressure drop across the valve, and draw a horizontal line at this pressure on Fig. 1.
7. Draw a vertical line on Fig. 1 at the capacity (cfh) previously determined. *Use the corrected capacity for a gas with a specific gravity other than 0.64.*
8. Use the valve size at the intersection of the horizontal and vertical lines. If the intersection is between valve sizes, use the next higher valve size to the right.

TO SIZE 2 IDENTICAL VALVES PIPED IN SERIES

1. Find the cfh for the type of gas used.
2. Consider both valves as 1 unit. Determine the total maximum pressure drop across the unit.
3. Find the pressure drop across the first valve by assuming it to be 45 percent of the total pressure drop.
4. Find the valve size from Fig. 1.
5. The second valve will be the same size as the first valve.

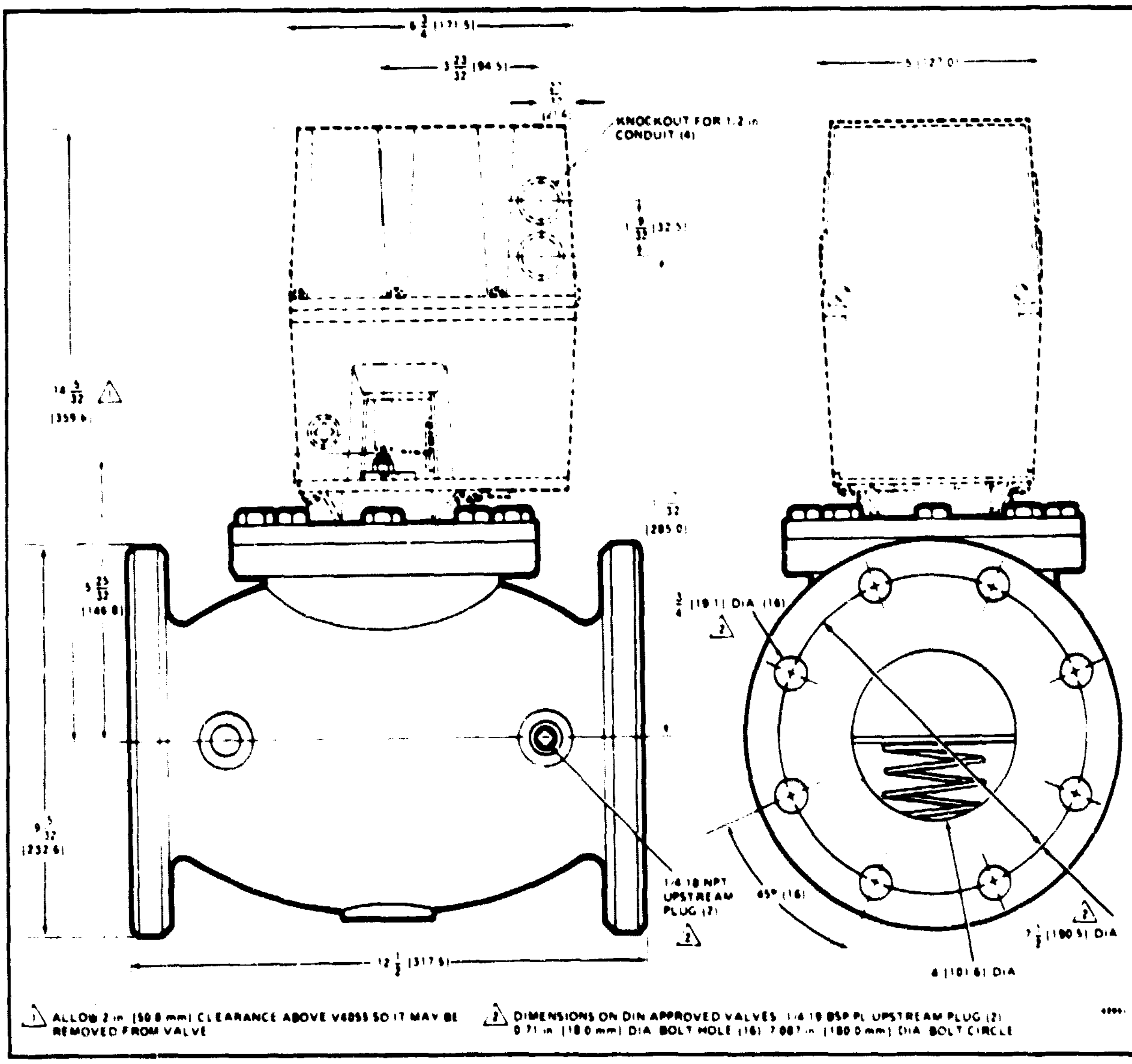


FIG. 3—APPROXIMATE DIMENSIONS OF THE 4 in. V5055 VALVES WITH VALVE ACTUATOR, IN in. [mm IN BRACKETS].

INSTALLATION

WHEN INSTALLING THIS PRODUCT . . .

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced, flame safeguard control technician.
4. After installation is complete, check out product operation as provided in these instructions.

CAUTION

1. Turn off gas supply before starting installation.
2. Disconnect power supply for valve actuator before beginning installation to prevent electrical shock and equipment damage.
3. The valve must be installed so the arrow on the valve points in the direction of gas flow. (Gas pressure helps to close the valve.)

LOCATION

Install the valve in the gas supply line downstream of the pressure regulator. The valve and actuator may be mounted in any position that allows sufficient clearance for installation and for repair or replacement.

1. The valve position indicators should be easily visible with the valve and actuator in their final position.
2. The final position of the valve and actuator must allow for damper linkage if used.

IMPORTANT

Allow room for turning the valve body (actuator not attached) onto the gas piping. "Swing" dimensions, measured from the center of the pipe are:

- 3/4 through 1-1/2 in. valves–4 in. [101.6 mm].
- 2 through 3 in. valves–5 in. [127.0 mm].
- 4 in. valves–7 in. [177.8 mm].

MOUNTING (FIGS. 4 THROUGH 6)

WARNING

If flow is not in direction of arrow on valve body, valve may not shut off.

1. Use new, properly reamed pipe, free from chips.
2. Do not thread pipe too far (Fig. 4). Valve distortion or malfunction may result from excess pipe in valve.
3. Remove the protective caps from the ends of the valve. Do not attach the valve actuator until the valve body installation is complete.
4. Apply good quality pipe dope, putting a moderate amount on the male threads only. Use dope sparingly; if pipe dope lodges on the valve seat, it will prevent proper closure. If using LP (liquefied petroleum) gas, use pipe dope resistant to action of LP gas.
5. Install valve with the gas flow in the direction indicated by the arrow on the casting.
6. Apply a parallel jaw wrench only to the flat next to the pipe being inserted (Fig. 5). A wrench applied to the valve body itself or to the end farthest from the pipe being inserted may distort the casting, causing a malfunction. Do not use the valve for a lever.
7. The gas flow MUST be in the same direction as the arrow on the bottom of the valve body.
8. Two threaded companion flanges, 2 gaskets (included with valve), and 16 bolts (with washers and nuts) are required for mounting a 4 in. V5055 valve. Mount a threaded flange and gasket on each end of the valve as shown in Fig. 6. Then screw the pipes into the threaded flanges. Apply dope sparingly, and use wrenches and vises properly as shown in Figs. 4 and 5.
9. *Make sure the power supply has been disconnected from the valve actuator.* Then mount the actuator on the valve body and complete the electrical and linkage connections as instructed in the sheet packed with the actuator.

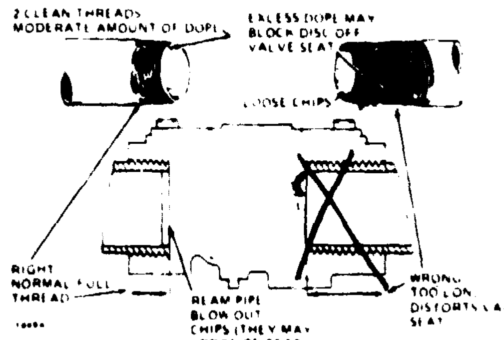


FIG. 4–PREPARING THE PIPES.

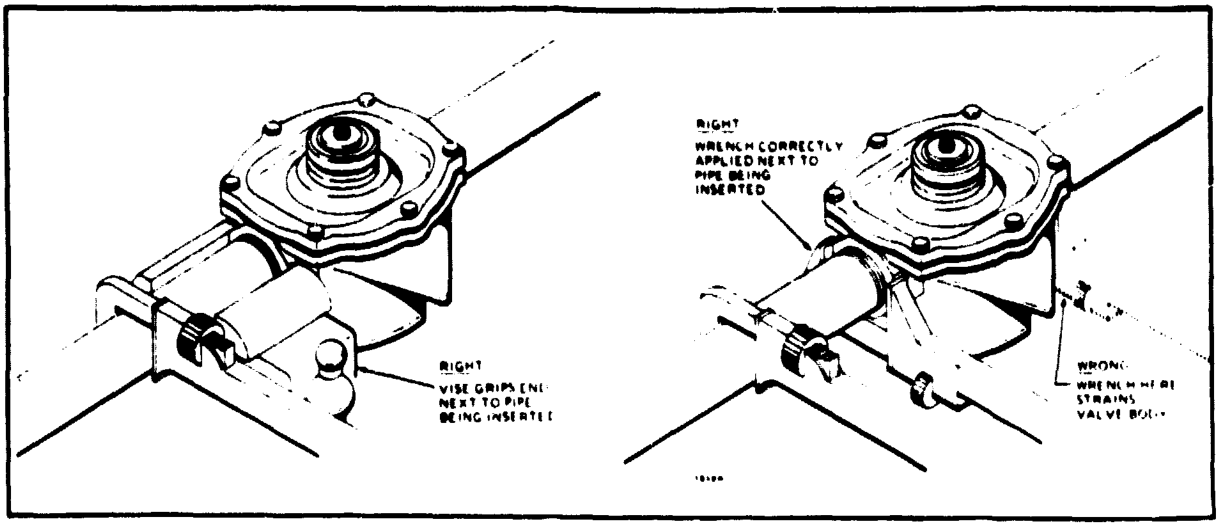


FIG. 5—INSTALLING A 3/4 THROUGH 3 in. V5055 VALVE.

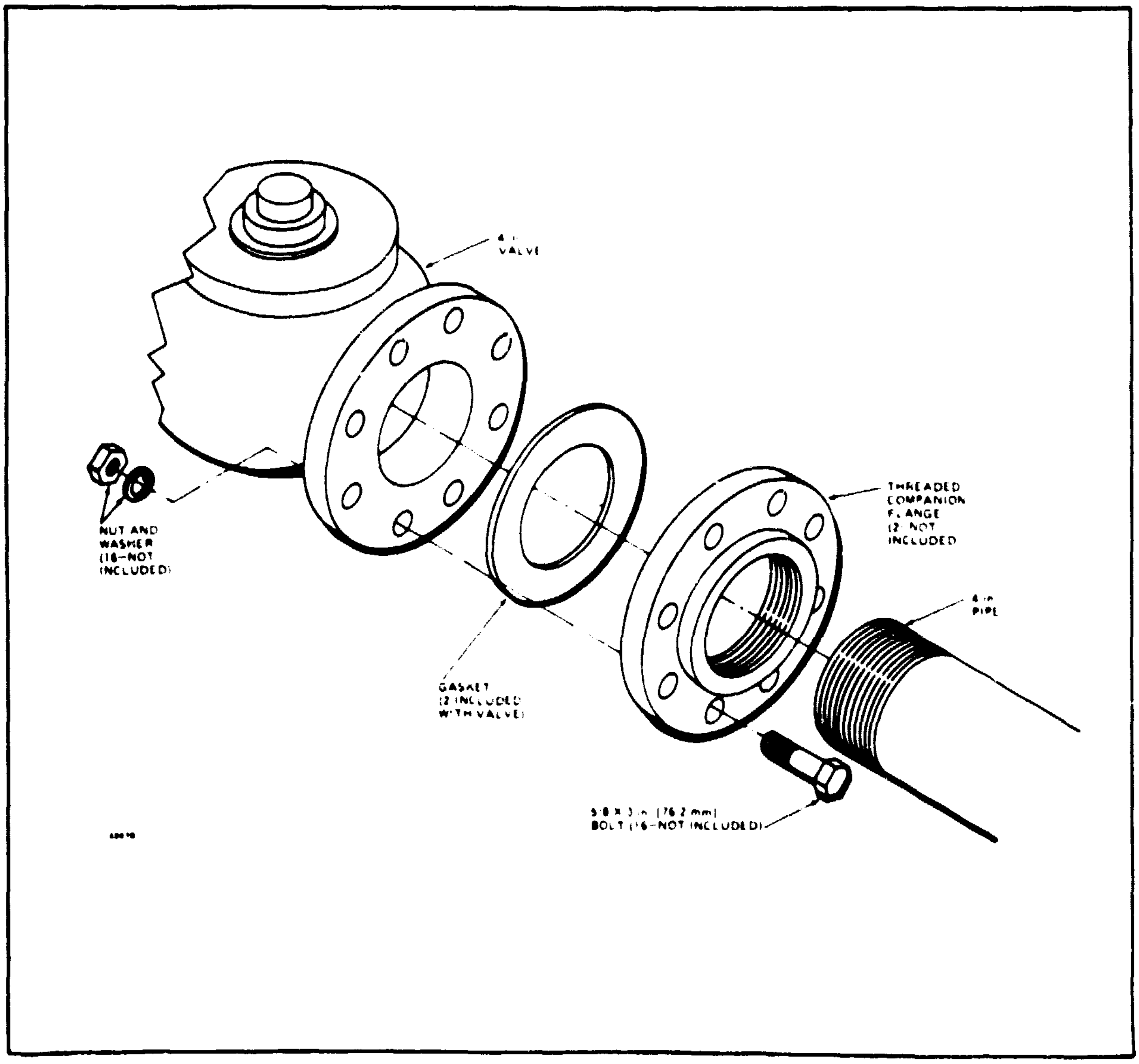


FIG. 6—INSTALLING A 4 in. V5055 VALVE.

OPERATION AND CHECKOUT

OPERATION

A V5055 Industrial Gas Valve is operated by a V4055, V4062, or V9055 Fluid Power Gas Valve Actuator. The valve opens when the actuator is energized, and closes when power is removed. When closed, the valve seals off against the rated close-off pressure with no power applied. For further information, refer to the instruction sheet for the actuator.

CHECKOUT

WARNING

Do not allow fuel to accumulate in the combustion chamber. If fuel is allowed to enter the chamber for longer than a few seconds without igniting, an explosive mixture could result.

CAUTION

1. Do not put the system into service until you have satisfactorily completed the Valve Leak Test below, all applicable tests described in the Checkout section of the instruction sheet for the flame safeguard control, and any other tests required by the burner manufacturer.
2. All tests must be performed by a trained, experienced flame safeguard control technician.
3. Close *all* manual fuel shutoff valves as soon as trouble occurs.

After the installation is complete, cycle the valve several times with the manual fuel shutoff cock closed. Make sure the valve and actuator function properly. Also perform the Valve Leak Test described below before putting the valve into service.

VALVE LEAK TEST (FIG. 7)

This is a test for checking the tightness of closure of a gas safety shutoff valve. It should be performed (by qualified personnel) during the initial startup of a burner system, or whenever the valve or valve bonnet is replaced (see Service Information). It is recommended that this test also be included in scheduled inspection and maintenance procedures. For a periodic inspection test, follow steps 1,3,4,5,8,9,10,12,14,16, and 17.

1. De-energize the control system to ensure that there is no power to the safety shutoff valve (C), shown in Fig. 7.
2. Close the upstream manual gas cock (A).
3. Make sure the manual test petcock (F) is closed in the leak test tap assembly (D).
4. Remove the leak test tap plug and connect the test apparatus to the Leak Test Tap (D).
5. Close the downstream manual gas cock (E).
6. Open the upstream manual gas cock (A).
7. Run the safety shutoff valve (C) to its fully open position (through the safety system); then immediately de-energize the system to close the valve.
8. Immerse a 1/4 in. tube vertically 1/2 in. [12.7 mm] into a jar of water.
9. Slowly open the test petcock (F).
10. When the rate of bubbles coming through the water stabilizes, count the number of bubbles appearing during a 10 second period. Each bubble appearing during a 10 second period represents a flow rate of approximately 0.001 cfh. To meet all U.S. requirements, there should be no more than 23 bubbles during a 10 second period (approximately 0.023 cfh = 650 cc/hr). If leakage exceeds 23 bubbles, replace the valve immediately.

NOTE: For international leak test requirements, contact the office of the appropriate approval agency.

FOLLOWING THE TEST:

11. Close the upstream manual gas cock (A).
12. Close the test petcock (F), remove the test apparatus, and replace the leak test tap plug (D).
13. Open the upstream manual gas cock (A) and energize the safety shutoff valve (C).
14. Test with soap bubbles to ensure that there is no leak at the test tap (D).
15. De-energize the safety shutoff valve (C).
16. Open the downstream manual gas cock (E).
17. Restore the system to normal operation.

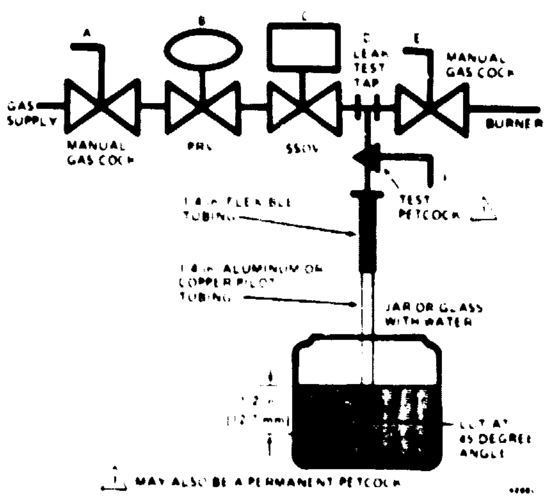


FIG. 7—VALVE LEAK TEST.

SERVICE INFORMATION

CAUTION

1. Turn off the gas supply and disconnect all electrical power to the valve actuator before servicing.
2. Only qualified service technicians should attempt to service or repair flame safeguard controls and burner systems.
3. Do not disassemble the valve bonnet assembly; the valve seat is not replaceable.
4. Failure to properly position and seat the seals in the valve body may result in a hazardous gas leak.

SCHEDULED INSPECTION AND MAINTENANCE

A schedule should be set up and followed for periodic inspection and maintenance, including the burner and all other controls as well as the valve(s). It is recommended that the Valve Leak Test in the CHECKOUT section be included in this schedule. Refer to the instruction sheet for the flame safeguard control for more information.

VALVE BONNET REPLACEMENT

The entire valve bonnet may be replaced without removing the valve body from the gas line. Do not disassemble the valve bonnet assembly; the valve seat is not replaceable.

For part numbers, refer to Replacement Parts in the SPECIFICATION section. Complete instructions on replacing the bonnet assembly are included with the replacement part.

NOTE: Any V5055 valve body can be fitted with a bonnet assembly with 2 seals to provide a valve seal overtravel interlock (valve-closed indication). Add a valve-closed switch (Part No. 133569) to the actuator when changing the bonnet. Identify this change by tagging the valve so that if the valve should require future replacement parts, the correct parts may be ordered. *This change is not approved by Factory Mutual.*

REPLACEMENT OF SEALS (FIG. 8 OR 9)

When removing the bonnet to inspect and clean the valve, install new seals (see Replacement Parts). Coat the new seals with the grease provided, and position them in the valve body as shown in Fig. 8 or 9.

Failure to properly position and seat the seals in the valve body may result in a hazardous gas leak.

After the new bonnet assembly has been installed, or the bonnet removed for any reason, check for gas leakage around the bonnet seal. Turn on the gas at the manual valve. Paint the seal area with a rich soap and water solution. Bubbles indicate a gas leak. If a leak is detected, check to see that the bonnet screws are tight. If necessary, turn off the gas again and remove the bonnet to be sure the seals are properly seated.

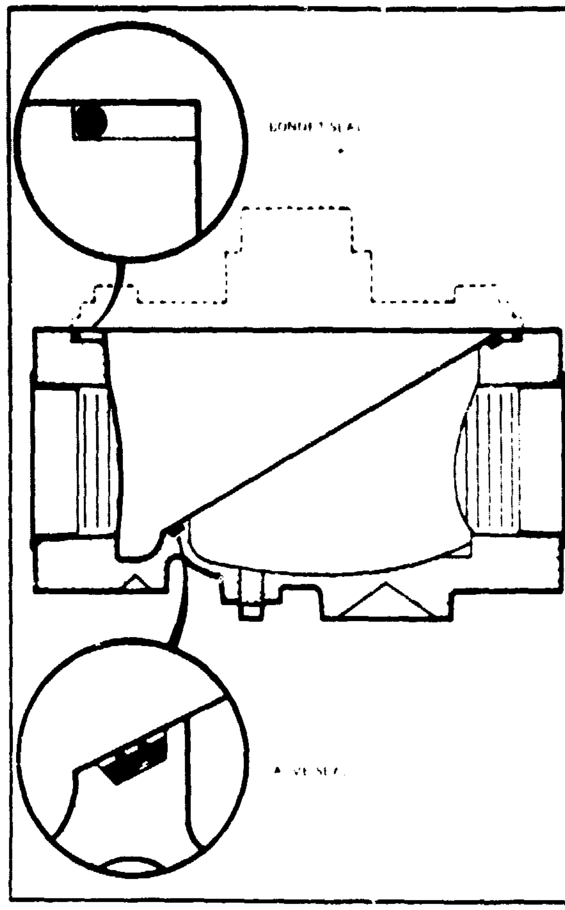


FIG. 8—PROPER POSITIONS OF VALVE AND BONNET SEALS IN 3/4 THROUGH 3 in. VALVES.

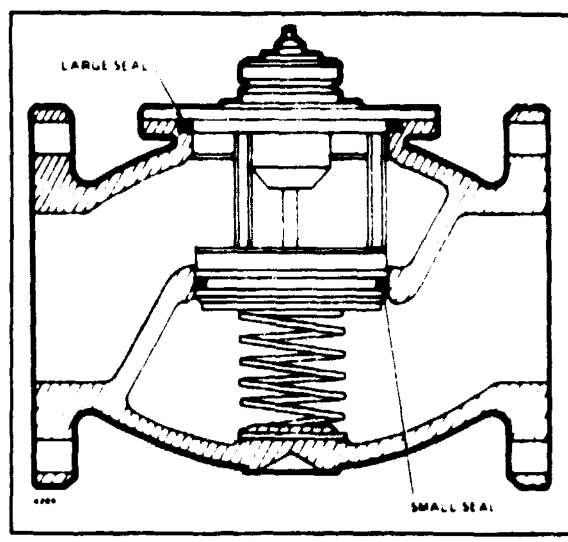


FIG. 9—PROPER POSITIONS OF VALVE AND BONNET SEALS IN A 4 in. VALVE.

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Honeywell

THE V9055 GAS VALVE ACTUATOR PROVIDES MODULATING (SERIES 90) CONTROL OF THE GAS SUPPLY TO COMMERCIAL AND INDUSTRIAL BURNERS.

□ Actuator opens the valve to the LO fire position when power is supplied. Actuator then modulates to meet firing rate controller demand.

□ Actuator is equipped with an integral shaft which may be used to drive a combustion air damper in unison with the valve.

□ The V5055 Gas Valve includes a yellow SHUT indicator. The actuator includes a red OPEN indicator. The indicators provide constant visual indication of valve position.

□ Actuator can be used with all V5055 valve models; however, best control and low fire repeatability will result with V5055B, with characterized guide.

□ Ambient temperature range minus 40 to 125 F [minus 40 to 53 C].

□ Auxiliary 1/2 hp rated switch is optional and may be added in the field.

□ Integral damper shaft provides a maximum of 20 pounds [9 kilograms] of force.

□ Valve and actuator may be mounted in any position.

□ Models available with NEMA 4 (weather-proof) enclosure.

□ V9055D/V5055C,E combinations available to meet Factory Mutual valve closed indication requirements for firing more than 250 hp (12.5 million Btuh or 10,000 lbs. per hour steam) and Underwriters Laboratories Inc. 795 requirements for valve seal overtravel interlock.

□ When replacing a V9034 actuator with a V9055, the V5034 valve body must also be replaced with a V5055.

MODULATING FLUID POWER GAS VALVE ACTUATOR

V9055

Form Number 60-2311-5

V.J.
REV. 1-77 (.046)

SPECIFICATIONS

MODELS:

V9055A-C,E Modulating Fluid Power Gas Valve Actuators.

V9055D Modulating Fluid Power Gas Valve Actuator with valve closed indication switch.

V9055/V5055 ACTUATOR-VALVE COMBINATIONS:

VALVE	ACTUATOR	
	V9055A	V9055D[a] (use with V5055C,E)
V5055B 3/4-3 in.	5 psi [35 kPa] diff.; 15 psi [105 kPa] close off	–
V5055B 4 in.	3 psi [21 kPa] diff.; 15 psi [105 kPa] close off	–
V5055A,C 3/4-3 in.	5 psi [35 kPa] diff.; 15 psi [105 kPa] close off	5 psi [35 kPa] diff.; 15 psi [105 kPa] close off
V5055A,C 4 in.	3 psi [21 kPa] diff.; 15 psi [105 kPa] close off	3 psi [21 kPa] diff.; 15 psi [105 kPa] close off
V5055D,E 3/4-1-1/2 in.	5 psi [35 kPa] diff.; 75 psi [525 kPa] close off	5 psi [35 kPa] diff.; 75 psi [525 kPa] close off
V5055D,E 2, 2-1/2, 3 in.	5 psi [35 kPa] diff.; 45 psi [315 kPa] close off	5 psi [35 kPa] diff.; 45 psi [315 kPa] close off

[a]The low fire position of the V5055A,C,D and E valves will differ from those of the V5055B. Check the valve flow curves in form 70-8311 and match the low fire adjustment to the burner design and application.

ELECTRICAL RATINGS:

VOLTAGE/ FREQUENCY	OPENING		HOLDING	
	WATTS	VA	WATTS	VA
120/60	60	122	20	32
100–50/60	57/46	100/81	25/20	36/31
200–50/60	75/53	164/114	22/19	36/30
220/50	68	141	20	32
240/50	88	194	19	36

AUXILIARY AND VALVE CLOSED (FACTORY MUTUAL) SWITCH RATINGS: 1/2 hp[a].

	120V	240V
Full Load	9.8 amp	4.9 amp
Locked Rotor	58.8 amp	29.4 amp

[a]Maximum total connected power to both switches (if used) is 1800 VA.

LOW FIRE ADJUSTMENT: 5 (nominal) to 50 (maximum) percent of actuator stem travel.

OPENING TIME: 50 Hz models–31 seconds (nominal). 60 Hz models–26 seconds (nominal).

CLOSING TIME: 1 second (maximum).

DAMPER ARM RATING (damper drives 1 direction only):

Standard Models–20 lb. maximum at 2-11/16 in. radius at plus 20 to 125 F and 5 lb. at minus 40 to 20 F [9 kg maximum at 68 mm radius at minus 7 to 66 C and 2.3 kg at minus 40 to minus 7 C].

Models with Damper Shaft Return Spring–10 lb. maximum at 2-11/16 in. radius at plus 20 to 125 F and 5 lb. at minus 40 to 20 F [4.5 kg at 68 mm radius at minus 7 to 66 C and 2.3 kg at minus 40 to minus 7 C].

ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALER OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER.

SPECIFY–
1. ORDER NUMBER.
2. VOLTAGE AND FREQUENCY.
3. STANDARD OPENING TIME.
4. ACCESSORIES, IF REQUIRED.
5. NEMA 4 ENCLOSURE, IF NEEDED.

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. YOUR LOCAL HONEYWELL RESIDENTIAL DIVISION SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY).
2. RESIDENTIAL DIVISION CUSTOMER SERVICE
   HONEYWELL INC., 1885 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422 (612) 542-7500

   (IN CANADA–HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9)
   INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

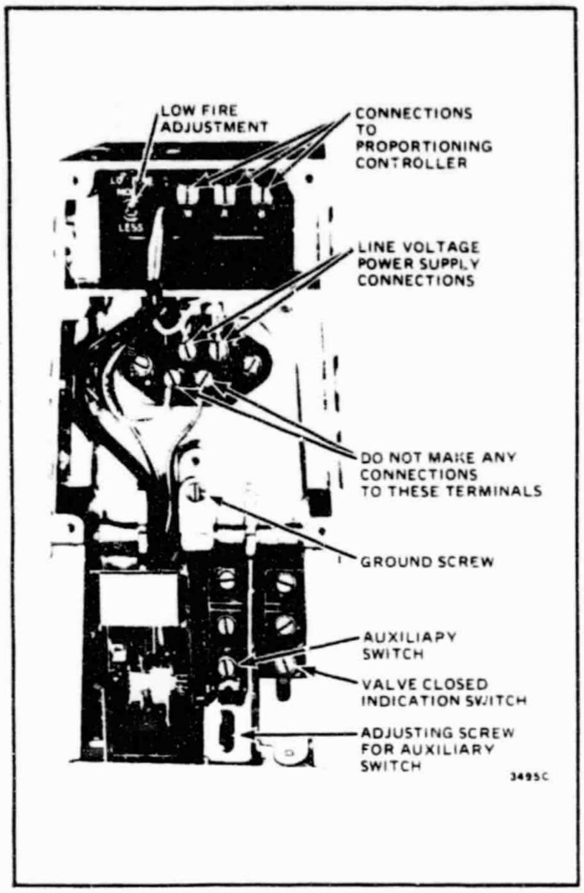

FIG. 3—INTERNAL COMPONENTS AND CONNECTIONS IN THE V9055.

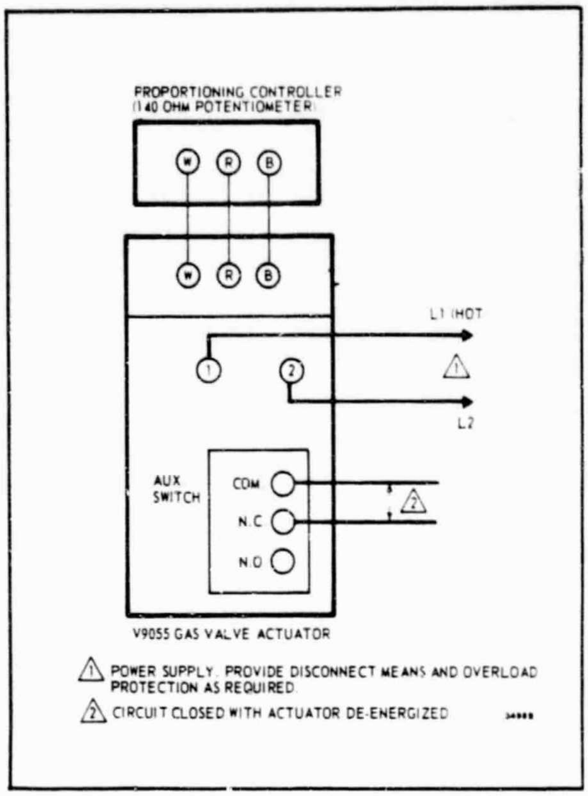

FIG. 4—HOOKUP FOR THE V9055 MODULATING GAS VALVE ACTUATOR.

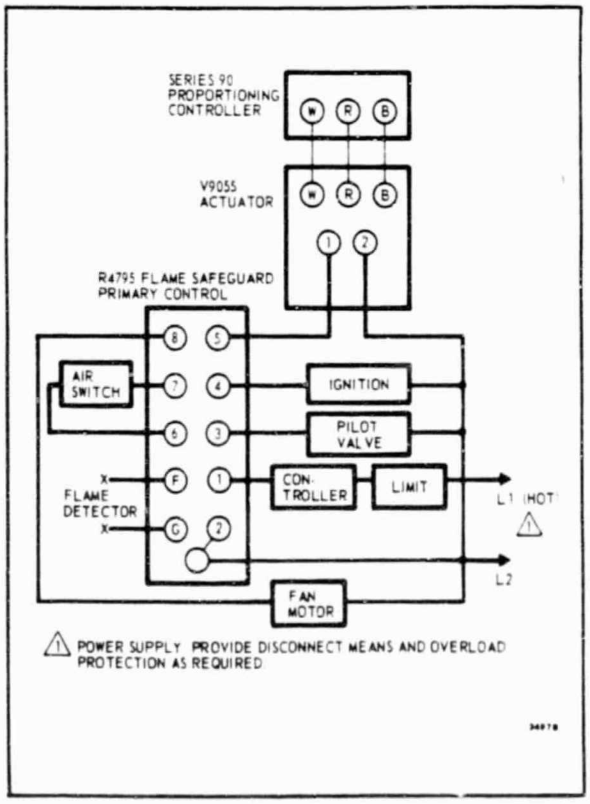

FIG. 5—V9055 CONNECTED TO THE R4795 IN A TYPICAL APPLICATION.

WIRING

CAUTION

Disconnect power supply before connecting wiring to prevent electrical shock and equipment damage.

All wiring must agree with applicable electrical codes and ordinances.

Connect power supply to terminals 1 and 2 on the terminal strip. Do not make any connections to the unmarked terminals shown in Fig. 3.

NOTE: If replacing a V9034, remove the 24 volt transformer since V9055 has a built-in transformer.

ADJUSTMENTS

IMPORTANT

When using the V9055 with the V5055C or E (with Factory Mutual double seat) match low fire minimum adjustment to burner and application. Too low an adjustment could result in loss of burner flame. This low fire adjustment should also be checked at periodic maintenance intervals.

ADJUST LOW FIRE ADJUSTMENT

The low fire setting is adjustable from 5 (nominal) to 50 (maximum) percent of actuator stem travel. The low fire adjustment is factory-set at the maximum position (approximately 50 percent of full gas flow capacity). Check to be sure the low fire setting is at maximum (full clockwise) before starting the adjustment procedure. To adjust:

1. Remove the lead to V9055 terminal R. Jumper terminal R to W. This will prevent the actuator from going to the high fire position.

2. Using a Phillips screwdriver, turn the low fire adjusting screw to the desired low fire position. DO NOT PUSH INWARD ON SCREW.

Shut down the burner, and then restart. Repeat several times to be sure the low fire setting is suitable for correct burner light off.

Turn off power supply. Remove R-W jumper, and reconnect the lead to terminal R on the V9055.

ADJUST THE AUXILIARY SWITCH (if used)

The auxiliary switch is adjustable throughout the stroke of the actuator. With the switch installed in the actuator, turn the adjusting screw (Fig. 3) clockwise ↷ to cause the switch to operate earlier in the stroke and counterclockwise ↶ to operate later in the stroke.

OPERATION

To function as intended, the V9055 must be connected to a properly sized valve. Too large a valve will not properly modulate the gas flow.

When the actuator is energized, it will drive at least to the adjustable low fire position. How far it will open beyond this low fire position depends on the demands of the modulating controller.

When the controller calls for no heat, the actuator will modulate the valve to the low fire position. When power to the actuator is interrupted, the valve will be closed all the way.

Fig. 5 shows the V9055 in a typical flame safeguard control system.

CHECKOUT AND SERVICE

CHECKOUT

CAUTION

Only a trained, experienced, flame safeguard control serviceman should service or replace this control.

After the valve installation is complete, cycle the valve a few times with the manual fuel shutoff cock closed before testing the system in actual operation.

SERVICE

The actuator is *not* field repairable, except for replacing the auxiliary switch. See page 4 for procedure.

Do *not* disassemble the valve actuator. Perform the following checks before removing and replacing the V9055 gas valve actuator.

1. With manual gas valve closed, energize the V9055 and check for voltage on terminals 1 and 2. Actuator should modulate to the low fire position.

2. Disconnect the leads from the modulating controller (terminals W, R, and B). Connect a manual potentiometer, color-to-color, to terminals W, R, and B on the actuator. With the valve energized, use the potentiometer to open and close the actuator. It should run from low fire position to full open.

If the actuator itself has failed, return it to the factory for repair.

