MASTER

HEAT POWERED REFRIGERATION COMPRESSOR

SEMI - ANNUAL TECHNICAL REPORT

RONALD R. GOAD

CONTRACT NO. DE-FG02-80R510221

DISCLAIMER

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

DISCLAIMER

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

DISCLAIMER

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

PROGRAM OBJECTIVES AND WORK ACCOMPLISHMENTS

The objective of this program is to develop and improve the design of previously started prototypes of the Heat Powered Refrigeration Compressor. To build this prototype and ready it for testing by the University of Evansville is another goal. This prototype will be of similar capacity as the compressor that will eventually be commercially produced.

This unit can operate on almost any moderate temperature water heat source. This heat source could include such applications as industrial waste heat, solar, wood burning stove, resistance electrical heat produced by a windmill, or even perhaps heat put out by the condenser of another refrigeration system.

Work performed in the past four months has consisted of:

1. Engineering of Hx-1
2. Comparisons of specifications from different companies to ensure state of the art applications of parts for project
3. Coordinating project requirements with machine shop
4. Designing condenser
5. Partial assembly of HX-1

Work still required to do:

1. Assembly of compressor
2. Building condenser
3. Finish assembly of HX-1
4. Design of compressor control circuit
5. Prepare for testing by the University of Evansville
6. Field application into an existing building
7. Test on various compounds for latent heat of fusion and specific heat that can be used for heat storing purposes when solar heat is used in driving this unit

TESTING

Testing will be performed by the University of Evansville using a General Electric Data Logger to monitor all variables in this system. This will allow constant monitoring of the efficiency of the system. Monitors of the system will consist of four pressure transponders and fourteen thermal couples. The flow of the water through the heat exchangers will be held at a constant by utilizing direct displacement rotary vane water pumps driven by an electric motor. This will guarantee constant water flow throughout the time the test is being conducted.

PROBLEMS

The only problem encountered has been a design problem with the slide valve. Correction of this problem was achieved through the design of rotary valve for switching. Detailed explanation of these changes will be explained in the following section detailing engineering progress shown on blueprints that are engineered for use by the machine shop.

ENGINEERING DETAILS

The first blueprint needed to be examined is drawing TRD 1, detailing part A7, the retainer plate. There is one required. This retainer plate contains four check valves, Kemper brand #2216, obtained from Neff Engineering in Indianapolis, IN. This retainer accepts a four inch ID chromed and polished tube detailed on the material requisition sheet SR3. This tube is recessed $5/8$ an inch into the retainer plate.

Looking at the front elevation there is clearly marked a 2 inch diameter bore receiving area for the entrance of the gas to the check valves.

On the side elevation the $5/8$ inch cylinder recession is shown and clearly marked is the 2 inch depth of the bore for the receiving area providing ample volume to accept the hex nut on the end of part A10 shown on drawing TRD 2. To the right of the side elevation we see a

one inch tapped taper pipe thread. This is plugged for purposes of assembly and for trouble shooting any problems with the piston travel limitations.

Please note - all dimensions or lack of dimensions, marked with an asterisk, will be verified at the time of assembly for custom machining for precise fit. These check valves #2216 are selected for their volume capabilities. These check valves in pairs should handle 40,212.3 cubic inches of R12 gas per minute. The opposing pair design on the check valves will assure smooth gas flow and lower the stress in the retainer plate itself, that could be caused from unbalanced pressure relief.

On the front elevation one $\frac{3}{4}$ inch hole is shown in each corner. These are used to hold the retaining rods which are used in assembly to hold the entire assembly together. Each corner is trimmed to form a 10 inch diagonal measurement to ensure that this piece will be able to swing in the lathe used for machining it.

The next drawing is TRD 2, featuring parts A10, S5 and S5A which make up the piston assembly with a 4 inch diameter for pumping the refrigerant gas R12. This cylinder head is mounted on a $1 \frac{5}{8}$ inch diameter ground and polished shaft with a number 16 polished finish on all surfaces. It is worthy to note that part A10 has several hundredths play between it and the shaft. This ensures lateral movement to prevent the piston from becoming lodged in the cylinder under long travel.

