ENGINEERING RESEARCH INSTITUTE
THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

NUCLEAR RESEARCH AND DEVELOPMENT

PROGRESS REPORT

(For the Period October 2, 1956 to April 2, 1957)

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TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
2.0	SUMMARY AND CONCLUSIONS	2
3.0	LOOP AND LOOP ACCESSORY STATUS	4
4.0	LOOP INSTRUMENTATION	13
5.0	HYDROGEN FIRING TESTS	18
6.0	LOOP OPERATIONS	20
7.0	MATERIALS PROGRAM	23
8.0	MANPOWER EXPENDITURES	33
9.0	EQUIPMENT AND MATERIAL STATUS	34

FIGURES

Figure No.		Page
1	Helium and Loop Control Panel	7
2	Liquid Level Determination by Radiography	11
3	West Side of Loop Enclosure	15
4	East Side of Loop Enclosure	16
5	Crucible and Support	25
6	Schematic Diagram for Vapor Plating Operation	28

LIST OF TABLES

Table No.		Page
I	Summary of Test Results on Oxidation Resistance Coatings	32
II	Equipment and Material Status	35-44

DRAWINGS

Drawing No.		Page
2505-89-1066	Radiation Cask Assembly	12
2505-94-1021	Thermocouple Locations	14
2505-92-1008	Vapor Plate Induction Furnace Schematic	31

1.0 INTRODUCTION

This report is the fourth progress report issued under the contract between The Chrysler Corporation and The Engineering Research Institute on nuclear energy research. This report covers the period October 2, 1956 to April 2, 1957, with prior periods being discussed in previous reports.

2.0 SUMMARY AND CONCLUSIONS

The loop proper with the melt tanks were received from Alloy Fabricators in Perth Amboy, New Jersey. The cleaning process of the system was performed at the Willow Run Laboratories. Upon the cleaning, purging and installation at Willow Run, the loop proper, melt and sump tanks, sampler and transfer lines were wrapped with heater wires. Thermocouple leads were welded in the various localities to be measured.

Routine leak testing of the loop revealed that the three Moore Products Company pressure transmitters were leaking. These were, therefore, removed from the system. The transmitters across the orifice plate flowmeter were replaced with an inverted manometer or riser which is radiographed to determine the pressure difference across the orifice. The transmitter on the sump tank was also replaced. Tank level measurements will be made using dip tubes and back pressures.

Due to leaks between the porcelain insulation and the stainless steel electrodes on the champion spark plugs of the sampler system, the plugs were replaced by Connax seal tight glands.

The helium purification reactors developed hot spots due to thermal insulation falling between the Calrod heating winding and the reactor wall. This difficulty was remedied by putting a thin stainless steel sheath around the Calrod so that loose insulation could not contact the heating unit. Operation has been satisfactory since this change was made.

Hydrogen firing tests were made to determine the effectiveness of reduction of oxides at temperatures that can be reached in the loop. At 1300°F, iron oxide is effectively removed, however, a black film remained on the croloy specimens which is believed to be chromium oxide. Hydrogen firing is also beneficial in removing slag and other oxide contaminants from bismuth.

The initial charging of the loop tanks was completed. Loop startup was delayed due to minor leaks that developed when the system heated up.

Several crucibles were prepared by coating a graphite base material with TiC using gaseous feed materials. These coatings were free of impurities and visually appeared to be uniform and dense. Thermal cycling tests on these crucibles showed no changes when heated to 2300°F and cooled to 700°F for 31 cycles. Equipment is being prepared to obtain thicker TiC coatings by using hydrocarbon gases as reductants. These methods should give thicker TiC coatings and permit a coating to be formed upon materials other than graphite.

Three runs were made in the metallic coating apparatus. These runs, while not completely satisfactory due to mechanical difficulties, definitely demonstrated that metallic molybdenum coatings can be uniformly applied to crucible shapes at very reasonable reaction temperatures. Equipment is being revised to purify the feed gas and to remedy the mechanical difficulties encountered.

Manpower expended on the project has been 866 mandays on the loop, and 185 days on the materials program.

3.0 LOOP AND LOOP ACCESSORY STATUS

3.1 Loop Construction and Cleaning

The loop proper with the melt tanks was received at Willow Run on November 9, 1956 from Alloy Fabricators in Perth Amboy, New Jersey. During the inspections before shipment, it was discovered that a stainless rod had been used to weld the orifice assembly into place. When a 502 rod was substituted for the stainless rod in rewelding the orifice, porosity resulted in the weld. The orifice was made from a piece of 416 bar stock. Consultation with the welding specialist at Brookhaven National Laboratories indicated the 416 would be difficult to weld. As a result, the 416 orifice assembly was removed and replaced with a new orifice assembly fabricated from 1/2 inch croloy pipe and 1 inch croloy tubing.

Efforts were made to clean the loop and tanks before shipment from Alloy Fabricators. In order to do this, the pressure transmitters which had been welded to the system were removed. The loop system, composed of croloy, was segregated from the dump and melt tank system, the latter being composed of stainless steel. This segregation of the croloy and the stainless system was accomplished by cutting the line between the sampler and the dump valve. Due to lack of facilities available at Alloy Fabricator and their poor success in cleaning the loop, it was decided to ship the loop as is with the cleaning to be done in our shop at Willow Run. Upon arrival, the loop was pumped down to less than 10 microns after some time. The system would not hold this pressure but the leakage was attributed to the temporary plugs installed in the openings and it was assumed that the freon leak detection tests, which were certified as being done at Alloy Fabricators, were adequate to insure the loop would meet the leak rate requirements. Also, the loop was found to have gross rust in all the croloy sections.

The following cleaning procedure was suggested by the personnel at Brookhaven National Laboratory and was used in cleaning of loop G.

A solution of 3% nitric plus 17% by volume commercial grade HCl and water was allowed to stand in the loop for a period of 30 minutes. At the end of this time, the solution was drained from the loop and immediately flushed with tap water. Following the flushing, the loop was filled with a pickling solution of 20% HCl. The pickling solution was left in the loop for approximately three minutes and at the end of that time was displaced by distilled water. A special addition flange was then installed that permitted the distilled water to be displaced by acetone. The acetone was blown out of the loop proper by an inert gas and the system held under the inert gas pressure with the gas being allowed to bubble out through a water trap. The outside of the loop was heated with an acetylene torch to raise the temperature to approximately 150^{o}. At the same time, inert gas was heavily purged through the system. All connections during the chemical washing of the loop were made with rubber hoses slipped over the ends of the pipes so there would be no end effect in the cleaning. After the loop had been purged for approximately two days, the temporary flange on the sampler was removed and it appeared that the sampler and the connecting lines as far as could be seen were quite clean.

The stainless steel tanks were cleaned in the same solutions and in the same manner as the loop. However, in this case, less care was taken to avoid air coming in contact with the loop after the acetone had been drained out. The tanks at the melt tank flange appeared to be very shiny and clean. The ball valve from the sampler had a burned out lower seat that was replaced and in addition, the diaphragm and the gas valve connected to the melt tank was replaced due to metal chips which had penetrated the diaphragm.

After the tanks had been thoroughly cleaned, heating wire was wrapped around the tanks using the lugs that had been welded to the tanks as a support. Thermocouples were also welded to the tank at the predetermined locations. The heating wire was wrapped on the top of the tanks by welding additional lugs to the top plate of the tank. The heating wire was covered first with heavy asbestos paper and later with aluminum sheet that was wired in place. This covering isolated the heating wire from the loose insulation that was to surround the tanks to avoid localized heating of the heating wire. The loop coil that extended through the furnace wall was wrapped with heating wire to a position within 4 inches of the interior of the furnace. The loop was then placed in the enclosure and the tanks located in two barrels on either side of the duct work so that the joint between the dump valve and the bottom of the sampler were matched.

The Moore pressure transmitters which were not attached to the loop or the sump tank at this time were cleaned separately. Greater control was used in cleaning the pressure transmitters to reduce the possibility of corroding the bellows.

With the loop and tanks in place, Mr. R. Kutchera of the Engineering Division of Chrysler Corporation assisted us in welding the loop to the dump valve and welding of the transmitters in place. After considerable experimentation, it was decided to use a backing ring of croloy wire for the welding of the transmitters and a stainless rod for connecting the croloy pipe to the pipe stub on the dump valve. The backing ring would also be used in welding the pressure transmitter on the sump tank. On November 27, the transmitters were welded to the loop and sump tank. Welding was done with inert gas blanket inside the loop after the sampler flange had been installed.

Upon installing the sampler flange, it was noted that there was a small amount of rust in the upper part of the sampler. The rust was removed mechanically and the sampler re-assembled. All of the sampler flange including the stand pipe and other connections had been mechanically cleaned by a wire brush or by sand blasting.

3.2 Loop Vacuum System

A new vacuum fore pump was received from the National Research

Corporation and together with the MCF-60 (Consolidated Electrodynamics) water cooled diffusion pump was installed as a permanent part of the loop and helium purification system. During operation of this pump, considerable difficulty was experienced and it was found necessary to bleed the fore pump when shutting it off; otherwise, the check valves between the oil reservior and the body of the pump leaked sufficient oil so the pump oil is forced back into the diffusion pump. A satisfactory shut-down procedure had been developed which calls for bleeding air into the diffusion pump at the same time the fore pump is shut off.

Additional sensing elements were obtained for the thermocouple gage. The agreement between different elements was so poor that the instrument had to be calibrated for one element and calibration curves prepared for the other elements used. The calibrations were run against either the Stokes Gage or the Phillips Gage. Unfortunately, some of the calibration curves were so steep that it was very difficult to read small changes in pressure, particularly at the lower micron values. The thermocouple gage is used only where approximate vacuum readings are required or transient pressure conditions are to be observed.

3.3 Control Board and Sampler

The pneumatic control board was completed and the lines connected to the melt and sump tanks and also to the top of the sampler. The coil, sample rod, and lifting device on the sampler were completed and the details of this apparatus were outlined in a publication request previously submitted to the Chrysler Corporation.

After assembly, the loop and panel board, shown at the extreme right in Figure 1, were pumped down in an effort to determine the leak rate, which appeared quite large. Some of the items which leaked and had to be repaired or replaced were the Special Champion spark plugs that were used as probes in the loop. The plugs were supposedly designed for this specific purpose. Leaks were also found in the bellows of both of the pressure transmitters on the orifice assembly. In addition, the extra pressure transmitter which had not been utilized in any way up to this point was also found to leak through the bellows. These leaks were determined on the freon leak detector.