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ATTENTION: *To assure safe and proper performance, read these instructions carefully before attempting to install or operate this Fenwal 05-16 Direct Spark Ignition System. Please retain for future reference.*

FENWAL®

SERIES 05-16
24VAC Direct Spark Ignition System

SERIES 05-16
24VAC Direct Spark Ignition System with 15-Second Cold Start Pre-Purge Option

SERIES 05-16TWO
24VAC Direct Spark Ignition System with 45-Second Pre-Purge Function

U.S. PATENT NOS. 3,847,533, 3,853,455 and 3,861,854. Other Patents Pending

INSTALLATION INSTRUCTIONS

GENERAL INFORMATION

The Fenwal Series 05-16 Direct Spark Ignition System offers an alternative to piloted ignition systems on gas-fired equipment burning natural, manufactured or LP gases at input rates up to 400,000 BTU per hour.

The Series 05-16 is also available with an optional cold start pre-purge feature.

The Series 05-16TWO, made primarily for conversion gas burners, incorporates a purge-timing circuit and greater flame sensitivity as required for conversion burners or power burners.

PRINCIPLE OF OPERATION

To ignite the burner, it is necessary only to set the thermostat. The thermostat powers the igniter to simultaneously provide the ignition spark and open the main burner valve.

In units incorporating the prepurge feature, after setting the thermostat, a delay period ensues allowing the combustion chamber to be purged of any residual gas. After the purge cycle, as specified for 05-16 or 05-16TWO, the ignitor simultaneously energizes the spark circuit and opens the main burner valve.

As soon as the flame is established, the spark ceases, thus minimizing radio and TV interference.

Electronic flame sensing circuitry in the ignitor detects the presence or absence of main burner flame. If the flame is not established during the Flame Establishing Period, the system closes the gas valve and locks out. If the flame is extinguished during the duty cycle, the ignitor will provide one immediate retry for ignition before going into lockout. To reactivate, or retry for ignition, simply reset the thermostat by turning it down for 5 seconds and then raising it again to the desired setting.

MOUNTING

The Series 05-16 is not position sensitive and can be mounted vertically or horizontally. The case, or printed circuit board, may be mounted with #6 hardware.

Integral standoffs on the bottom of the PC board provide proper electrical and thermal isolation between the board and the mounting surface.

**Design is certified by A.G.A. to ANS Z21.20 Automatic Ignition Systems*

WIRING

CAUTION: *Do not apply power to control unit until wiring is completed and electrode is properly grounded.*

LOW VOLTAGE CONNECTOR AND ASSEMBLY
(Fenwal P/N 05-127324-024):

Insert plastic connector onto edge of PC board as shown in Figure 1. (Connector will not fit if reversed). Connect leads as follows (See Figure 3):

Red wire to 24VAC transformer
Brown wire to valve
Black wire to flame sensing electrode
Yellow wire to ground

NOTE 1: *Flame sensing lead has .187 female quick connect terminal to mate with male terminal on flame sensing electrode*

NOTE 2: *If low voltage connector assembly and lead wires are not ordered from Fenwal, component parts may be procured using Table 1 below.*

HIGH VOLTAGE ASSEMBLY
(5mm Silicon Rubber Insulated Wire):

Connect the female spark plug connector to the High Voltage Terminal on top of the control. Attach ¼" female quick connect terminal to the High Voltage Electrode. See Figure 2B.

Caution: High Voltage

TABLE 1

6-pin edge connector	AMP #480519-6 with terminals #61668-1. Molex #09-01-1061 with terminals #08-01-6102.
High Voltage lead wire	5mm stranded wire with insulation rated 250°C. Rodix #3257.
Flame sensing lead wire	18AWG stranded wire with insulation rated at 200°C. Tensolite #726TX33UL.
Insulator Boot	Jamak (Detroit Silicon Div.) #935.
Terminals	Quick connect, and sparkplug type female connector.

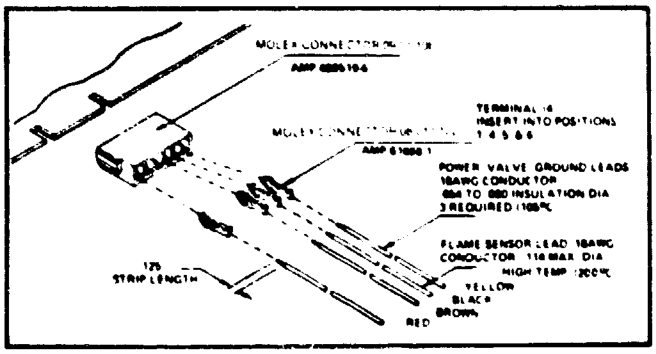


FIGURE 1

ELECTRODE

Proper location of the electrode assembly is important for optimum system performance. It is recommended that electrode assemblies be mounted temporarily using clamps or other suitable means so that the system can be checked before permanently mounting the assembly. The electrode assembly should be located so that the tips are inside the flame envelope and about ½" above the base of the flame. (Figure 2A)

IMPORTANT: *Ceramic insulators should not be within or close to the flame pattern. Study the illustrations below before positioning the electrodes.*

NOTE: *Electrode assemblies should not be adjusted or dis assembled. Electrodes should have a gap spacing of 0.125 ± 0.032". If this spacing is not as specified, return the electrode assembly to Fenwal for replacement. Electrodes are NOT field adjustable.*

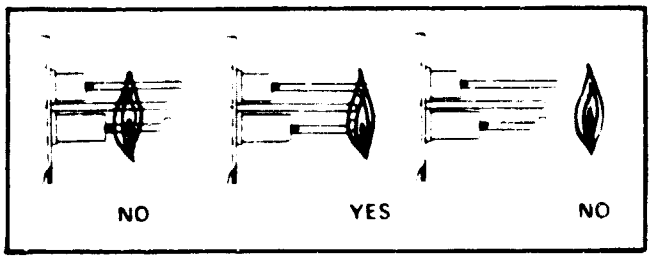


FIGURE 2A

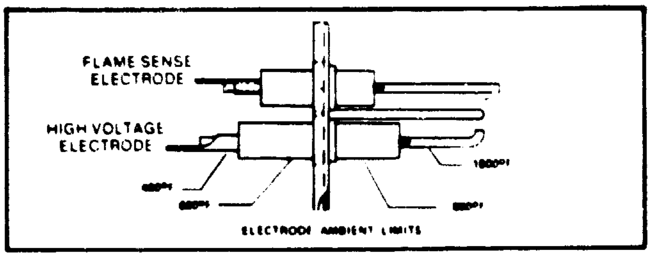


FIGURE 2B

WARNING: Do not apply power to input terminals unless electrode is properly connected & grounded

PRELIMINARY SYSTEM CHECKS

The system must be checked after installation and before gas supply is turned on.

Be sure that input is polarized as shown in Figure 3 and the installation is electrically grounded.

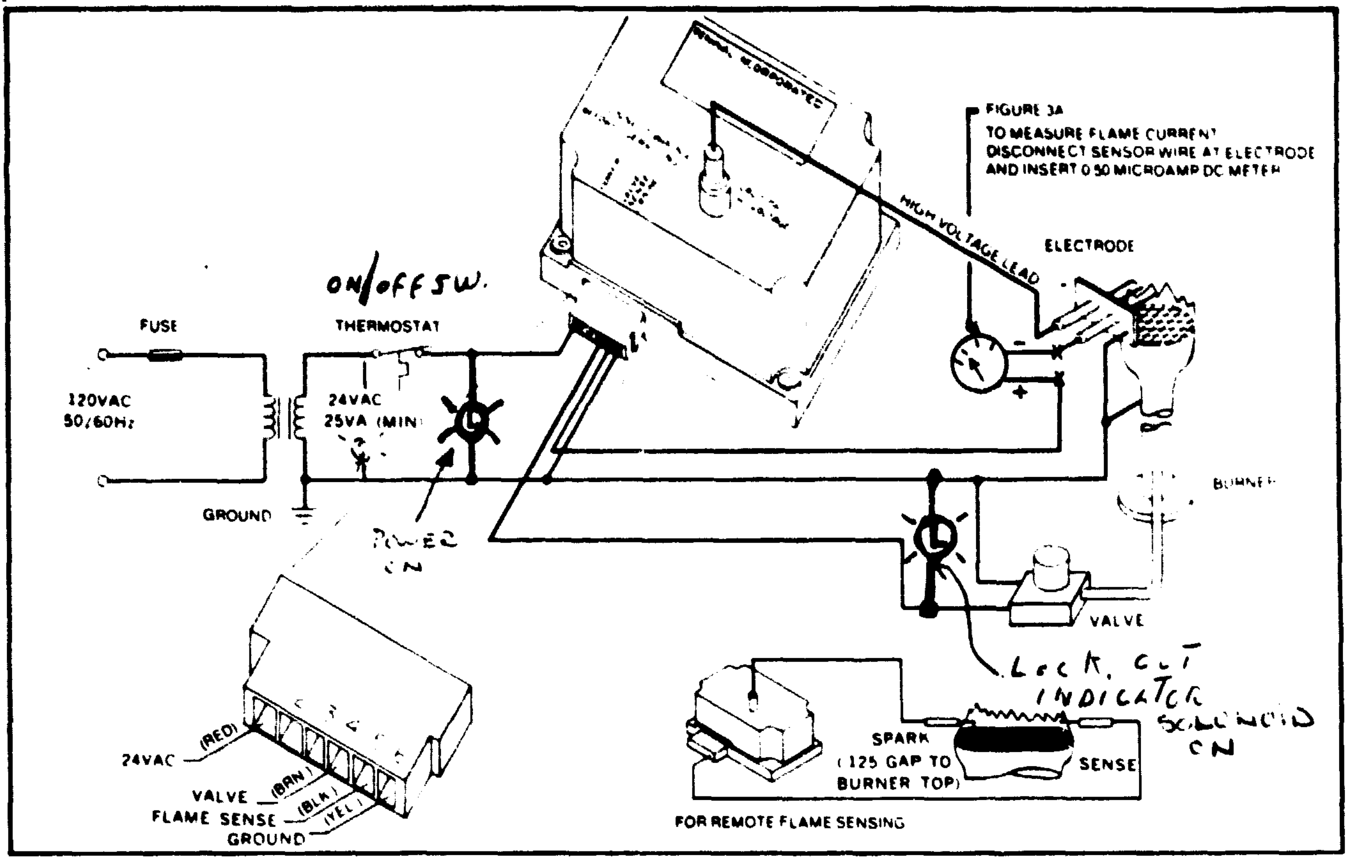


FIGURE 3

INITIAL OPERATION

1. Check installation, mounting, and electrode gap to insure conformance to specifications.

2. With the gas supply shut off, apply electrical power to the system by advancing the thermostat.

3. Check to insure that a spark is being produced at the electrode during the trial-for-ignition period specified for the unit. Units should lock out after trial-for-ignition period. Set thermostat below ambient temperature.

NOTE: *Pre-purge units have a typical delay of 15 seconds before ignition sparks occur. Series 05-16TWO units have a typical delay of 45 seconds.*

4. Manually open the gas supply line and advance the thermostat to recycle the unit.

5. Check that ignition has been accomplished within the trial period. Sparking will cease a few seconds after establishing the flame.

6. If system ignites but fails to hold in, check for 5 micro-amp minimum flame sense current and check to assure the system is properly grounded per Figure 3.

7. For multiple unit installation, assure that all units are powered by a common supply voltage and all are correctly polarized and grounded.

SAFETY CHECKS

1. Manually shut off gas supply and apply power to the control board by advancing the thermostat. After unit has locked out, check that there is no voltage output between "Valve" and "Ground" with a suitable volt-meter. Set thermostat below ambient temperature.

2. Manually open the gas supply valve and reactivate control unit by raising the thermostat above room temperature. Sparking should occur (after the purge period on pre-purge units) and cease when the flame is established. While running, manually close the gas supply valve. Sparking should start as soon as the flame is extinguished. The spark should remain on for the trial-for-ignition period and then lock out. Check that there is no voltage between "Valve" and "Ground" as described above.

SERVICE CHECKS

Flame current is the current which passes through the flame from the sensor to ground to complete the primary safety circuit. The minimum flame current necessary to keep the ignitor from lockout is five microamps. To measure flame current, DISCONNECT INPUT VOLTAGE then remove low voltage sensing lead wire from electrode terminal and insert a 0-50 DC microamp meter in a series with the sensor probe and sensor wire. (See Figure 3a.) Meter reading should be 5 microamps or higher. If meter reads below "0" on scale, the leads are reversed. Disconnect power and reconnect leads for proper polarity.

If the flame current reading is less than 5 microamps reposition the electrode in the flame to get a higher reading.

REPAIRS

The Fenwal Series 05-16 Direct Spark Ignition Systems are not field repairable. Any modifications or repairs to the Series 05-16, or 05-16TWO, will invalidate Fenwal's standard warranty as well as agency certifications. Faulty units should be returned to the factory for repair or replacement.

SPECIFICATIONS

		CONTROL UNITS	COMMENTS
		05-162426-00X	With case
		05-162425-00X	Without case
		15-162426-10X	Purge unit, with case
		05-162425-10X	Purge unit, without case
		05-162426-20X	05-16TWO unit, with case
		05-162425-20X	05-16TWO unit, without case
TRIAL FOR IGNITION (Flame-Establishing Period and/or Lockout Time) Nominal:		05-16242X-X00	3.3 seconds
		05-16242X-X01	4.7 seconds
		05-16242X-X02	5.6 seconds
		05-16242X-X03	6.8 seconds
		05-16242X-X05	10.0 seconds
		05-16242X-X06	12.0 seconds
PRE-PURGE DELAY TIME:		05-16 Units	7.0 seconds minimum 15.0 seconds typical
		05-16TWO Units	30.0 seconds minimum 45.0 seconds typical
IGNITION MEANS:	Interrupted		
FLAME FAILURE RE-IGNITION TIME:	Less than .8 seconds		
INPUT VOLTAGE:	24VAC, 60Hz.		Operating range 20 to 28 VAC
INPUT CURRENT DRAIN:	90mA		Ignitor current drain only 300mA (momentary during ignition). Does not include valve power.
AMBIENT RANGE:	−40 to 165°F.		
MOISTURE RESISTANCE:	to 90% humidity		Control is moistureproof but not waterproof and must be protected against direct exposure to water
TYPES OF GAS:	Natural, LP, Manufactured		
VALVE RELAY CONTACT RATING:	1.0A continuous @ 24VAC		

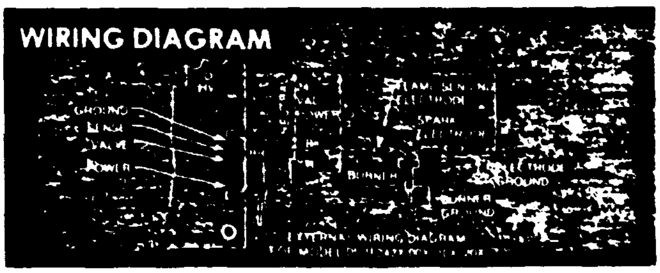
LEAD WIRE & CONNECTORS

HIGH VOLTAGE ASSEMBLY:		05-127328-0XX	5mm stranded wire rated at 200°C. Supplied with ¼" quick connect and spark plug-type terminals. Designate length in last two digits of catalog number. Max. length 48". Assembled
LOW VOLTAGE ASSEMBLY:		05-127324-4XX	6-pin plastic edge connector with four lead wires for input power, valve, ground and flame sensing. Assembled
INSULATOR BOOT:	(straight)	05-115548-000	Provides electrical and environmental protection of electrode high voltage terminal
	(90°)	05-115548-001	

Specifications subject to change without notice.

OUTLINE DIMENSIONS

WIRING DIAGRAM



CAUTION: *The Fenwal Series 05-16 Direct Spark Ignition Systems are designed for use only on new products by manufacturers of gas fired equipment. It may only be used as such, or as replacement for an existing Fenwal Spark Ignitor. Any substitution or application must be expressly approved by Fenwal or the manufacturer of the equipment. Improper substitution or application may result in malfunction of equipment such as loss of flame sensing safety circuit creating an explosive atmosphere*

LIMITED WARRANTY STATEMENT

Fenwal Incorporated represents that this product is free from defects in material and workmanship and it will repair or replace any product or part thereof which proves to be defective in workmanship or material for a period of 18 months after delivery of the product to the buyer. For a full description of Fenwal's LIMITED WARRANTY, which among other things, limits the duration of warranties of MERCHANTABILITY and FITNESS FOR A PARTICULAR PURPOSE and EXCLUDES liability for CONSEQUENTIAL DAMAGES please read the entire LIMITED WARRANTY on the Fenwal Quotation. Acceptance of Order and/or Original Invoice which will become a part of your sales agreement. Defective units should be returned to the factory, Ashland, Massachusetts, shipment prepaid. Fenwal Incorporated will repair or replace and ship prepaid.

M.P.3.3 10/28/75

FENWAL INCORPORATED

Division of Walter Kidde & Company, Inc.

KIDDE

Ashland, Massachusetts 01721

FENWAL®

SERIES 05-15 & 05-16

HOT TIPS

Direct Spark Ignition System Service Guide

SERVICE HINTS, DIAGNOSIS and CORRECTIVE MEASURES

The only tools required to service the 05-15 and -16 are a Phillips head screwdriver and a 20,000 ohms/volt multi-tester (Radio Shack 28-4013, Allied WV-518A, Triplett Model 310-C or equivalent)

What's Wrong	Why	What to do
1 Lockout occurs 3-10 seconds after ignition	1 Reverse polarity	Para. 1
	2. System unproperly grounded	Para. 2.
	3. Gas pressure too high, causing flame to lift off burner	Check to insure input pressure as specified on manufacturer's data plate
	4. Sensor probe incorrectly positioned in flame pattern	Para. 6
2. Flame not established	Spark gap too small	Para. 3.a
Arcing to ground	Spark gap too large	Para. 3.a
3 No Spark	Corroded connector	Para 3.b
4. Arcing other than across gap	1. Cracked or dirty insulator	Para 3.c
	2 Broken high voltage lead	Para 3.c
Weak Spark	High voltage lead too close to metal surface	Para. 3.e
No flame	Valve malfunction	Para 4
Low flame current and/or nuisance lockouts sance lockouts	Electrode improperly placed	Para 5
	1 Flame current falls below 2.5 uA	Para 6
	2 Low gas pressure	Check to ensure that manifold pressure meets manufacturer's specifications

DESCRIPTION

The Fenwal Series 05-15 (12VDC) and 05-16 (24VAC) Direct Spark Ignition Systems operate through a thermostat to provide a means of ignition for the main burner on gas-fired equipment. This is accomplished by generating a spark between high voltage electrode and ground. Once the flame is established a flame rod monitors the main burner flame (see Figure #1). Refer to Bulletins No. 5.15.A and 5.16.A for installation instructions.

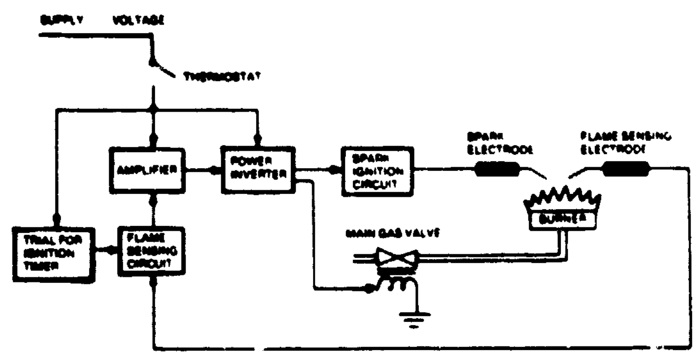
SEQUENCE OF OPERATION

On a call for heat, voltage is applied to the ignitor across Terminals 1 (power) and 6 (ground) of the input connector. A high voltage spark is then generated from the spark electrode to ground. Simultaneously, the gas valve is energized.

At the start of each heat cycle, there is a "Trial for ignition period" of three to ten seconds duration depending upon the model ignitor used. Normally, main burner flame will be established before the end of this period. Once the flame is established, sparking will cease and the "flame rod" will provide flame monitoring for the remainder of the heat cycle. If the flame is extinguished during this cycle, the ignitor will start sparking automatically in an attempt to re-establish the flame. If this does not occur within the "Trial for ignition period," the system will go into lockout, closing the gas valve.

Troubleshooting

Although the following tests can be made using a standard volt meter, it is quicker and more convenient to use a Fenwal Model 05-125539-001 Test Adaptor (See Figure #3).



Block Diagram

PRELIMINARY CHECKS

1. Input Polarity. If a spark is present and the gas valve opens for the flame establishing period but then locks out at the end of three to ten seconds, check the input voltage at Terminals 1 and 6 for the proper polarity. Terminal 1 should be "hot"; [12VDC (05-15) or 24VAC (05-16)] with respect to ground. Terminal 6 is neutral, or zero voltage, with respect to ground (See Figure #1).

2. Improper Grounding. If a flame is present during the Trial for ignition period but the system shuts down, insure that the burner is properly grounded. If the burner is not grounded, the flame monitoring signal will not function and the system will go into lockout. Check for loose or corroded terminals and replace if necessary. Insure good electrical connection be scraping paint or any other foreign matter off the area where ground connection is made.

If is equally important to be certain that the electrode bracket assembly is properly grounded. The bracket should be common with the ground lead on the input connector (ground terminal 6). If the bracket is not properly grounded, damage to the ignitor can result.

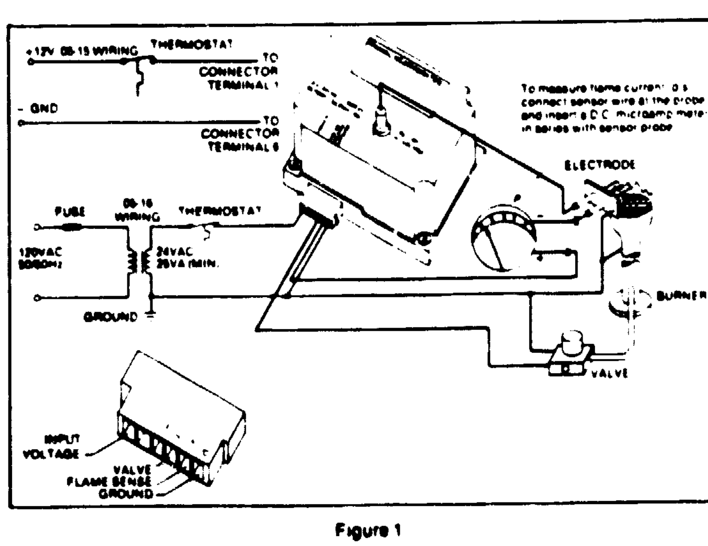


Figure 1

3. **Inoperative High Voltage.** If there is no spark or sparking is intermittent, check the following after disconnecting voltage to the system.

a. Check spark gap. Gap should be 1/8 ± 1/32" FROM H.V. TO GRND. CAUTION: NEVER REPLACE THE COMPONENT BOARD WITHOUT FIRST CHECKING TO INSURE THAT THE ELECTRODE HAS THE PROPER GAP. IF THE GAP IS TOO WIDE, DAMAGE TO THE IGNITOR CAN RESULT.

b. Check electrode leads and determine there is no corrosion at the terminals. If there is corrosion, clean it off.

c. Check ceramic insulators for cracks, foreign matter, and carbon. If there are cracks, replace electrodes. If there is carbon or foreign matter, clean it off.

d. Check high voltage lead wire for cracks or breaks. If there are cracks, breaks or chaffing, replace high voltage wire.

e. Check that the high voltage lead wire is not too close to a metal surface to insure that arcing will not occur at any point other than across the H.V. electrode. Also, insure that the high voltage lead wire is not taped or connected to a metal frame along its length, sharp metal edges, or crossing, *do not bundle with other wires*. Always leave one inch spacing between the high voltage lead wire and any other metal or wires.

f. For best operation, the high voltage wire should be as short as possible and should not exceed 24 inches in length.

g. Check to insure that the high voltage terminal is clear of dust, moisture or any foreign matter that could create high voltage leakage to ground.

4. **Valve Malfunction.** With power applied to the ignitor, sparking should occur and the solenoid valve should open simultaneously. If sparking occurs but the valve does not open, place a volt meter between Terminal 4 on the input connector and ground (or across valve). Recycle the ignitor by turning the thermostat down for five seconds minimum and then back up and determine if voltage is present at the valve. [Terminals 4 (valve) and 6 (ground) in Figure 1.] If voltage is present and the valve does not open, remove wires from the valve terminals and retest the valve on a own voltage source. If valve still does not function, it should be replaced. If the voltage is not present at Terminals 4 and 6, the ignitor should be replaced. Check p.c. connector area. (Clean with soft rubber eraser only.) Also, check the terminals in the plastic connector for good contact.

The valve relay is rated for 12VDC on the 05-15 and 24VAC on the 05-16, both at .5 amps. If a valve is used with a higher current rating than that specified, damage can result to the relay contacts.

5. **Electrode Placement.**

a. Electrode should be placed so optimum flame current is achieved for proper application.

b. Flame should not impinge on any portion of ceramic insulator.

6. **Flame Current.** The flame detector circuit uses the ionized gas flame to conduct the flame signal. This signal is a small DC current which can be measured directly with a 0 to 50 microamp meter.

Although the minimum flame current necessary to keep the 05-15 and 05-16 ignitor from going into lockout is 2.5 microamps, the lowest recommended is 5.0 microamps. These ignitors can stand flame currents as high as 30 to 40 microamps.

To measure flame current, first shut off the power to the system and then remove the flame sensing lead wire from the electrode terminal and insert a 0-50 DC microamp meter in series with the sensor electrode and the sensor lead wire. "Plus" terminal of meter to component board and "negative" terminal to sense electrode. Energize the ignitor. If the meter reads below zero, shut the system off and reverse meter leads.

Once the flame is established, assure that the flame current is above the minimum specified. If not, assure that the system has the proper input voltage, and then relocate the sensor electrode in the flame pattern until flame current is increased.

Once the flame has been established and the system is in its heat cycle, occasional sparking may occur. This is common in some installations and is not significant. Sparking will not damage the ignitor.

7. **Ambient Temperatures.** The 05-15 and 05-16 are designed to operate over the temperature range of −40 to 150°F. Care should be taken to insure that it operates within this range.

8. **Relative Humidity.** The 05-15 and 05-16 are coated for moisture resistance to 90 percent relative humidity. Caution should be taken to protect the component board against direct exposure to water.

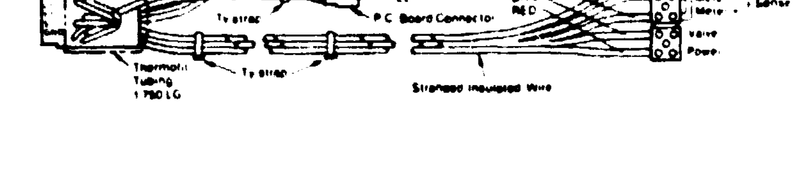
WARRANTIES

If the ignitor is damaged due to mishandling, or is not applied or installed properly, warranties will be voided. the 05-15 and 05-16 ignitors are not field repairable. All ignitors that fail to function properly should be returned to Fenwal, Incorporated, Ashland, Mass. 01721, to the attention of Customer Service.

CAUTION

The Fenwal Series 05-15 (12VDC) and 05-16 (24VAC) Direct Spark Ignition Systems are designed for use on new gas-fired equipment or as replacements for an existing Fenwal spark ignitor. Any substitution or other application must be expressly approved in writing by Fenwal Incorporated or the manufacturer of the equipment. Improper substitution or application may result in a malfunction of equipment, and the creation of an explosive atmosphere.

Figure 3.
05-15 & 16
Test Adapter
Part No. 05-127539-001



Fenwal® IGNITES GAS . . . RELIABLY

FENWAL INCORPORATED • ASHLAND, MASSACHUSETTS

Division of Walter Kidde & Company, Inc.

Printed in USA

Residential Div. Form Number 60-2083 5-71 L.M.

SOLENOID GAS VALVES

V4036A,B,X V8036A

The V4036A,B,X, and V8036A are solenoid gas valves for medium pressure gas burners. V4036A,B, and X provide ON-OFF control from a two wire line voltage controller. V8036A is for low voltage applications. These solenoid gas valves may be used as safety shutoff valves on either pilot or main fuel supply line, and are suitable for all gases, including LP and scrubbed coke oven gas.

☐ Powerhead, including integral junction box, rotates horizontally for convenient wiring.

☐ Two pilot gas tappings upstream of the valve disc provide piping convenience.

60-2083 5/71

SPECIFICATIONS

MODELS:

MODEL	COIL NUMBER	BAG ASSEMBLY NUMBER[a]	VOLTAGE	FRE-QUENCY (HZ)
V4036A	116634	7640NB	120	60
	116635	---	120	50
	116636	7640NC	208	60
	116637	7640ND	208, 220	50
	116637	7640ND	240	60
	116638	---	240	50
V4036B	116769	7640NH	120	60
V4036X	116636	7640NC	200	50/60
V8036A	116834	---	24	60

[a]Order by assembly number, if available. Bag assembly includes coil, new nameplate, and instruction sheets.

ELECTRICAL CONNECTIONS: Two 6 inch leads from solenoid coil; wiring compartment with two knockouts for 1/2 inch conduit.

VALVE PATTERN: Straight through, non-offset, with two pipe tappings.

MAXIMUM WATTS V4036A — 16 watts.
V4036B — 19 watts.
V4036X — 16 watts.
V8036A — 16 watts.

MAXIMUM VA RATING:
V4036A—24 va.
V4036B—33.5 va.
V4036X—26 va.
V8036A—25.2 va.

MAXIMUM AMBIENT TEMPERATURE
V4036A — 125 F.
V4036B — 140 F.
V4036X — 125 F.
V8036A — 125 F.

DIMENSIONS:

PIPE SIZE	VALVE BODY DIMENSIONS A[a]	B[a]	C[a]	D[a]	PILOT TAPPINGS
3/8, 1/2	2-13/16	1-7/16	1-1/4	1-7/8	1/8-27NPT
3/4	3-1/2	1-5/8	1-5/16	2-1/8	1/8-27NPT
1	4	1-3/4	1-7/16	2-7/8	1/8-27NPT
1-1/4	4-5/8	1-7/8	1-9/16	3-1/8	1/4-18NPT
1-1/2	5-5/16	1-7/8	1-1/2	3-5/8	1/4-18NPT

[a]Code letter. See Figs. 1 and 2.

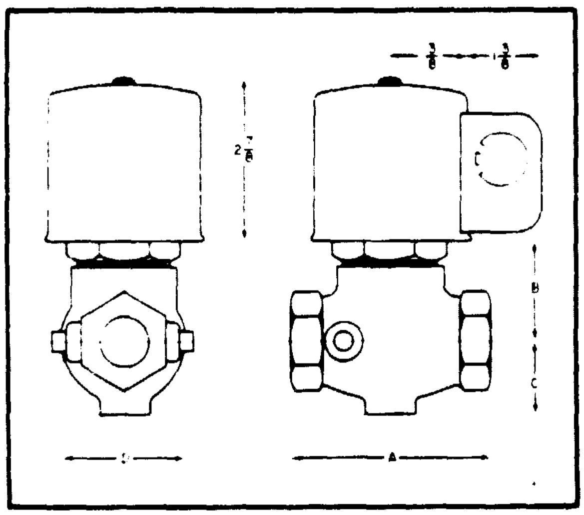


FIG. 1—OUTLINE DIMENSIONS OF 3/8, 1/2, 3/4, 1 INCH VALVES.

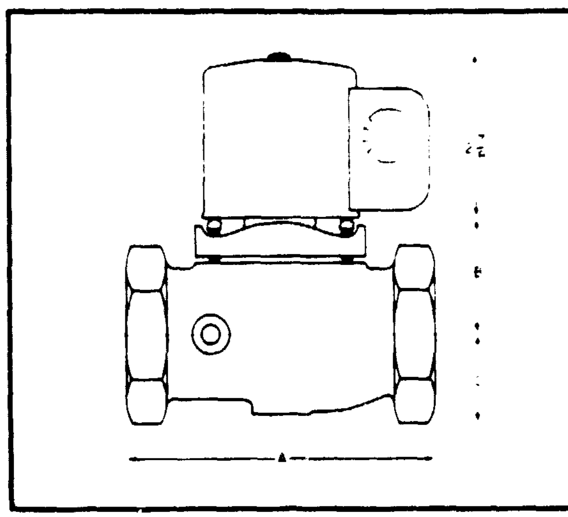


FIG. 2—OUTLINE DIMENSIONS OF 1-1/4, 1-1/2 INCH VALVES.

(continued on page

ORDERING INFORMATION

WHEN ORDERING REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING SPECIFICATION NUMBER, OR . . .

SPECIFY—
1. MODEL NUMBER.
2. VOLTAGE AND FREQUENCY.
3. PIPE SIZE.
4. REPLACEMENT COIL, IF NEEDED.

ORDER FROM—
1. YOUR USUAL SOURCE, OR
2. HONEYWELL
   1885 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422
   (IN CANADA—HONEYWELL CONTROLS LIMITED
   740 ELLESMERE ROAD
   SCARBOROUGH, ONTARIO)
   INTERNATIONAL SALES AND SERVICE OFFICES
   IN ALL PRINCIPAL CITIES OF THE WORLD.

SIZES AND CAPACITIES:

PIPE[a] SIZE (IN.)	PRESSURE RATING (PSI)	FLOW CAPACITY (CFH) P.D. 1 IN., SP GR 0.6	BTU/HR. AT 1 IN. P.D. 0.64 SP GR 1000 BTU/CU. FT. NAT. GAS
3/8	10	108	104,400
1/2	5	238	230,900
3/4	3	485	470,000
1	1.5	772	748,800
1-1/4	1.25	1058	1,026,400
1-1/2	1.0	1409	1,366,700

[a]V8036A is available in 1-1/4 (in.) only.

To calculate gas flow for other than 1 in. p.d.
New cfh = (cfh at 1 in.) x $\sqrt{\text{new p.d.}}$

To calculate gas flow for other than 0.6 sp gr
New cfh = (chf at 0.6) x $\sqrt{\frac{0.6}{\text{New sp gr}}}$

VALVE BODY MATERIAL: Aluminum alloy.

REPLACEMENT PARTS: See coil numbers listed under MODELS.

UNDERWRITER'S LABORATORIES, INC. LISTED: V4036A, B and V8036A all sizes; File No. MH1639, Guide No. YIOZ.

C.S.A. LISTED: V4036A only, File No. LR1626.

FACTORY MUTUAL APPROVED: 3/8, 1/2, and 3/4 inch sizes only.

A.G.A. CERTIFIED: All sizes.

INSTALLATION

WHEN INSTALLING THE VALVE BE SURE TO—

1. Use new pipe, properly reamed and free of chips.
2. Install the valve coil vertically with no more than a 5 degree lean.
3. Install the valve so that the flow will be in the same direction as the arrow on the valve body.
4. Install a hand valve and (preferably) a strainer ahead of the valve.
5. Install a drip leg in the gas supply line if necessary.
6. Follow approved valve piping procedures.
7. Conduct gas leak test as follows:

TEST FOR GAS LEAKS

Paint connections with rich soap and water solution. Bubbles indicate gas leak. Tighten connections.

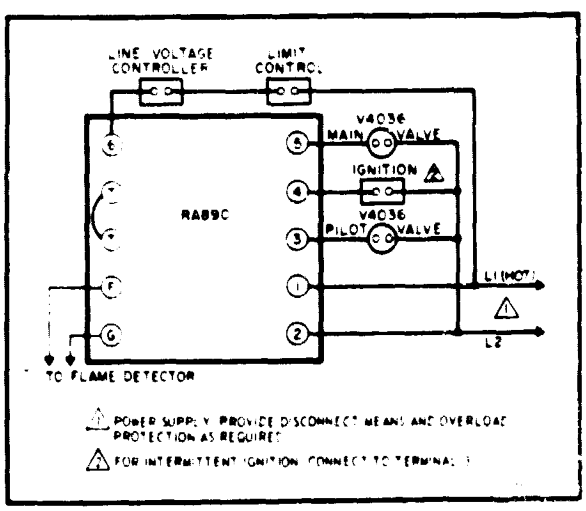


FIG. 3–V4036 TYPICAL CONNECTIONS USING AN RA890F PRIMARY CONTROL.