The piston A10 is held together by a one inch hex nut on the end of the shaft. Major sealing on this piston is done with Shamban piston ring #40G0400-42 and is held in place with "O" ring #2-340. Steel plate S5 is incorporated into the end of the piston to retain the crane bearing in place. This is to ensure the integrity of the piston if it should bottom out on the extended end of the stroke. The parts making up piston assembly A10 are listed on materials requisition sheets SR1 and SR2.

Technical analysis of drawing TRD 3. Detailed on this blueprint is part A3 alignment plate. Parts needed are listed on material requisition sheet SR1. One side of the alignment plate accepts chromed and polished tube, part ST3. The other side of this alignment plate engages into part A1, marked on drawing TD46. The $1 \frac{5}{8}$ inch chromed and polished shaft is inserted through the bore in the center of the part. As noted in drawing TRD 1, the $\frac{3}{4}$ inch holes in each corner are for the retaining rods for assembly. The diagonal measurement is retained to 10 inches.

The ports at the top of A3 are used for refrigerant oil flow. This can be used for switching of the rotary valve gas controls and can also be used in restricting the length of the stroke. Part A3 is also used as a retaining plate for the crane bearing which guides the 1 5/8 inch shaft.

Technical analysis of drawing TRD 46. This is a detail of part A1 with two required on each side of the high pressure power assembly. These contain the Polymyte seals used for sealing the 1 5/8 inch shaft and the crane bearing is used for supporting the 1 5/8 inch shaft. This block's principal design is for flow control of the high pressure R502 gas used to power the piston. The design of the gas flow ports of the front elevation is specifically engineered to guarantee high volume gas flow. These ports are designed for high strength while still allowing low resistant gas flow. Parts for part A1 are itemized on material requisition sheet SR1. The one inch bore hole shown on the side elevation and the outline of the bore on the front elevation shown 3/8 inch above the shaft assembly is for cooling purposes of the aluminum block. The 1/4 inch pipe thread shown at the top of the front elevation will be used for pressure monitoring and refrigerant oil flow control.

Analysis of drawing TRD 7. Part A2 alignment plate. There is one of these required. Materials used in making this plate are listed on material requisition sheet SR1. The purpose of part A2 alignment plate is to align and hold concentric part A1 and part ST2. Looking at the front elevation the ports of the top of this assembly are designed for refrigerant oil control.

Analysis of drawing TRD 8. This drawing shows part A9 assembly. This is a piston head used for pumping liquid refrigerant number 502.

This assembly is made up of five parts. The 1 5/8 inch chromed and polished shaft with the number 16 finish, parts S4 and S3 which are steel retaining plates, A9 which is the aluminum bearing and seal fixture, and holding this assembly together is a one inch hex nut securing plate S3.

The interior dimensions of A9 is reamed to 1.262 inches. This is done with an adjustable ream. The seal on A9 is a teflon seal with "O" ring reenforcement to ensure extension. Alignment is controlled with a crane bearing. This is a teflon bearing to ensure low resistance yet still protect the assembly from scarring either the cylinder wall or getting lodged in the cylinder.

Analysis of drawing RD 9. This is part A6 - end retainer. One of these is required. The purpose of this retainer is to secure the liquid end of the compressor. It has a 3/4 inch hole in each corner used for the securing rods. In the center of the retainer you have a two inch round bore two inches deep. This is used as a receiving area for the liquid refrigerant to find its way to two check valves. These are Kemper check valves #2216 obtained from Neff Engineering of Indianapolis, IN.

Looking at the side elevation you can see to the right. There is a one inch bore. This will be tapped and plugged in assembly. This can be used for finding the location of the piston, alignment of the piston and can also be used at a latter time for a pressure relief port. This port may be needed to control the large amount of liquid flow when the condensing unit is working in excess of its normal capacity.

Analysis of drawing TRD 10. This shows the specifications on parts ST2 and ST3. This shows where the ports are to be machined out so that they can mesh correctly with parts A2 and A3.

Analysis of drawing RV 1. On the original grant application a spool switching valve design was used for switching. This has been replaced by a special rotary valve. The spool switching valve had tendencies to appear slow in working having high friction and resistance problems within itself plus leakage problems. There were also cam problems connecting the electric motor to the valve. On the special rotary valve these problems have been overcome. On the five top views you can see the positions of the rotary valve and how its design aids in the quick switching of hot high pressure gas from one cylinder to another. This is a preliminary prototype and there is more engineering to be done before this will be used on the final prototype compressor.