During the process of finding leaks, it was determined that the best method of operating the freon leak detector was to fabricate a probe of such dimensions that a pressure of about 150 microns would be maintained at the sensing element located on the vacuum pump. The object to be leak checked is then loaded with freon and the probe run along the outside of the equipment being checked in order to catch any freon leaking out through cracks or openings in the equipment. The response time for this type of arrangement is quite rapid and according to our calculations, the arrangement is more sensitive then the use of the leak detector actually in the system with freon sprayed on the exterior.

Due to the characteristic of the Imperial valves, which causes them

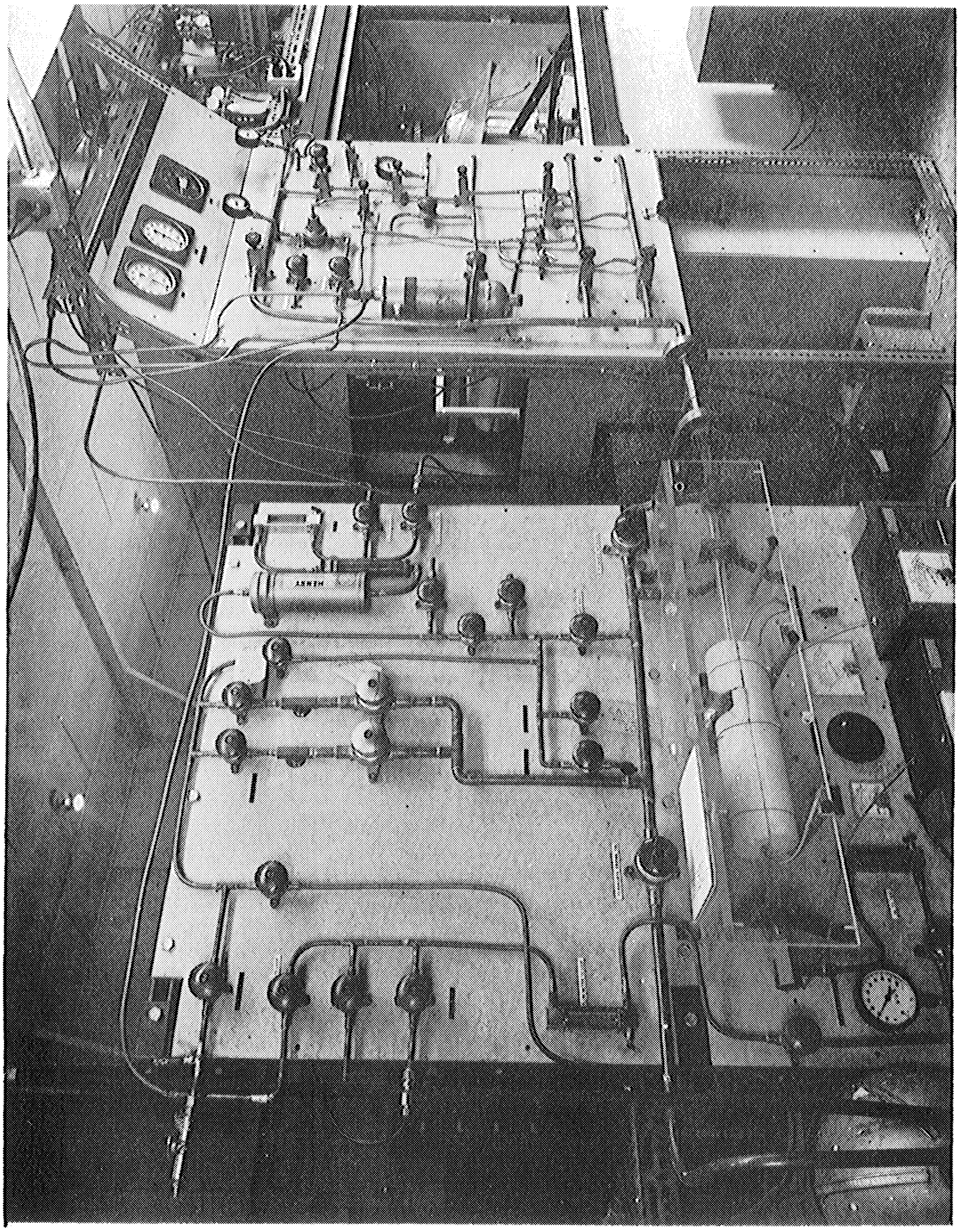


Fig. 1. Helium and loop control panel.

to develop leaks after considerable usage, several changes were made on the panel board. The changes initially were made to turn the valves in such a way that the seat side of the valve would always be exposed to the loop and the bonnet side of the valve exposed to the helium inlet or the vent or vacuum. In those places in which the loop was exposed to the valve on both sides, such as a bypass valve or inter-connecting valve between the lines going into the stand pipe and body of the sampler, more reliable valves were required. A new and more responsible vacuum valve was purchased from the Vacuum Electronic Engineering Company. This valve has a rubber seat and a copper bellows and the bonnet is sealed with a rubber O-ring. These valves were soldered in the line as shown in Figure 1 on the right panel board connected to the loop enclosure.

The special spark plug electrodes received from Champion were installed and after some difficulty, a seal was made between the top of the sampler flange and the spark plug. Subsequent testing indicated that the plugs did leak and they were removed and replaced by Connax gland which supports and insulates the electrode. The Connax gland is insulated by a conical teflon washer that is compressed by a steel sleeve or held in place by a follower between the outside walls of the body of the gland and against the inter-electrode. The nut and the follower are separated from the electrode by a porcelain insulator. The bottom of the Connax gland was welded to the top of the sampler. These glands were found to be leak tight when properly installed.

3.4 Pressure Transmitters

Due to the long delivery on the pressure transmitters, it was decided that they had best be replaced with another type of instrument for measuring the pressure at various points in the system. A radioactive source for use in investigation of plugging in the system and for determining corrosion of the loop wall had already been studied and it was decided that the same source could be used to determine the liquid level of bismuth in risers on either side of the orifice in such a way as to provide a pressure differential across the orifice and hence measure the flow. The risers were installed on the orifice. The material used was the same croloy pipe and tubing that was used in the rest of the loop. The top of the risers at the orifice were vented to a line from the panel board going to a connection just below the ball valve on the sampler. It was determined that the pressure transmitter on the sump tank could be replaced by the dip leg system for measuring liquid level that had already been installed. The line leading from the bottom of the sump tank to the pressure transmitter on the sump tank was sealed with a welded-in plug.

3.5 Seal Bellows

After the pressure transmitters have been removed and replaced with other measuring instruments, further leak checking of the system determined that the seal bellows on the Fulton Sylphon valves leaked. On the dump valve, a 400 series stainless plug had been welded to the very thin 18-8 bellows. A leak appeared at this joint. The plug was cut off the bellows and a stainless ring fabricated to which the bellows was welded. The 400 series plug was then welded to this ring. With this arrangement only fairly massive dissimilar metals were welded and the 347 bellows welded to a 304 ring. With the bellows repaired, the valve was reassembled and the flange of the bellows was welded to the top of the body of the valve and the bonnet replaced. The drain valve bellows was welded to the body in the same manner as the dump valve. No leaks were found in these valves after these modifications.

3.6 System Components

Prior to receipt of the loop at Willow Run, the helium purification system was completed and a trial run made. It was discovered that loose insulation falling between the calrod heater and the body of the reactor resulted in hot spots in the heater. These hot spots melted the sheath of the heater resulting in a short circuit. The reactors were removed and a new calrod heating coil wrapped and installed. The new coil was tied with inconel wire to the gas inlet tube which runs around the reactor parallel with the heating coil. Over the top of the coil and inlet tube a stainless steel shield was made and wired in place. The shield kept the poured insulation around the reactor from getting between the reactor body and the heating coil. Thermocouples were connected to various points on the calrod, inlet tube, and reactor wall. A trial run was made with these thermocouples connected to a temperature recorder and a control thermocouple selected from the recorder data. The control couple was placed on the hotest point of the calrod unit. As a result of the limitations in the maximum temperature of the calrod sheath, design temperatures are not achieved the full length of the reactor. Later tests have determined that the purification of the helium appears adequate in that tarnish free pieces of uranium are obtained when exposed to the purified gas. However, it is thought that the capacity of the bed and the life of the bed will be reduced somewhat since optimum temperatures are not used during the operation of the purification system.

On the basis of information from the Brookhaven National Laboratories that oxides could be reduced from the inside of a croloy system by hydrogen firing, the No. 2 reactor of the helium purification system was designated for the purification of commercial hydrogen for use in hydrogen firing tests and later hydrogen firing the loop. A highly pyrophoric material, titanium hydride, is formed in the reactor during hydrogen purification and special precautions are necessary during bed replacement. A procedure will be developed so that this process can be done safely when it appears that the reactor bed will have to be changed to assure sufficient purity of the hydrogen.

A series of hydrogen firing tests were conducted in the tube furnace using the purified hydrogen gas from the No. 2 reactor on the helium purification system. These tests indicated that the iron oxides could be reduced, however, there is a film of oxide left which thermodynamics would indicate is chromium oxide and is not reducible at temperatures that can be attained in the loop.

After considerable experimentation, a satisfactory method of polishing the uranium sample for the helium purification system purity test was developed by using a standard method of making up the helium or preparing the system for making up the helium and keeping down the velocity of gas going through the reactor and insuring that the reactor has been turned on for a long enough time to reach thermal equilibrium. A consistant purity has been obtained. Future tests will be made to attempt to make a quantitative determination of the sensitivity of the test in a heated polished uranium sample that is exposed to the helium that has been purified. If the sample clouds over or turns color in any way, the gas is assumed to be insufficiently pure to use in the loop or other places where a pure inert gas is required.

3.7 Liquid Level Determination by Radiography

One of the lavatories on the main floor of the laboratory has been converted to a darkroom for the development of the radiograph negatives. A reference bar has been installed on the risers so that any parallax between the height of the bismuth actually in the riser and the film behind can be corrected for. The arrangement of this is shown in Figure 2. A drawing of the cask is shown in Drawing 2505-89-1066. Preliminary calculations and methods for use of the radiograph equipment have been developed and distributed as a supplementary internal report. A one curie cobalt source was ordered and secured in a cask. The cask was designed for holding the source during storage and for positioning the source in the use location. The Co-60 source upon arrival was found to have a activity in excess of one curie and as a result, the cask has a reading on the surface of slightly higher than the eight hour day tolerance. However, since close contact with the cask is unnecessary, it will be used as planned.