WIRING

CAUTION
Disconnect power supply before making wiring connection to avoid possible electrical shock or equipment damage.

All wiring must agree with local electrical codes and ordinances.

Connect the leadwires to the line voltage control. The powerhead may be rotated horizontally for convenient wiring.

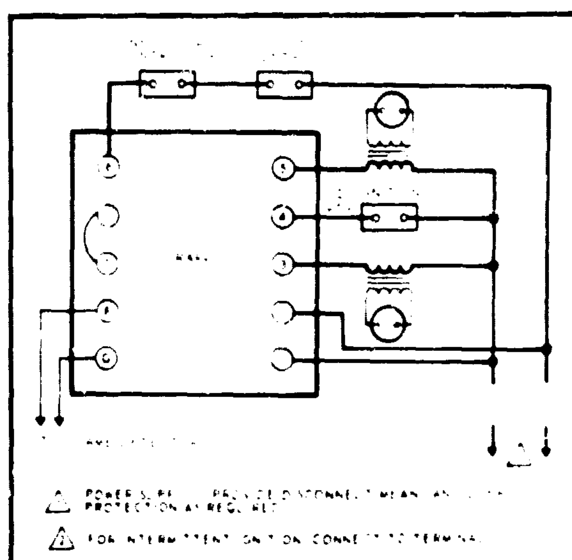


FIG. 4–V8036 TYPICAL CONNECTIONS USING AN RA890F PRIMARY CONTROL

IMPORTANT

After all connections are made, make certain that the main gas valve is closed and the combustion chamber is free of unburned gas.

Light the pilot according to manufacturer's instructions, and let it burn for about five minutes. At the end of this time, turn on the power supply to the system, and open the main gas valve.

Once power is on, adjust the settings on the thermostat and limit controls so that:

1. The valve opens when all controls call for heat.
2. The burner lights normally.
3. The valve closes when the thermostat is satisfied.
4. The valve closes when the limit control breaks the circuit.

TEST THE COIL

1. Remove the outlet box cover, and bare the wire splices.
2. Connect a trouble light or meter between the splices, being careful not to cause a direct short between the splices or a short to the metal body of the valve.
3. Start the system. If the light goes on or the meter shows line voltage, but the valve does not operate, replace the valve coil. If the light does not go on, check the wiring from the valve to the programming relay.

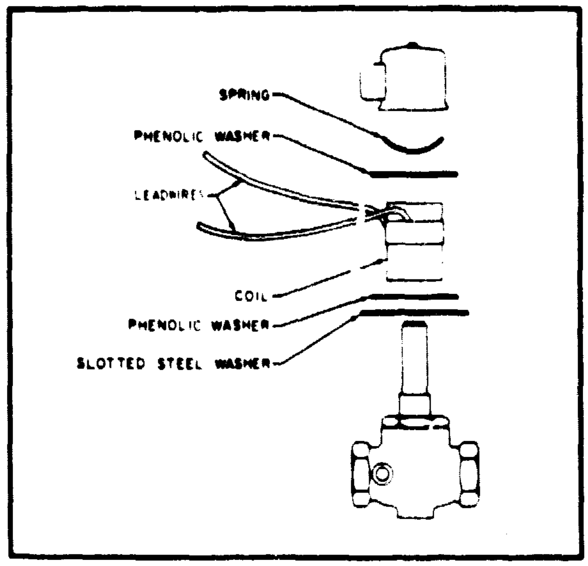


FIG. 5-ASSEMBLY OF POWERHEAD.

A Division of

UNIVERSAL SILENCER

NELSON

Industries, Inc.

Small Air Filters and Filter Silencers

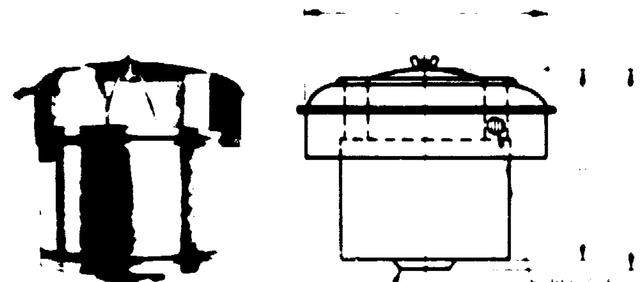
Product Catalog No. 242-A

Specifications

CCS Series Filter Silencers
CCF Series Filter

For use on small blowers, compressors and engines

CCS Series Filter Silencer



NOTE
1 THRU 4 FEMALE NPT PIPE CONNECTIONS
5 THRU 8 125/150# ANSI DRILLED FLANGES

Universal CCS Series is a combination filter silencer with a heavy-duty type construction, shrouded for weather protection and finished with a high quality black paint. Sizes 5, 6 and 8" have flanged connections drilled to 125# ANSI standards — the other sizes have female NPT type connections. The weatherhood is removable for access to the filter element. The replaceable dry pleated paper element is 99.5% efficient on 2 microns — 97% on 1 micron particle size. The element may be cleaned and reused a number of times. Replacement elements are available. (Galvanized wire mesh elements are also available for replacement — contact factory.)

Normally the CCS provides adequate noise attenuation, however if additional silencing is necessary, this filter may be used in series with an inlet silencer.

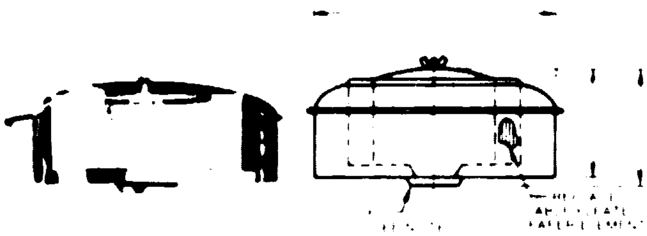
MODEL	RATED CAP (CFM)	P	D	H	L	WT	ELEMENT P/N
CCS-.	15		7 .	6 .	6	4	81-0470
CCS-.	22	.	7 .	6 .	6	4	81-0470
CCS-1	35	1	7 .	6 .	6	4	81-0470
CCS-1 .	60	1 .	9	7 .	7 .	6	81-0471
CCS-1 .	75	1	9	7 .	7 .	6	81-0471
CCS-2	120	2	9	7 .	7 .	6	81-0471
CCS-2 .	190	2	12	11	12 .	14	81-0472
CCS-3	275	3	12	11 .	12 .	14	81-0472
CCS-3 .	375	3 .	12	14	14 .	20	81-1063
CCS-4	500	4	12	14	14 .	20	81-1063
CCS-5	750	5	16	17 .	20	40	81-0474
CCS-6	1100	6	18	23 .	26	50	81-0475
CCS-8	2200	8	18	31	34	60	(2) 81-0475

Noise Attenuation — CCS Series

Octave Band Cent. Freq. - Hz	63	125	250	500	1000	2000	4000	8000
Attenuation - dB	5	8	10	13	14	14	14	13

% of rated flow	50	75	100	125	150
PRESSURE DROP—INCHES H_2O	0.7	1.6	2.8	4.4	6.3

CCF Series Filter



NOTE
1 THRU 4 FEMALE NPT PIPE CONNECTIONS
5 THRU 8 125/150# ANSI DRILLED FLANGES

Universal CCF Series is fundamentally similar to the CCS Series except it does not include the integral silencing section. All of the other features are included: heavy-duty construction, high quality black paint and highly efficient paper element. (See CCS description for details.)

The unit may be used alone or in series with an inlet silencer.

MODEL	RATED CAP (CFM)	P	D	H	L	WT	ELEMENT P/N
CCF-	15		7 .	3	3	2	81-0470
CCF-.	22	.	7 .	3	3	2	81-0470
CCF-1	35	1	7 .	3	3	[illegible]	81-0470
CCF-1 .	60	1 .	9	3	3	4	81-0471
CCF-1 .	75	1	9	3	3	4	81-0471
CCF-2	120	2	9	3	3	4	81-0471
CCF-2 .	190	2	12	5	5	11	81-0472
CCF-3	275	3	12	5	5	11	81-0472
CCF-3 .	375	3	12	6 .	7 .	16	81-1063
CCF-4	500	4	12	6 .	7 .	16	81-1063
CCF-5	750	5	16	7	10	34	81-0474
CCF-6	1100	6	18	9	12 .	40	81-0475
CCF-8	2200	8	18	18	20	50	(2) 81-0475

% of rated flow	50	75	100	125	150
PRESSURE DROP—INCHES H_2O	0.7	1.6	2.8	4.4	6.3

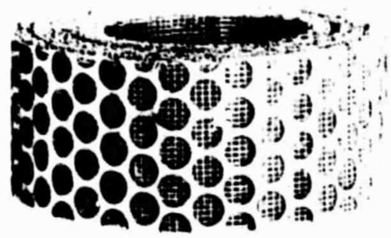
Filter Element Service Instructions

Dry Pleated Paper Element for CCS or CCF Series

CLEANING: Shake or rap element gently to dislodge accumulated dirt. Wash thoroughly, using warm water and mild detergent. Allow filter to air-dry completely before using. Alternate method is to direct compressed air (100 PSI max.) through element opposite the direction of flow.

NOTE: This element is a dry type, do not apply oil or adhesive.

Galvanized Wire Mesh Element for CCS or CCF Series



CLEANING: Rap element gently to dislodge accumulated dirt. Wash thoroughly, using warm water and detergent or a solvent, such as kerosene. Allow filter to dry completely before recharging. Drying may be accelerated by directing compressed air through media.

RECHARGING: Element may be recharged by spraying both sides of media with Filter Adhesive (shown below), or by dipping in standard motor oil. If oil dip is used, use SAE30-50 and allow element to drain thoroughly before putting into use.

Universal Oil Free Adhesive

Universal oil free adhesive is an oil-free product developed for use on viscous impingement type filters. It is a substitute for oil for applications which do not permit oil wetting of the elements, such as oil-free compressors.

New Filters should be treated on each side by applying a thorough coat of the adhesive and allowing to dry about ten minutes before placing into service. Used filters must be cleaned and dried according to instructions prior to application of the adhesive.

Universal Oil-Free Filter adhesive is available in 20 ounce aerosol spray cans, packaged 6 cans per carton. Order by part number 81-0323.

Small Air Filters and Filter Silencers

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- Centrifugal Compressors
- Specialty Applications (Such as Pressure Reduction
- Valves, Rotary Screw Compressors, etc.)

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CINCINNATI FAN & VENTILATOR CO.
SUPER RADIATOR CORP.
VENTROL, INC.

Sharpe
HEATING & VENTILATING, INC.

820 South Palm Avenue, Suite 21 / Alhambra, Calif. 91803 / Tel. (213) 289-4651

October 3, 1979

RECEIVED

FAIRCHILD

Fairchild, Statos division
1800 Rosecrans Blvd.
Manhattan Beach, California 90266

Attention: Mr. Al Aiello
Advanced Projects

Gentlemen:

Supplementing our telephone conversation of this morning, we are enclosing a copy of a catalog on Siemens blowers and we are pleased to quote the following item for your consideration.

Siemens Model 2BH4-000-0AB-16Z, side channel compressor.
Standard construction per page 6 of the enclosed catalog.
1.15 HP, 3320 RPM, 1/60/115 volt, ODP motor.
70 CFM at 40.0" S.P. when used on pressure system. See page 4 of attached catalog for performance curve.
No accessories included.

For the fan as described above, your net cost each f.o.b. factory, Iselin, New Jersey is. $549.00

Please note that the attached catalog is an old issue and that this unit is listed as Model #2CH4 in all references therein.

The new model number is #2BH4 and this has been changed merely because of correction of printing errors made when transmitting from metric to American units and from German to English. New catalogs are currently being printed which will match with the 2BH4 nomenclature and these are supposed to be available for distribution some time before the end of this year.

The unit as quoted is available from stock and it is the only one of the various models offered in this size that is in stock at the moment. If other models are required, i.e., 230 volt, single phase, or 3 phase units, these would have to be shipped in from Germany and it is our understanding that the current shipping time is running 8 to 10 weeks.

Yours truly,

SHARPE HEATING & VENTILATING, INC.

Thomas B. McKelvey

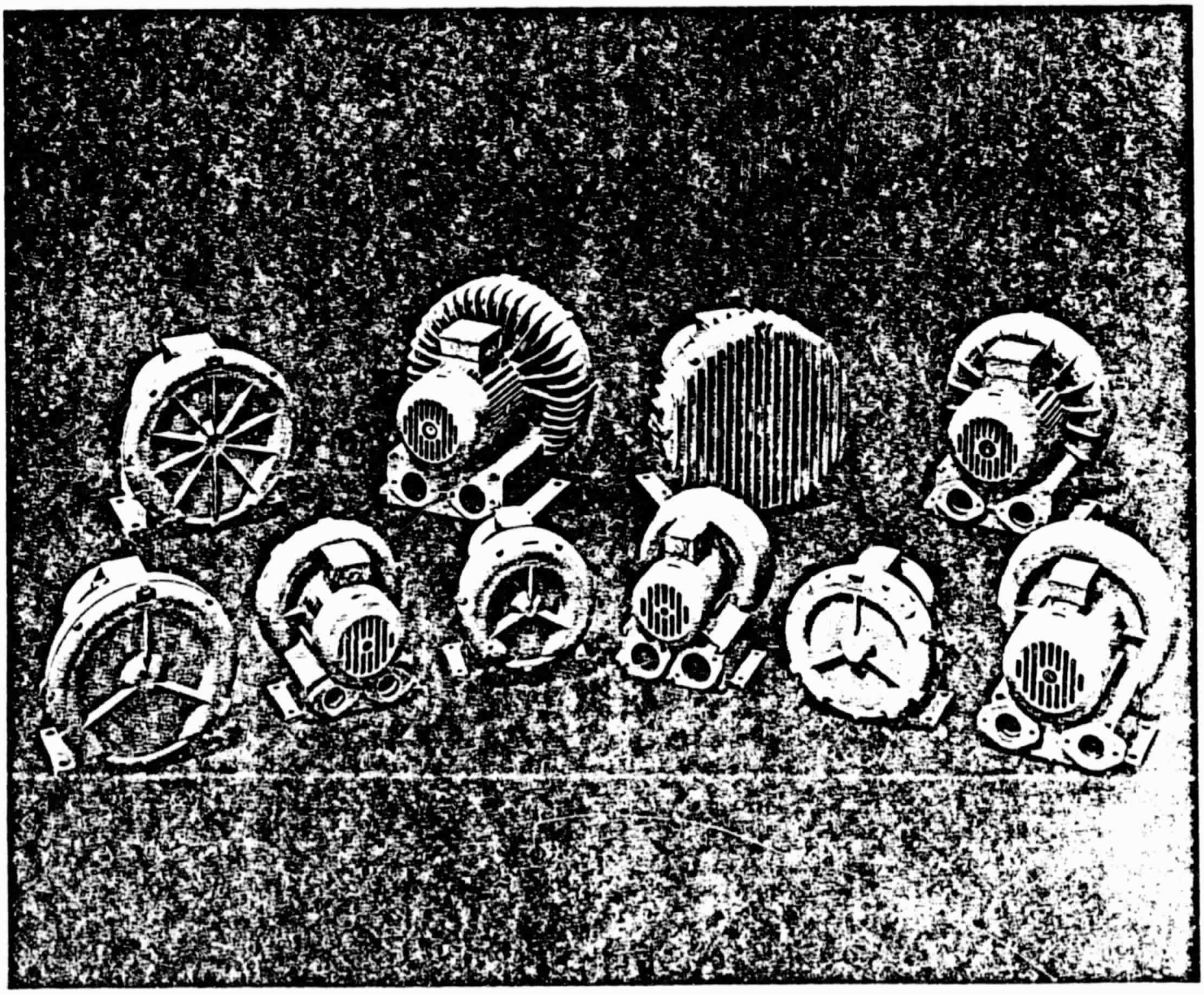
TBM:ss

SIEMENS

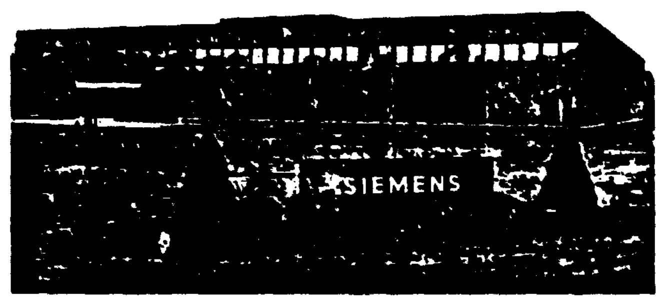
High Performance Side Channel Compressors

Series 2CH

For Pressure and Vacuum



Siemens is a major multi-national corporation with facilities on all continents and in over 100 countries. U.S. headquarters, shown here, is at Iselin, N.J., about 30 minutes drive from Manhattan. Siemens employs over 300,000 people and has an annual sales volume of over $6 billion.



Single Source Responsibility

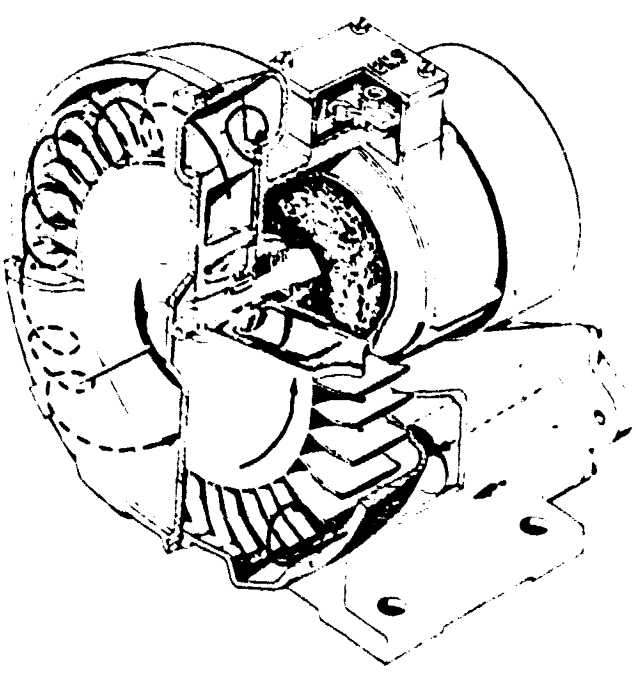
With regard to the side channel compressors described herein, Siemens designs and manufactures both the compressor portions and the motors, thus the customer is assured of single source responsibility for *all* components not only with respect to manufacture but also for service.

Principle of Operation

The Siemens' family of Side Channel Compressors produces substantial volumes of oil-free compressed air at moderate pressure/vacuum differentials. In the 2CH Series, which this brochure covers, the basic machines have flow rates to approximate 200 cfm, pressure ratings to 120 inches of water and vacuum ratings to nearly 100 inches of water.

For applications requiring greater flow, greater pressure differential or both in combination, Siemens offers a larger machine, the 2BH8, which is available in a single stage and 2-stage versions. The 2BH8 is covered in a separate technical bulletin available on request. Various delivery requirements also can be satisfied by operating 2CH units in parallel or staged. Data on staged and parallel operation are given on pages 13, 14 and 15.

Air or other gas, according to application, enters the compressor through an intake port and is admitted to a toroidal housing. Within this housing is a unique, vaned impeller mounted co-axially on a shaft common with the armature of the induction motor. The design of this impeller is such that the air is caused to flow in a spiral path constantly accelerating as it is forced to the pressure discharge port.



Construction

The cutaway view diagrams the flow and shows the construction of a typical Siemens Side Channel Compressor. Note that the armature and compressor shaft is supported by heavy duty, permanently lubricated sealed bearings. In the 2CH2, 2CH3 and 2CH4 models the compressor and the motor housings are integral. On the 2CH5, 2CH51 and 2CH6 the entire motor is removable. (See exploded view on page 12). To exclude dust, fibers or other contaminants which may be present in some industrial applications, the compressor section is effectively isolated from the front bearing and the motor section. On all models the front end and rear bearings are double sealed.

On the sizes up to 2CH6 both the impeller and the toroidal housing are made of an aluminum alloy. On the 2CH6, the toroid is cast iron. A low copper content aluminum alloy is used because such an alloy has superior corrosion resistance qualities. For all models the impeller is cast as a single piece so that there need be no concern that blades will loosen with use nor is periodic inspection and service required. Furthermore there are no rings, sliding vanes or other wearing parts needing replacement from time to time.

Dynamic balancing assures freedom from vibration, contributing to the long life of Siemens Side Channel Compressors. They may be mounted in any plane without affecting life or performance.

Siemens manufactures a wide variety of motors for the side channel compressors. Stock models include units for operation on 115V or 230V, 60 Hz single phase current and for 230/460, 50/60 Hz three phase current. Other models are available for a wide range of voltages –200 to 600V @ 60 Hz and 185 to 590V @ 50 Hz. This broad operating range is particularly advantageous for equipment destined for export since all of the voltages found throughout the world can be accommodated. Terminal boxes are NEMA Type 4, standard on all units. A terminal board with binding head screws is included.

All models have thermal overload protection as a standard feature. On the single phase motors reset is automatic except on the single phase 2CH5 and the single phase 2CH6. On the three phase units the thermal overload protectors are wired directly to the motor starter so that no pilot relay is needed. Reset is manual. In all three phase motors the overload circuit is wired to prevent single phase running.

Insulation is NEMA Class B for 2CH2, 2CH3 and 2CH4 models and Class F for the 2CH5, 2CH51 and 2CH6. All motors are UL Approved (Yellow Card Approval No. E48364). They all also have VDE approval. CSA approval has been obtained for all models except the 2CH2 for 60 Hz machines up to 600 volts.

All motors are totally enclosed, fan cooled (TEFC).

Where greater flow or greater pressure differential than that obtainable from a single unit is required, two or more units may be combined. They may be operated in parallel for increased flow or staged for higher pressure or greater vacuum. It is advisable that only machines of the same model be combined. Typical arrangements are illustrated and representative performance data are shown on Pages 13, 14 and 15. For even greater flows, pressure and vacuum, Siemens produces a series of larger units, the 2BH8. These compact machines are available as single units or as dual units, incorporating two impellers on a common shaft and dual shrouds. The compressor sections of a dual unit may be connected in parallel to double flow or in series for higher pressure or greater vacuum. A separate technical bulletin is available on request.

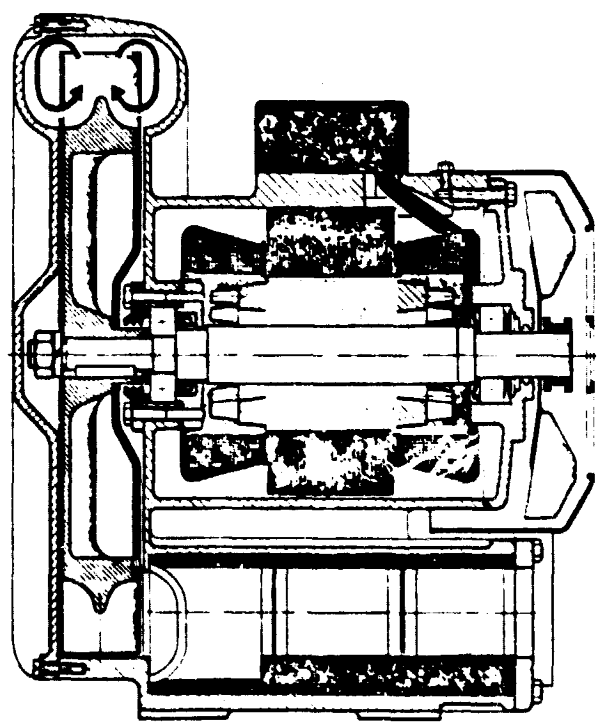
While dynamic as opposed to positive displacement machines, the Siemens Side Channel Compressors do not have the inherent operating limitations of axial or centrifugal flow compressors. They are designed for continuous duty and may be operated with either the intake or the discharge port restricted and even run for extended periods with either port fully throttled. Furthermore, the Siemens machines can be used effectively where reversing cycles, i.e. compression-vacuum, vacuum-compression, is required. Data giving maximum operating temperature range, the fully throttled operating period for each model and the open and reset points of the thermal overload protection incorporated in the motors are included in the Specifications Table on Pages 8 and 9.

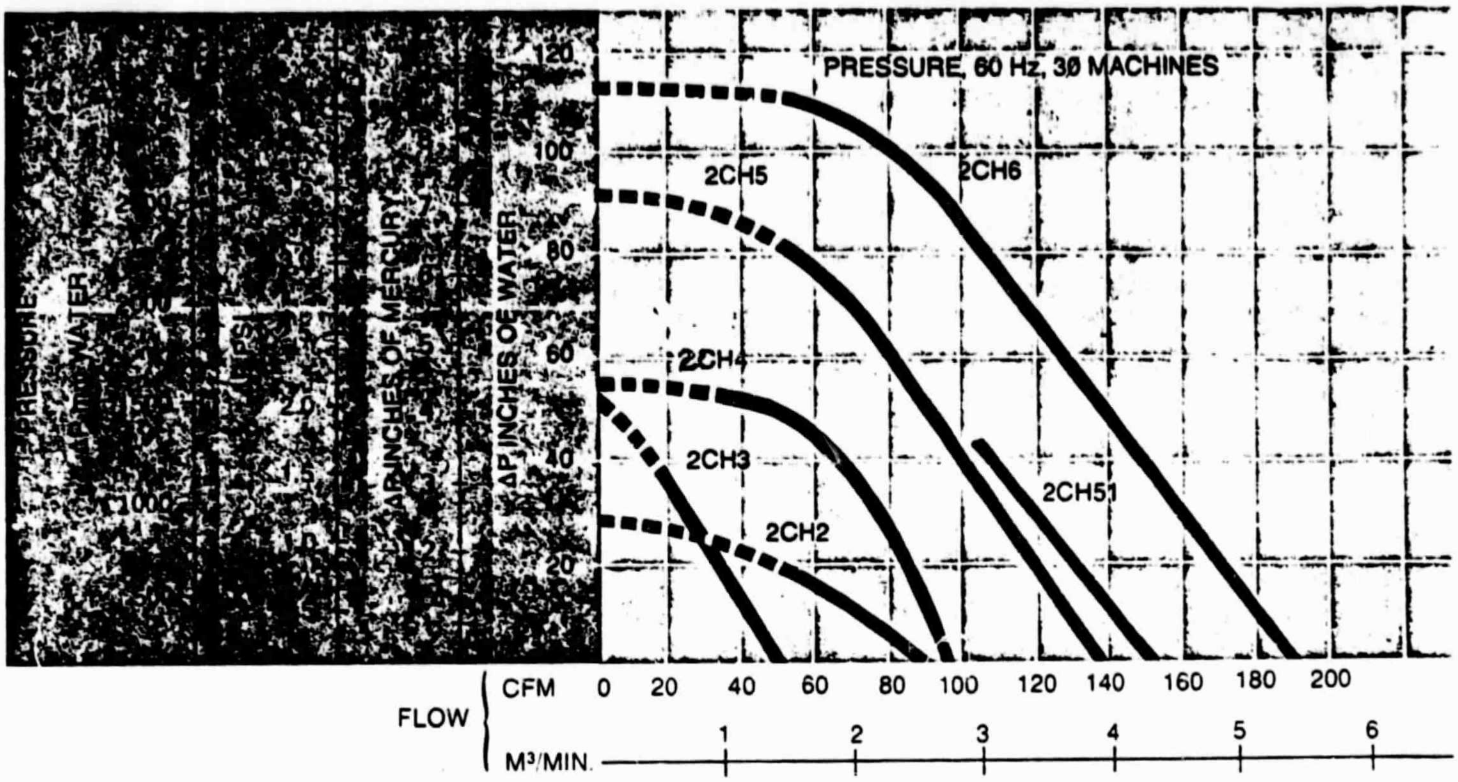
All compressors make noise, including the side channel type. In the Siemens units, noise is minimized inherently by the characteristics of the design and by attenuation in the intake and discharge ducts which incorporate integral mufflers. Noise is below the levels cited in OSHA documents.

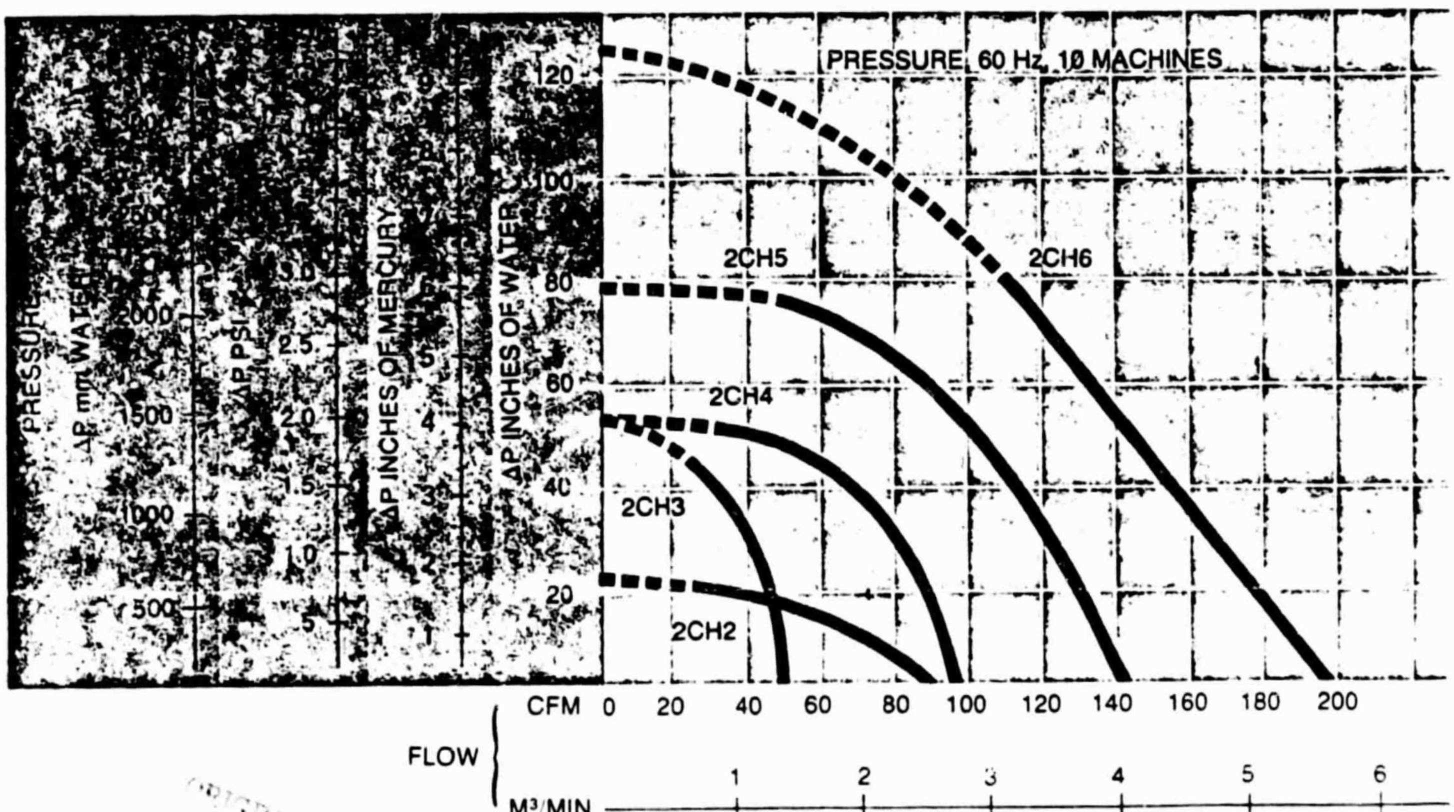
For requirements where even lower noise levels are desired, external silencers are available. Data on noise levels for each machine and information on silencers are given on Page 10, 11 and 14.

All Siemens Side Channel Compressors are lubricated with synthetic grease having a broad operating temperature range –40° to +400°F (–40 to 204°C). It is a dual purpose grease selected for long operating life under load at high speeds and high or low temperature.

The grease used in all models is high temperature Aeroshell 16. It is a thickened mineral polyester synthetic, corrosion inhibited and heavily fortified against oxidation. For unusual high temperature applications the compressors can be supplied with Dow Corning FS-1292, a fluorosilicone thickened with an organic solid, which meets MIL-G-27617, a specification that requires good high temperature performance and a high degree of resistance to solvents and oxidation.



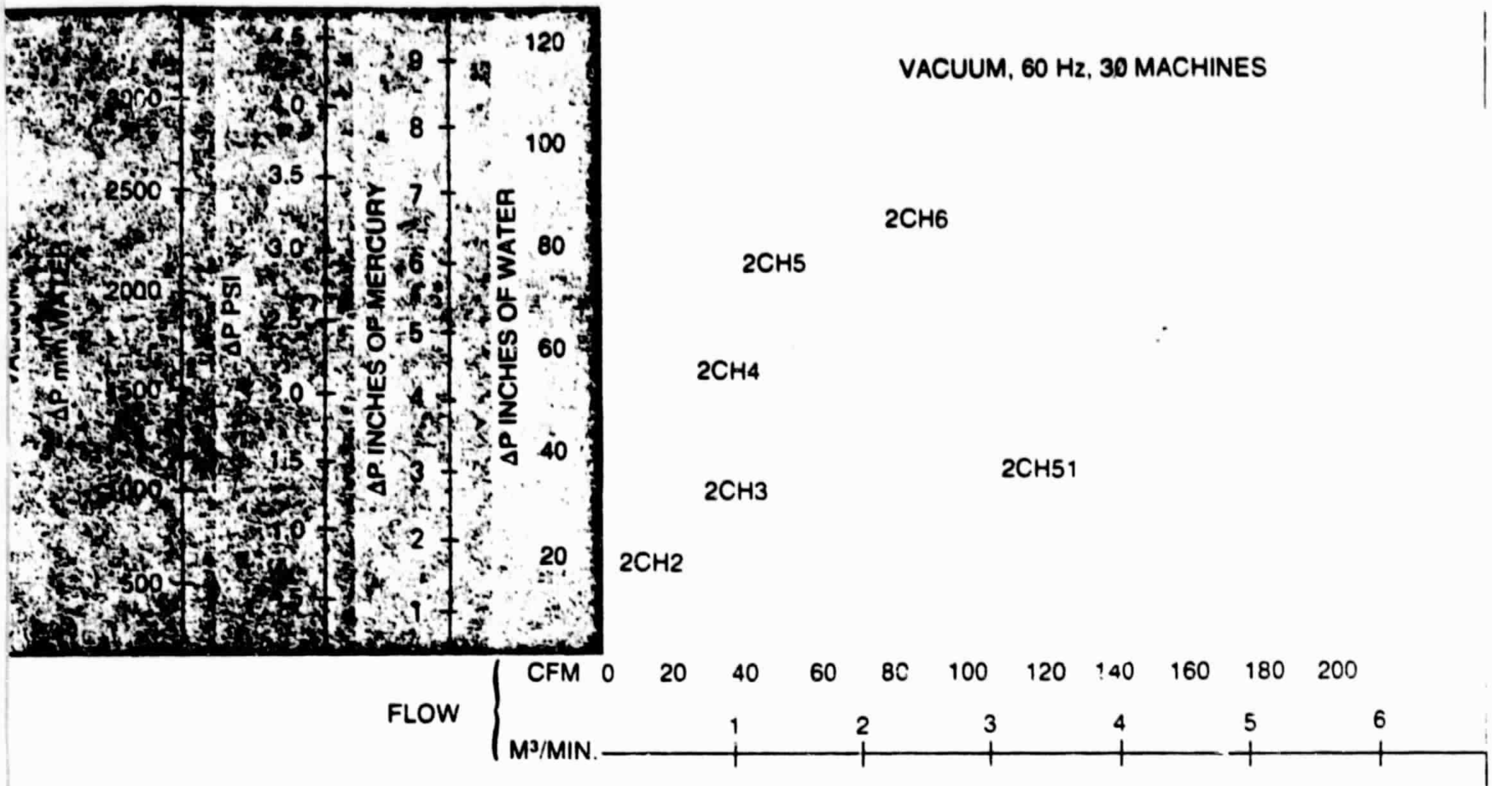


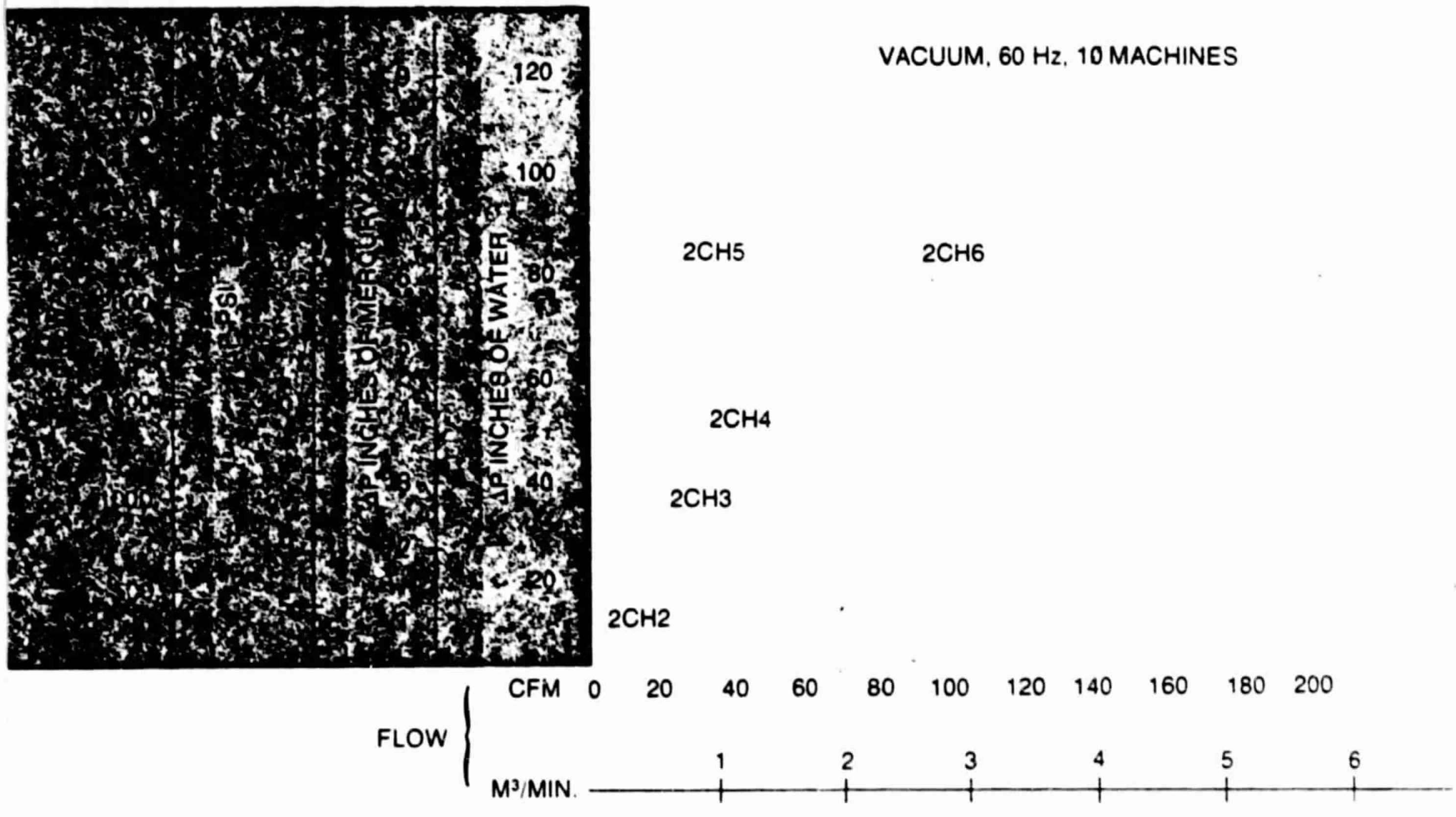


The performance of the various basic models of the Siemens Side Channel Compressors is shown on the curves. Performance curves for 50 Hz machines are available and will be supplied on request.