We are now in the position to look at the assembly on drawing TRF 11. This is a full size assembly drawing of the HEAT POWERED REFRIGERATION COMPRESSOR. This is a spool piston assembly design with a 16 inch stroke. It has basically three sections. The left cylinder pumps and compresses R12 for the Refrigeration System. The right cylinder is a circulation pump which circulates liquid R502 through the condensing system. The cylinder and piston assembly in the center powers the unit and is moved by high pressure R502. To the right and left of this piston is where the rotary valve units are placed. These control the R502 gas and therefore the action of the piston.

The area in the left cylinder behind part A10 - the piston, is filled with oil and is pumped through the upper port and can be used as a sensor to measure the location of the piston in its travel, in part of the switching device, or can be used in the cylinder cooling process.

At this point attention should be focused on part ST6. This is a cylinder mounted as an outside sleeve around ST3. This sleeve is mounted for cooling purposes to prevent overheating of the teflon seals. These seals generally do not have any friction problems. What must be taken into consideration in this application is that this compressor may run as rapidly as 200 cycles per minute, therefore seal overheating problems may be encountered.

This is the same purpose served by ST5 around ST1 in the center assembly and ST4 around ST2 in the right assembly. The right piston used to pump liquid R502 through the condensing system has a rear volume displacement of 78.5398 cubic inches per stroke. The left cylinder used for pumping and compressing R12 refrigerant gas has a rear displacement volume of 167.878 cubic inches per stroke. This system is designed to perform at or around 200 strokes per minute. On the right cylinder the amount of oil in the return area consists of 45.3568 cubic inches per stroke.

Now that the heat powered refrigeration compressor has been examined, closely, let us take a look at reference drawing number 3. This is the whole assembly of the system and you'll be able to see how it works.

The R502 cycle of R502 system starts in heat exchanger HX-1. This heat exchanger is detailed in sketch 57. Here this heat exchanger filled with liquid R502 has circulated through it hot water and upon a temperature drop, it extracts heat from the hot water to increase the high pressure. This pressure leaves there and goes towards the switching valves, spool type valves which have now been replaced by the rotary valves, but work on the same principle.

This switching mechanism causes the high pressure gas to switch the piston right and left operating it very similarly to the way most steam engines were operated 50 to 60 years ago. After this gas has done its work pumping to the right or left, it is then ejected through the rotary valve through the exhaust. This heads towards the special condenser where the injectors mix the hot refrigerant gas 502 with cooled liquid 502. This should drop the pressure sufficiently and decrease the volume within this chamber.

The level of the liquid R502 in the special condenser is controlled by the Sporlan Company Levelmaster Control. The right side of the compressor draws the liquid R502 from the condenser into the piston area and then pumps this liquid towards the air cooled condenser. The Dunham-Bush condenser has been replaced under provisions in contract for cost sharing by another brand condenser furnished by Grantee.

After liquid refrigerant is cooled in the condenser, it is pumped through the expansion valve section of the Levelmaster Control and is pumped through injectors where it is mixed with hot gas.

When the liquid level rises in the special condenser the Levelmaster Control restricts flow through the expansion valve. This causes increased pressure in the air cooled condenser system. When pressure in this system rises above pressure in HX-a, HX-a is filled with liquid. This increase in pressure will greatly increase the heat output of the air cooled condenser.

Sketch #57

REVISIONS		
DATE	DESCRIPTION	BY
4-18	GENERAL PER DESIGN MEETING 4-16-80	H.G.

PRINTS ISSUED					
NO	KEY	DATE	NO	KEY	DATE
3	AP	4-12-80			
2	RT	4-18-80			

KEY EXPLANATION	
AP - APPROVAL	ER - ERECTION
F.A. - FINAL APPROVAL	RT - REQUEST
DB - DISTRIBUTION	R.R. - REPR. REFERENCE
S.I. - SHOP INSPECTION	

WE ASSUME NO RESPONSIBILITY AS TO MEASUREMENTS OR DETAILS AFFECTING ANY WORK BUT OUR OWN AND ARE NOT RESPONSIBLE FOR ANY ERRORS OCCURRING THRU THE USE OF THESE DRAWINGS BY OTHER PARTIES.