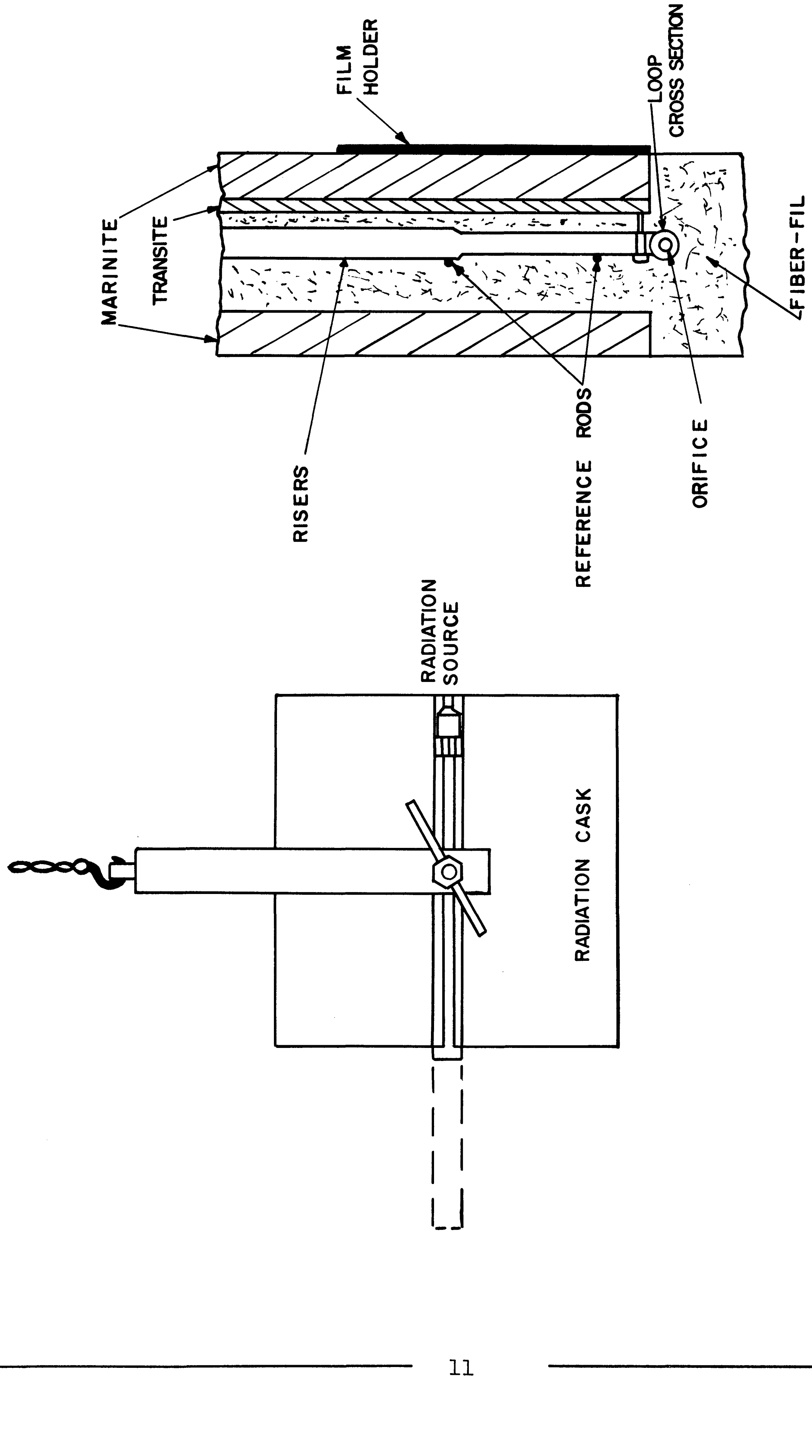
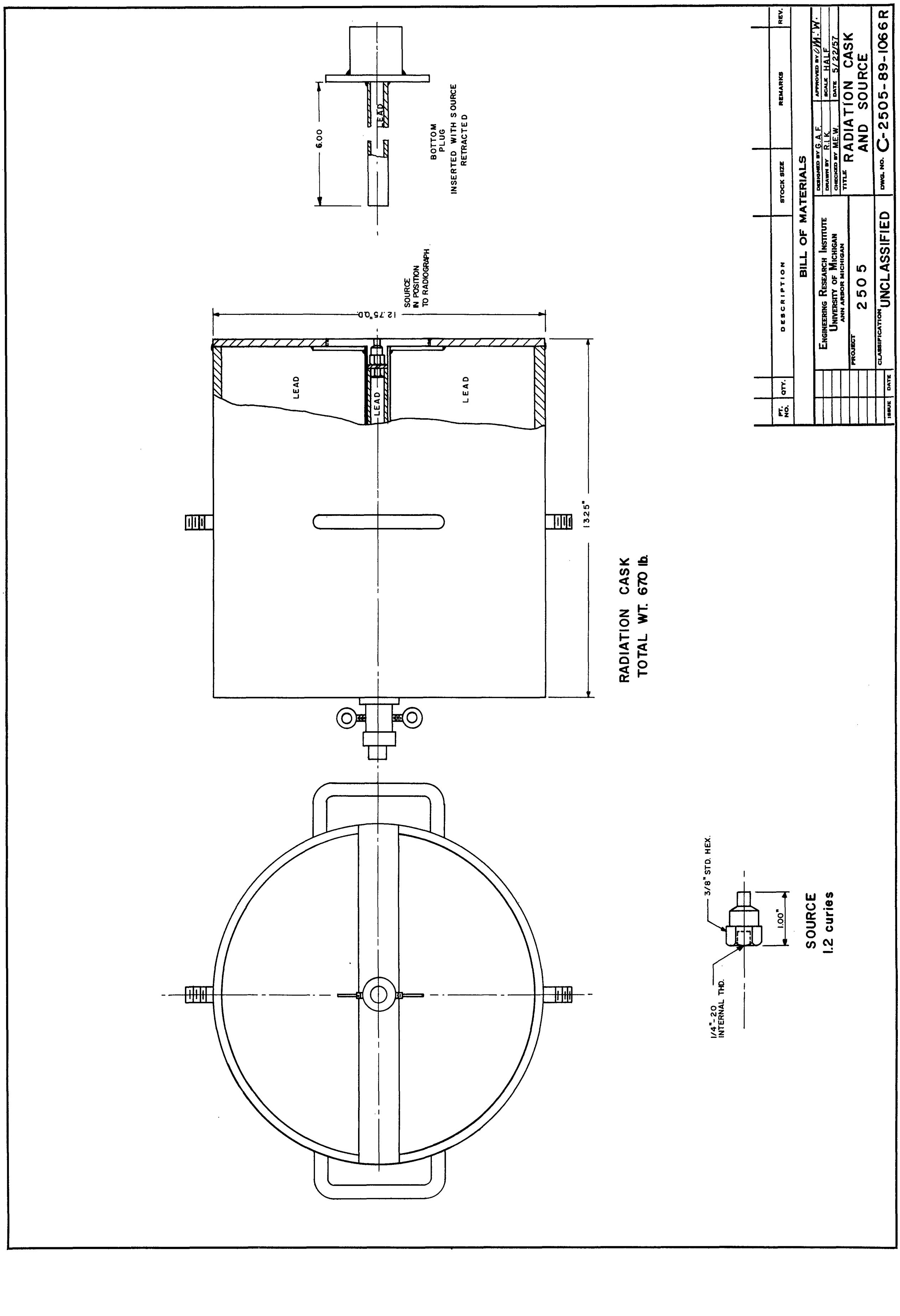


Fig. 2. Liquid level determination by radiography.


6.00
LEAD
BOTTOM PLUG INSERTED WITH SOURCE RETRACTED
SOURCE IN POSITION TO RADIOGRAPH
12.75" O.D.
LEAD
LEAD
LEAD
13.25"
RADIATION CASK
TOTAL WT. 670 lb.
3/8" STD. HEX.
1.00"
1/4"-20 INTERNAL THD.
SOURCE
1.2 curies
PT. NO.
QTY.
DESCRIPTION
STOCK SIZE
REMARKS
REV.
BILL OF MATERIALS
ENGINEERING RESEARCH INSTITUTE
UNIVERSITY OF MICHIGAN
ANN ARBOR MICHIGAN
DESIGNED BY G.A.F.
DRAWN BY R.I.K.
CHECKED BY M.E.W.
APPROVED BY
SCALE HALF
DATE 5/22/57
TITLE RADIATION CASK AND SOURCE
PROJECT 2505
CLASSIFICATION UNCLASSIFIED
DWG. NO. C-2505-89-1066R
ISSUE
DATE

4.0 LOOP INSTRUMENTATION

With the loop installed in the furnace, the following instrument items were attached to the loop as the work schedule permitted:

a) Thermocouples

b) Lewis Engineering Company heater wire and lead wire

c) Pressure connections to sump and melt tanks and Moore Products Company pressure transmitters

d) Automatic Dump System

4.1 Thermocouples

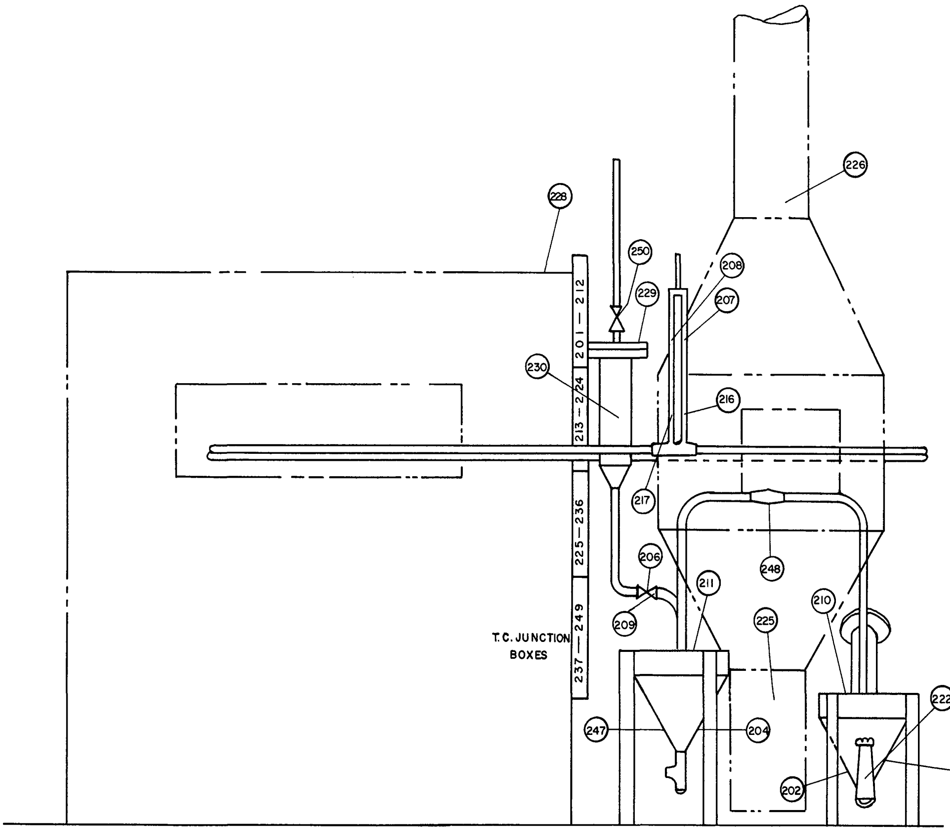
The thermocouples inside of the furnace are #14 B and S gage Chromel-Alumel attached to the furnace coil by stainless steel clamps. Clamps were used to eliminate damage to the nickel plating of the furnace coil which would result from welding. The couples located outside of the furnace are of #20 B and S gage Chromel-Alumel wire welded to the pipe according to Brookhaven National Laboratories specifications. The locations of all thermocouples is shown by Drawing 2505-94-1021.