Note
The values apply with a tolerance of ± 10% to a medium with a specific gravity of .0765 lbs/ft³, referred to air at 15°C and intake conditions equaling 29.92" Hg.

All data refer to continuous duty performance measured after 30 minutes of running when temperatures have stabilized and *not* at start-up "cold" conditions when flow and pressure would be somewhat higher.





To select the proper compressor, determine from the performance curves which are likely to meet the requirements—making allowance for possible future increase if this is at all probable—and refer to the detailed specifications Tables on Pages 8 and 9 to select the optimum match.

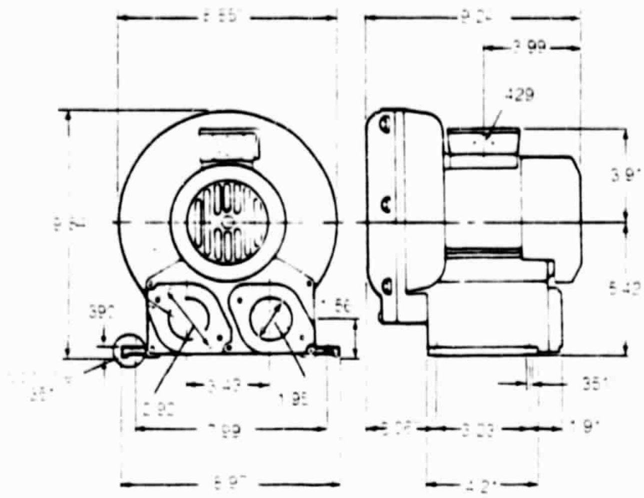
Should the requirements fall outside the capabilities of the units whose performance is shown here, they may be met by using two or more units in parallel or staged or by a larger machine in Siemens 2BH8 series. The 2BH8 machines are compact units available in single or dual models. Dual models incorporate two impellers on a common shaft and dual shrouds. The compressor sections of a dual unit may be connected in parallel or in series at the user's option. A single unit 2BH8 machine may be converted to a dual unit by the addition of a second impeller housing assembly.

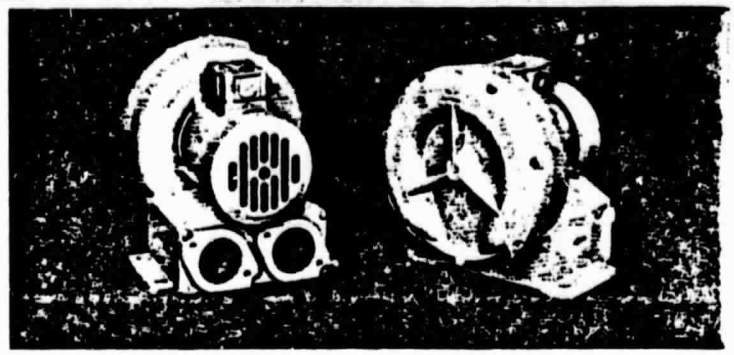
2CH2

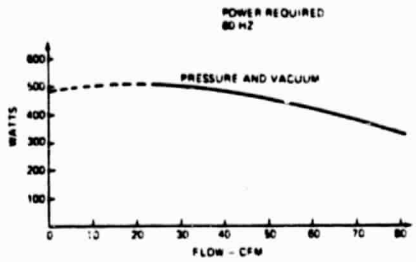
KEY MOUNTING DIMENSIONS

Bolt Holes: Center to Center

Front-to-Back	3.23"
Across	7.99"
Diameter	.351"





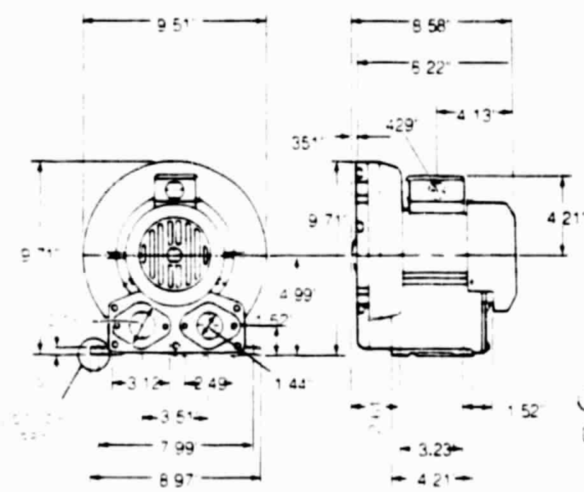


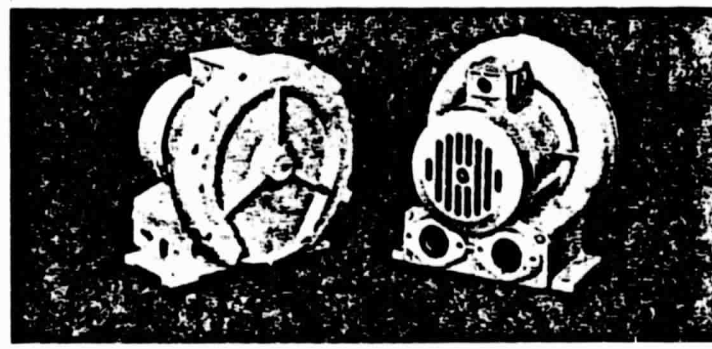
2CH3

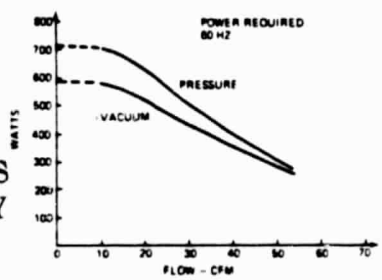
KEY MOUNTING DIMENSIONS

Bolt Holes: Center to Center

Front-to-Back	3.23"
Across	7.99"
Diameter	.351"





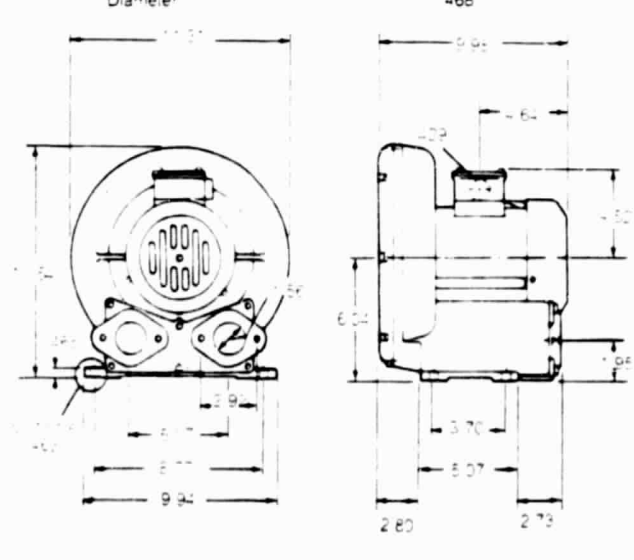


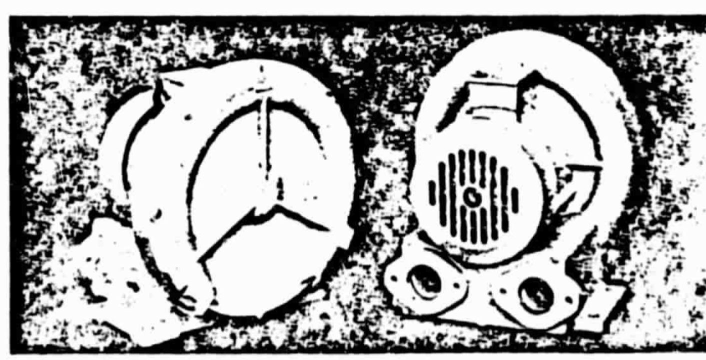
2CH4

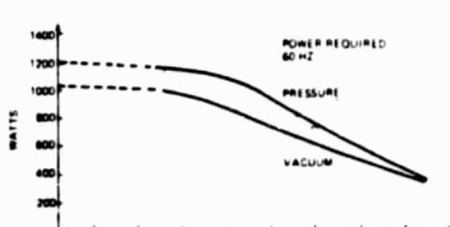
KEY MOUNTING DIMENSIONS

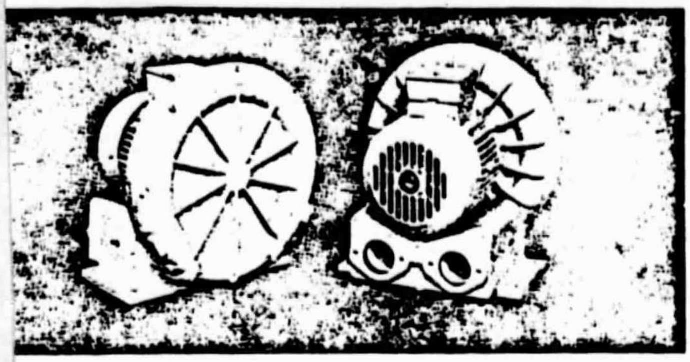
Bolt Holes: Center to Center

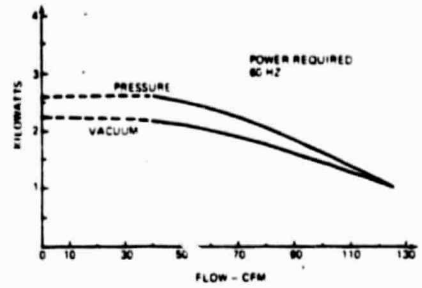
Front-to-Back	3.70"
Across	8.77"
Diameter	.468"







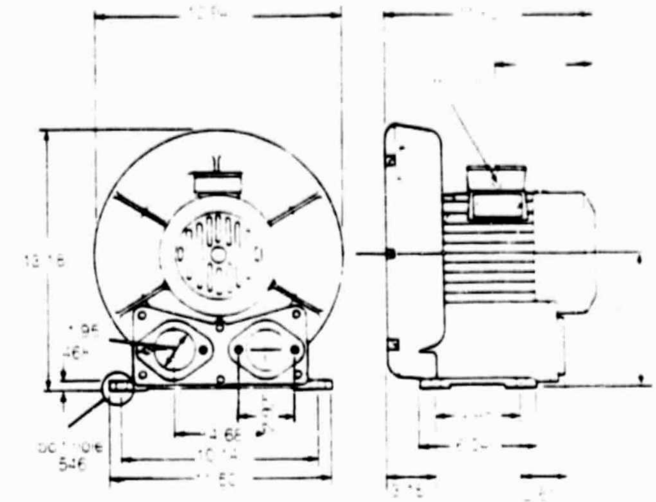


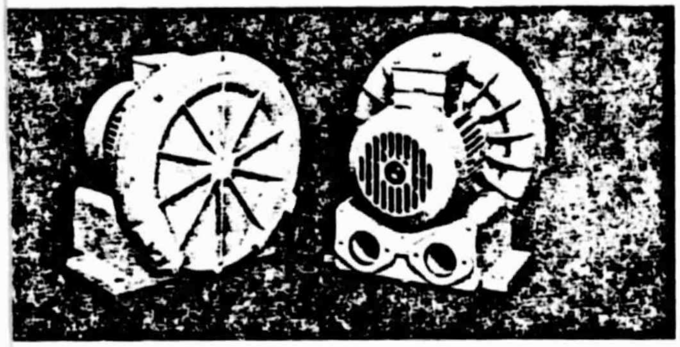


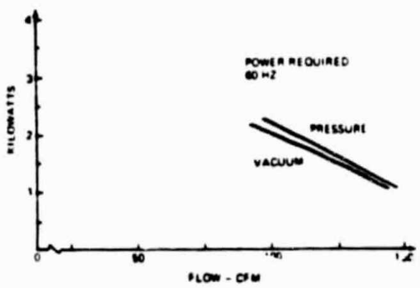
2CH5

KEY MOUNTING DIMENSIONS

Bolt Holes, Center to Center	
Front-to-Back	4.48"
Across	10.14"
Diameter	546"



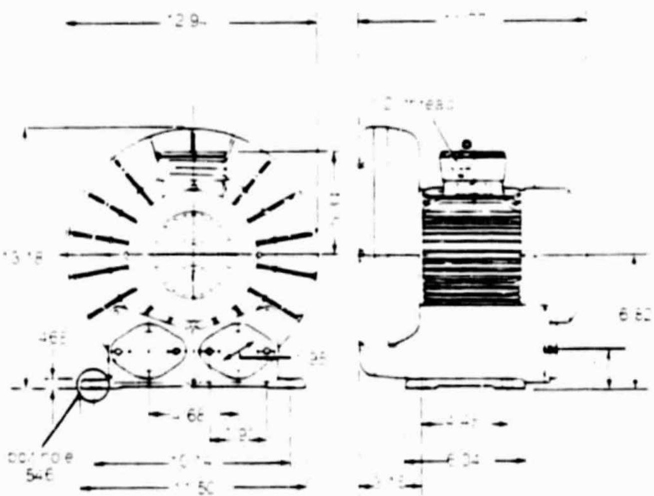


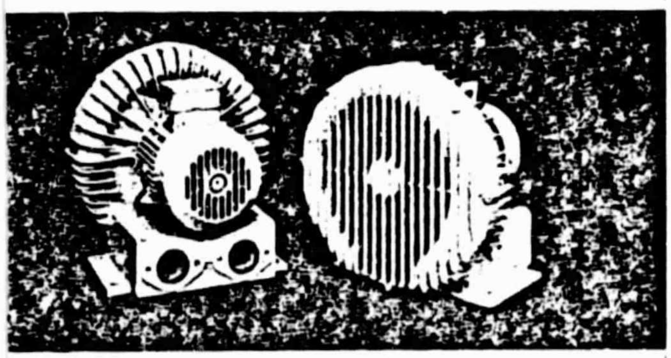


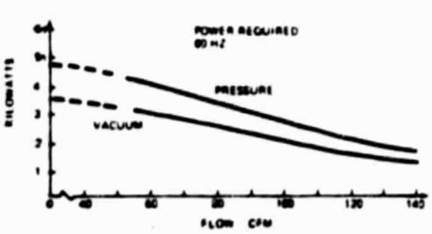
2CH51

KEY MOUNTING DIMENSIONS

Bolt Holes, Center to Center	
Front-to-Back	4.48
Across	10.14"
Diameter	546"



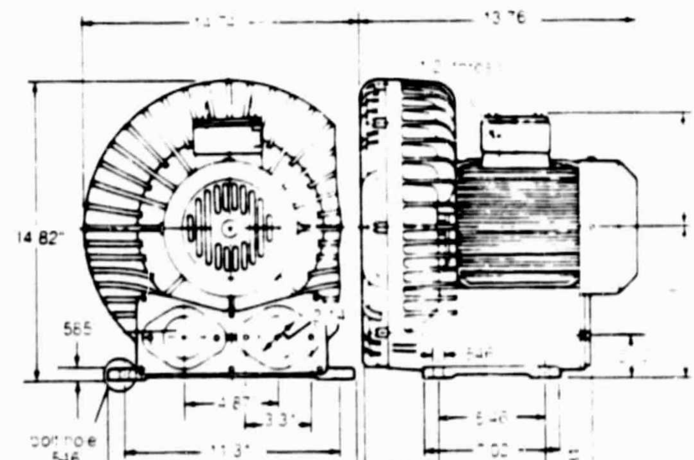




2CH6

KEY MOUNTING DIMENSIONS

Bolt Holes, Center to Center	
Front-to-Back	5.46"
Across	11.31"
Diameter	546"



Note: Dimensions are for reference only. A certified print is available on request.

		2CH2 SERIES		2CH3 SERIES		
Model No.		**2CH2 010-IU**	**2CH2 001-IU**	**2CH3 010-IU**	**2CH3 031-IU**	**2CH4 010-IU**
Electrical Data						
Voltage & Phase [1]		115, 1Φ	230/460, 3Φ	115, 1Φ	230/460, 3Φ	115, 1Φ
Frequency, Hz		60	50/60	60	50/60	60
Shaft h.p. of Motor	60 Hz	0.38	0.38	0.57	0.57	1.15
	50 Hz	0.33	0.33	0.50	0.49	1.00
Rated kW	60 Hz	0.28	0.29	0.42	0.43	0.86
	50 Hz	0.28	0.25	0.33	0.47	0.75
Locked Rotor Current, amp		12.5 @ 115V	7 @ 220V	14 @ 115V	8.3 @ 220V	31 @ 115V
Capacitors, mfd		20 @ 220V		30 @ 220V		60 @ 220V
Nameplate Current, amps	60 Hz	4.7	1.44/0.72	6.2	1.86/0.93	10
	50 Hz		1.62/0.81		1.74/0.87	
Insulation Class, NEMA [2]		B	B	B	B	B
Operating Data						
Rated rpm	60 Hz	3230	3250	3210	3200	3320
	50 Hz		2700		2800	
Fully Throttled Operating Period		Continuous	Continuous	10 min	Continuous	10 min
Max. Operating Temp.						
Ambient	°C	40	40	40	40	40
	°F	104	104	104	104	104
Pumped Medium	°C	40	75	40	75	40
	°F	104	167	104	167	104
Overload Protection						
Open	°C	135 ± 5	120 ± 5	135 ± 5	120 ± 5	135 ± 5
	°F	275 ± 9	248 ± 9	275 ± 9	248 ± 9	275 ± 9
Reset	°C	88 ± 15	77 ± 15	88 ± 15	77 ± 15	88 ± 15
	°F	190 ± 27	170 ± 27	190 ± 27	170 ± 27	190 ± 27
Klixon Model No. [3]		9700H-06-11	9700H-01-EA	9700H-06-11	9700H-01-EA	9700H-06-11
Peak Noise Level dB(A) Without External Silencer	60 Hz	74	74	69	69	73
	50 Hz		72		66	
Dimensional Data						
Width, inches		8.85		9.51		
Height, inches		9.84		9.71		
Length, inches		9.24		8.58		
Weight, lbs		17		22		

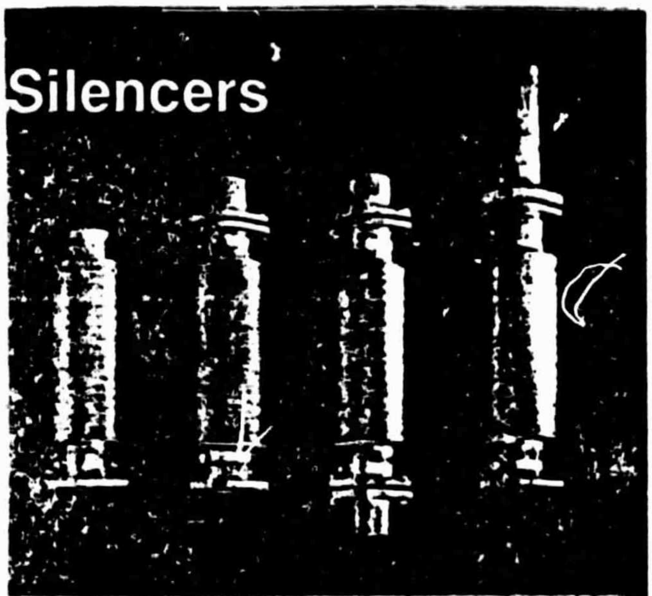
Notes:

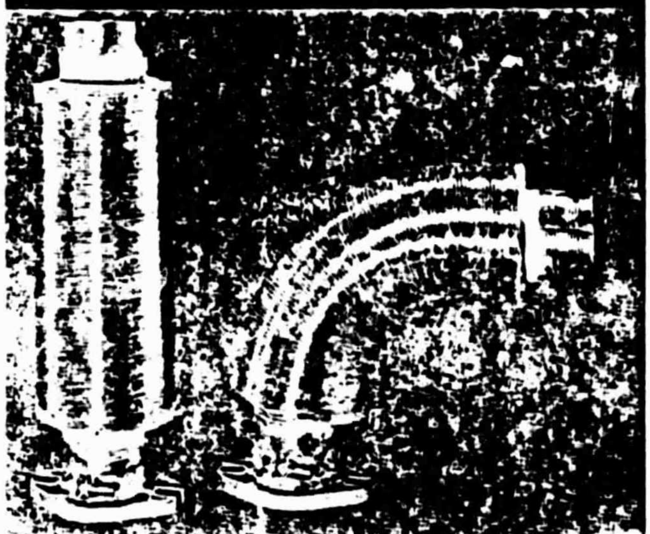
1. Voltages ± 10% all models except ± 5% 2CH6 Series.
2. Insulation Class B = 130°C, 266°F,
   Class F = 155°C, 311°F, H = 180°C, 356°F.
   Any motor can be supplied with Class F or Class H to order.
3. 1 ϕ motors one per unit, 3 ϕ motors three per unit.
   1 ϕ auto reset except 2CH5 and 2CH6
   all 3 ϕ and 1 ϕ 2CH5 and 1 ϕ 2CH6 are manual reset. 3ϕ are wired to prevent 1 ϕ running.
4. To meet the needs of customers with 208 or 550 volt power a limited quantity of units powered by 3 ϕ motors for these voltages are kept in stock. The 2CH6 208V, 3ϕ nameplate current is 14.8 amps.

2CH4 SERIES		2CH5 SERIES		2CH51 SERIES	2CH6 SERIES	
2CH4 011-IU	2CH4 001-IU	2CH5 060-IU	2CH5 041-IU	2CH5 141-IU	2CH6 071-IU	2CH6 041-IU
230 10	230 460 30	115 10	230 460 30	230 460 30	230 10	230 460 30
60	50 60	60	50 60	50 60	60	60
1 15	1 15	2 31	2 31	2 31	3 40	3 40
1 00	1 00	2 00	2 00	2 00	3 00	3 00
0 86	0 86	1 72	1 72	1 72	2 54	2 54
0 75	0 75	1 50	1 50	1 50	2 20	2 20
	15 6 @ 220V	87 @ 115V	30 @ 220V	85 @ 115V	95 @ 220V	85 @ 220V
20 @ 450V		140 @ 220V			50 @ 450V	
5 0	2 8 1 4		8 0 4 0	6 0 3 0	17	13 4 6 7
	2 2 1 1		7 6 3 8	5 6 2 8		
B	B	F	F	F	F	F
3320	3350	3300	3450	3450	3300	3440
	2900		2930	2920		
10 min	Continuous	not over 82" WG	30 min	30 min	not over 78" WG	over 100" WG 30 min max
40	40	40	40	40	40	40
104	104	104	104	104	104	104
40	75	40	75	75	75	75
104	167	104	167	167	167	167
135 ± 5	120 ± 5		145 ± 5	120 ± 5		145 ± 5
275 ± 9	248 ± 9		293 ± 9	248 ± 9		293 ± 9
88 ± 15	77 ± 15		88 ± 15	77 ± 15		88 ± 15
190 ± 27	170 ± 27		190 ± 27	170 ± 27		190 ± 27
9700H-06-11	9700H-01-EA		9700H-76-11	9700H-01-EA		9700H-76-11
73	73		77	77		80
	69		73	73		
11 31		12 94		12 94	14 74	
11 54		13 18		13 18	14 82	
9 98		11 62		11 77	13 76	
33		60		68	110	

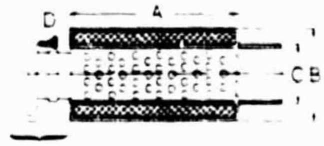
Larger Models [illegible]

Silencers





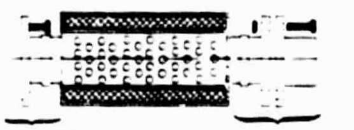
All Siemens Side Channel Compressors incorporate [illegible] noise levels. [illegible] external silencers are [illegible]. These [illegible] and are designed so that they may be [illegible] between the compressor and connected [illegible] eliminate an elbow or tight quarters. [illegible] be bent by hand without tools.



See Hose Flange Dimensions

Flanged (F)

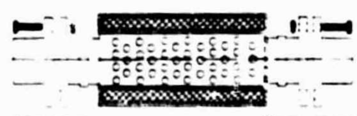
Used where the silencer is mounted on the compressor and discharge is directly to atmosphere as is the case in some vacuum applications.



See Hose Flange Dimensions | See Hose Flange Dimensions

Flange to Nipple (F/N)

Used where the silencer mounts on the compressor and discharge is into a hose.



See Hose Flange Dimensions | See Hose Flange Dimensions

Nipple to Nipple (N/N)

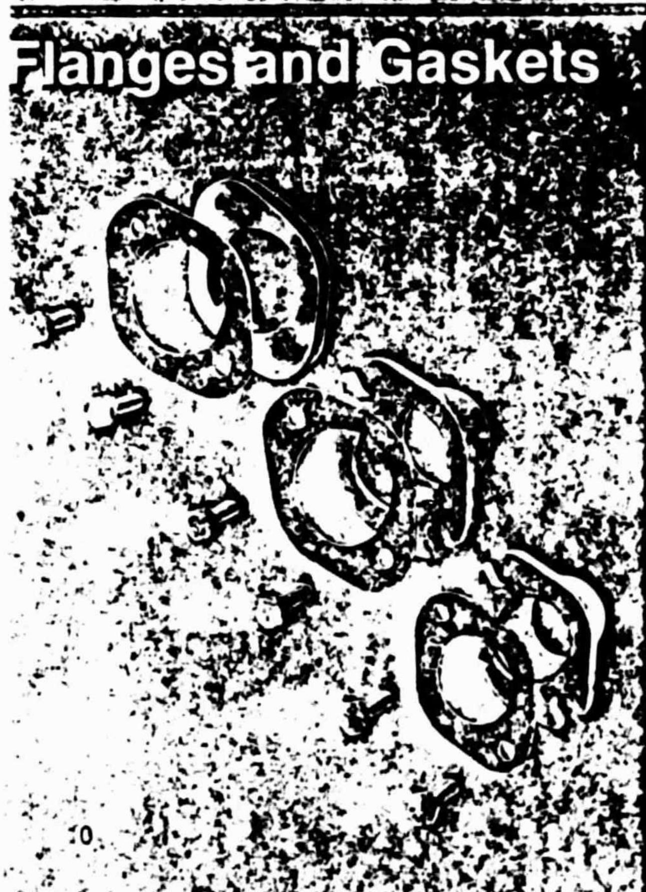
Used where the silencer is to be installed in a hose line.

Flange to Pipe (F/P)

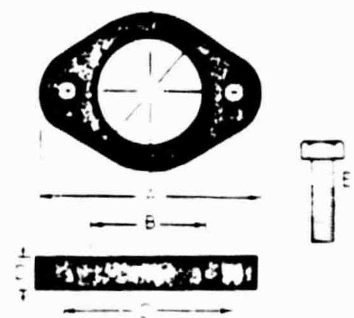
Used where the silencer is to be mounted on the compressor and discharge into piping. (Terminates in a threaded pipe flange on one end.)

See Hose Flange Dimensions | See Hose Flange Dimensions | See Pipe Flange Dimensions

Flanges and Gaskets



THREADED PIPE FLANGE



Two types of flanges are available: threaded pipe flanges and hose flanges.

The accompanying drawings [illegible] [illegible] dimensions.

HOSE FLANGE

Attenuation with External Silencer

Compressor Series	Noise Level Without External Silencer*		Reduction With External Silencer*	
	60Hz	50Hz	Overall dB(A)	dB(A) @ 2100Hz
2CH2	74	72	10	20
2CH3	69	66	5	9
2CH4	73	69	4	7
2CH5	77	73	5	8
2CH51	77	73	5	8
2CH6	80	77	6	8

*easured at a distance of 3 feet and at 50% maximum ΔP

External Silencer Part Nos.

mpressor Series	Flanged*	Flange to Nipple*	Nipple to Nipple	Flange to Pipe
2CH2	2CX1 030-1F	2CX1 030-1 F N	2CX1 030-1 N N	2CX1 030-1 F P
2CH3	2CX1 031-1F	2CX1 031-1 F N	2CX1 031-1 N N	2CX1 031-1 F P
2CH4	2CX1 030-1F	2CX1 030-1 F N	2CX1 030-1 N N	2CX1 030-1 F P
2CH5	2CX1 030-1F	2CX1 030-1 F N	2CX1 030-1 N N	2CX1 030-1 F P
2CH51	2CX1 030-1F	2CX1 030-1 F N	2CX1 030-1 N N	2CX1 030-1 F P
2CH6	2CX1 028-1F	2CX1 028-1 F N	2CX1 030-1 N N	2CX1 028-1 F P

*upplied with gasket and mounting bolts (m8 x 25 for all
xcept 2CH6 m10 x 25 for 2CH6)

Silencer Dimensions Table

t No.	A	B	C	D
x1 030-1	8" (Approx)	3 15	1 97	M8 25
x1 030-1	8" (Approx)	2 95	1 57	M8 25
x1 028-1	8" (Approx)	3 15	1 97	M10 25

THREADED PIPE FLANGE
Part Nos. and Dimensions

Compressor Series	Threaded Pipe Flange*	Dimensions (Inches) A	B	C	D	E
2CH2	2CX1 038	3 94	1½	2 95	511	M8 25
2CH3	2CX1 037	3 15	1¼	2 95	511	M8 25
2CH4	2CX1 038	3 94	1½	2 95	511	M8 25
2CH5	2CX1 038	3 94	1½	2 95	511	M8 25
2CH51	2CX1 038	3 94	1½	2 95	511	M8 25
2CH6	2CX1 041	4 41	2	3 35	630	M10 25

*Includes bolts and gasket

HOSE FLANGE
Part Nos. and Dimensions

Compressor Series	Hose Flange*	Dimensions (Inches) A	B	C	D	E
2CH2	2CX1 033	3 93	2 55	2 0	1 83	M8 25
2CH3	2CX1 032	3 34	2 12	1 5	1 43	M8 25
2CH4	2CX1 033	3 93	2 55	2 0	1 83	M8 25
2CH5	2CX1 033	3 93	2 55	2 0	1 83	M8 25
2CH51	2CX1 033	3 93	2 55	2 0	1 83	M8 25
2CH6	2CX1 034	3 93	2 55	2 0	1 83	M10 25

*Includes bolts and gasket

To specify a Siemens Side Channel Compressor consult the performance curves on Pages 4 and 5 to determine which basic model best suits your flow and pressure or vacuum requirements. Make allowance for a possible future increase in your requirements if this is at all likely. Refer to the specifications table on Pages 8 and 9 for the model number of the appropriate size unit which matches your available power.

As an example, the requirement is for 60 cfm at a minimum pressure of 50 inches of water. Power available is 230V, 30, 60 Hz. The performance curves show that a 2CH5 machine will satisfy this requirement, it having a rating of 60 cfm and 60 inches of water. The Specifications Table shows Model 2CH5 041-IU is rated for 30 230 460 volts 60 Hz. Therefore the unit to specify is 2CH5 041-IU.

Next, considering the installation, ascertain whether or not an external silencer is needed. The curves on Page 14 give noise data. Silencer part numbers are listed on Page 11. For silencer consult configuration drawings and specify the one conforming to your application and the appropriate compressor. Obtain the model number from the External Silencer Parts No. Table. For a 2CH5 machine the Silencer would be 2CX1 030-1F, 2CX1 030-1F N, 2CX1 030-1N N or 2CX1 030-1 F P as appropriate.

If hose is to be connected to the compressor directly, specify the appropriate hose flange. If a threaded pipe is to be connected to the compressor, specify the appropriate threaded pipe flange. (It is not necessary to specify the bolts or the gaskets since these are automatically provided as needed with the silencer or flanges.)