GOAD ENGINEERING
318 NORTH THIRD STREET
BOONVILLE, INDIANA 47601

JOB **HEAT POWERED REFRIGERATION COMPRESSOR**
FOR: **RON R. GOAD**
317 SEQUOIA LANE
EVANSVILLE, IN. 47712
GENERAL CONTRACTOR

DETAIL NUMBER	LOCATION	DETAIL SHEET	DETAIL SYMBOL

MATERIAL
PISTON & BEARING BLOCKS - ALUMINUM
TUBING & TIE RODS - STEEL

FINISH **ALUMINUM - DURANODIC HARD COAT #315**
PAINT AFTER FINAL ASSEMBLY - SHOP COAT BLUE.

DRAWN: **DATE 4-12-80** DRAWING NO. **76527-4623**
CHECKED: **DATE**
SCALE **3" = 1'-0"**
SHEET **OF**

JOB NO.

SHIPPING LIST										DESCRIPTION & REMARKS	
FRT. LOG	FRT. LOG	FRT. LOG	FRT. LOG	MFG. CTR.	ASSY. MK #	ITEM MK #	NO. REQ'D	HOW SHIPPED

1. PURCHASE OF INSIDE 2 1/2" DIAM
SHAFT & END PLATES LATER.
1-8-81 H.G.

GOAD ENGINEERING CO.
RON R. GOAD
317 Sequoia Lane
Evansville, IN 47712
Phone: (812) 423-8618

1	ADDED MK NUMBERS & NOTE	1-8-81
No.	REVISIONS	Date

JOB SPECIAL ROTARY VALVE	
FOR _____	
Sheet No. _____	Job No. _____
Drawn by _____	Scale _____
Checked by _____	Date _____
Print _____	
This drawing in design and detail is our property, and must not be used except in connection with our work. All rights of design or invention are reserved. This drawing must be returned if requested by us.	

PRELIMINARY
ONLY

PISTON ASSEMBLY FOR REFRIGERANT GAS #R-12.

REVISED 1-9-81

GOAD ENGINEERING CO.
RON R. GOAD
317 Sequoia Lane
Evansville, IN 47712
Phone: (812) 423-8618

HOLD
CONCENTRIC

$\frac{3}{8}$ "

$\frac{3}{8}$ "

$\frac{15}{8}$ " ϕ

MK-A3- ALIGNMENT PLATE
ONE REQ'D ALUMINUM 3"x10"x10"

GOAD ENGINEERING CO.
RON R. GOAD
317 Sequoia Lane
Evansville, IN 47712
Phone: (812) 423-8618

REVISED 1-9-81

DR $1\frac{47}{64}" \phi$ TAP $1\frac{1}{2}"-11$ TAPER THD. MKAI BEARING BLOCK
2-REQ'D AS SHOWN
ALUMINUM 4" X 10" X 10"

REVISED 1-4-81

GOAD ENGINEERING CO.
RON R. GOAD
317 Sequoia Lane
Evansville, IN 47712
Phone: (812) 423-8618

REVISED 1-9-81

HOLD
CONCENTRIC

AK-A2- ALIGNMENT PLATE
ONE REQ'D ALUMINUM 3" X 10" X 10"

GOAD ENGINEERING CO.
RON R. GOAD
317 Sequoia Lane
Evansville, IN 47712
Phone: (812) 423-8618

REVISED 1-9-81

DWG-TRD 8

PISTON FOR #
REFRIGERANT LIQUID. 502.

REVISED 1-4-81
1-9-81

GOAD ENGINEERING CO.
RON R. GOAD
317 Sequoia Lane
Evansville, IN 47712
Phone: (812) 423-8618

DWG-TRD9

MK-A6- END RETAINER
 ONE REQ'D ALUMINUM 3 1/2" x 10" x 10"
 REDESIGNED 12-29-80

GOAD ENGINEERING CO.
 RON R. GOAD
 317 Sequoia Lane
 Evansville, IN 47712
 Phone: (812) 423-8618

6.500" I.D. x $7\frac{1}{4}$ " O.D. x 20" ROUGH LGTH.

2.500" I.D. x 3.000" O.D. x 23" ROUGH LGTH.

MK ST-3 ONE REQ'D
4.000" I.D. x 4.500" O.D. x 21" ROUGH LGTH.

DETAILS LATER

NOT HOANED.