4.2 Heater Wire

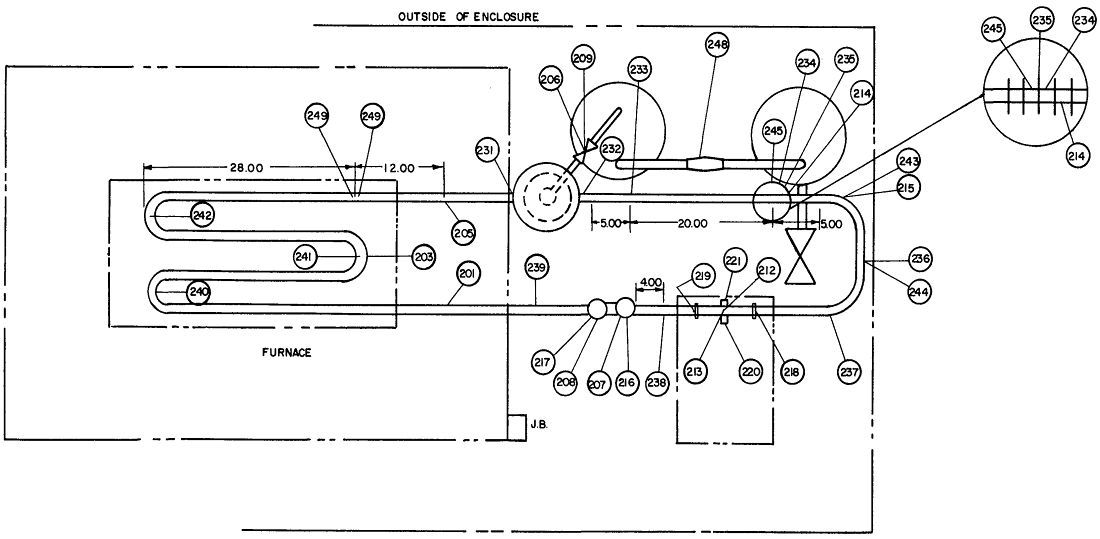
Following the installation of the thermocouples, the #20 B and S gage Nichrome heating wire obtained from The Lewis Engineering Company was wound on the loop. The heating wire was fastened in place with inconel or stainless steel wire bands. Care was taken to keep the heating wire as far away from the thermocouple junctions as possible. Following this, the loop was covered with a layer of asbestos paper and magnesia pipe insulation. Figures 3 and 4 show the insulation and wiring on the west and east side respectively of the loop enclosure. The ends of the heating wire were brought through the insulation in 3/4" O.D. copper tubing to prevent over heating of the wire inside of the insulation. Connections to copper lead wires were made with 1/8" nickel tubing as per Brookhaven National Laboratories procedures.

4.3 Pressure Transmitters

Routine leak testing of the loop revealed that the three Moore Products Company pressure transmitters were leaking. These were, therefore, removed from the system. The transmitters across the orifice plate flowmeter were replaced with an inverted manometer which is radiographed to determine the pressure difference across the orifice. The transmitter on the sump tank was not replaced. The pneumatic tubing associated with the transmitters was removed from the system.



ELEVATION



PLAN

PT. NO.	QTY.	DESCRIPTION	STOCK SIZE	REMARKS	REV.

BILL OF MATERIALS

ENGINEERING RESEARCH INSTITUTE
UNIVERSITY OF MICHIGAN
ANN ARBOR MICHIGAN

DESIGNED BY C.H. — APPROVED BY M.W.
DRAWN BY R.I.K. — SCALE TENTH
CHECKED BY G.A.F. — DATE 5/22/57

PROJECT 2505

TITLE THERMOCOUPLE LOCATIONS

CLASSIFICATION UNCLASSIFIED

DWG. NO. D-2505-94-1021R

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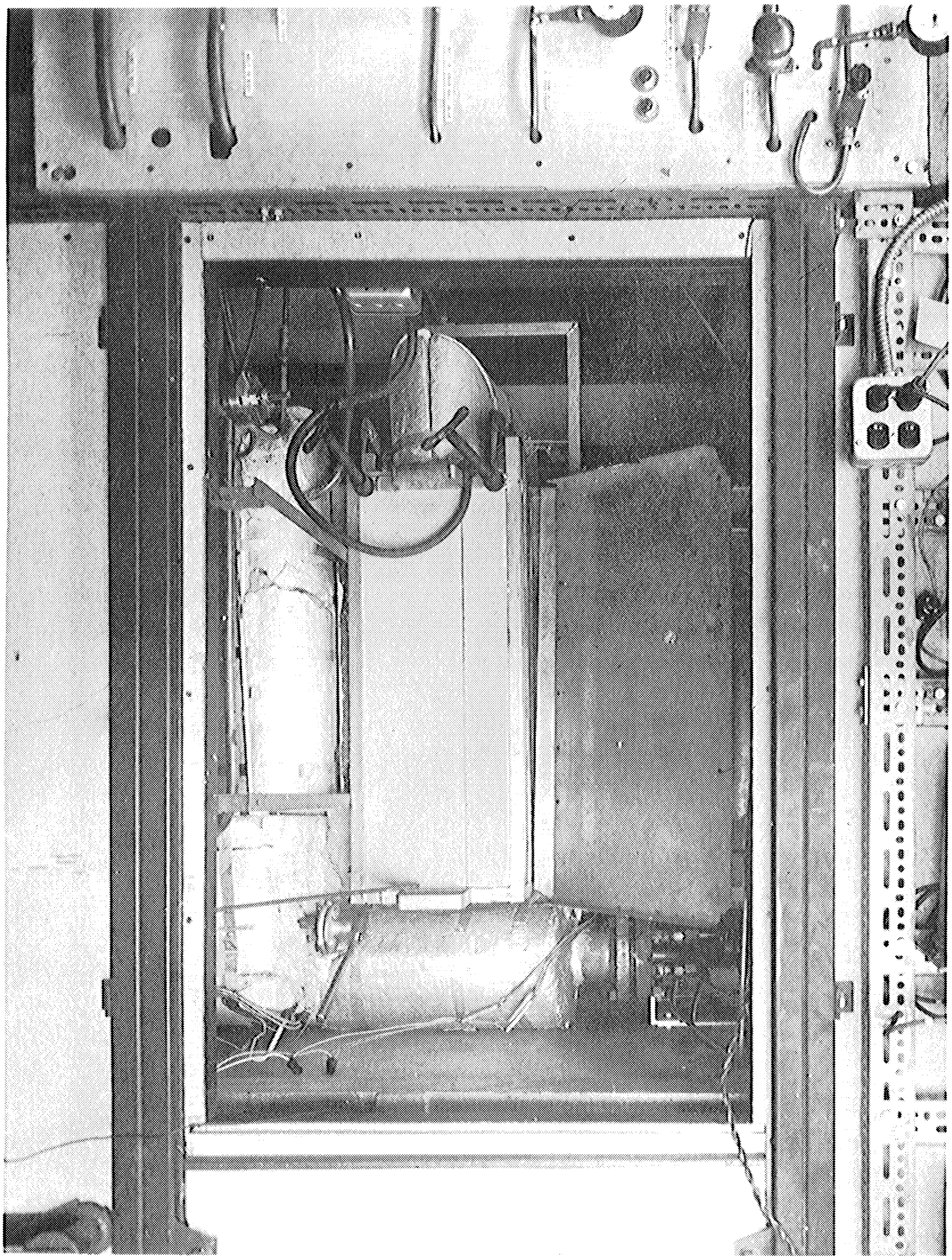


Fig. 3. West side of loop enclosure.