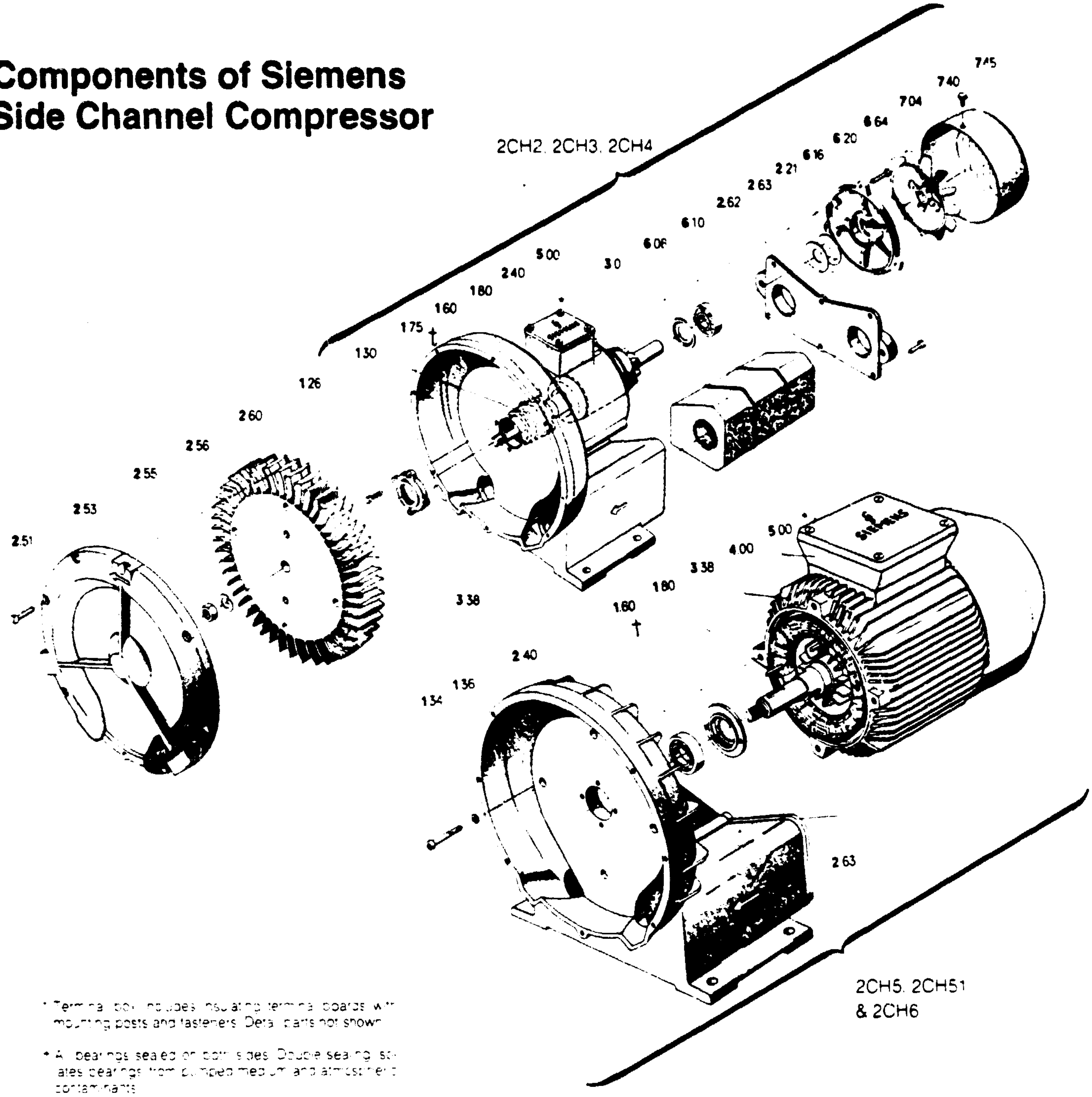
Four silencer arrangements are offered to accommodate the requirements of various installations. (See photograph and dimensional drawings.) The hose flanges and threaded pipe flanges used to assemble the units are those illustrated separately. Each configuration is complete with gaskets, mounting bolts and the nuts and bolts required to couple the flanges. Other configurations, for instance pipe flange to pipe flange, obviously can be created. For such special applications, order the basic unit (F) and the components required to create the configuration.

If the equipment being built is for export and requires a motor for operation on electrical power other than 115, 230 or 460 volts, one of the units available on special order may fit. (Some wide range voltage motors are available from stock.) Motors are available on special order at any voltage up to 600 volts for 60 Hz and 590 volts for 50 Hz. For the rare exception custom motors can be manufactured to meet a specific voltage and frequency.

To meet the needs of customers with 208 or 550 volt power, limited quantity of units powered by 30 motors for these voltages are kept in stock.

ORIGINAL PAGE IS
OF POOR QUALITY

Components of Siemens Side Channel Compressor



* Terminal box includes insulating terminal boards with mounting posts and fasteners. Detail parts not shown.

♦ All bearings sealed on both sides. Double sealing isolates bearings from pumped medium and atmospheric contaminants.

Spare Parts.

1 00 Bearing assembly, drive end
26 Screw
30 Outer bearing cap
34 Screw
36 Washer
.60 Front end bearing
75 Radial seal
80 Inner bearing cap

2 00 Compressor components
.21 Screw
40 Housing
51 Screw
.53 Cap
.55 Nut, retaining
56 Lock washer
60 Impeller
62 Internal muffler w/screen
63 Cap

3 00 Rotor, complete
38 Key, shaft

4 00 Motor frame, complete
04 Motor casting only
30 Stator for motor

5 00 • Terminal box, complete
10 • Terminal board w/supplementary parts
44 • Upper part of Terminal
84 box w/cover

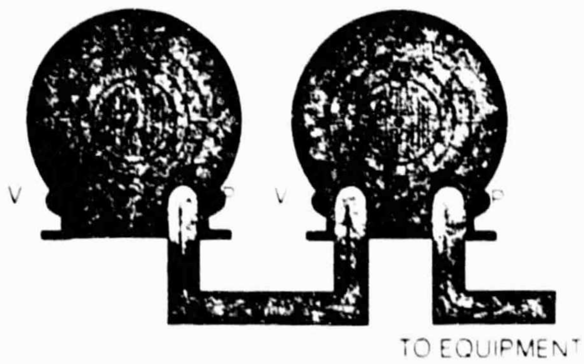
6 00 Bearing assembly, non drive end
02 Bearing cap, non drive end
08 Sealing ring
10 Ball bearing
16 Resilient preloading rings
20 End Shield
64 Screw

7 00 Ventilating accessories for the motor
04 Fan
40 Fan cowl
45 Screw

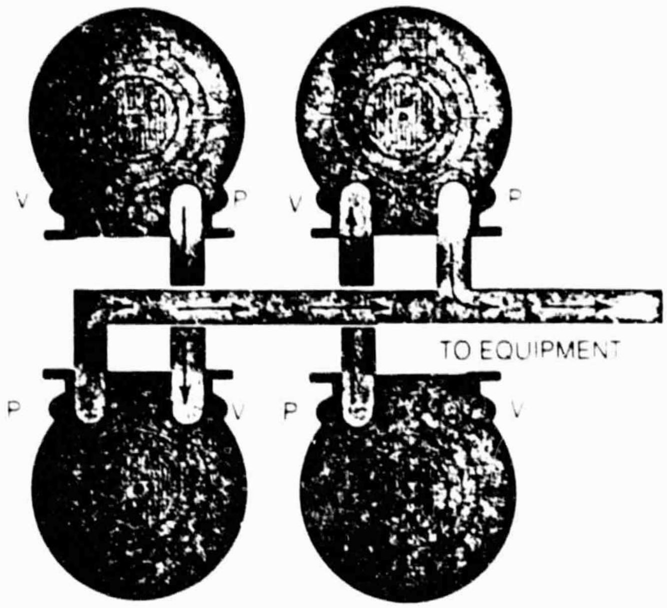
Units in Series and Parallel

V = INTAKE PORT
P = DISCHARGE PORT

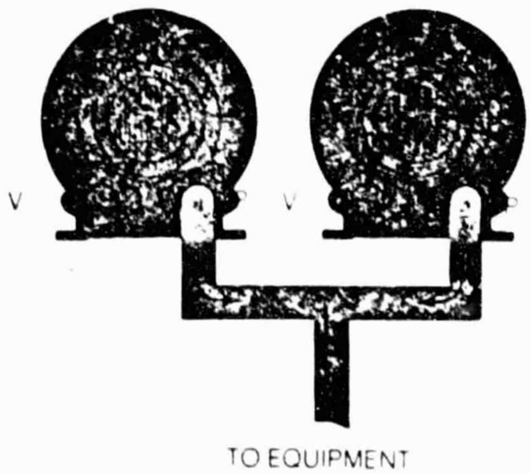
In Series for Increased Pressure



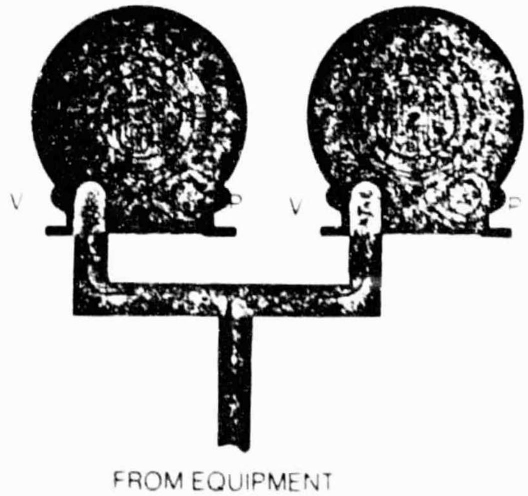
In Series-Parallel for Increased Pressure and Flow

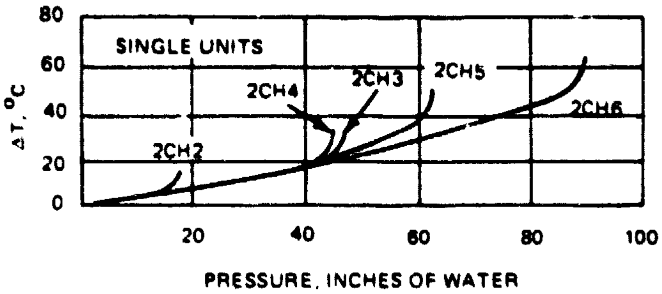


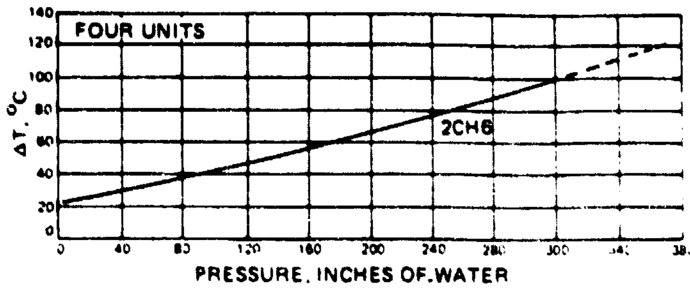
In Parallel for Increased Flow Pressure Application



In Parallel for Increased Flow Vacuum Application

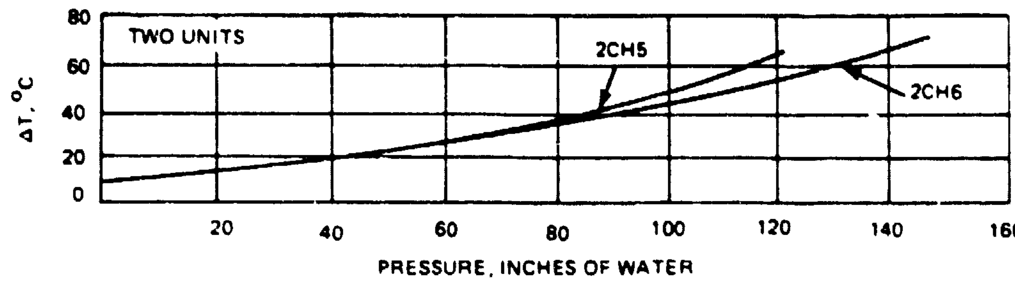


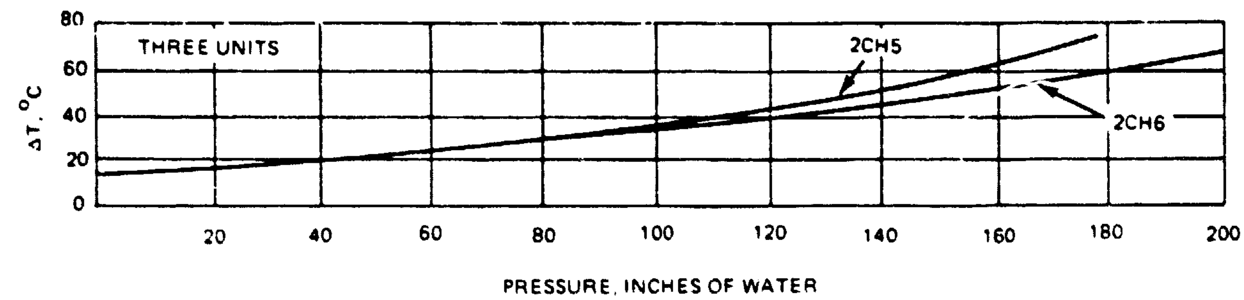


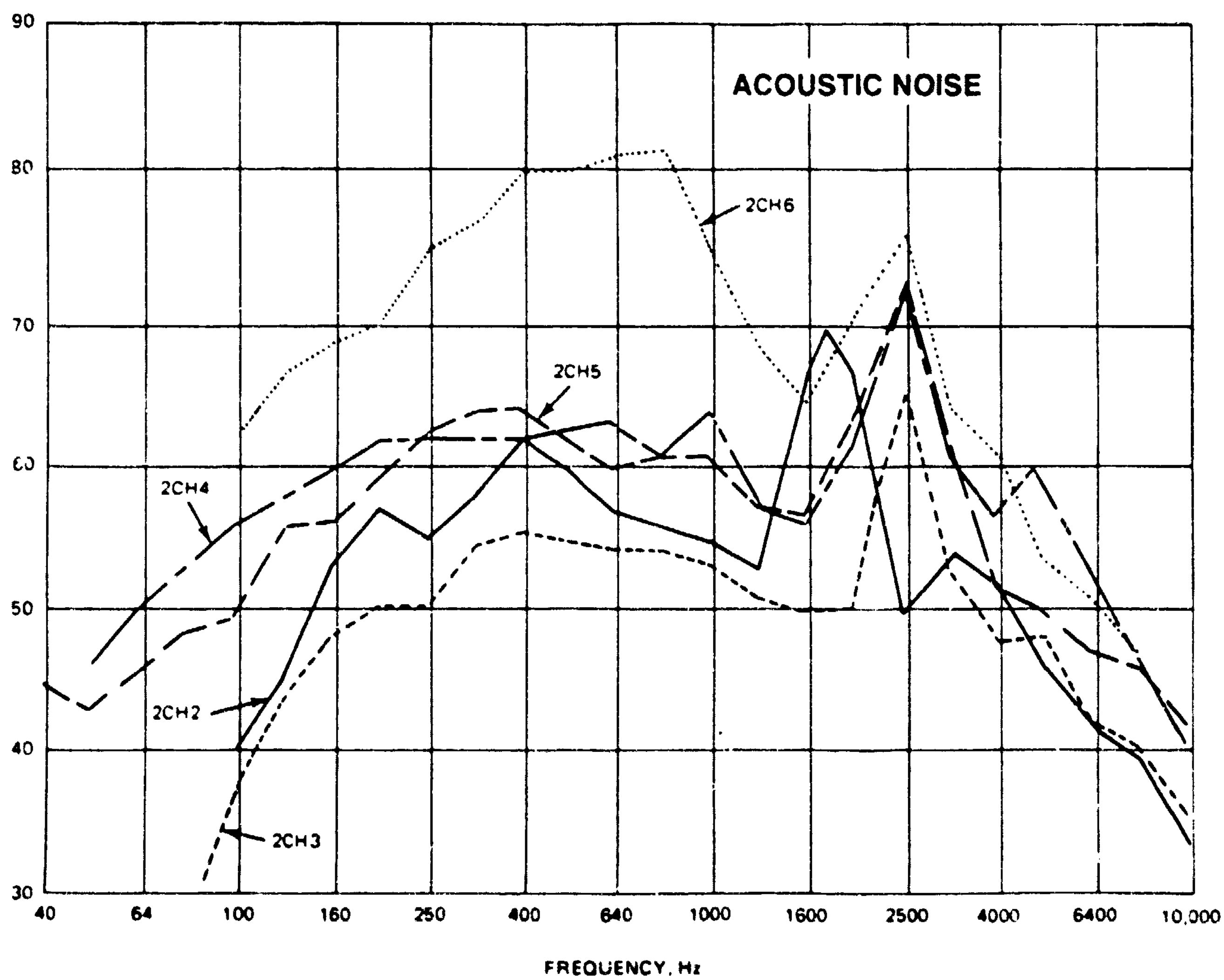


TEMPERATURE RISE

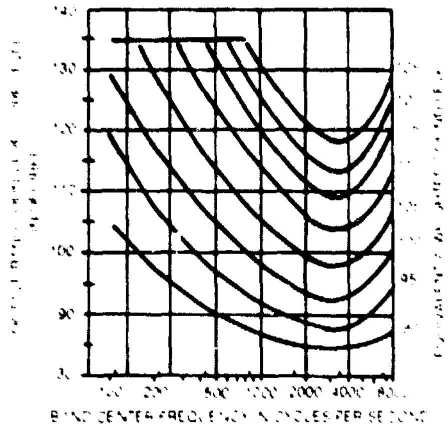
Pumped Medium
Ambient, 20°C —
Tolerance ±10%







Permissible Noise Exposure (OSHA Standards)



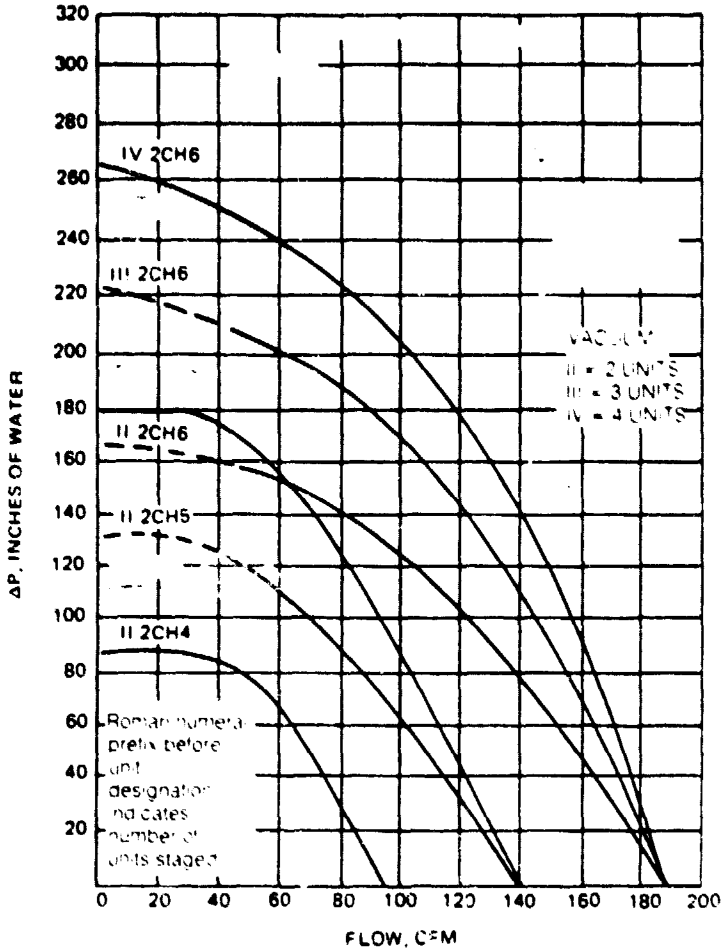
Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C1/T1 + C2/T2 \ldots Cn/Tn$ exceeds unity, then, the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level.

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

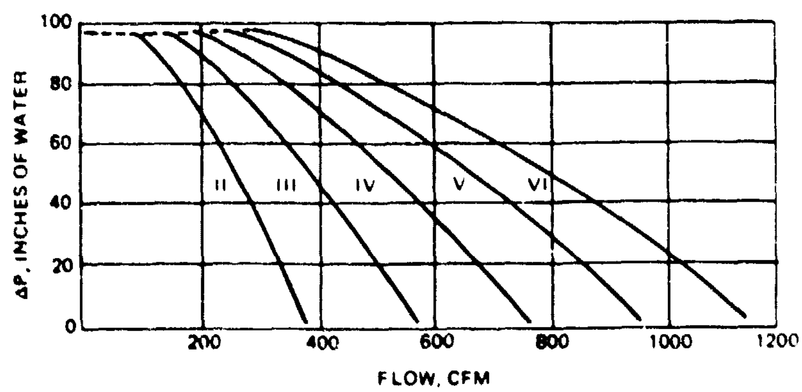
Octave band sound pressure levels may be converted to the equivalent A-weighted sound level by plotting them on this graph and noting the A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits.

TYPICAL PERFORMANCE
Units in Series (Staged)



- - - Indicates upper operating limit for continuous duty

TYPICAL PERFORMANCE
Units in Parallel
(Model 2CH6 @ 3400 r.p.m.)

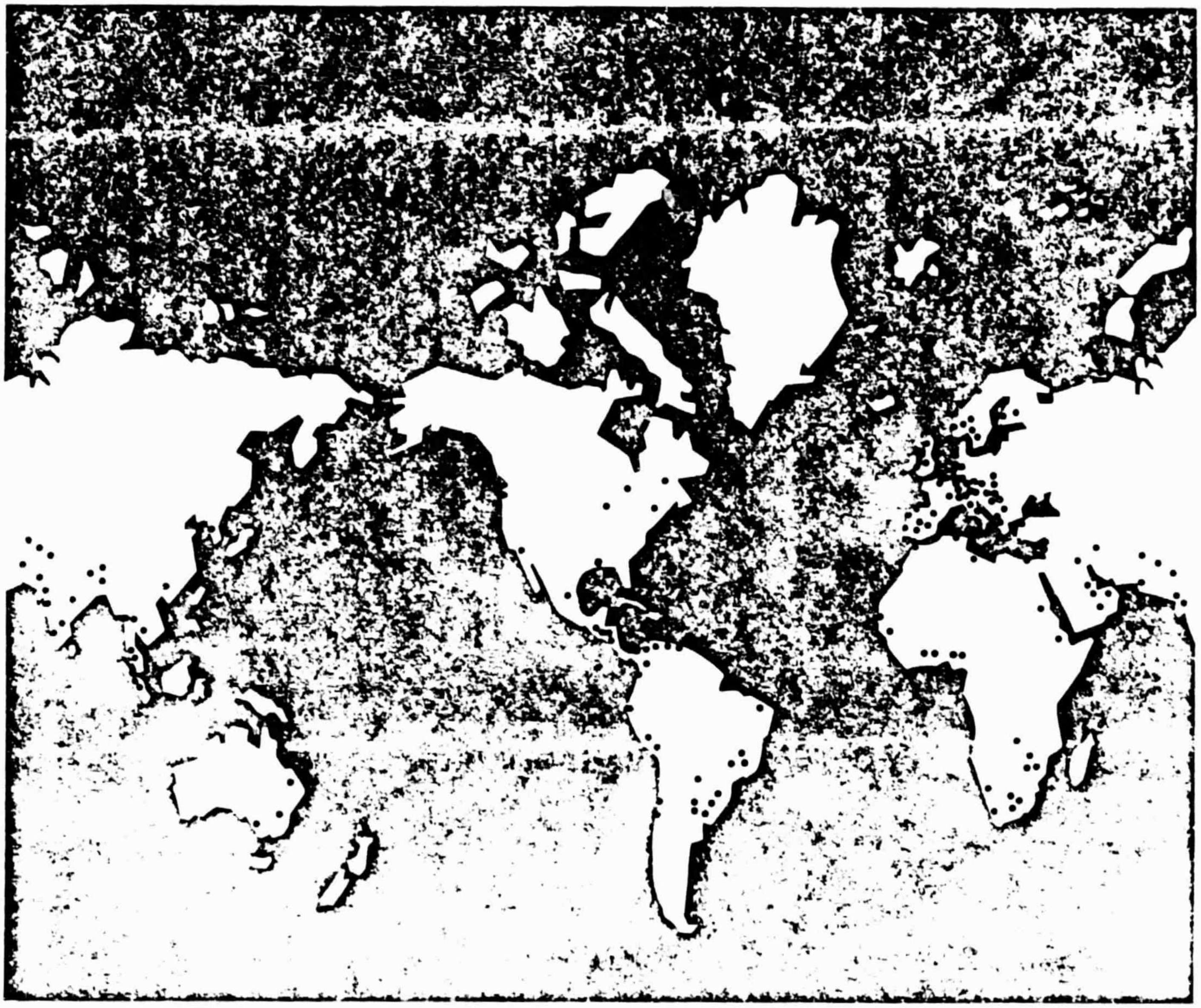


Larger Machines—Series 2BH8

Besides the units whose performance is indicated above, Siemens offers units of a larger size, the 2BH8 series. Models are available as single units and as dual units in series or parallel, with two impellers on a common shaft and dual shrouds. Details are contained in a separate bulletin, available on request.

World Wide Service

In the United States, Siemens has four stocking warehouses — at Iselin, N. J., Chicago, Ill., Houston, Texas, and Burlingame, Cal., plus 25 field offices. Throughout the world there are Siemens customer service offices. They are situated in cities on all the main trade routes. This, plus the fact that the Siemens' motors for the side-channel compressor meet any of the specific power requirements found in overseas countries, makes these compressors doubly attractive for equipment destined for export.



SIEMENS CORPORATION
Power Engineering Division (Mail Stop 13.02)
186 Wood Avenue South Iselin, New Jersey 08830
Telephone: 201-494-1000 Teletype Nos. WU 84-4491 WU 84-4492
Extensions 397, 463

FAIRCHILD
STRATOS DIVISION
1800 ROSECRANS AVENUE
MANHATTAN BEACH, CALIF. 90266

APPENDIX C

ER 79917-2

DSSR ACCEPTANCE TEST

DOCUMENT NUMBER ER 79917-2

DSSR ACCEPTANCE TEST

Ken R. Parish, Test Project Engineer

Richard A. Hag~~lund~~, Senior Project Engineer

Robert J. Burns, Director of Engineering

5 December 1980

FAIRCHILD

STRATOS DIVISION

1800 ROSECRANS AVENUE MANHATTAN BEACH CALIF 90266

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MANHATTAN BEACH CALIF. 90266

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1.0 INTRODUCTION

This test report documents the DSSR acceptance test results. The DSSR assembly was tested for the first time in its final configuration with the air blower and air and gas (motorized) flow control valves installed.

2.0 OBJECTIVES

The primary test objectives are summarized as follows:

a. Achieve light-off at 50% power level and determine the air flow control valve position required for light-off.

b. Operate the DSSR at power levels from 10% to 100% in 10% increments with 10% excess air to assure that the (motorized) air and gas flow control valves can achieve proper operation at all power levels.

c. Verify that the new (three-electrode) ignitor operates satisfactorily and that operation at low power levels is achievable.

d. Record sufficient data to provide a baseline record of initial performance and to allow calculation of heat transfer data at each power level.

3.0 TEST RIG CONFIGURATION

Included in this test report is the DSSR Test Rig Final Assembly (Drawing No. 79917001), as a photograph of the complete test setup, Photo 1. Figures 1 through 4 schematically depict the plumbing and instrumentation for the natural gas, combustion air, water, and miscellaneous instrumentation, respectively. A schematic of the test rig electrical system is shown in Figure 6 and Drawing No. 10097290.

The testing had the "real" configuration heat exchanger installed, as well as the copper cone. An external water reservoir, water pump, and heat exchanger were used to control water recirculation (Figure 5) and thereby control water inlet temperature to the test rig heat exchanger. No air preheater was installed. Since air flow was not instrumented (because of impracticality), DSSR power control was achieved by presetting the gas flow to the desired value and then adjusting the air flow to achieve 10% excess air while monitoring the flue gas analyzer. Previous turn-down testing of the Honeywell gas flow control valve indicated that the required

3.0 TEST RIG CONFIGURATION (continued)

turn-down could not be achieved. The subject valve was then modified internally at FSD and retested for turn-down capability. These tests were performed utilizing air and applying appropriate correction factors to simulate natural gas. Tests of the modified valve indicated that the required turn-down could be achieved with a constant 3-psi supply to the valve.

Test rig instrumentation is as follows:

a. Gas supply pressure to gas flow rotameters

b. High range gas flow rotameter

c. Low range gas flow rotameter

d. Gas pressure into Honeywell gas control valve

e. Gas pressure leaving Honeywell gas control valve

f. Combustion air plenum pressure

g. Water supply pressure to water flow rotameter

h. Water flow rotameter

i. DSSR inlet water temperature

j. DSSR outlet water temperature

k. Upper cone flue gas temperature

l. Lower cone flue gas temperature

m. Flue gas analyzer

n. Flame sensing current (from Fenwalignitor)

4.0 TEST SCENARIO

Water flow was established through the DSSR heat exchanger. Gas flow was set at 50% power level, with the pressure regulator upstream of the Honeywell valve set at 3.0 psi. The air flow was set at nearly maximum and light-off was attempted while slowly decreasing air flow. Light-off was easily achieved. An attempt was then made to adjust air flow to achieve a 10% excess air condition. This adjustment was very difficult to achieve because a very minute valve position change created a huge change

4.0 TEST SCENARIO (continued)

in excess air. After attempting adjustment for approximately 10 minutes, excess air of 11% was achieved (10% excess air could not be achieved). It is believed that the difficulty in achieving 10% excess air (i.e., air flow control valve position setting) is due to the relatively slow valve response time and the relatively insensitive potentiometer used to position the valve. It is suggested that a more sensitive potentiometer (i.e., more turns) be installed for the air control.

Once 11% excess air was achieved, the light-off air flow potentiometer was set to the required (11% excess air) flow position and locked in place. Another problem exhibited itself at the 50% power level and persisted subsequently at all power levels. This problem was that, with excess air set (above but as close to 10% as achievable) at 10%, the combustibles scale of the gas analyzer indicated unacceptably high combustibles value (in some cases, off the scale). It is believed this problem was caused by poor air distribution within the air plenum, particularly in those areas furthest from the point of air introduction. Note that these tests were performed without the integral air preheater installed. It is believed that installation of the preheater will assist in achieving uniform air distribution and hopefully eliminate or at least reduce this problem significantly. For this reason, no internal modifications of the air plenum are recommended until testing with the preheater is accomplished. Another possible contributing factor to the high combustible value is the fact that the sensing line was relatively long and condensation was observed at the gas analyzer. According to the manufacturer, excess condensation can cause fuel-rich readings. It is suggested that a water trap be installed in the sensing line for future tests.

The unit was then shut down and light-off was attempted again at 50% fuel flow with air flow set by the (preset) light-off potentiometer. Light-off was successful. Pertinent data were taken at the 50% power level and then the power level was decreased in 10% increments while maintaining the gas pressure into the Honeywell gas valve at 3 psi. It was found that, with a constant 3-psi inlet pressure, the lowest power level attainable was 12.8%. Data were taken at each 10% power increment from 40% down to 12.8% with 3-psi inlet pressure. A test was then conducted to determine the gas inlet pressure required to achieve 10% power. This test demonstrated that 9.6% power could be achieved with 2.1-psi gas inlet pressure to the Honeywell valve. Data were then taken at the 9.6%

4.0 TEST SCENARIO (continued)

power level. This test indicates that further modification of the gas valve may be desirable to achieve full turn-down with a fixed inlet gas pressure.

Gas inlet pressure was then reset to 3 psi and tests were conducted in 10% power increments from 60% to 100% power levels; data were taken at each power level. At the higher power levels, a slight air leak could be felt by hand at the lower air plenum/baseplate interface. Subsequent teardown and inspection indicated a discoloration and slight deterioration of the Fiberfrax seal at a point farthest from the point of air introduction. This finding tends to support the earlier observation of the possibility of poor air distribution. (The Fiberfrax material will be replaced prior to delivery to JPL.) Blower performance was adequate but marginal at the high power levels. It is hoped that this condition will be rectified by installation of new Fiberfrax seals.

The new (three-electrode) ignitor/flame scanner assembly functioned perfectly throughout the test, including low power operation. Data sheets for each power level are included in this report.