ST4 STEEL TUBING 5" I.D. x $\frac{1}{4}$ " WALL (5 $\frac{1}{2}$ " O.D.) x 20" ROUGH LGTH.

ST5 STEEL TUBING 8" I.D. x $\frac{1}{4}$ " WALL (8 $\frac{1}{2}$ " O.D.) x 21" ROUGH LGTH.

ST6 STEEL TUBING 5 $\frac{1}{2}$ " I.D. x $\frac{1}{4}$ " WALL (6" O.D.) x 19" ROUGH LGTH.

ST7 HOANED & CHROMED I.D. STEEL TUBING 2.500" I.D. x $\frac{1}{4}$ " WALL (3" O.D.) x 38" ROUGH LENGTH (FOR ROTARY VALVE)

REVISED 1-9-81

EVANSVILLE, IND. MATERIAL REQUISITION

Date of Req. 12-14-80 By Job No. Job Name COMPRESSOR FOR RON GOAD Sheet No. SR-1

Unit Price			Item No.	IR PL	Description of Item	Qty	Vendor	Ship Via	Ship To	Date Req'd	To Stk. Rm	On Stk		To Purch.	P.O.No.	Where Used	How Ship			Vendor Date		Received		Remarks
List	Disc.	Net										1	2				W	S	D	Prom.	Ship.	Part.	Comp.	
					ALL ALUMINUM IS 6061-T6 OR SIMILAR ALLOY																			
					A-1 ALUMINUM BEARING BLOCK 4" x 10" x 10"	2	J.T.									COMPRESSOR ASSEMBLY								
			>		A-2 ALUMINUM ALIGNMENT PLATE (FOR 2 1/2" I.D. TUBE) 3" x 10" x 10"	1	J.T.									"								
			>		A-3 ALUMINUM ALIGNMENT PLATE (FOR 4" I.D. TUBE) 3" x 10" x 10"	1	J.T.									"								
			>		A-4 NOT REQ'D	-																		
			>		A-5 NOT REQ'D	-																		
					A-6 ALUMINUM END RETAINER BLOCK (FOR 2 1/2" I.D. TUBE) 3 1/2" x 10" x 10"	1	J.T.									COMPRESSOR ASSEMBLY.								
					A-7 ALUMINUM END RETAINER BLOCK (FOR 4" I.D. TUBE) 3 1/2" x 10" x 10"	1	J.T.									"								
			>		A-8 ALUMINUM MAIN PISTON 3" x 6 1/2" DIA. ROUGH SIZE (6.474" FINISHED DIA.)	1	J.T.									"								
			>		A-9 ALUMINUM END PISTON (FOR 2 1/2" DIA CYLINDER) 2 3/4" DIA. X 3" LG ROUGH DIMENSIONS.	1	J.T.									"								
			>		A-10 ALUMINUM END PISTON (FOR 4" DIA CYLINDER) 4 1/4" DIA. X 3" LG ROUGH DIMENSIONS.	1	J.T.									"								
			>		A-11 3 1/2" DIA. X 1 1/2" LG ROUGH DIMENSIONS. (RETAINER FOR SEALS)	2	J.T.									"								

Special Instructions: ISSUED FOR PURCHASE 1-9-81
Sheet No. SR-1

GOAD ENGINEERING CO
RON R. GOAD
317 Sequoia Lane
Evansville, IN 47712
Phone: (812) 423-8618

EVANSVILLE, IND.

MATERIAL REQUISITION

REVISION (1) ITEM S9 + S10 12-15-80.
REVISION (2) 1-8-81Date of Req. 12-14-80 By _____ Job No. _____ Job Name COMPRESSOR FOR RON GOADSheet No. SR-2