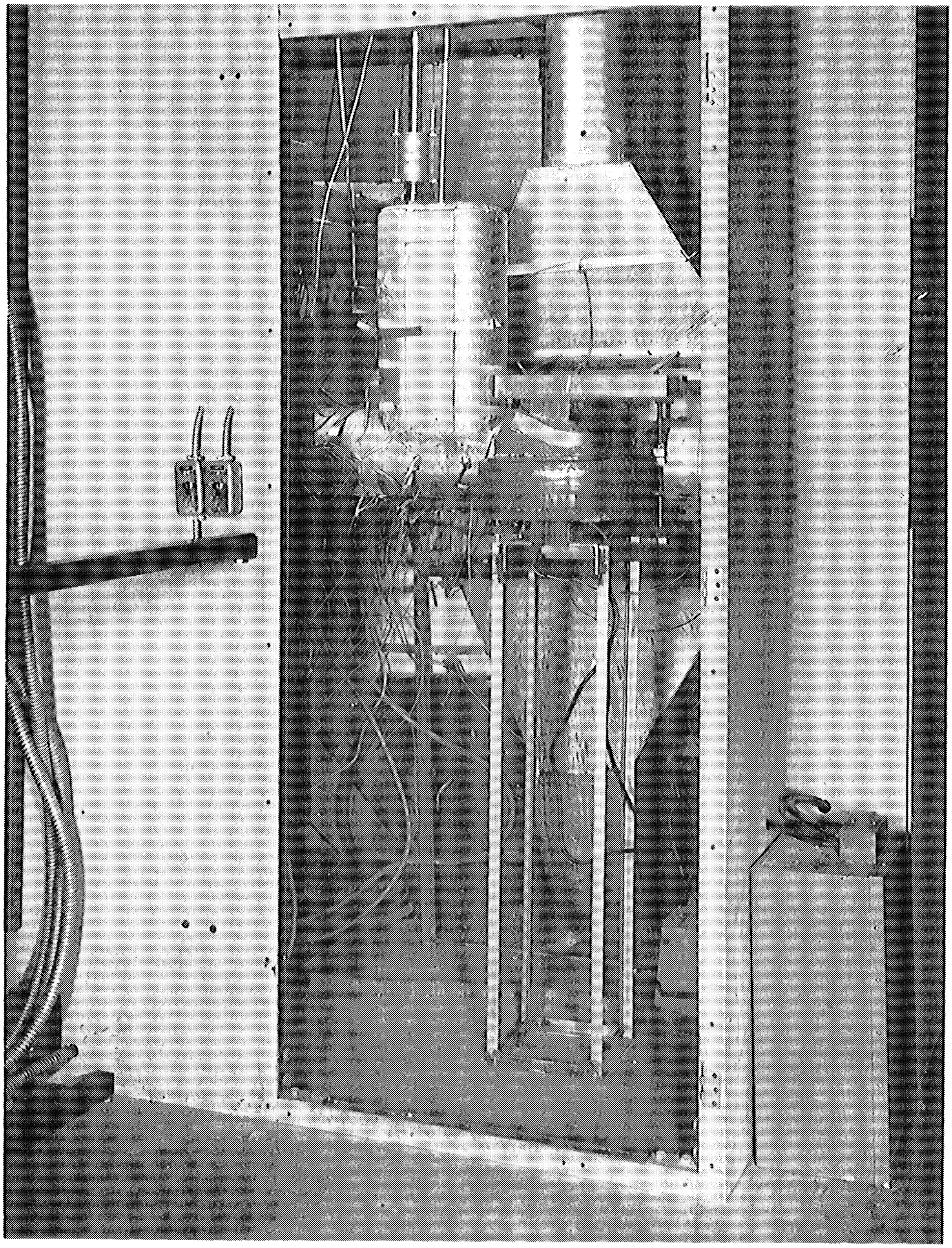


Fig. 4. East side of loop enclosure.

4.4 Sump and Melt Tank Levels

Considerable difficulty was experienced in keeping gas flowing through the dip legs in the sump and melt tanks, especially during bismuth transferring operations. The bismuth was often forced back up the dip legs to cold zones with subsequent freezing of the bismuth in the lines. Increased flow of helium purge gas could eliminate this, however, the amount of gas required would be prohibitive.

4.5 Automatic Dump System

Provisions were added to the control system of the loop to cause the dump valve to be opened in the event instrument power is lost for any reason. The system consists of a solenoid valve controlling the high pressure air supply to an Aro pneumatic impact wrench operating the dump valve. The solenoid valve is opened by the 12V DC emergency power supply in the event of instrument power failure. A micro switch is included to turn off the air to the impact wrench after the valve has opened one turn.

4.6 Operation Manual

Detailed operating instruction for the instruments and controls of the loop have been written for inclusion in the Loop Operating Manual.

4.7 Loop Design Manual

A compilation of all design calculations construction details and manufacturers instruction manuals pertaining to the equipment comprising the control system of the loop is being included in the Loop Design Manual.

5.0 HYDROGEN FIRING EXPERIMENTS

In order to determine the effect of hydrogen firing on loop materials and to develop a satsifactory procedure for the operation, a series of experiments on small samples of Croloy tubing and bismuth were performed and investigated.

The experiments were conducted in a 1-3/4 diameter Vycor tube which was inserted horizontally through a tubular type Hoskins Electric Furnace operating at 20 volts and 50 amps. A small diameter Vycor tube, sealed at one end, was used as a thermocouple well for the Sym-ply-trol temperature controller. The well and the gas inlet and outlet tubes were inserted through rubber stoppers fitted into each end of the large Vycor tube. A trap and bubbler was used on the outlet line to provide a gas seal.

A standard procedure was used for cleaning the Croloy samples. The procedure is as follows:

1) Rinse in acetone to remove lacquer coating.

2) Wash in detergent solution to remove grease.

3) Acid pickle for 30 minutes in a solution of 17% conc. HCl and 3% conc. HNO_3 by volume.

4) Rinse under running water.

5) Pickle in a solution of 20% conc. HCl for 5 minutes.

6) Rinse in distilled water.

7) Dip in acetone and air dry.

In the first experiments, tank hydrogen was used in firing and welding grade argon was used in purging. With this system, severe tarnishing of the samples occurred upon cooling with hydrogen and with argon. As a result of this difficulty, it was decided to use one of the titanium reactors to purify the hydrogen. No tarnishing has resulted with the use of the purified hydrogen.

In sending the hydrogen through the titanium reactors, it was necessary to be on guard against the formation of titanium hydride within the reactor. Approximately 56 scf of hydrogen reacted with the 1616 g. charge at 1300°F. The temperatures that can be reached by the reactor are evidently not high enough to completely prevent formation of titanium hydride. Hydrogen firing was tried on both clean and pre-rusted croloy samples. In all runs, the tube was purged with hydrogen for at least ten minutes before heating and then heated to 1300°F for 30 minutes with a reduced hydrogen flow. At the end of that time, the tube was pulled out of the furnace so that the samples were out of the furnace hot zone and could be observed while cooling. The procedure for the bismuth samples was similar except that the samples were first weighed and were heated to 850°F for about one hour in a silica boat.

The hydrogen firing procedure effectively removed all reddish rust from the prerusted croloy samples but did not restore the surface to a bright appearance. A black film presumably chromium oxide remained after firing. The unrusted samples were left unchanged in appearance.

Two bismuth samples were hydrogen fired. One sample was clean and the other had previously been melted in air. The samples were weighed before heating in air, before firing in hydrogen and after firing in hydrogen. The air heating left the bismuth surface so badly oxidized that the individual pieces did not coalesce upon melting. This 24 gram sample also gained 0.0078 grams during the heating. After the hydrogen firing, the individual pieces had coalesced and only a slight film remained on the surface. A weight loss of 0.0082 grams was obtained. The 23 gram clean sample lost 0.0010 grams after hydrogen firing for the same length of time. This data indicates that hydrogen firing does serve to "clean" molten bismuth at 850°F.

6.0 LOOP OPERATIONS

6.1 Initial Startup and Charging of Melt and Sump Tank

After the leak rate in the loop had been reduced by various means to a room temperature rate of less than 4 microns per hour, the heaters were turned on to bring the system up to temperature in order that it might be outgassed and also to determine if the control points were at the correct thermocouples or whether other temperatures overrode the control points by considerable amount. As a result of the initial heating up, some of the control points were shifted. It was found that it was necessary to clamp the fin tube heater tightly against the duct work and pack insulation around it in order to get the fin tube to come up to temperature. It was also necessary to pack fiber glass insulation around the pump cell in order to get a reasonable temperature span throughout the length of the cell.

As the melt tank had been leak checked with the melt tank flange in place and as the tightness of the ring joint flanges are always a matter of conjecture, it was decided to load the melt tank through the ball valve without disturbing the ring joint flange. The bismuth was broken up into small pieces, not over 3/4" in diameter and the fines separated. The bismuth was first washed in a detergent, rinsed in tap water, rewashed in a 5% nitric acid solution, rinsed with distilled water, rinsed with acetone and dried with a blast of air. The bismuth was loaded through the ball valve with a helium purge entering the body of the melt tank and being expelled through the open ball valve. The tank had been brought above the bismuth melting point at the time the bismuth was loaded. This method of adding the bismuth to the tank took a considerable period of time and was very tedious. After the bismuth had been placed in the tank, the system was hydrogen fired by introducing the hydrogen into the line entering the sampler directly below the ball valve. The hydrogen passed through the sump tank and through the transfer line and filter, through the melted bismuth in the melt tank and was vented from the melt tank vent to the seal pot. The seal pot is equipped with a needle valve which permits a back pressure to be applied to get better circulation of the hydrogen throughout the system. The hydrogen line or the vent line enters the discharge pipe from the loop enclosure ventilating blower. As the blower was operating continuously, the dilution is more than sufficient to reduce the possibility of an explosive mixture. After the hydrogen had been charged through the hot loop and tanks containing bismuth for several hours, the system was pumped down through the vacuum system connected both to the sump and the melt tank pulling a simultaneous vacuum on the free board in each tank. After a vacuum of less than 50 microns had been reached as recorded by the thermocouple gauge on the sampler, helium was introduced into the loop and the system pressurized to 20 psig. The system was left in this condition overnight. It was discovered the following morning that the drain valve on the main melt tank had been left open sufficiently to allow bismuth to pass through the valve and attack the gas tight plugs silver soldered on the discharge side of the valve. The bismuth in the melt tank pressured by the 20 pounds of helium was forced out. Because of possible air oxidation after the loss of bismuth, the sampler flange was removed and the system chemically cleaned again using the cleaning procedure outlined earlier. To facilitate this cleaning, it was necessary to remove the plug from the line in the sump tank so that the sump tank could be drained. The cleaned completed loop was dried with inert gas, the sampler top returned and the evacuation procedure repeated. After considerable time spent in trying to evacuate the system, it became apparent that porosity in the sampler flange prevented a positive seal being obtained with the ring joint. As a last resort, it was decided to weld the sampler flanges together in order to eliminate the leaks in this point. After this flange had been welded together, the system was again evacuated and as at this time a helium leak detector had been received in the laboratory, this detector was used to check all of the exposed parts of the loop in the panel board to determine the leak location. The only point of leakage determined at this time was a pressure reducing valve between the helium supply and the dip legs. After several attempts, the leak in this valve was considerably reduced. However, as it could not be made vacuum tight, it was suggested as an operating procedure that a positive pressure would be maintained on the valve at all times. Before evacuating the loop after the chemical cleaning, the melt tank was loaded through the melt tank flange with 125 pounds of bismuth. Due to the low bulk density of the bismuth particles, the tank was completely filled when 125 pounds of lumps were charged with bismuth. The liquid level normally with this amount of charge should not be above the top of the conical section which would leave about 3 inches of freeboard in the tank. The leak rate determined while the bismuth was charged and before it was melted was approximately 15 microns per hour. With this leak rate no detectible leaks could be found with the helium leak detector in the exposed part of the loop. By isolating the loop at the ball valve, it became evident that the largest leak was in the tank section and probably in the sump tank. Therefore, it was decided to charge the system into the loop, and isolate it by a column of bismuth between the dump valve and the bottom of the sampler. Before charging the bismuth in the loop, about 20 grams of magnesium were melted in a crucible in the small resistance furnace. The melting was done under a vacuum to outgass the magnesium. The billet was removed from the crucible turned down on the outside and a hole tapped in one end. The billet was then added through the ball valve on the melt tank to the molten bismuth charge. The Mg. was left in the melt tank over night and was completely dissolved by the next morning. The zirconium was placed in a graphite capsule that was perforated with holes smaller than the smallest zirconium particle. The capsule was charged with zirconium and lowered into the bismuth for a two hour period, and on removal it was found that the capsule had not drained free of bismuth. As a result, the bottom was cut out of the capsule and it was again inserted into the bismuth. After a two hour soaking period, some bismuth and zirconium still remained in the capsule in the upper half. The bottom half of the capsule was cut away and the capsule returned to the melt tank. The following morning the zirconium capsule was broken off from the additive rod in the melt tank while attempting to remove it. As the graphite will float on the top of the bismuth in the melt tank and could not enter the dip leg, it was not felt that its presence would be detrimental to the experiment. Before charging the additives to the bismuth in the melt tank, the bismuth was hydrogen fired as in the case of the first loading. After firing the system was evacuated as far as possible and purified helium admitted to the system. The evacuation and purging was done a minimum of four times and all lines leading into the system were heavily purged with helium.