APPENDIX A

DSSR ACCEPTANCE TEST DATA SHEETS

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Test Date: 11-26-80
Power Level: 100% Nominal (101% Actual)
Heat Transfer to Water: 61.22 kW

Specific Data

Natural Gas:

Gas pressure into rotameter:	5.0 psi
Rotameter reading:	66.5%
Gas pressure into Honeywell valve:	3.0 psi
Gas pressure out of Honeywell valve:	32.1" H_2O
Rotameter pressure correction factor (from table):	0.863
Correction factor = $\frac{1}{\text{Table Factor}}$:	1.158

Actual Flow = CF x Rotameter curve reading = 1.158 x 0.4 = 0.463 PPM air

$$\frac{\text{PPM air}}{.05875} = 7.88 \text{ scfm gas (101\% power level)}$$

Combustion Air:

Air pressure within air plenum: 3.6" H_2O

Water:

Water inlet pressure: 85 psi

Water rotameter reading: 88% (9.5 GPM scale flow)

Water inlet temperature: 144°F; Sp Gr = 8.1948 lb/gal

Water outlet temperature: 188°F

$$\text{Actual flow} = \text{scale flow} \times \frac{\text{Sp Gr } 70}{\text{Sp Gr } T_{in}} = 9.5 \times \frac{8.3290}{8.1948} = 9.655 \text{ GPM}$$

Miscellaneous:

(Upper Cone) Flue gas temperature:	1003°F
(Lower Cone) Flue gas temperature:	914°F
Flue Gas, $\%O_2$:	0.2%
Flue Gas, % combustibles:	1.4%
Flame current:	15 microamp

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Test Date: 11-26-80
Power Level: 93% Nominal (91% Actual)
Heat Transfer to Water: 55.65 kW

Specific Data

Natural Gas:

Gas pressure into rotameter:	5.0 psi
Rotameter reading:	60%
Gas pressure into Honeywell valve:	3.0 psi
Gas pressure out of Honeywell valve:	27.1" H_2O
Rotameter pressure correction factor (from table):	0.863
Correction factor = $\frac{1}{\text{Table Factor}}$:	1.158

Actual Flow = CF x Rotameter curve reading = 1.158 x 0.36 = 0.417 PPM air

$$\frac{\text{PPM air}}{.05875} = 7.096 \text{ scfm gas (91\% power level)}$$

Combustion Air:

Air pressure within air plenum: 3.5" H_2O

Water:

Water inlet pressure: 85 psi

Water rotameter reading: 88% (9.5 GPM scale flow)

Water inlet temperature: 148°F; Sp Gr = 8.1847 lb/gal

Water outlet temperature: 188°F

$$\text{Actual flow} = \text{scale flow} \times \frac{\text{Sp Gr } 70}{\text{Sp Gr } T_{in}} = 9.5 \times \frac{8.3290}{8.1847} = 9.667 \text{ GPM}$$

Miscellaneous:

(Upper Cone) Flue gas temperature:	988°F
(Lower Cone) Flue gas temperature:	918°F
Flue Gas, $\%O_2$:	1.2%
Flue Gas, % combustibles:	off scale high
Flame current:	14 microamp

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MANHATTAN BEACH CALIF 90266

Test Date: 11-26-80
Power Level: 80% Nominal (82.3% Actual)
Heat Transfer to Water: 54.27 kW

Specific Data

Natural Gas:

Gas pressure into rotameter: 5.0 psi
Rotameter reading: 54%
Gas pressure into Honeywell valve: 3.0 psi
Gas pressure out of Honeywell valve: 22.8" H_2O
Rotameter pressure correction factor (from table): 0.863

Correction factor = $\frac{1}{\text{Table Factor}}$: 1.158

Actual Flow = CF x Rotameter curve reading = 1.158 x 0.325 = 0.377 PPM air

$$\frac{\text{PPM air}}{.05875} = 6.42 \text{ scfm gas (82.3\% power level)}$$

Combustion Air:

Air pressure within air plenum: 3.0" H_2O

Water:

Water inlet pressure: 85 psi

Water rotameter reading: 88% (9.5 GPM scale flow)

Water inlet temperature: 145°F; Sp Gr = 8.1923 lb/gal

Water outlet temperature: 184°F

$$\text{Actual flow} = \text{scale flow} \times \frac{\text{Sp Gr } 70}{\text{Sp Gr } T_{in}} = 9.5 \times \frac{8.3290}{8.1923} = 9.659 \text{ GPM}$$

Miscellaneous:

(Upper Cone) Flue gas temperature: 936°F
(Lower Cone) Flue gas temperature: 911°F
Flue Gas, $\%O_2$: 2.0%
Flue Gas, % combustibles: off scale high
Flame current: 15 microamp

Test Date: 11-26-80
Power Level: 70% Nominal (68.2% Actual)
Heat Transfer to Water: 48.7 kW

Specific Data

Natural Gas:

Gas pressure into rotameter:	5.0 psi
Rotameter reading:	45%
Gas pressure into Honeywell valve:	3.0 psi
Gas pressure out of Honeywell valve:	16.8" H_2O
Rotameter pressure correction factor (from table):	0.863
Correction factor = $\frac{1}{\text{Table Factor}}$:	1.158

Actual Flow = CF x Rotameter curve reading = 1.158 x 0.27 = 0.313 PPM air

$$\frac{\text{PPM air}}{.05875} = 5.32 \text{ scfm gas (68.2\% power level)}$$

Combustion Air:

Air pressure within air plenum: 2.5" H_2O

Water:

Water inlet pressure: 85 psi

Water rotameter reading: 88% (9.5 GPM scale flow)

Water inlet temperature: 137°F; Sp Gr = 8.2118 lb/gal

Water outlet temperature: 172°F

$$\text{Actual flow} = \text{scale flow} \times \frac{\text{Sp Gr } 70}{\text{Sp Gr } T_{in}} = 9.5 \times \frac{8.3290}{8.2118} = 9.636 \text{ GPM}$$

Miscellaneous:

(Upper Cone) Flue gas temperature:	829°F
(Lower Cone) Flue gas temperature:	874°F
Flue Gas, $\%O_2$:	2.4%
Flue Gas, % combustibles:	off scale high
Flame current:	15 microamp

Test Date: 11-26-80
Power Level: 60% Nominal (63.1% Actual)
Heat Transfer to Water: 43.13 kW

Specific Data

Natural Gas:

Gas pressure into rotameter:	5.0 psi
Rotameter reading:	42%
Gas pressure into Honeywell valve:	3.0 psi
Gas pressure out of Honeywell valve:	14.9" H_2O
Rotameter pressure correction factor (from table):	0.863
Correction factor = $\frac{1}{\text{Table Factor}}$:	1.158

Actual Flow = CF x Rotameter curve reading = 1.158 x 0.25 = 0.2895 PPM air

$$\frac{\text{PPM air}}{.05875} = 4.927 \text{ scfm gas (63.1\% power level)}$$

Combustion Air:

Air pressure within air plenum: 2.1" H_2O

Water:

Water inlet pressure: 85 psi

Water rotameter reading: 88% (9.5 GPM scale flow)

Water inlet temperature: 129°F; Sp Gr = 8.2302 lb/gal

Water outlet temperature: 160°F

$$\text{Actual flow} = \text{scale flow} \times \frac{\text{Sp Gr 70}}{\text{Sp Gr } T_{in}} = 9.5 \times \frac{8.3290}{8.2302} = 9.614 \text{ GPM}$$

Miscellaneous:

(Upper Cone) Flue gas temperature:	750°F
(Lower Cone) Flue gas temperature:	805°F
Flue Gas, %O_2:	1.2%
Flue Gas, % combustibles:	off scale high
Flame current:	15 microamp

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1800 ROSECRANS AVENUE
MANHATTAN BEACH, CALIF. 90266

Test Date: 11-26-80
Power Level: 50% Nominal (50.5% Actual)
Heat Transfer to Water: 29.22 kW

Specific Data

Natural Gas:

Gas pressure into rotameter:	5.0 psi
Rotameter reading:	33%
Gas pressure into Honeywell valve:	3.0 psi
Gas pressure out of Honeywell valve:	8.3" H_2O
Rotameter pressure correction factor (from table):	0.863
Correction factor = $\frac{1}{\text{Table Factor}}$:	1.158

Actual Flow = CF x Rotameter curve reading = 1.158 x 0.2 = 0.23 PPM air

$$\frac{\text{PPM air}}{.05875} = 3.942 \text{ scfm gas (50.5\% power level)}$$

Combustion Air:

Air pressure within air plenum: 0.9" H_2O

Water:

Water inlet pressure: 75 psi

Water rotameter reading: 88% (9.5 GPM scale flow)

Water inlet temperature: 141°F; Sp Gr = 8.2038 lb/gal

Water outlet temperature: 162°F

$$\text{Actual flow} = \text{scale flow} \times \frac{\text{Sp Gr } 70}{\text{Sp Gr } T_{in}} = 9.5 \times \frac{8.3290}{8.2038} = 9.645 \text{ GPM}$$

Miscellaneous:

(Upper Cone) Flue gas temperature:	543°F
(Lower Cone) Flue gas temperature:	567°F
Flue Gas, %O_2:	1.2%
Flue Gas, % combustibles:	off scale high
Flame current:	(missed)

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Test Date: 11-26-80
Power Level: 40% Nominal (40.4% Actual)
Heat Transfer to Water: 26.44 kW

Specific Data

Natural Gas:

Gas pressure into rotameter:	5.0 psi
Rotameter reading:	27%
Gas pressure into Honeywell valve:	3.0 psi
Gas pressure out of Honeywell valve:	6.0" H_2O
Rotameter pressure correction factor (from table):	0.863
Correction factor = $\frac{1}{\text{Table Factor}}$:	1.158

Actual Flow = CF x Rotameter curve reading = 1.158 x 0.16 = 0.185 PPM air

$$\frac{\text{PPM air}}{.05875} = 3.154 \text{ scfm gas (40.4\% power level)}$$

Combustion Air:

Air pressure within air plenum: 0.8" H_2O

Water:

Water inlet pressure: 76 psi

Water rotameter reading: 88% (9.5 GPM scale flow)

Water inlet temperature: 150°F; Sp Gr = 8.1797 lb/gal

Water outlet temperature: 169°F

$$\text{Actual flow} = \text{scale flow} \times \frac{\text{Sp Gr } 70}{\text{Sp Gr } T_{in}} = 9.5 \times \frac{8.3290}{8.1797} = 9.673 \text{ GPM}$$

Miscellaneous:

(Upper Cone) Flue gas temperature:	501°F
(Lower Cone) Flue gas temperature:	570°F
Flue Gas, $\%O_2$:	2.2%
Flue Gas, % combustibles:	off scale high
Flame current:	10-12 microamp

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Test Date: 11-26-80
Power Level: 30% Nominal (30.3% Actual)
Heat Transfer to Water: 22.26 kW

Specific Data

Natural Gas:

Gas pressure into rotameter:	5.0 psi
Rotameter reading:	19.5%
Gas pressure into Honeywell valve:	2.95 psi
Gas pressure out of Honeywell valve:	3.4" H_2O
Rotameter pressure correction factor (from table):	0.863
Correction factor = $\frac{1}{\text{Table Factor}}$:	1.158

Actual Flow = CF x Rotameter curve reading = 1.158 x 0.12 = 0.139 PPM air

$$\frac{\text{PPM air}}{.05875} = 2.365 \text{ scfm gas (30.3\% power level)}$$

Combustion Air:

Air pressure within air plenum: 0.5" H_2O

Water:

Water inlet pressure: 75 psi

Water rotameter reading: 88% (9.5 GPM scale flow)

Water inlet temperature: 136°F; Sp Gr = 8.2141 lb/gal

Water outlet temperature: 152°F

$$\text{Actual flow} = \text{scale flow} \times \frac{\text{Sp Gr } 70}{\text{Sp Gr } T_{in}} = 9.5 \times \frac{8.3290}{8.2141} = 9.633 \text{ GPM}$$

Miscellaneous:

(Upper Cone) Flue gas temperature:	458°F
(Lower Cone) Flue gas temperature:	498°F
Flue Gas, $\%O_2$:	3.0%
Flue Gas, % combustibles:	0.4%
Flame current:	8-10 microamp

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MANHATTAN BEACH, CALIF. 90266

Test Date: 11-26-80
Power Level: 20% Nominal (20.2% Actual)
Heat Transfer to Water: 13.91 kW

Specific Data

Natural Gas:

Gas pressure into rotameter:	5.0 psi
Rotameter reading:	13%
Gas pressure into Honeywell valve:	3.0 psi
Gas pressure out of Honeywell valve:	1.6" H_2O
Rotameter pressure correction factor (from table):	0.863
Correction factor = $\frac{1}{\text{Table Factor}}$:	1.158

Actual Flow = CF x Rotameter curve reading = 1.158 x 0.08 = 0.093 PPM air

$$\frac{\text{PPM air}}{.05875} = 1.577 \text{ scfm gas (20.2\% power level)}$$

Combustion Air:

Air pressure within air plenum: 0.2" H_2O

Water:

Water inlet pressure: 80 psi

Water rotameter reading: 88% (9.5 GPM scale flow)

Water inlet temperature: 118°F; Sp Gr = 8.2538 lb/gal

Water outlet temperature: 128°F

$$\text{Actual flow} = \text{scale flow} \times \frac{\text{Sp Gr } 70}{\text{Sp Gr } T_{in}} = 9.5 \times \frac{8.3290}{8.2538} = 9.587 \text{ GPM}$$

Miscellaneous:

(Upper Cone) Flue gas temperature:	359°F
(Lower Cone) Flue gas temperature:	355°F
Flue Gas, $\%O_2$:	1.75%
Flue Gas, % combustibles:	1.5%
Flame current:	(missed)

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MANHATTAN BEACH, CALIF. 90266

Test Date: 11-26-80
Power Level: 10% Nominal (12.8% Actual)
Heat Transfer to Water: 11.13 kW

Specific Data

Natural Gas:

Gas pressure into rotameter:	5.0 psi
Rotameter reading:	61% "Low" meter
Gas pressure into Honeywell valve:	3.0 psi
Gas pressure out of Honeywell valve:	0.9" H_2O
Rotameter pressure correction factor (from table):	0.863
Correction factor = $\frac{1}{\text{Table Factor}}$:	1.158

Actual Flow = CF x Rotameter curve reading = 1.158 x 0.665 = 0.77 scfm air

$$\frac{\text{scfm air}}{0.768} = 1.002 \text{ scfm gas (12.8\% power level)}$$

Combustion Air:

Air pressure within air plenum: 0.15" H_2O

Water:

Water inlet pressure: 80 psi

Water rotameter reading: 88% (9.5 GPM scale flow)

Water inlet temperature: 107°F; Sp Gr = 8.2752 lb/gal

Water outlet temperature: 115°F

$$\text{Actual flow} = \text{scale flow} \times \frac{\text{Sp Gr } 70}{\text{Sp Gr } T_{in}} = 9.5 \times \frac{8.3290}{8.2752} = 9.652 \text{ GPM}$$

Miscellaneous:

(Upper Cone) Flue gas temperature:	324°F
(Lower Cone) Flue gas temperature:	252°F
Flue Gas, $\%O_2$:	2.8%-4% (oscillating)
Flue Gas, % combustibles:	off scale low
Flame current:	6 microamp

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MANHATTAN BEACH, CALIF. 90266

Test Date: 11-26-80
Power Level: 10% Nominal (9.6% Actual)
Heat Transfer to Water: 9.74 kW

Specific Data

Natural Gas:

Gas pressure into rotameter: 5.0 psi
Rotameter reading: 45% ("Low" meter)
Gas pressure into Honeywell valve: 2.1 psi
Gas pressure out of Honeywell valve: 0.6" H_2O
Rotameter pressure correction factor (from table): 0.863

Correction factor = $\frac{1}{\text{Table Factor}}$: 1.158

Actual Flow = CF x Rotameter curve reading = 1.158 x 0.5 = 0.579 scfm air

$$\frac{\text{scfm air}}{0.768} = 0.754 \text{ scfm gas (9.6\% power level)}$$

Combustion Air:

Air pressure within air plenum: 0.015" H_2O

Water:

Water inlet pressure: 80 psi

Water rotameter reading: 88% (9.5 GPM scale flow)

Water inlet temperature: 100°F; Sp Gr = 8.2877 lb/gal

Water outlet temperature: 107°F

$$\text{Actual flow} = \text{scale flow} \times \frac{\text{Sp Gr } 70}{\text{Sp Gr } T_{in}} = 9.5 \times \frac{8.3290}{8.2877} = 9.547 \text{ GPM}$$

Miscellaneous:

(Upper Cone) Flue gas temperature: 280°F
(Lower Cone) Flue gas temperature: 179°F
Flue Gas, $\%O_2$: 6.4%
Flue Gas, % combustibles: off scale low
Flame current: 3 microamp

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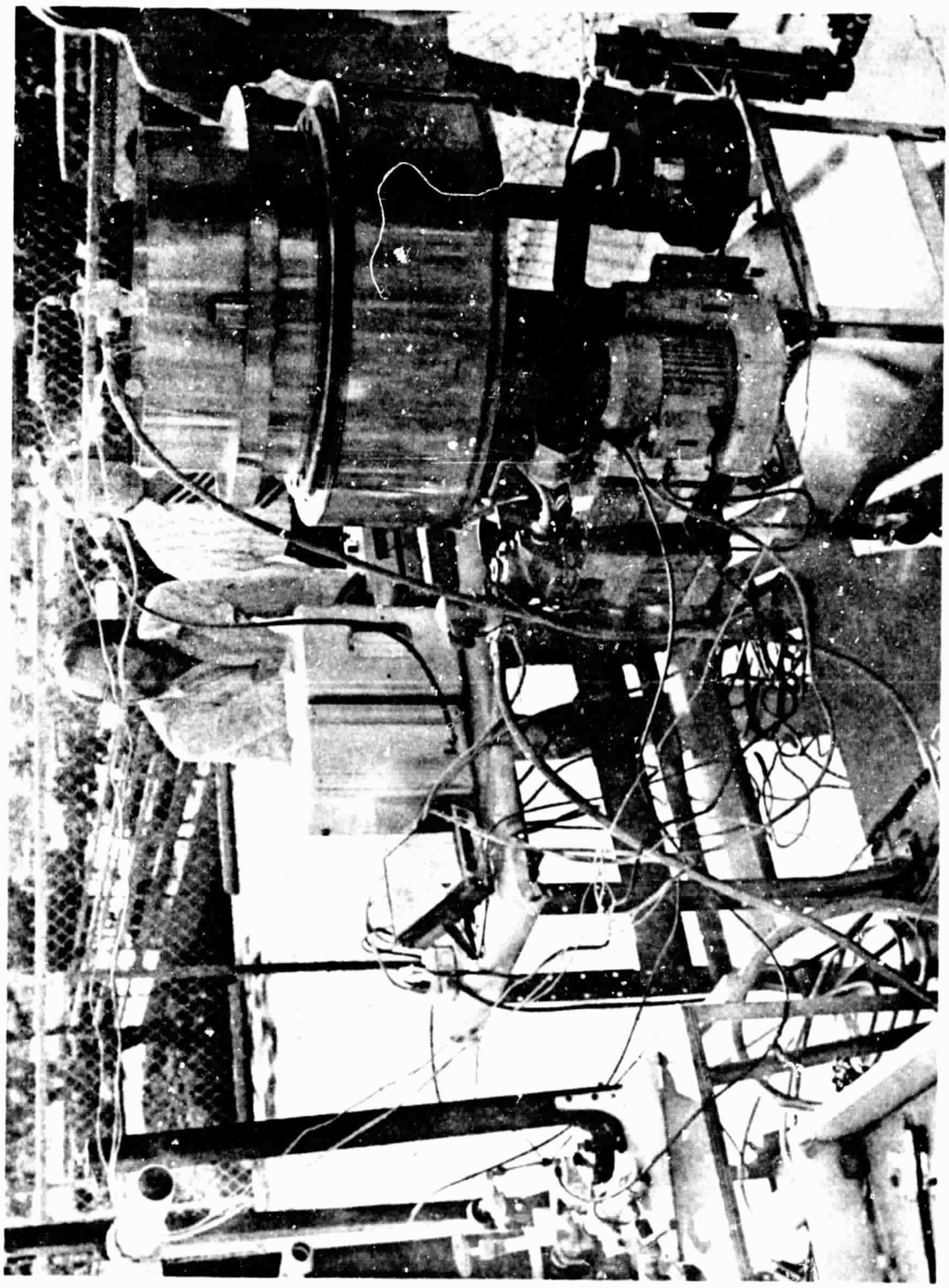
SYSTEMS DIVISION
1800 ROSECRANS AVENUE
MANHATTAN BEACH, CALIF. 90266

APPENDIX B

ILLUSTRATIONS AND DRAWINGS



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MANHATTAN BEACH, CALIF. 90266

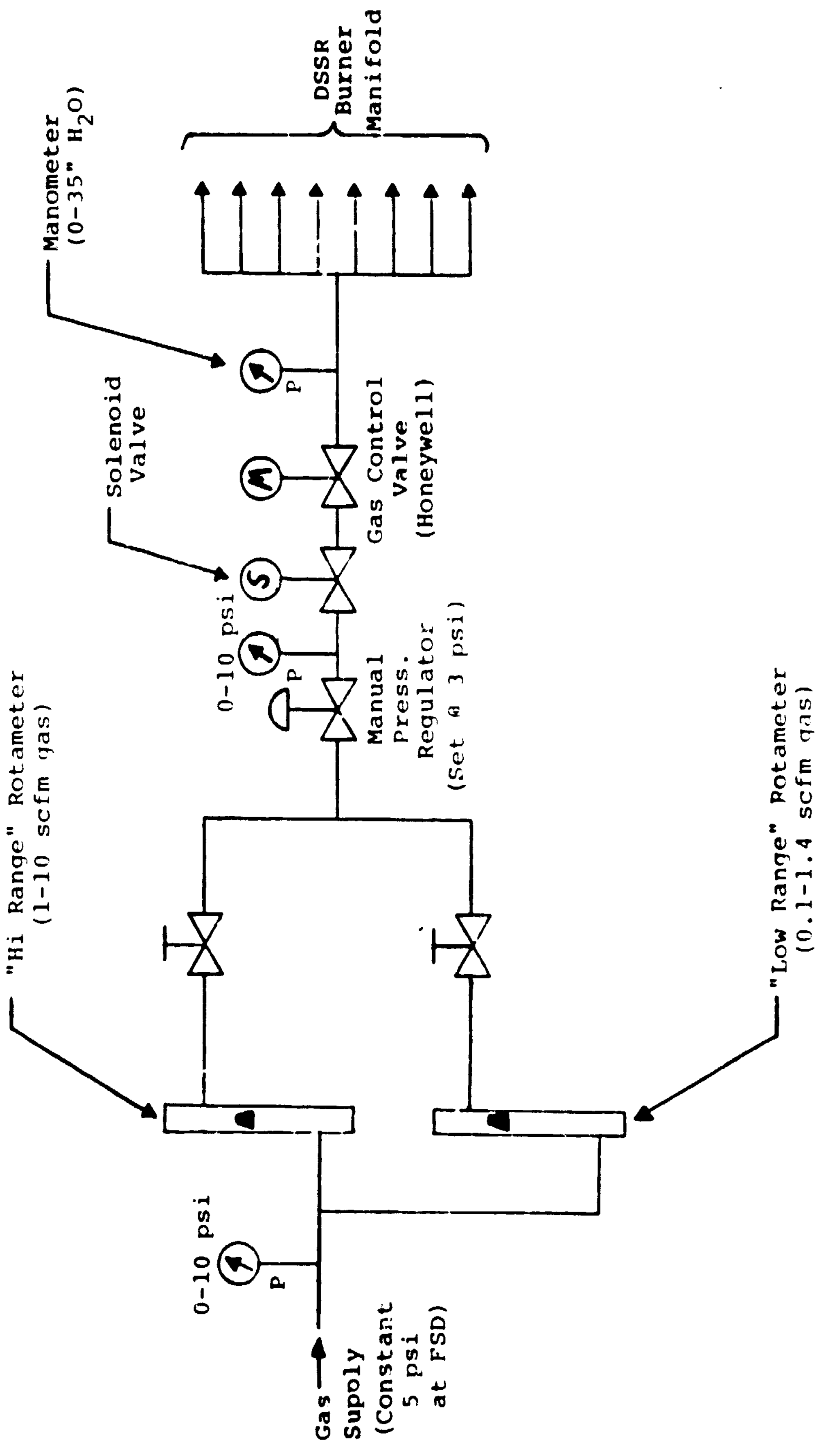

Figure 1. Natural Gas Supply Plumbing and Instrumentation

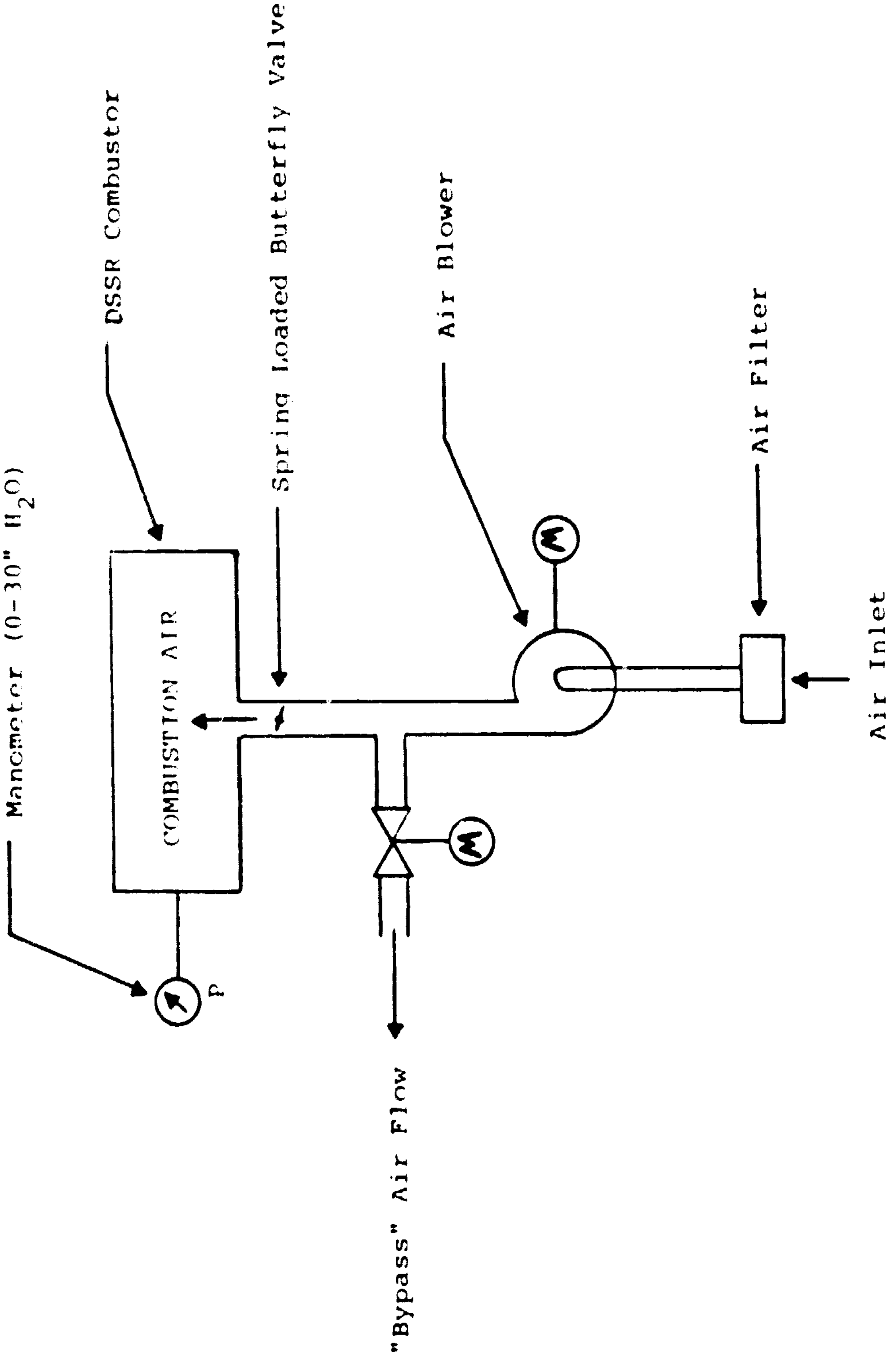

Figure 2. Combustion Air Supply Plumbing and Instrumentation

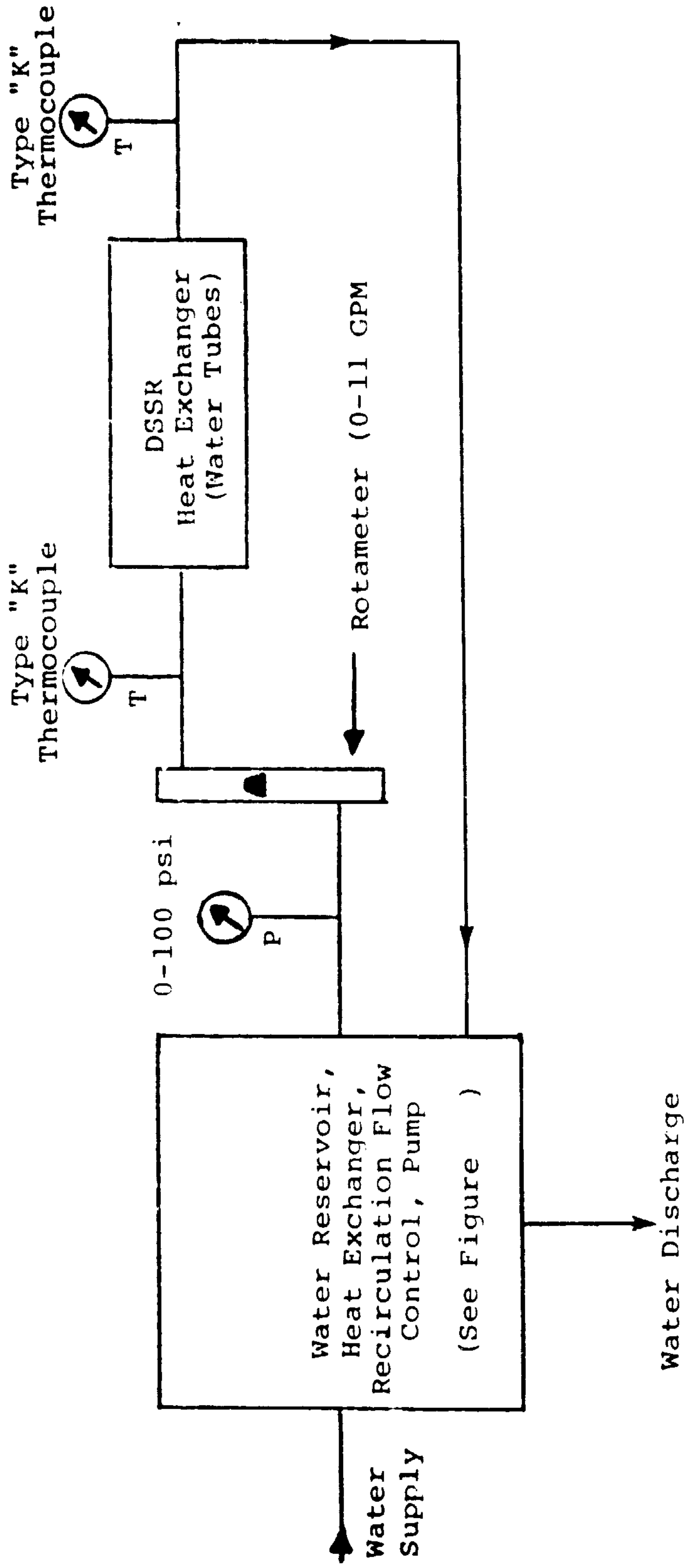

Figure 3. Water Supply Plumbing and Instrumentation

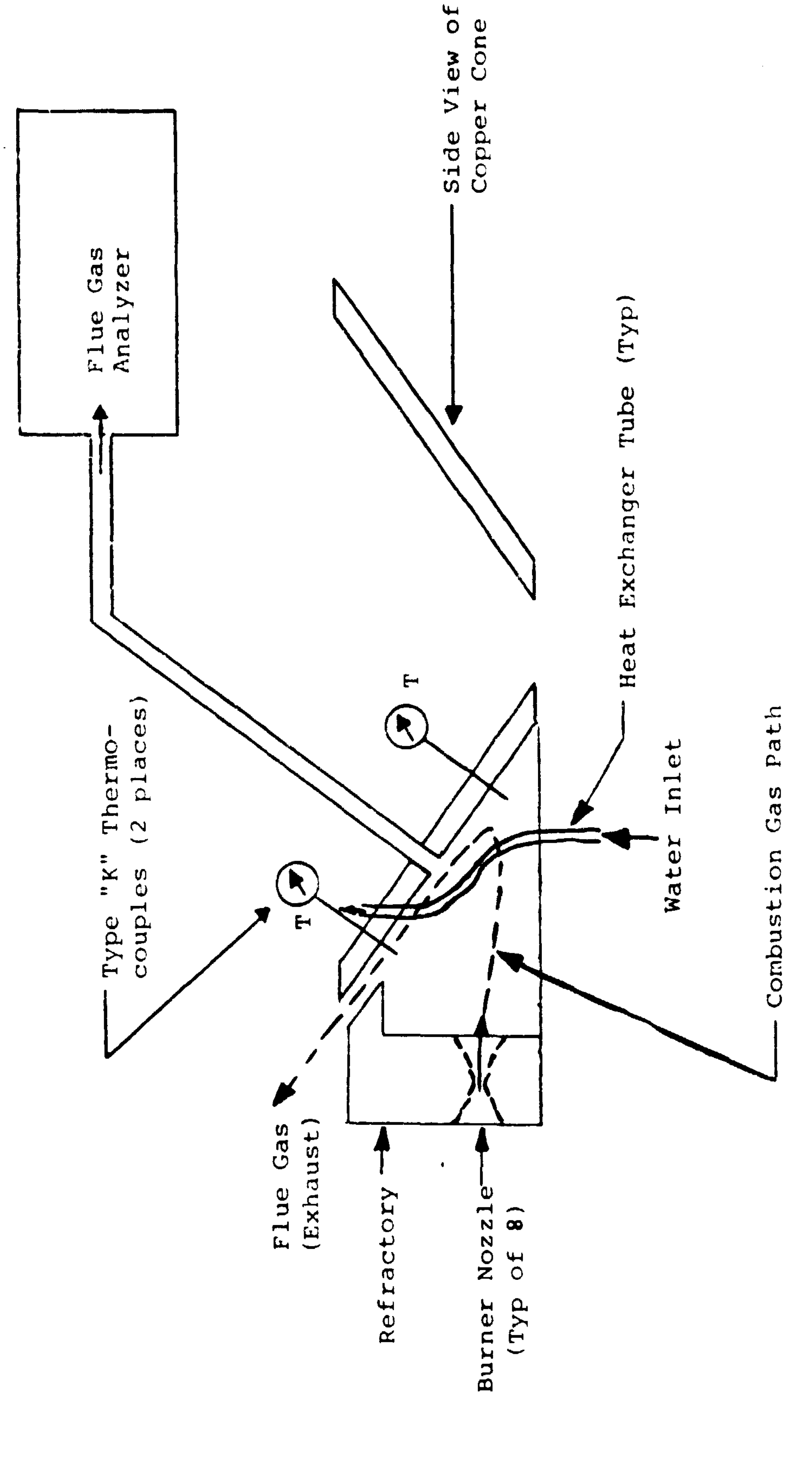

Figure 4. Miscellaneous Instrumentation

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MANHATTAN BEACH, CALIF., 90266

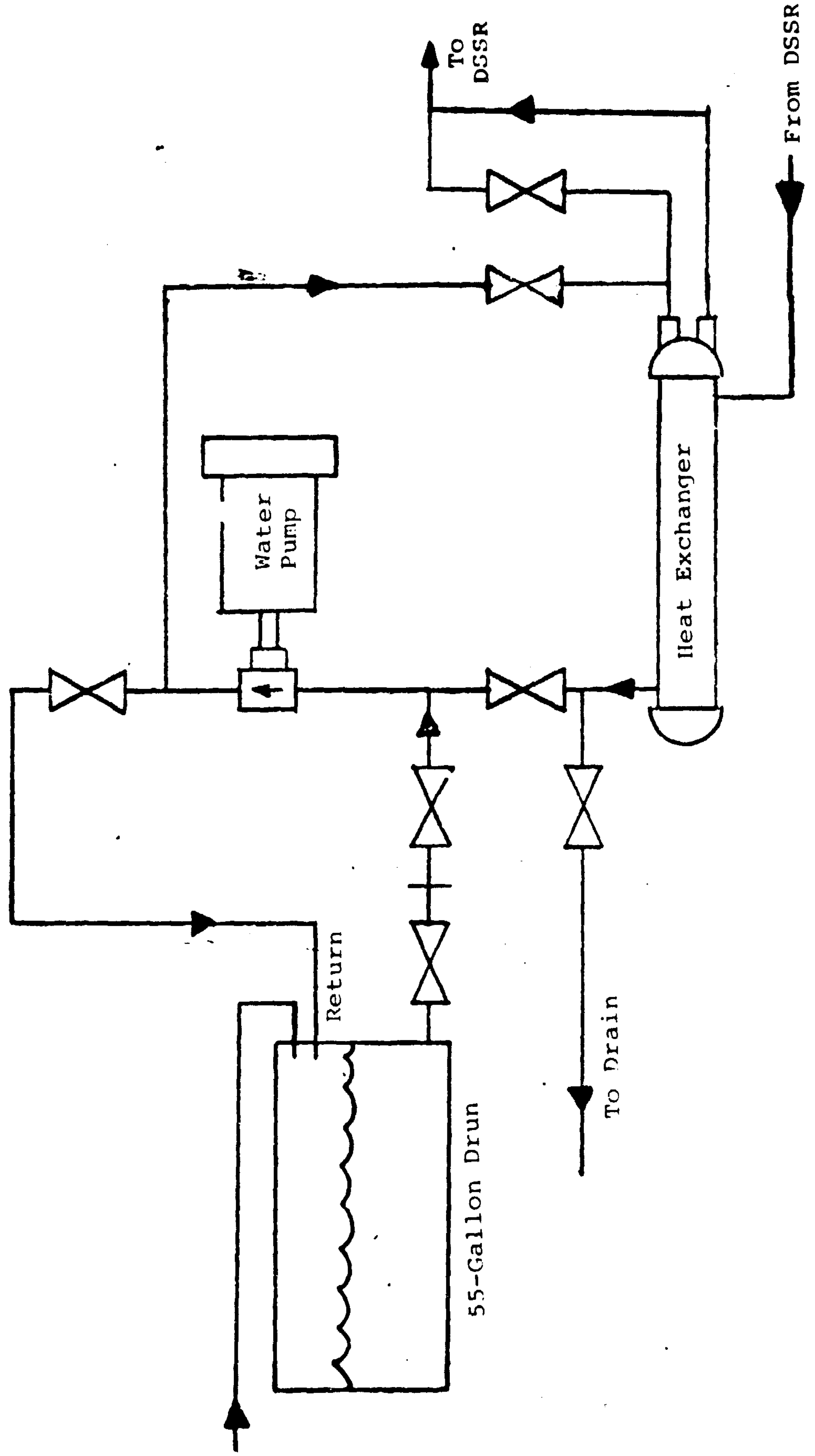
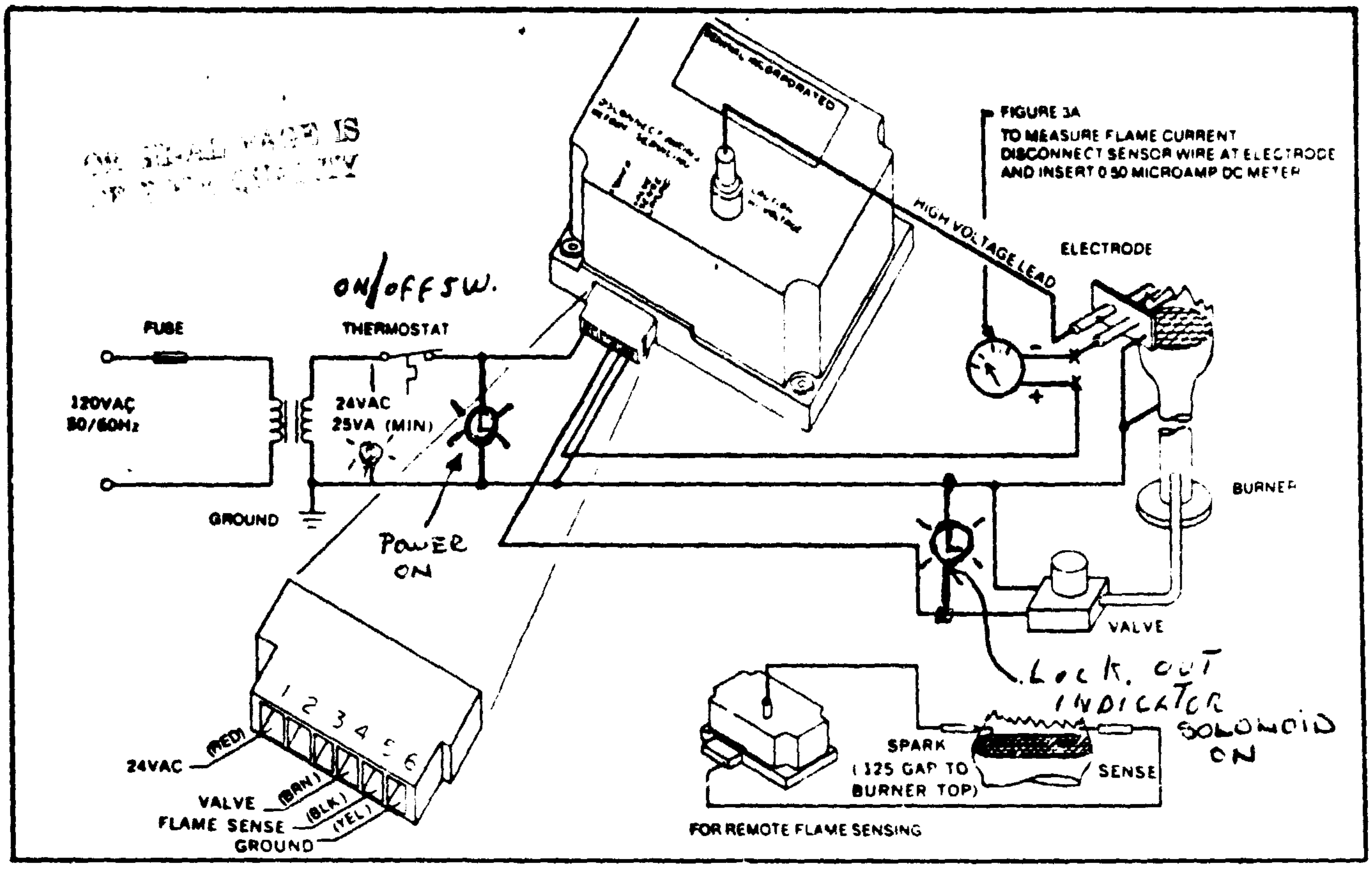


Figure 5. Water Reservoir, Pump and Heat Exchanger



INITIAL OPERATION

1. Check installation, mounting, and electrode gap to insure conformance to specifications.

2. With the gas supply shut off, apply electrical power to the system by advancing the thermostat.

3. Check to insure that a spark is being produced at the electrode during the trial-for-ignition period specified for the unit. Units should lock out after trial-for-ignition period. Set thermostat below ambient temperature.