Unit Price			Item No.	IR PL	Description of Item	Qty	Vendor	Ship Via	Ship To	Date	To In Stk	To	P.O.No.	Where Used	How Ship			Vendor Date		Received		Remarks
List	Disc.	Net													W	S	D	Prom.	Ship.	Part.	Comp.	
			S-1		STEEL PL 3/8" X 6 1/2" X 6 1/2"	1	J.T.							COMPRESSOR ASSEMBLY								
			S2		STEEL PL 3/8" X 6 1/2" X 6 1/2"	1	J.T.							"								
			S3		STEEL PL 3/8" X 3" DIAM	1	J.T.							"								
			S4		STEEL PL 3/8" X 3" DIAM	1	J.T.							"								
			S5		STEEL PL 3/8" X 4" DIAM	1	J.T.							"								
			S5A		STEEL PL 3/8" X 4" DIAM	1	J.T.							"								
			S6		FOR 4" END PISTON																	
			S6		5" DIAM X 2 3/8" LG STL.	2	J.T.															
			S7		5" DIAM X 2 3/8" LG STL.	2	J.T.															
			S8		5" DIAM X 2 3/8" LG STL.	2	J.T.															
			S9		GROUND & POLISHED STEEL	1	J.T.															
			S10		SHAFTING 1.625 "DIAM X 30"																	
			S10		GROUND & POLISHED STEEL	1	J.T.															
			S10		SHAFTING 1.625 "DIAM X 25"																	
			S10		(FOR 4" DIAM PISTON)																	
			S11		4" X 4" X 3/8" STRUCTURAL STL	2	RON GOAD															
			S11		ANGLE X LG																	
			S12		4" X 4" X 3/8" STRUCTURAL STL	2	RON GOAD															
			S12		ANGLE X 12" LG																	
			S13		3" X 3" X 1/4" STRUCTURAL STL	4	RON GOAD															
			S13		ANGLE X 38" LONG																	

2> THESE HAVE BEEN PURCHASED

ROTARY SWITCHING VALVE

COMPRESSOR MAIN PISTON SHAFT.

R. GOAD CHANGED FROM 1 9/16" TO 1 5/8" 12-15-80. AFTER CHECKING WITH BRAKE SUPPLY CO.

GOAD ENGINEERING CO.
RON R. GOAD
317 Sequoia Lane
Evansville, IN 47712
Phone: (812) 423-8618

Special Instructions: ISSUED FOR PURCHASE 1-9-81

Sheet No. SR-2

EVANSVILLE, IND.

MATERIAL REQUISITION

Date of Req. 12-14-80 By _____ Job No. _____ Job Name COMPRESSOR FOR RON GOAD

Sheet No. SR-3

Unit Price			Item No.	LR PL	Description of Item	Qty	Vendor	Ship Via	Ship To	Note Req'd	To Stk. Rm	To 1	To 2	To Purch.	P.O.No.	Where Used	How Ship			Vendor Date		Received		Remarks
List	Disc.	Net															W	S	D	Prom.	Ship.	Part.	Comp.	
			ST-1		HOANED & CHROMED 1.D. STEEL TUBING 6.500" I.D. X 3/8" WALL (7 1/4" O.D.) X 20" ROUGH LENGTH.	1	J.T.									COMPRESSOR ASSEMBLY								
			* ST-2		HOANED & CHROMED 1.D. STEEL TUBING 2.500" I.D. X 1/4" WALL (3" O.D.) X 23" ROUGH LENGTH.	1	J.T.									"								
			ST-3		HOANED & CHROMED 1.D. STEEL TUBING 4.000" I.D. X 1/4" WALL (4 1/2" O.D.) X 21" ROUGH LENGTH.	1	J.T.									"								
			ST-4		STEEL TUBING 5" I.D. X 1/4" WALL (5 1/2" O.D.) X 20" ROUGH LENGTH. (NOT HOANED)	1	J.T.									"								
			1 > ST-5		STEEL TUBING 8" I.D. X 1/4" WALL (8 1/2" O.D.) X 21" ROUGH LENGTH (NOT HOANED)	1	J.T.									"								
			1 > ST-6		STEEL TUBING 5 1/2" I.D. X 1/4" WALL 6" O.D. X 19" ROUGH LENGTH. (NOT HOANED)	1	J.T.									"								
			* ST-7		HOANED & CHROMED 1.D. STEEL TUBING 2.500" I.D. X 1/4" WALL (3" O.D.) X 38" ROUGH LGTH. (FOR ROTARY SWITCHING VALVE)	1	J.T.									ROTARY SWITCHING VALVES.								

Special Instructions:

* THESE ITEMS USE THE SAME
TYPE 2.500" I.D. HOANED & CHROMED
TUBING -
ISSUED FOR PURCHASE 1-9-81

Sheet No.

SR-3

GOAD ENGINEERING CO.
RON R. GOAD
317 Sequoia Lane
Evansville, IN 47712
Phone: (812) 423-8618