7.0 MATERIALS PROGRAM

The approach to the materials problem for molten fuel reactor application had been given in the latter two previous progress reports. This report contains a continuation to the previous periodic report (July 2 - October 2, 1956).

7.1 Graphitic Materials

7.1.1 Graphite Impregnation

Most of the work up to this time has been directed toward plugging the pores in a graphite crucible with TiC using $TiCl_4$ and H_2 gas.

A total of twenty-three runs have been made. The results of one through nine were given in the last report. Runs 11 and 12 produced very little carbide formation -- due to leaks through cracks in the graphite below the crucible. Run 13 failed becasue of formation of a white deposit which plugged the feed line. This was thought to be due to traces of water vapor in the hydrogen. Run 14 was made without drying the H_2 gas and no plugging occurred. However, only a narrow band of carbide formed near the top of the crucible. Very pronounced violet and yellow bands were deposited lower down in the crucible. Some discoloration had occurred in most of the previous runs, due to oxygen or water present as an impurity in the hydrogen. Subsequent runs were all made with purified hydrogen from the loop gas purification system. Run 15 produced a crucible with a smooth, even, and adherent coating of carbide with no discolorations.

Run 16 through 23 were made to obtain crucibles for testing purposes. Some of these were of little value due to very rough and uneven coatings that seemed to be the result of insufficient purging before the furnace was heated up. This always results in a pressure surge due to combination of H_2 and O_2 as the furnace hot zone approaches 1400°F. The O_2 which is present below this temperature oxidizes the graphite surface, resulting in concentration of impurities on the surface of the graphite.

Near the end of runs producing a good coating of carbide, the pressure rises as the crucible pores become plugged. The maximum pressure allowed is 45" of Hg, and after this is attained, the H_2 flow rate decreases to a point where very little carbide can be formed in a reasonable length of time. In some cases, the graphite joints permit the feed gases to escape below the crucible. In either event, it appears that only a relatively thin and slightly porous coating can be applied to the crucible using this method.

In order to build up a thicker coating and also to plug the pores more effectively, it has been decided to add a hydrocarbon to the feed gas. This will decompose in the heated crucible and provide carbon for the reaction with titanium. The hydrogen produced will have little effect because a large excess of it is present as a carrier for the $TiCl_4$. The reaction can then proceed independent of the coated surface and it is hoped that coating can be built up of considerable thickness. Gases which are most suitable for this purpose are methane, ethane and propane. Analyses of these gases obtained from Matheson Company indicate that they all contain harmful impurities in appreciable amounts. A system has been designed for purification of propane. Ethane can also be purified, but at a lower capacity. Parts and materials for the system have been ordered.

A trial run of the furnace has been made using unpurified ethane. The crucible has a very small amount of discolored carbide coating down one side. This was due to uneven flow of the gases through the crucible.* The graphite inlet tube which carried the reaction gases up into the top of the crucible has a much heavier coating of carbide both inside and outside. In future runs, the flow through the crucible will be controlled by holding a slight pressure on the exit gas line, and also by use of a gas dispersion head placed on the inlet tube.

7.1.2 TiC Coating Evaluation

In run #10, crucible #20 was temperature cycled under a helium atmosphere in the resistance furnace. The crucible withstood 31 cycles of alternate cooling and heating between the temperatures 700°F and 2300°F. Cooling rates of 500°F per minute were achieved in this test. The test was discontinued, however, because no discernable change in coating was found.

To test porosity of the coating, a 69.23 gram lump of uranium metal was placed in the crucible; and the crucible was placed in the small furnace. The crucible, under helium, was heated and held at a temperature of 2300°F for four hours. When the crucible was removed, it was found to be severely attacked by the uranium. A large amount of the UC was distributed in the uranium.

Seemingly enough, it was not the TiC which had been dissolved, but rather the coating had been penetrated and the gold colored uranium carbide formed underneath. Porosity evidently is still too great in the coatings currently being prepared.

7.1.2.1 Future Program

A new coating technique is being planned for the

* See Figure 5.

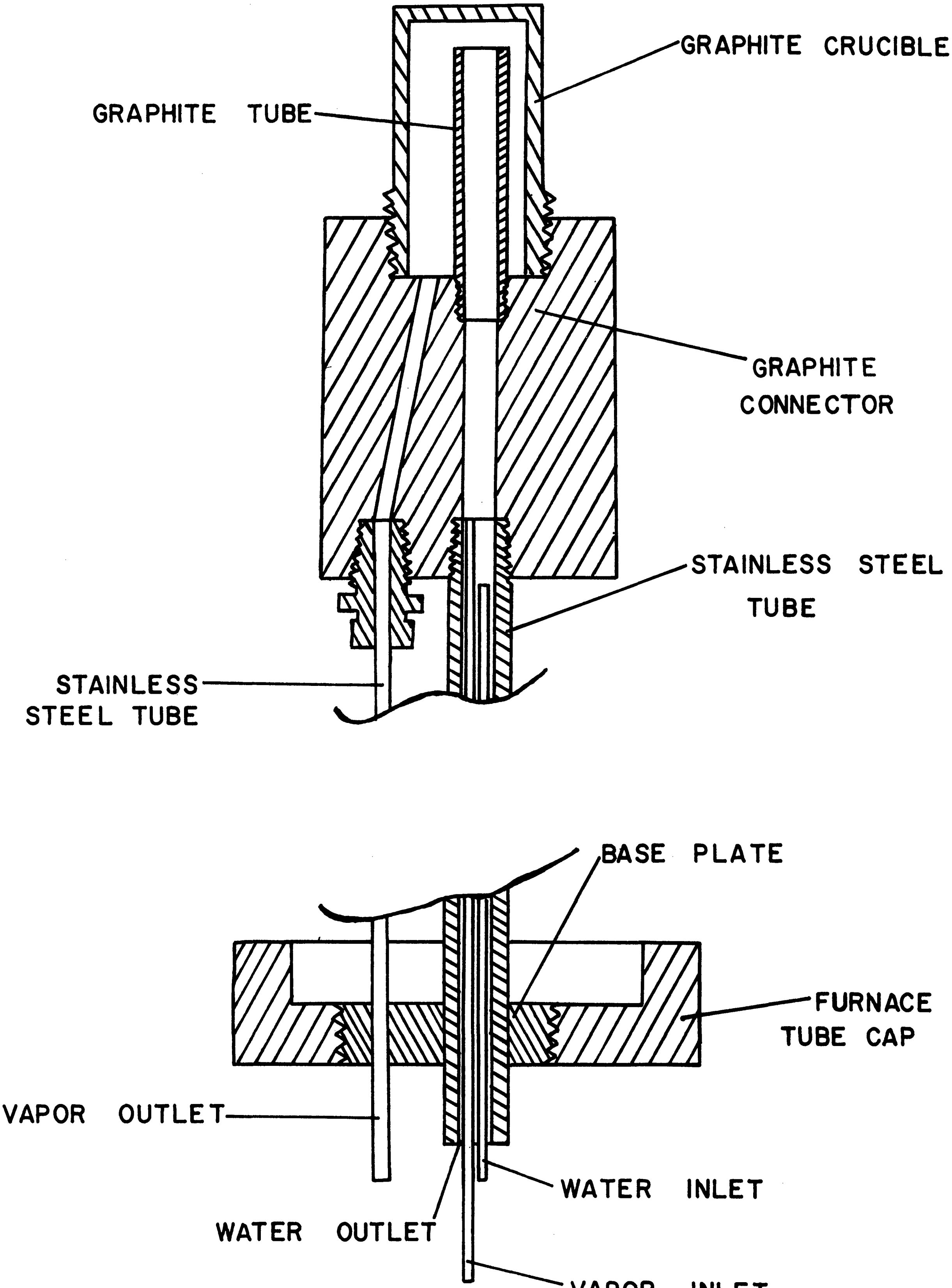


Fig. 5. Crucible and support.

near future program. An investigation of the solubility of TiC in molten uranium will be made. The latter program is being initiated by preparing a sample of TiC from titanium sponge and graphite.

Future investigations are held up due to a leakage in the small furnace. This leakage is through the Imperial diaphragm valves, which will be replaced as soon as delivery of new valves permit.

7.1.3 Miniature Carbon Resistance Furnace

Since the last progress report, one additional run was made in the glass pipe furnace. Prior to this, the furnace was reassembled with extreme care and degassed at 2800°F before putting in the charge. The charge, a 95% copper - 5% zirconium mixture, was placed in a degassed graphite crucible, and the crucible was placed and degassed in the furnace at room temperature. It was hoped that Zr would react with the graphite wall to form an adherent layer of ZrC by this means. After degassing at room temperature, the temperature was raised. The charge was again degassed at this latter heat setting (too low to read with pyrometer) for several hours. During the melting period of a prior dry run, the vacuum system was able to maintain the furnace at a pressure of 0.15 microns with a temperature below 2400°F. Due to the presence of metallic vapors, the Philips gauge could not be used during the actual melt of this latest run. The temperature in the furnace during the run was above 2000°F for one hour and above 2200°F for 30 minutes. Upon the cooling and removal of the metal slug, the crucible was sectioned. A thin coating of zirconium carbide and some graphite that pulled loose from the crucible wall was found adhering to the surface of the billet. Slag deposits did not appear to be present, but the upper surface was covered by a thin uniform dark gray coating. No zirconium carbide could be seen adhering to the crucible wall. At the present time, this was the only Cu-Zr melt in which considerable slag did not form. No further runs are planned using this method of ZrC formation.