NOTE: *Pre-purge units have a typical delay of 15 seconds before ignition sparks occur. Series 05-16TWO units have a typical delay of 45 seconds*

4. Manually open the gas supply line and advance the thermostat to recycle the unit.

5. Check that ignition has been accomplished within the trial period. Sparking will cease a few seconds after establishing the flame.

6. If system ignites but fails to hold in, check for 5 micro-amp minimum flame sense current and check to assure the system is properly grounded per Figure 3.

7. For multiple unit installation, assure that all units are powered by a common supply voltage and all are correctly polarized and grounded.

SAFETY CHECKS

1. Manually shut off gas supply and apply power to the control board by advancing the thermostat. After unit has locked out, check that there is no voltage output between "Valve" and "Ground" with a suitable volt-meter. Set thermostat below ambient temperature.

2. Manually open the gas supply valve and reactivate control unit by raising the thermostat above room temperature. Sparking should occur (after the purge period on pre-purge units) and cease when the flame is established. While running, manually close the gas supply valve. Sparking should start as soon as the flame is extinguished. The spark should remain on for the trial-for-ignition period and then lock out. Check that there is no voltage between "Valve" and "Ground" as described above.

SERVICE CHECKS

Flame current is the current which passes through the flame from the sensor to ground to complete the primary safety circuit. The minimum flame current necessary to keep the ignitor from lockout is five microamps. To measure flame current, DISCONNECT INPUT VOLTAGE then remove low voltage sensing lead wire from electrode terminal and insert a 0-50 DC microamp meter in a series with the sensor probe and sensor wire. (See Figure 3a.) Meter reading should be 5 microamps or higher. If meter reads below "0" on scale, the leads are reversed. Disconnect power and reconnect leads for proper polarity.

If the flame current reading is less than 5 microamps reposition the electrode in the flame to get a higher reading.

REPAIRS

The Fenwal Series 05-16 Direct Spark Ignition Systems are not field repairable. Any modifications or repairs to the Series 05-16, or 05-16TWO, will invalidate Fenwal's standard warranty as well as agency certifications. Faulty units should be returned to the factory for repair or replacement.

Figure 6. Ignitor/Flame Scanner Circuitry

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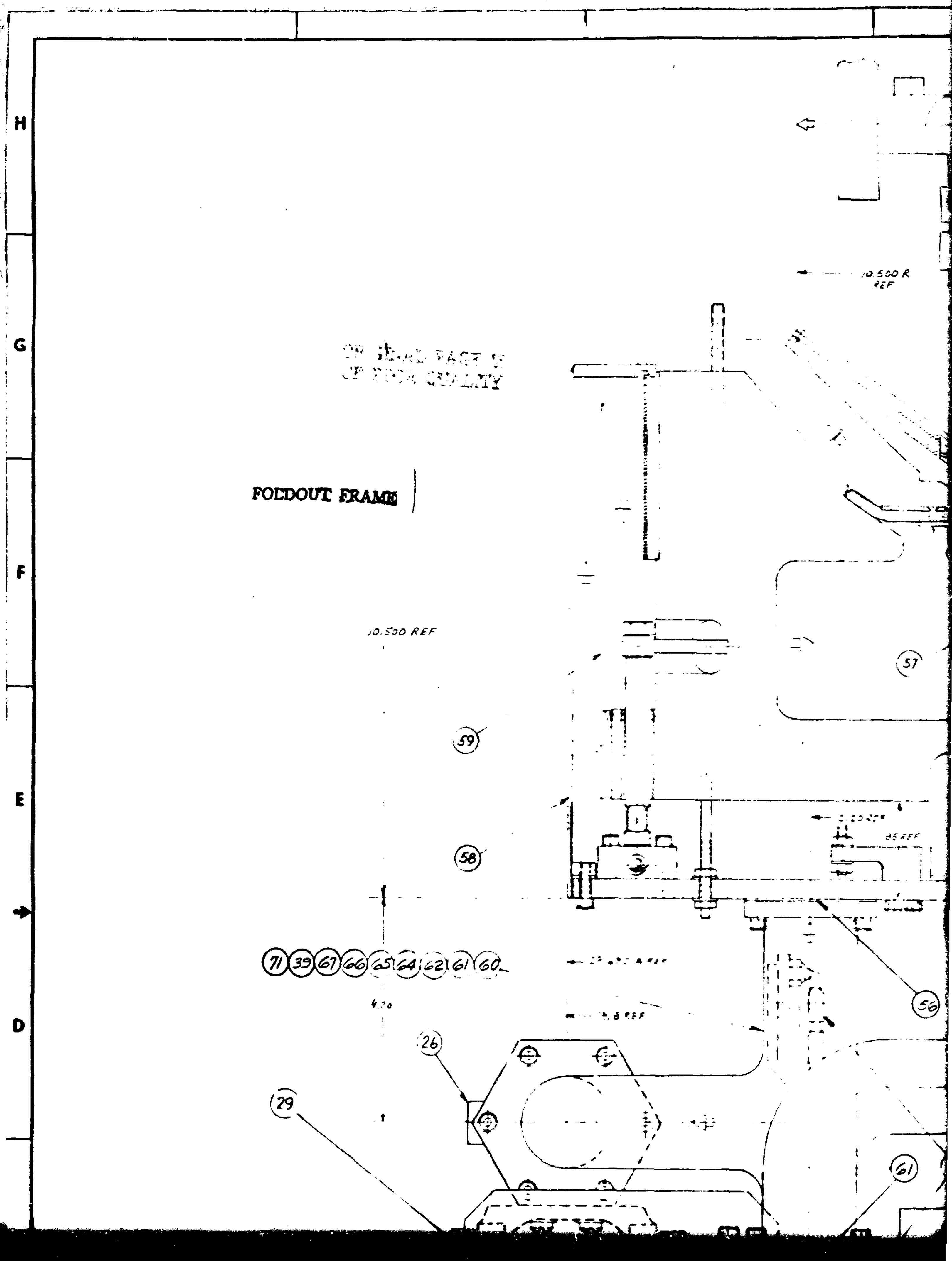

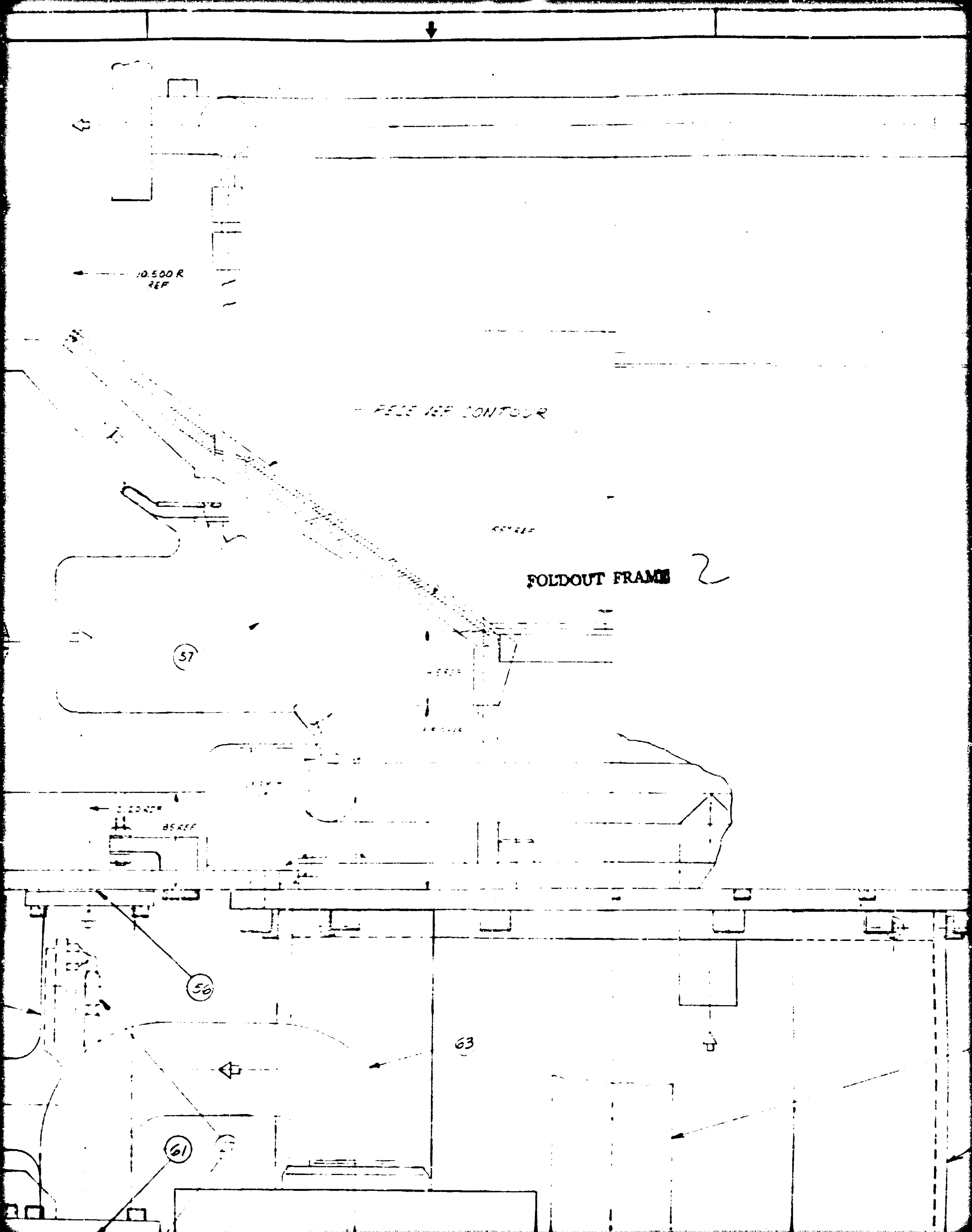
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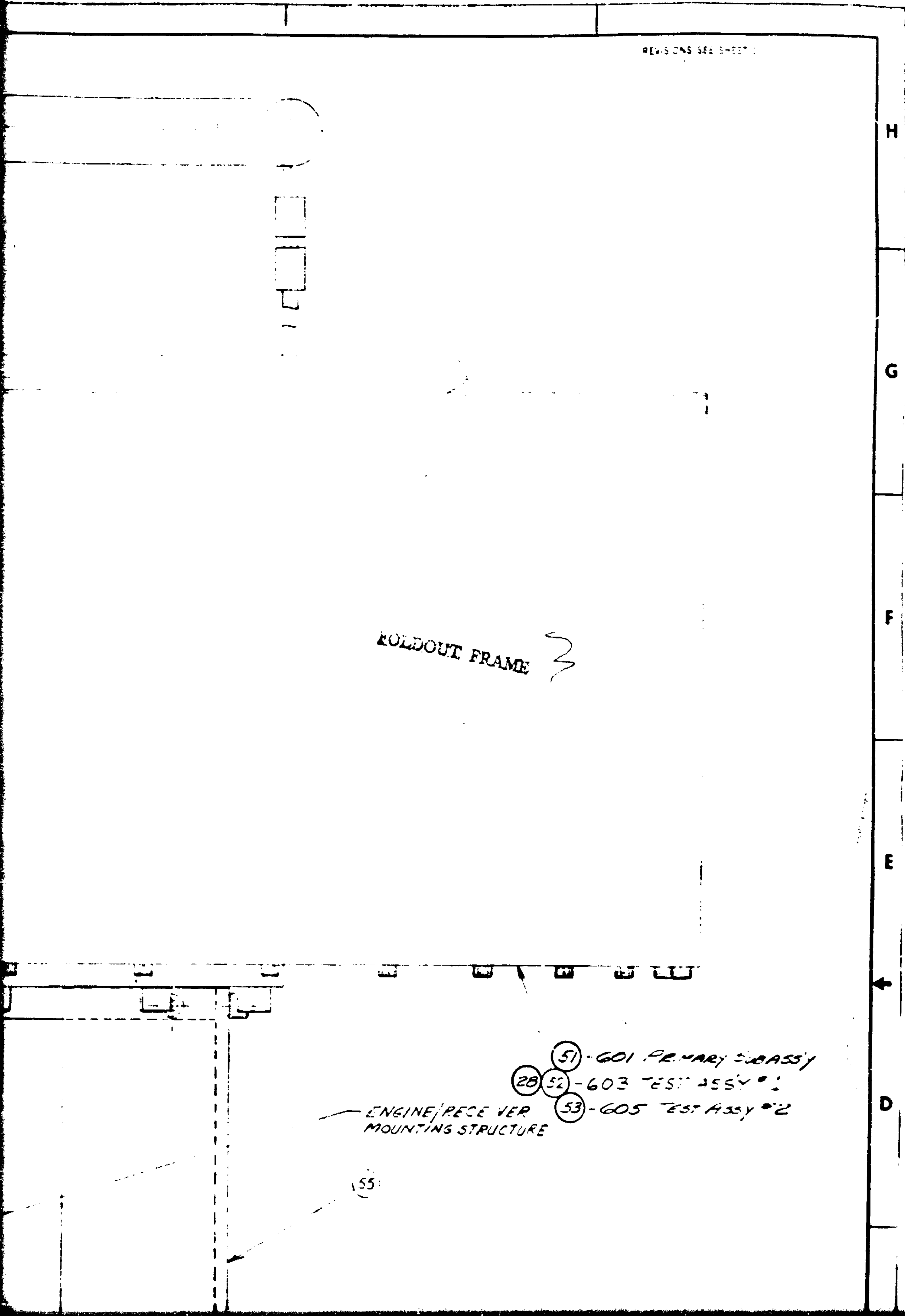

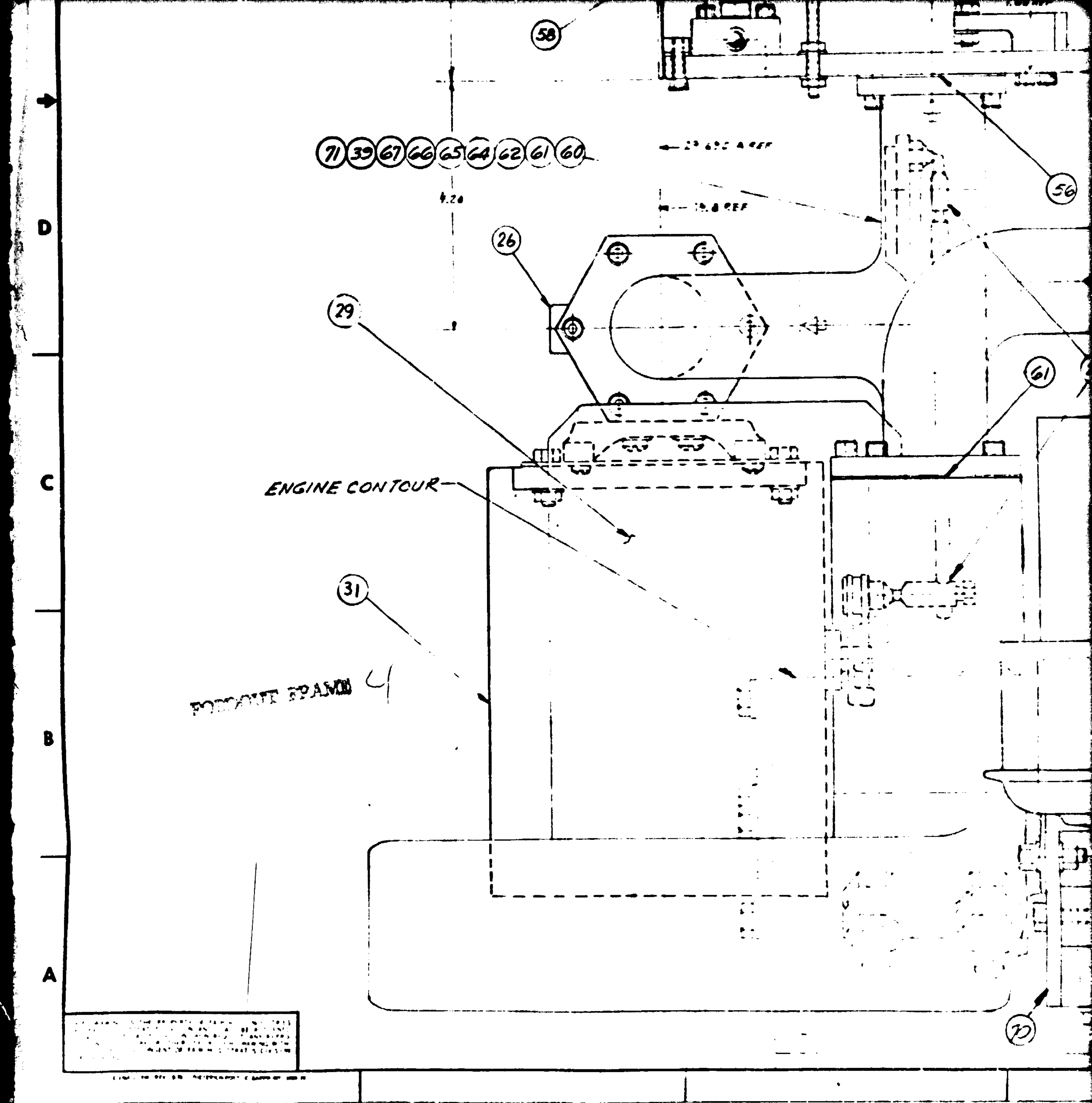
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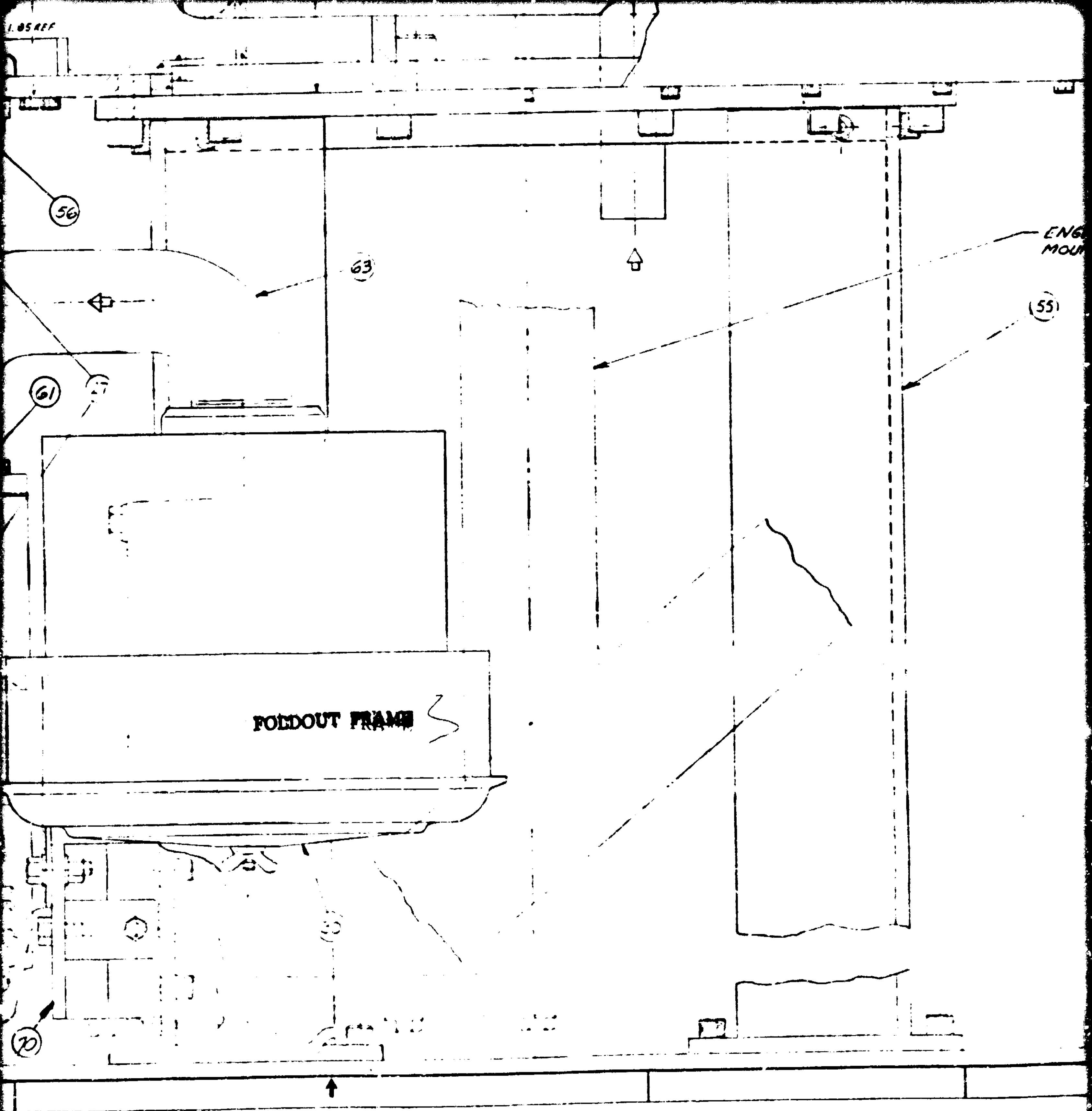

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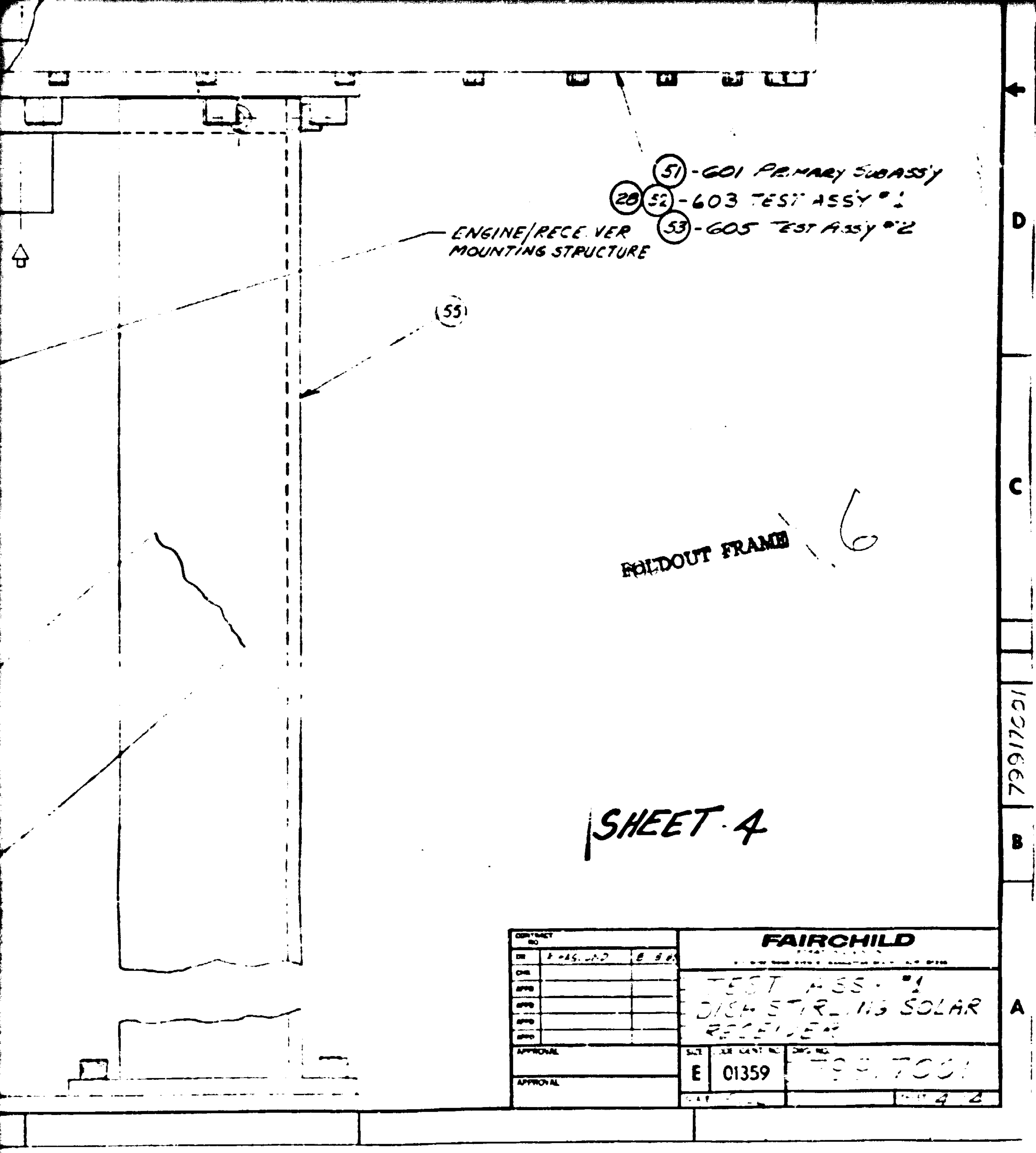

51 -601 PRIMARY SUBASS'Y
28 52 -603 TEST ASSY #1
53 -605 TEST ASSY #2
ENGINE/RECEIVER MOUNTING STRUCTURE
55
FOLDOUT FRAME
6
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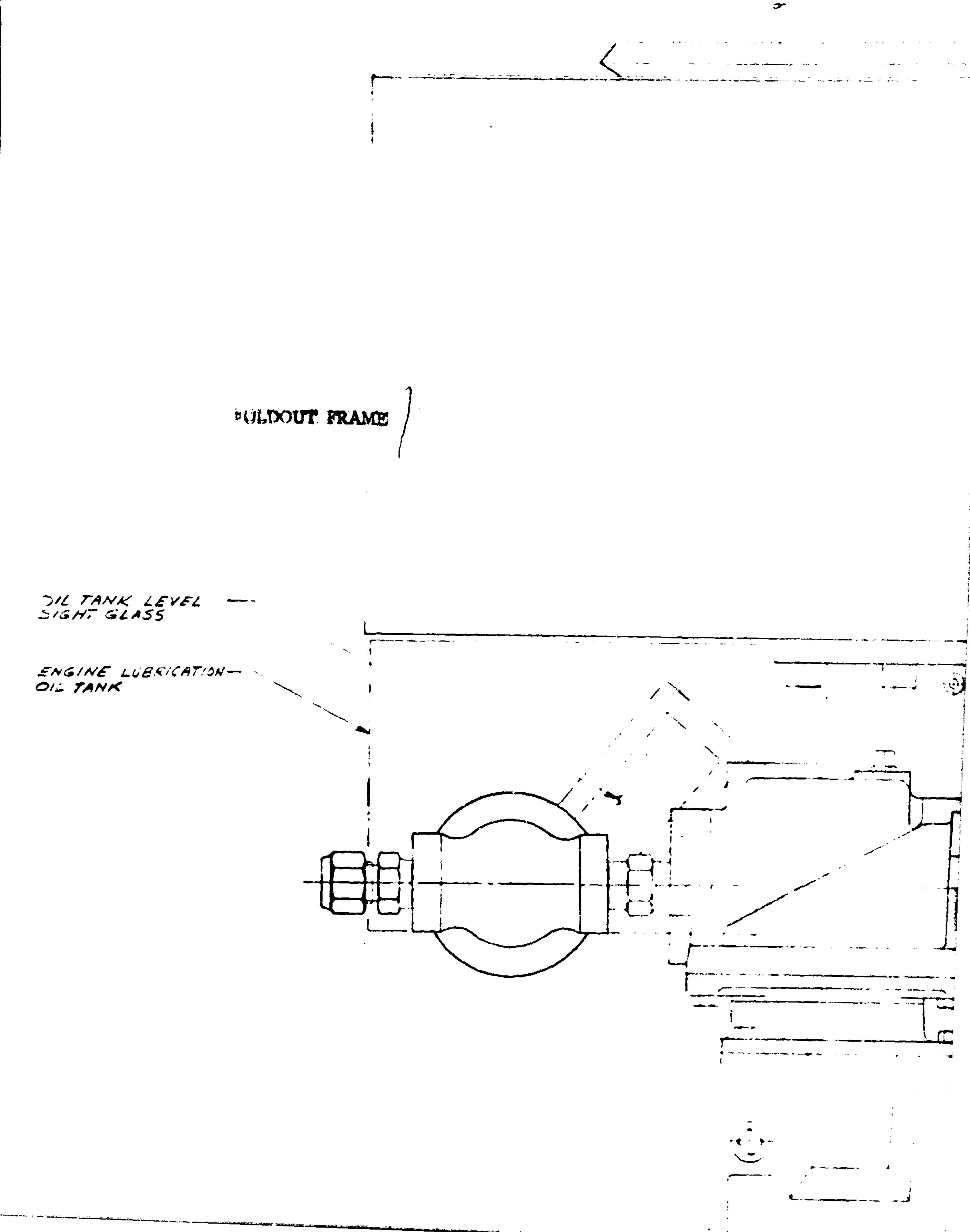
TEST ASSY #1 DISH STIRLING SOLAR RECEIVER
E
01359

FOLDOUT FRAME



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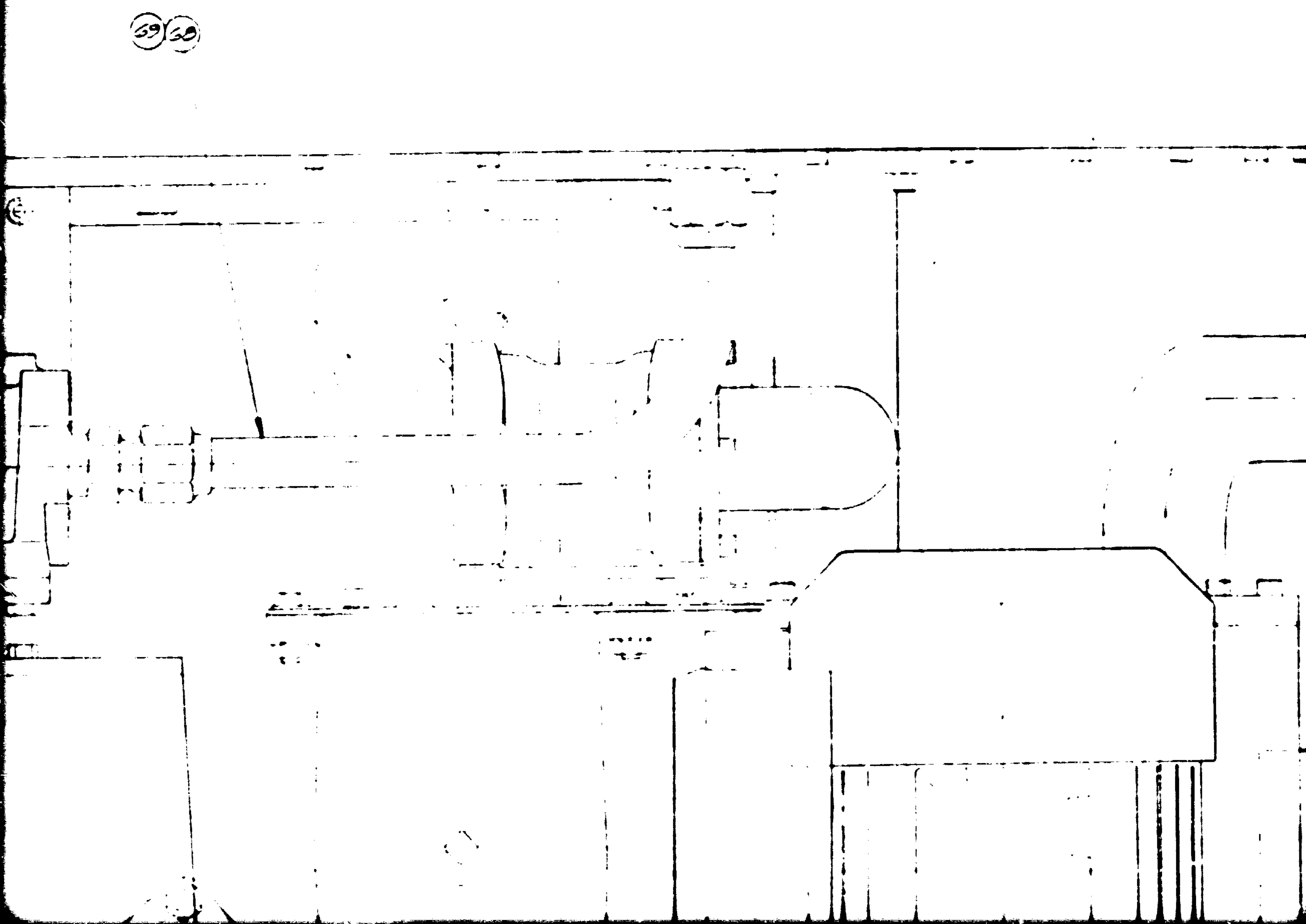