Due to the inability to maintain vacuum tightness at high temperatures, a new furnace has been designed and built to replace the glasspipe furnace. The new design consists of a stainless steel shell with a top flange electrically insulated from it by a neoprene O-ring and a teflon separator. This prevents any possibility of metal to metal contact. Three radiation shields, two inner shields and one outer shield, are employed with this new design. The two inner shields are made of molybdenum foil and the outer one is made of stainless steel. Copper cooling coils are brazed to the outer walls of the furnace. The bottom part is grounded and the top flange is insulated from ground by lengths of plastic tubing in the cooling line. The graphite resistance tube and the method of connecting the tube to the electrical circuit are identical to that of the previous system. Drawing 2505-89R-1050 on page 29 of the April 2 to July 2, 1956, Progress Report shows the details of construction. One additional feature is the incorporation of a rotating or sliding seal attached and perpendicular to the viewing and loading extension above the flange. This will permit some degree of crucible manipulation while the furnace is sealed. The sliding seal will permit dumping a molten charge from the crucible without exposing it to air.

The furnace has been in operation for several weeks. No serious difficulties have been experienced in the operation of the furnace although it still has not been checked out at high temperatures under vacuum. Most of the runs thus far have been made under helium pressure.

The limited data obtained under vacuum operation permit a rough comparison of the performance of this furnace to that of the previous one with a glasspipe shell. It appears that, depending on the temperature, approximately 0.5 - 1.5 KW less power is required for the new furnace. For example, at 2500°F the old furnace operated at 5.6 volts and consumed 6.0 KW as compared to 4.6 volts and 5.3 KW for the new furnace. However, under gas pressure, power consumption is considerably increased.

No difficulty in keeping the flanges cool has been experienced with the furnace operating at temperatures up to 3300°F with 20 p.s.i. helium pressure.

7.2 Metallic Materials

The basic design for the vapor plating procedure as described in the November 5, 1956 Progress Report was slightly altered. In the previous design, various metallic chlorides were prepared by passing dry chlorine gas over the metal powder in a reaction tube and the resulting vapors were condensed. The chlorides were then re-vaporized and passed into an induction with hydrogen. However, this design was altered so that the metallic chloride was produced and passed into the furnace in one operation. The latter design was tested with molybdenum.

Figure 6 shows the apparatus and design used for the vapor plating of $MoCl_4$ on a stainless steel crucible. The hydrogen came from the purification system shown in the last report. The chlorine was purified and dried by passing it through two concentrated sulforic acid traps and a pyrex wool trap. The chlorine was then passed through a reactor-vaporizing tube which contained a closed packed bed of molybdenum powder. The chloride produced in the reactor vessel was maintained in the vapor state by heating coils placed around the tube connecting the reactor vessel to the furnace. The reactor vessel itself was maintained at the chloride production temperature of 600°F by a General Electric Thermostat Unit.

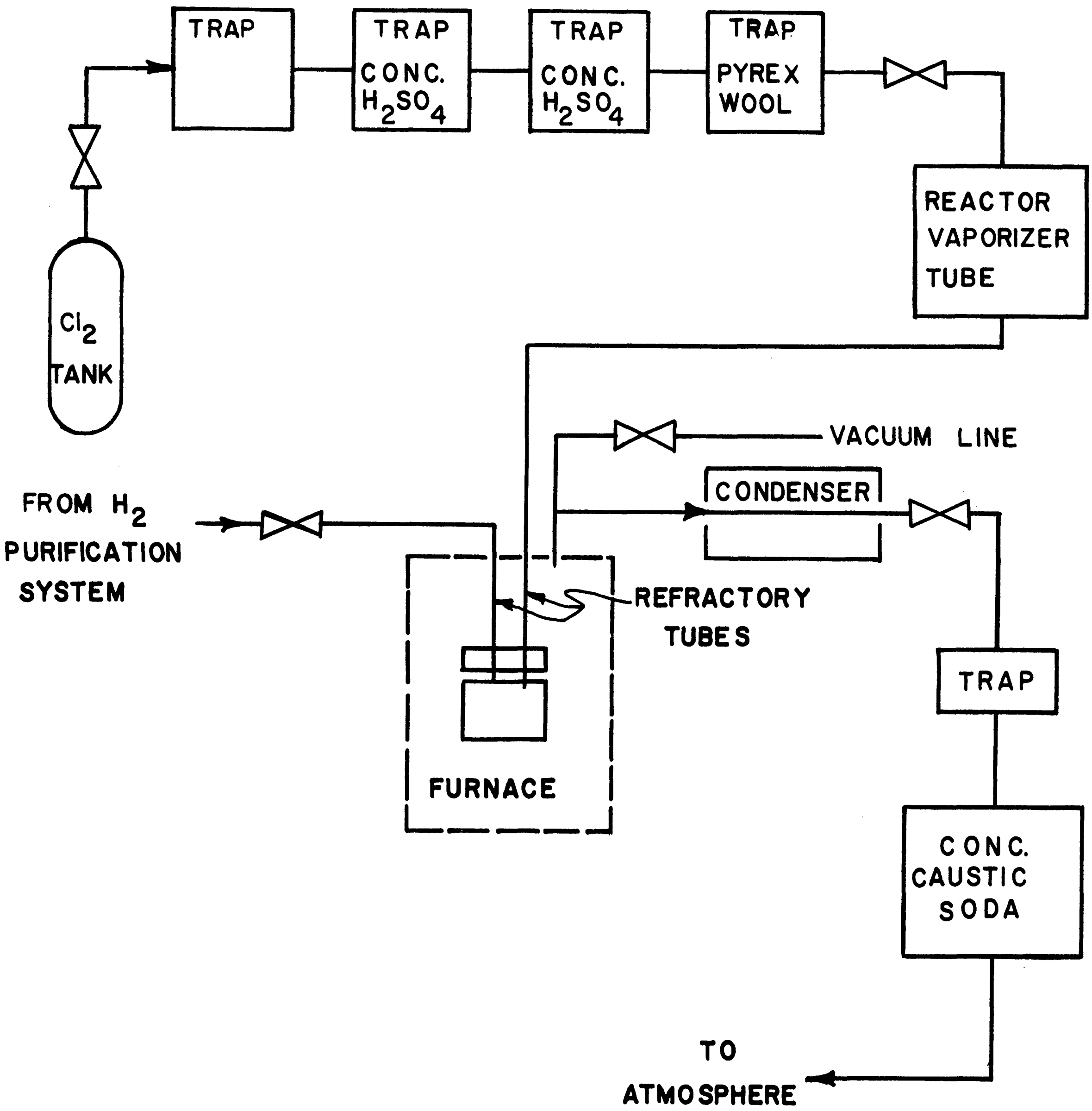


Fig. 6. Schematic diagram for vapor plating operation.

Thermodynamically, the most probable molybdenum chloride formed is the tetrachloride, MoCl (at 600°F). This, as well as the pentachloride, can be reduced according to thermodynamic calculations by hydrogen to molybdenum plus HCl at room temperatures (F = -30.2 Kcal/mole $MoCl_4$). This is the reason for the two separate inlet tubes entering the crucible, one for the H_2 and the other for the chloride vapor. Separate feed tubes will prohibit reactions from occurring before the gases reach the desired reaction zone. Subsequent reaction gases are forced out the crucible and vented through the vacuum line, which had been adapted for their removal. The vent gases passed through a water-jacket condenser, into a trap, and thence to a concentrated sodium hydroxide solution (10% solution). This solution both neutralized the HCl vapors and regulated the furnace pressure. The vent gases then passed to the atmosphere.

In the actual plating procedure, several difficulties were encountered. Sufficient vacuum could not be reached in the furnace because of numerous tube fittings. The furnace was evacuated as much as possible. Chlorine was passed through the furnace for 10-15 minutes to purge any remaining air from the system. After purging, the reactor tube was heated to produce the $MoCl_4$, which was forced into the furnace.

Run #1: After heating the reactor tube for 10 minutes, the convertor was turned on to supply power to the inductance coils. The hydrogen flow rate was decreased by a factor of two. As the molybdenum foil heat reflector support (an alundum cylinder) was heated, it partially disintegrated to porous particles. The particles filled the furnace and prevented subsequent temperature readings with an optical pyrometer. At the end of 5 minutes of convertor operation, the increased vibration of the inductance coils caused the molybdenum foil to slip to the bottom of the furnace. The convertor was then turned off because the heat loss from the crucible was enough to prevent the temperature from rising to the reaction magnitudes. The pressure inside the furnace was approximately 0.8 psig. Upon examination, a slight vapor plating was found to exist on the crucible. The refractory inlet tubes and the porcelain crucible support had a better molybdenum plate than the crucible.

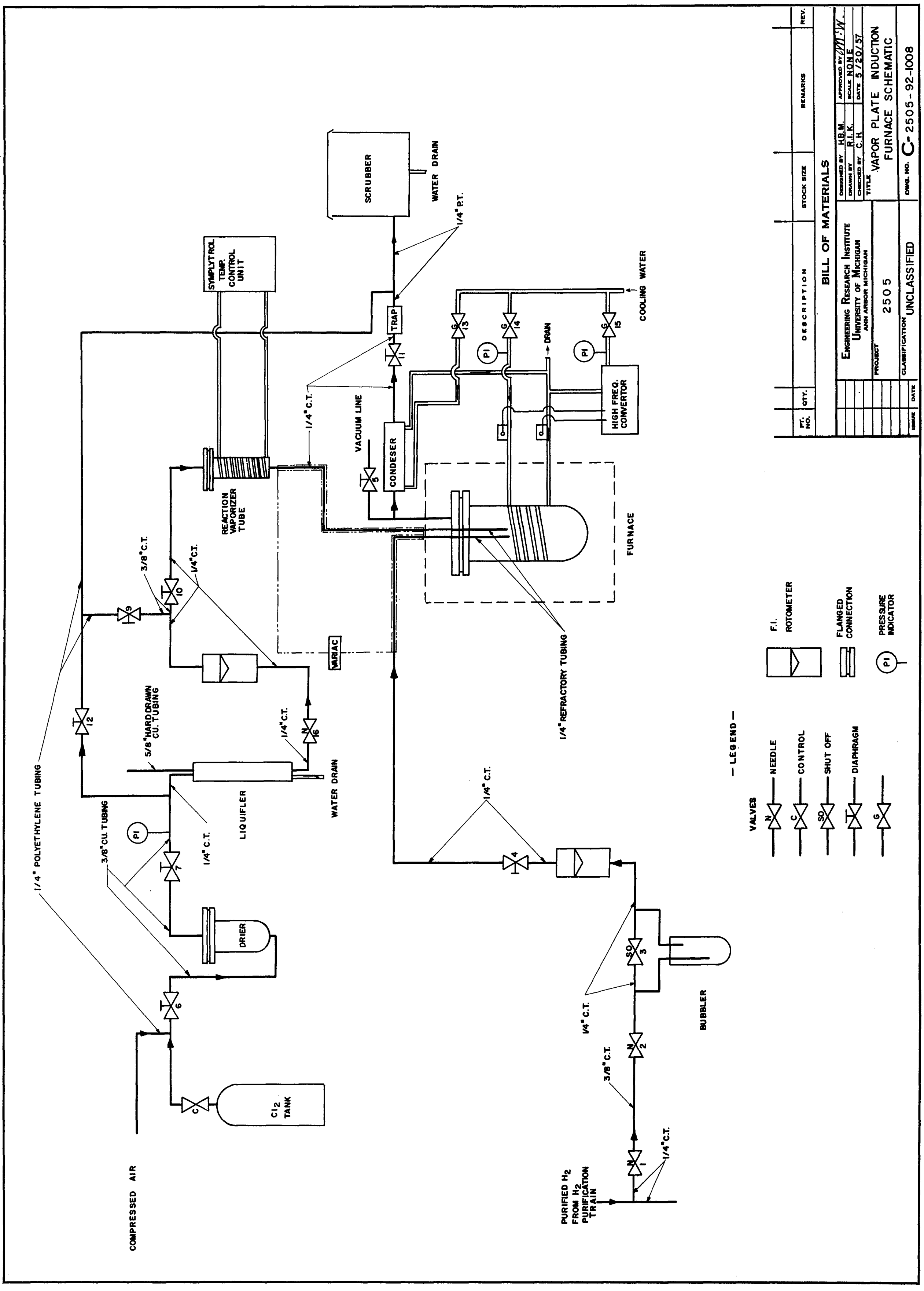
Run #2: The preliminary purging operation employed on this run was the same as that used on run #1. The convertor was turned on and operated for 15 minutes, at which time the silicone rubber insulation surrounding the inductance coils started to melt. The alundum foil holder also started to disintegrate and filled the furnace with particles, thus hindering the optical determination of the temperature. Before the convertor was turned off, a high temperature of 1600°F was reached. The operating pressure was approximately 0.9 psig. The crucible, having a very good molybdenum plate, has only been macroscopically examined. There has been no microscopic or spectrographic analysis of the crucible as yet.