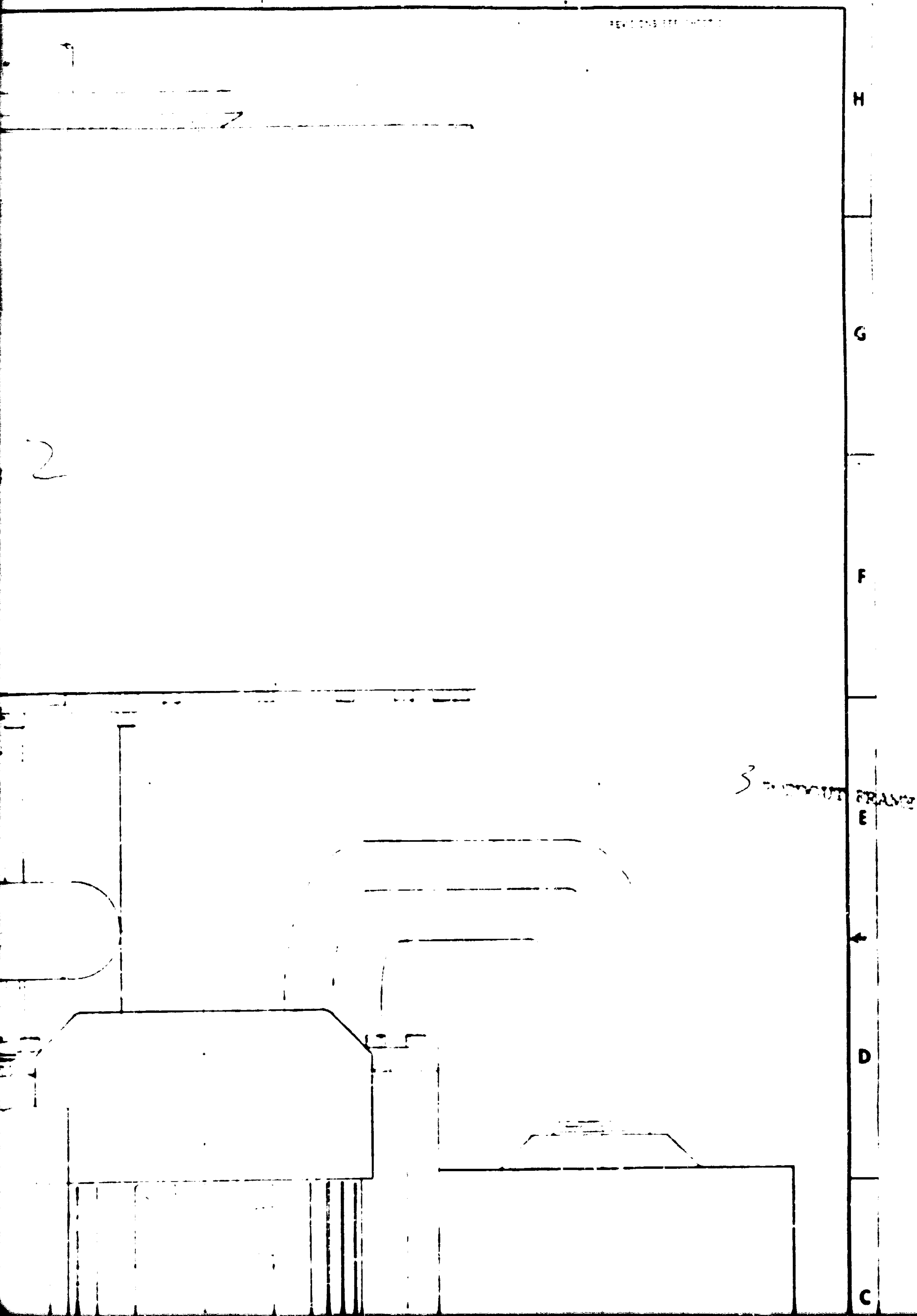
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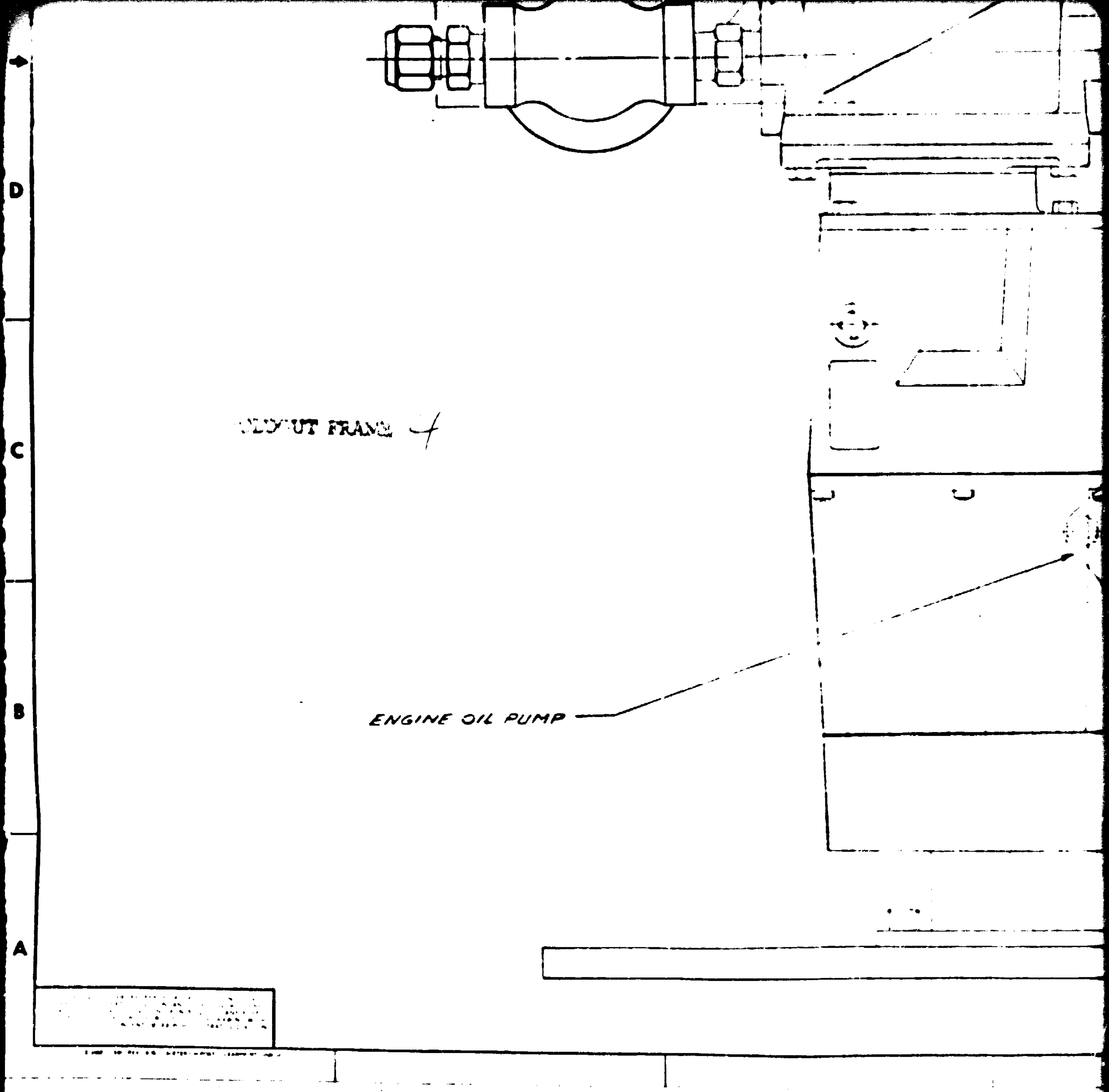

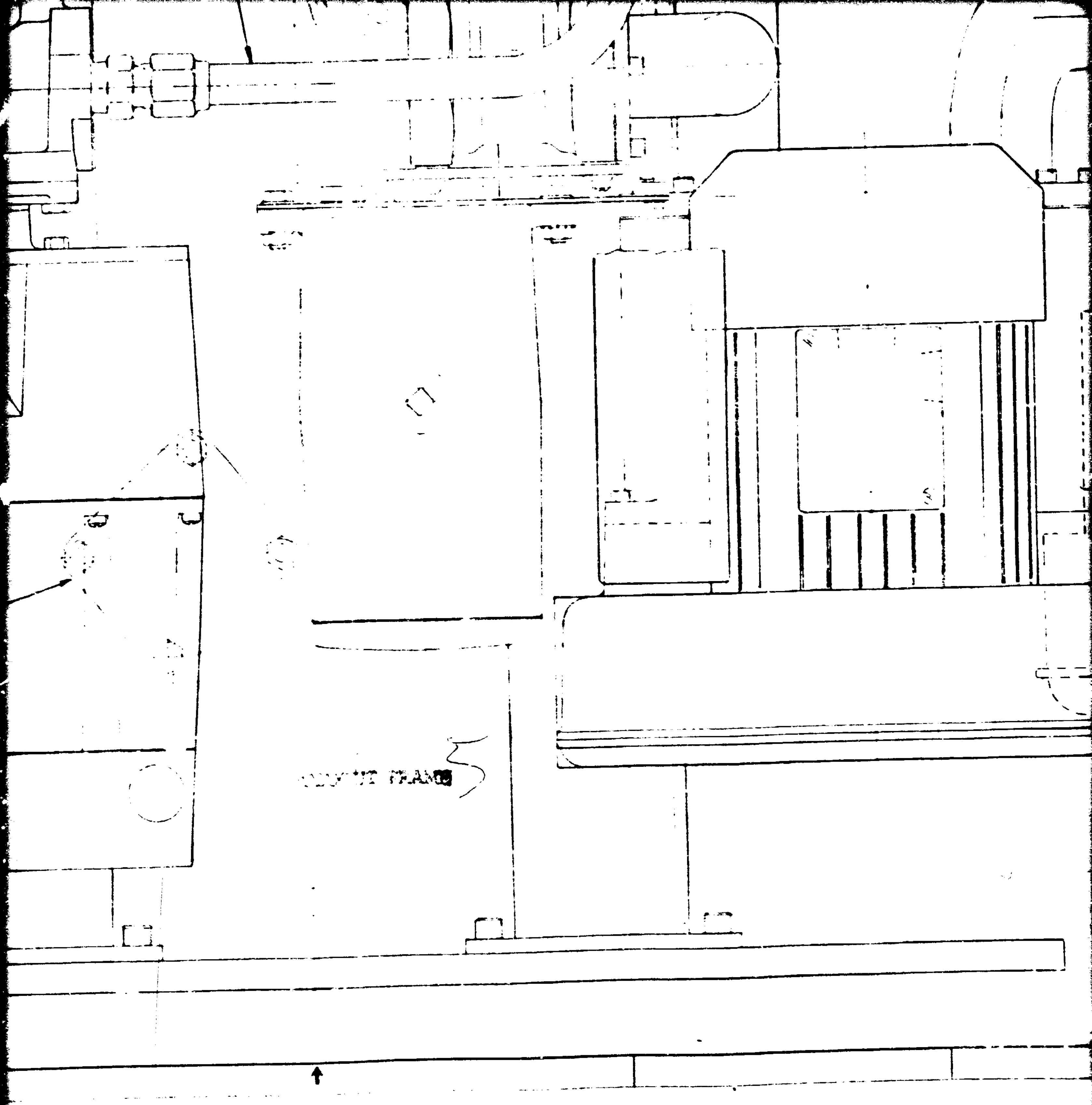

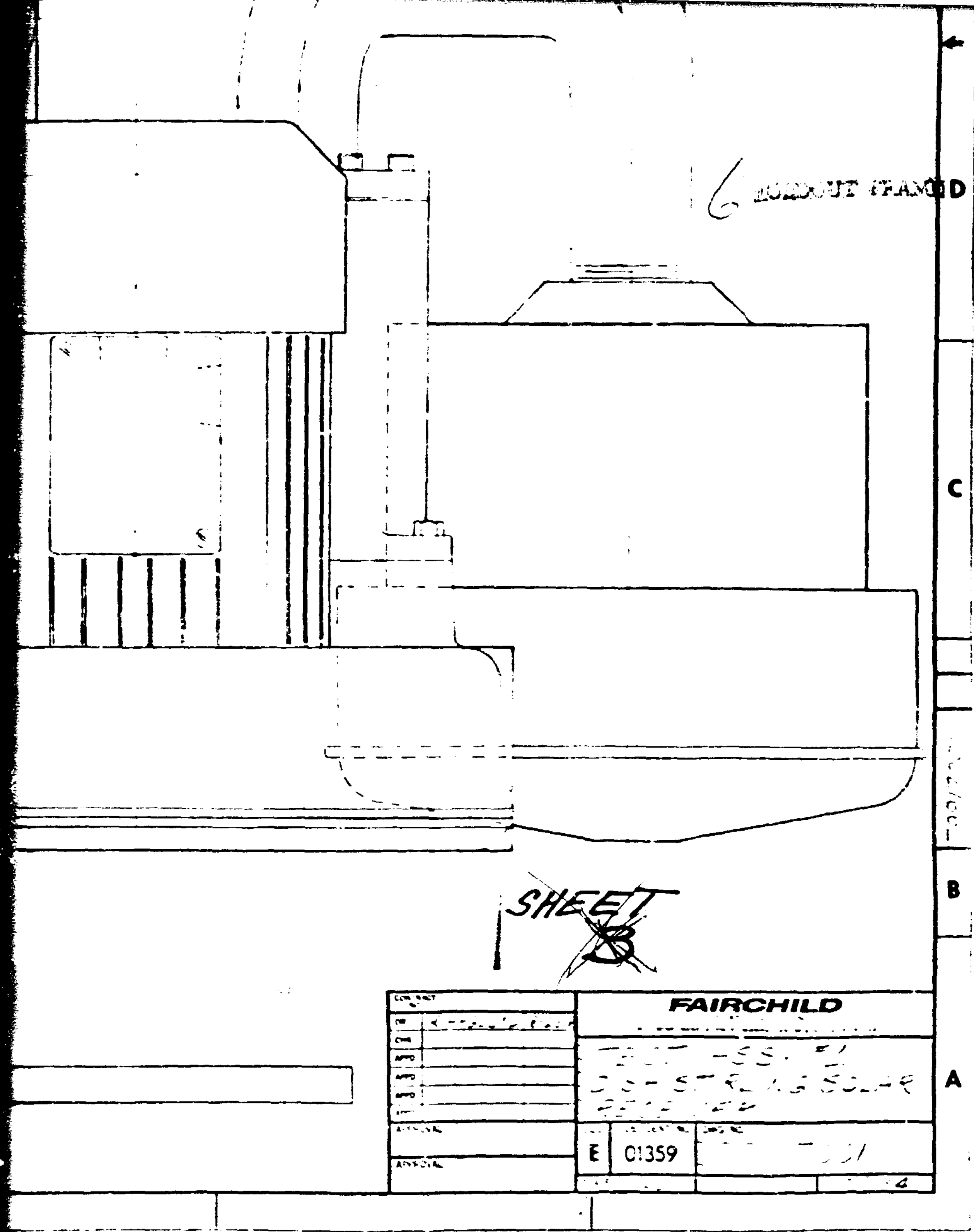
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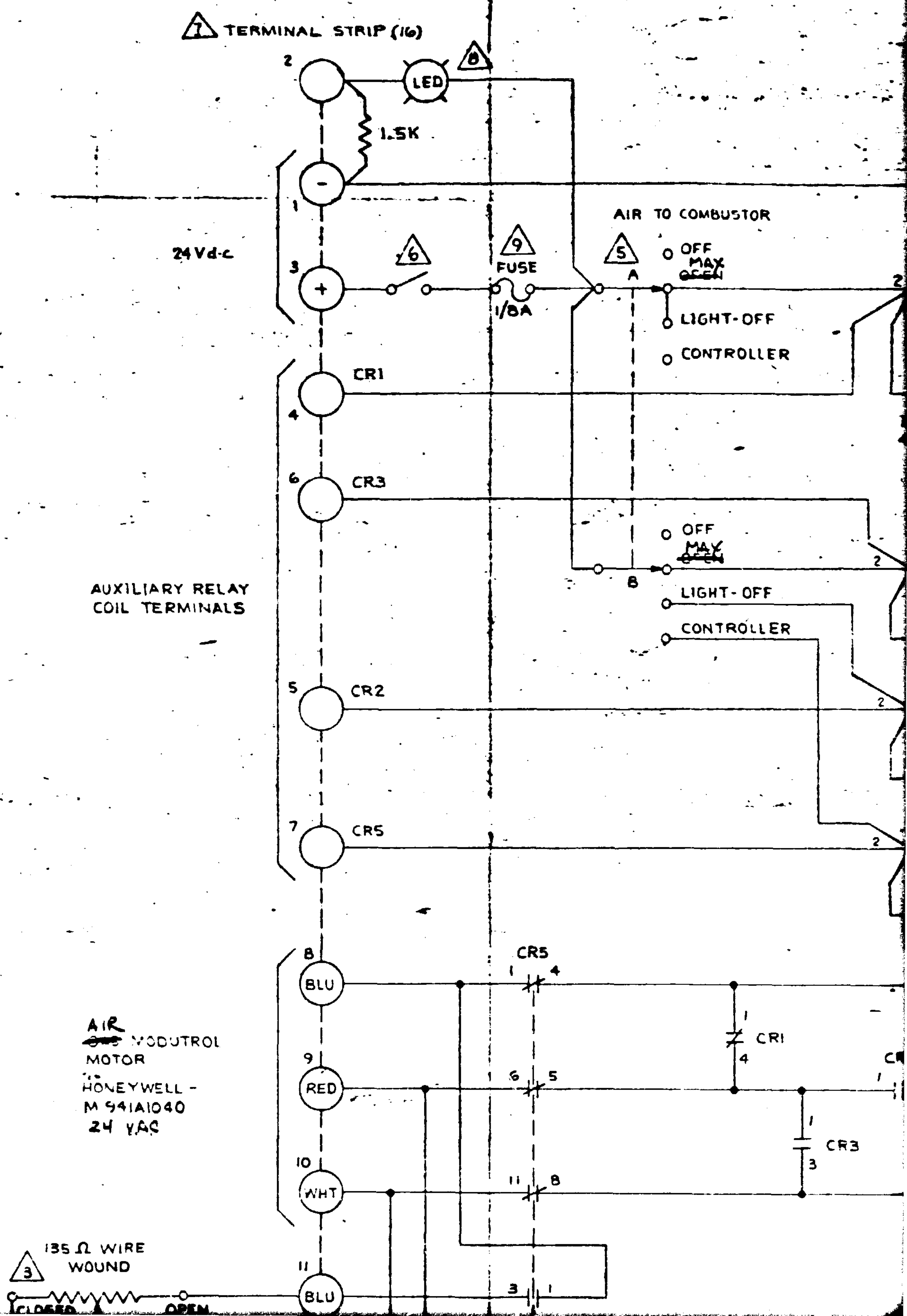

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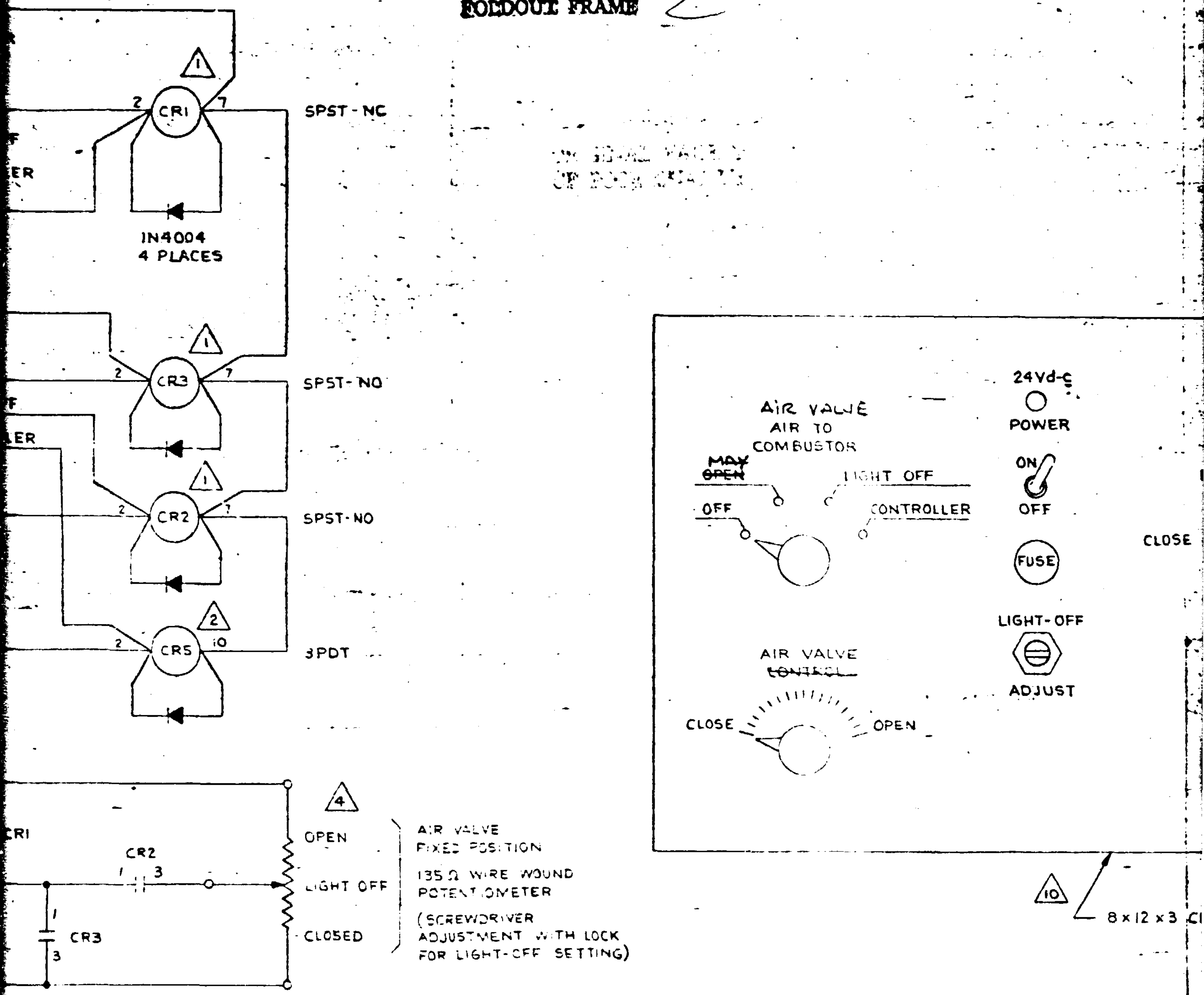

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HONEYWELL
OPERATED

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A		INITIAL RELEASE		SEE TITLE BLOCK								

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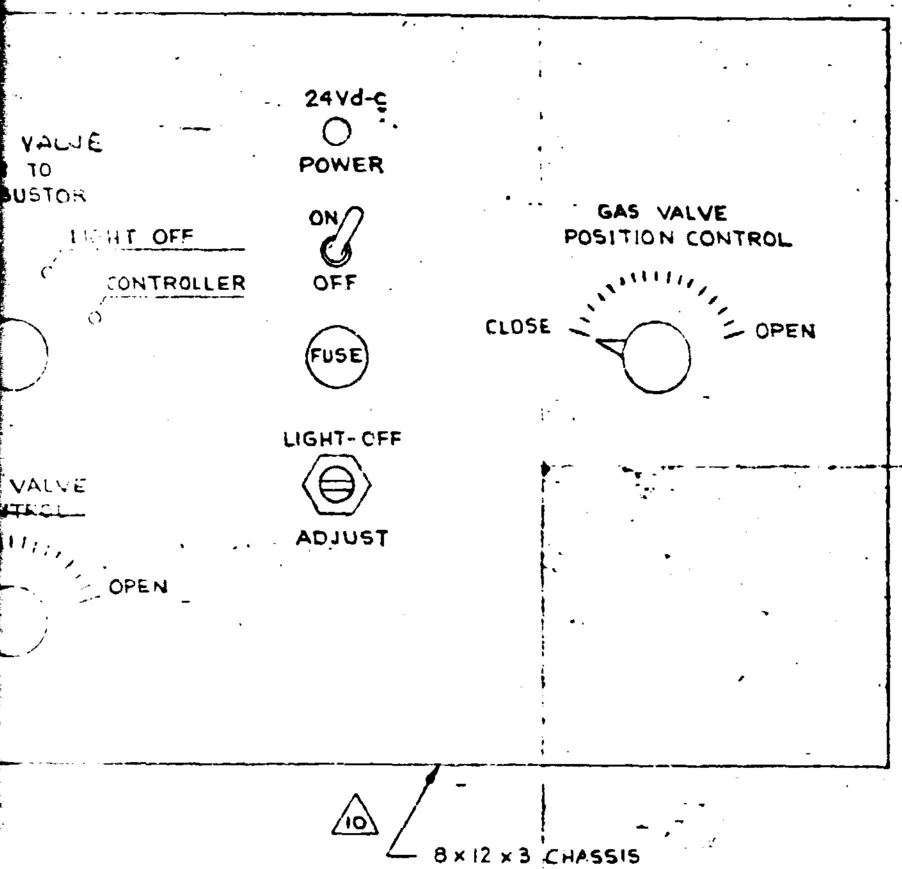
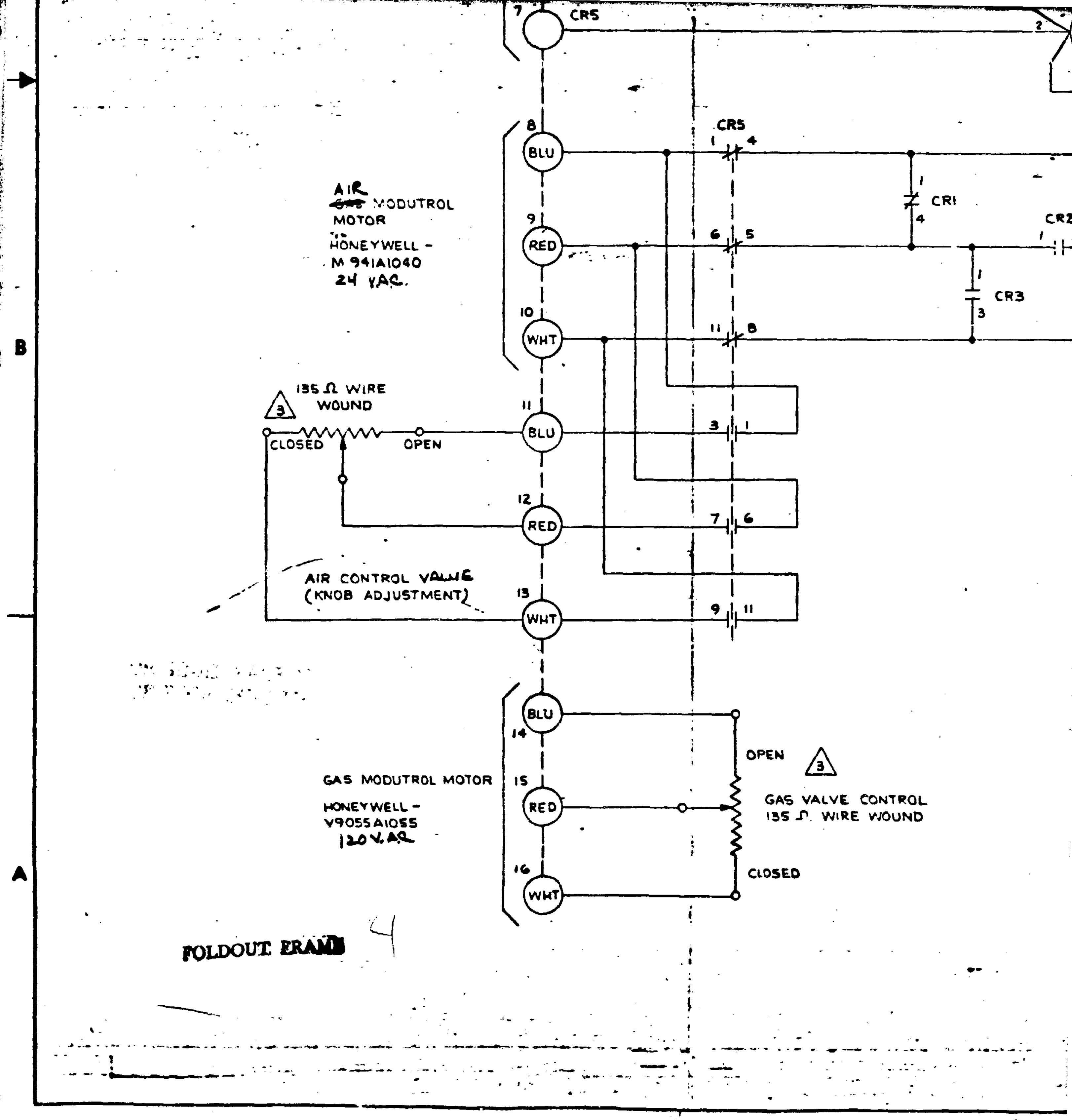


DISH STIRLING SOLAR RECEIVER
TEST PANEL FOR CONTROL OF
HONEYWELL MODUTROL MOTOR
OPERATED VALVES



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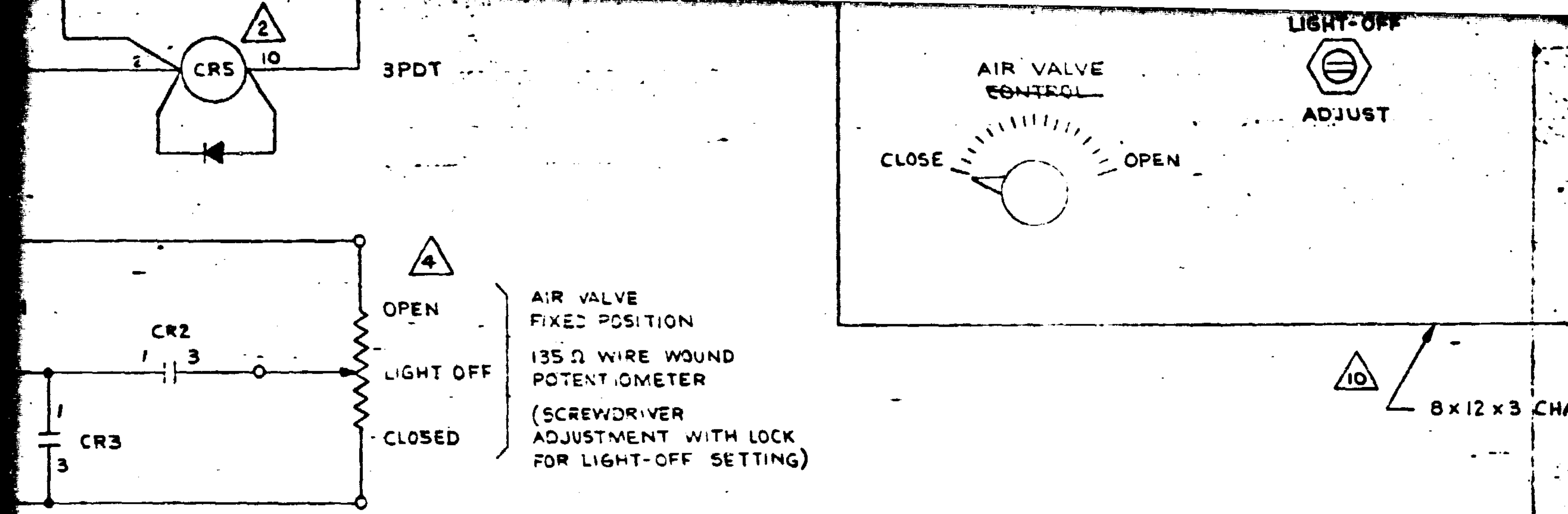


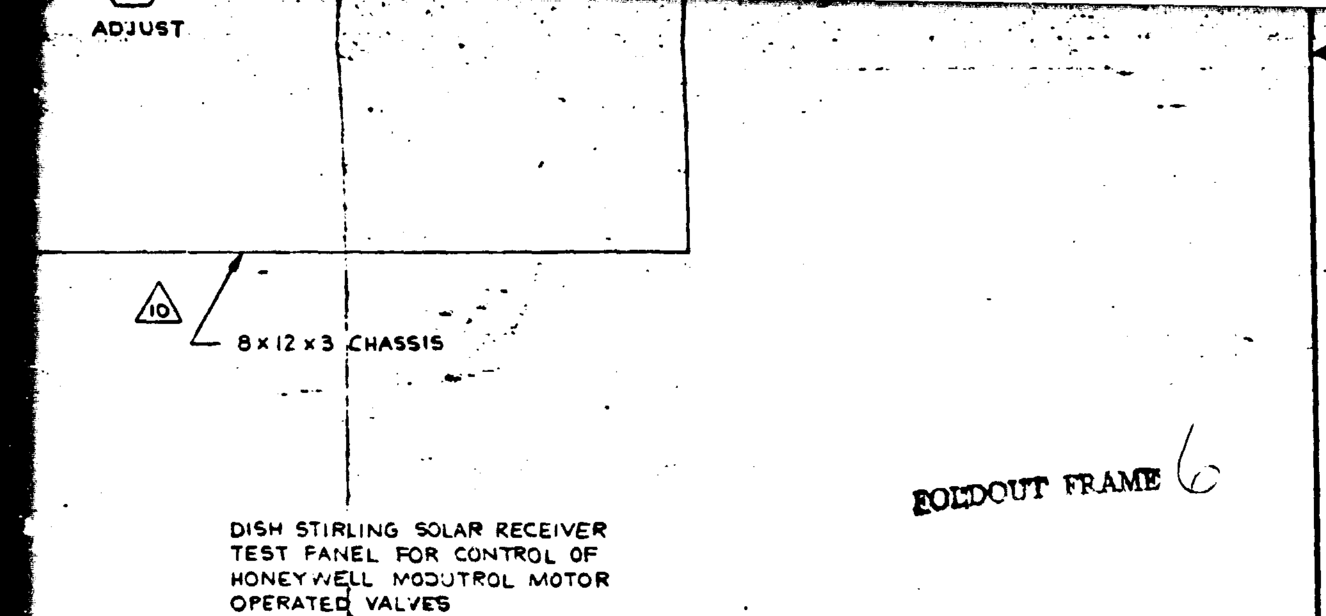
DISH STIRLIN
TEST FANEL
HONEYWELL
OPERATED V

FOLDOUT FRAME

10. CHASSIS CALIFORNIA CHASSIS PART NO A124 (JPL PART NO. 101486-6)
9. FUSEHOLDER LITTLEFUSE PART NO 342006 (JPL PART NO. 103154-0)
8. LED XCITON PART NO. XL-556 (JPL PART NO. 107413-3)
7. TERMINAL STRIP KULKA PART NO. 600-16 (JPL PART NO. 108104-0)
6. TOGGLE SWITCH SPST ARROW-HART PART NO. 86994N (JPL PART NO 107992-5)
5. TAP SWITCH 2 POLE, 4 POSITION. CENTRALAB PART NO. PA2003 (JPL PART NO. 107884-8)
4. POTENTIOMETER - 100 OHM WIRE WOUND (JPL PART NO 106700-6) WITH ~50 OHM RESISTOR IN SERIES (IN LIEU OF 135 Ω POT).
3. POTENTIOMETER 135 OHM WIRE WOUND HONEYWELL PART NO 30112A.
2. RELAY CR5 IS MAGNACRAFT PART NO. W88CPX11 (JPL PART NO. 104348-3)
1. RELAYS CR1, CR2 & CR3 ARE MAGNACRAFT PART NO. W88CPX7 (JPL PART NO 104344-0)

NOTES. UNLESS OTHERWISE SPECIFIED

NEXT ASSEMBLY	USED ON
APPLICATION	



FOLDOUT FRAME 6

DISH STIRLING SOLAR RECEIVER
TEST PANEL FOR CONTROL OF
HONEYWELL MODUTROL MOTOR
OPERATED VALVES

INFORMATION ONLY
OCT 17 1980

QTY REQD	ITEM NO	REF DES	CODE IDENT NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL OR NOTE	ZONE

PARTS LIST

NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS ANGLES
DO NOT SCALE DRAWING
MATERIAL

CONTRACT NO.
APPD DATE
DR 10-6-80
CHK
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PKG
ENGR

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA
RELEASED THROUGH SECT. 356

TEST PANEL — COMBUSTOR CONTROL

SIZE	CODE IDENT NO		REV
J	23835	10097290	A

SCALE NONE | UNCLASS | SHEET 1 OF 1

1