7.2.1 Future Work

Future vapor plating operations will be conducted with slightly altered apparatus. The basic concept of passing chlorine through a reactor vessel containing the metal powder and then forcing the metal chloride vapor into the furnace to react with the hydrogen will be kept. The helium train now in use on the loop, instead of the purification system previously used. The chlorine will also by purified by passing it through a silica-gel drying unit and through a liquifier which will remove the gaseous impurities. The drier and liquifier are shown in drawing 2505-92-1008. The operation of the liquifier will be controlled by a liquid level float assembly and a magnet. Chlorine has a vapor pressure of 2550 m.m. Hg. at $0^{o}C$ and, therefore, could be readily liquified at ice temperatures. The vapor-liquid separation of the impurities will be adequate providing that the concentration of the impurities are originally low. The pyrex pipe being used as the furnace will also be changed. The use of other materials, such as quartz or vicor, which would allow higher operating temperatures, are too expensive. The original pyrex pipe will be sealed at one end. This will make it much easier to handle and adapt to the inductance coils. Vent and reaction gases will be forced from the furnace as previously described. The vent gases will pass through a water jacket condenser, a trap, and thence to a gas scrubber, which will be located outside. All lines involving chlorine or the chlorides will be constructed of copper tubing; all joints and fittings will be constructed of copper tubing; all joints and fittings will be silver-soldered to insure maximum protection from chlorine to all operating personnel. A schematic diagram for the vapor plating apparatus is shown in drawing 2505-92-1008.

7.3 Protective Coatings

Tests on the oxidation resistance of protective coatings on 2-1/4 croloy have been completed. Results from the last group of samples are presented in the summary under Table I. Suppliers who requested information have been given reports on their individual samples.



SCRUBBER
WATER DRAIN
1/4" P.T.
SYMPLYTROL TEMP. CONTROL UNIT
TRAP
COOLING WATER
VACUUM LINE
CONDESER
1/4" C.T.
DRAIN
PI
HIGH FREQ. CONVERTOR
REACTION VAPORIZER TUBE
FURNACE
3/8" C.T.
VARIAC
1/4" REFRACTORY TUBING
5/8" HARD DRAWN CU. TUBING
LIQUIFIER
WATER DRAIN
1/4" POLYETHYLENE TUBING
3/8" CU. TUBING
DRIER
BUBBLER
Cl_2 TANK
COMPRESSED AIR
PURIFIED H_2 FROM H_2 PURIFICATION TRAIN
— LEGEND —
VALVES
NEEDLE
CONTROL
SHUT OFF
DIAPHRAGM
F.I. ROTOMETER
FLANGED CONNECTION
PRESSURE INDICATOR
PT. NO.
QTY.
DESCRIPTION
STOCK SIZE
REMARKS
REV.
BILL OF MATERIALS
ENGINEERING RESEARCH INSTITUTE
UNIVERSITY OF MICHIGAN
ANN ARBOR MICHIGAN
DESIGNED BY H.B.M.
DRAWN BY R.I.K.
CHECKED BY C.H.
SCALE NONE
DATE 5/20/57
PROJECT 2505
TITLE VAPOR PLATE INDUCTION FURNACE SCHEMATIC
CLASSIFICATION UNCLASSIFIED
DWG. NO. C-2505-92-1008

Table I

Summary of Results

Air Oxidation and Temperature Cycling of Various Coatings

Coating Material	Supplier	Sample Number	Max. Temp. °F	No. of Cycles	Failed Yes	Failed No
1) Nickel Plate (Loop Material)	Bart Manufacturing Company	2	1320	818		X
2) Aluminizing S10-33A	Solar Aircraft Company	1	1380	344		X
		2	1400	763		X
3) Enamel #632-A*	Lorain Metal Treating Company	1	1400	42	X	
4) Enamel #N-49*	Lorain Metal Treating Company	1	1400	522		X
5) Enamel #2501-02*	Lorain Metal Treating Company	1	1400	42	X	
6) Process #33	Metal Cladding, Inc.	2	1380	720		X
		3	1350	608		X
		4	1440	547		X
7) Process #11	Metal Cladding, Inc.	2	1340	608		X
8) Process #45	Metal Cladding, Inc.	2	1380	756		X
9) Alcerment S1177	Solar Aircraft Company	1	1320	481	**X	
		2	1320	481	X	
10) Ceramic A-19	Ferro Corporation	1	1400	522		X
		2	1400	522		X
11) Paint XP 310	Dow Corning Company	1	1350	322	X	
		2	1350	322	X	
		3	1400	207	X	
		4	1400	207	X	
12) Paint XP 310	Dow Corning Company	1	1370	2	X	
		2	1400	2	X	
13) Paint XP 412	Dow Corning Company	1	1370	60	X	
		2	1400	60	X	

* Flat Plate samples, mild steel base material.

8.0 MANPOWER EXPENDITURES

Time spent on the project for the two areas of activity is tabulated below. An eight hour working day is assumed for each working day.

	Work Days
Loop	866
Materials Program	185
Total	1051

9.0 EQUIPMENT AND MATERIAL STATUS

Status of the equipment and outstanding purchase requisitions are given in Table II. This table covers the period October 2, 1956 to April 2, 1957. Previous periods were covered in other reports.

TABLE II
MATERIAL STATUS REPORT

ORDER NO.	QUANTITY	DESCRIPTION	MANUFACTURER		DATES (1956) REQUISIT. TO CHRYSLER	CHRYSLER APPROVAL RECEIVED	REQUISIT. TO PURCHSING	ORDER TO VENDOR	PROMISED DELIVERY	REMARKS	COSTS
1	10 pc.	Dexion Angle #225	Plant Department		**		10/3	Cancelled			
2	--	Brass Fittings (Imperial)	Royal Inc.	(2505A)	**		10/3	10/11	Stock	*10/31 196041	$245.00
3	--	Fittings, Tubing, Couplings	Taylor Supply Company	(2505A)	**		10/3	10/11	Stock	*12/11 194409	$30.00
4	--	Pyrex Pipe and Flange	Corning Glass Works	(R.K.)	**		10/4	10/16	Cancelled	196343	$85.18
5	6	Stainless Steel Rod and Tubing	J. T. Ryerson & Son, Inc.	(2505A)	**		10/5	11/7 11/6	Stock	*11/15 200410 *11/14 200411	$20.00 $60.49
6	2	Graphite Rods	Graphite Specialties Corporation	(2505A)	**		10/5	10/16	Stock	*11/5 196348	$15.00
7	1	Stainless Steel Porous Sheet	Micro Metallic Corporation	(2505A)	**		10/5	10/16	Stock	*10/31 196347	$15.00
8	1	Gas Regulator (Helium)	Air Reduction Company	(2505A)	**		10/5	10/16	Stock	*10/22 196345	$25.00
9	10 ft	Vacuum Tubing	Welch Scientific Company	(H.M.)	**		10/5	10/16	Stock	*10/29 196344	$7.70
10	1	Variac 10 amp.	General Radio Company	(2505A)	**		10/8	10/16	Stock	*11/15 196346	$40.00
11	--	#20 AWG Resistance Wire	Lewis Engineering Company	(M.W.)	**		10/8	10/8	Stock	*10/22 194408	$66.96
12	5#	Welding Rod #502	Welding Equipment & Supply Company	(C.D.)	**		10/10	10/19	Stock	*10/26 197215	$10.00
13	10 ft	Silicone Rubber Rod	Detroit Silicone Rubber Company	(G.F.)	**		10/10	10/19	Stock	*10/31 197217	$6.58
14	5 pc	Stainless Steel Rod and Pipe	Ryerson Steel Company	(2505A)	**		10/10	11/8	Stock	*11/14 200446	$15.79
15	2 pc	Stainless Steel Pipe and Sheet	Ryerson Steel Company	(G.F.)	**		10/10	11/7	Stock	*11/13 200455	$240.50
16	6	Allen Bradley Switch and Box	Allen-Bradley Company	(2505A)	**		10/10	10/19	Stock	*11/26 197214	$44.00
17	1	Rockwood Ball Type Valve	Rockwood Sprinkler Company	(2505A)	**		10/10	10/19	Stock	*10/29 197219	$16.00
18	1	Molybdenum Sheet	Rembar Company	(G.F.)	**		10/10	10/19	Stock	*1/2 197216	$20.00
19	--	Buff Wheel and Emery Cloth	C. A. Strelinger Company	(G.F.)	**		10/11	10/19	Stock	*11/13 197254	$20.25
20	2	Oxygen and Acetylene Gas	Plant Department	(C.D.)	**		10/11	10/15	10/19	*10/9 178314	$5.00
21	1	CVC Thermocouple Tube	Consolidated Vacuum Corporation	(2505A)	**		10/10	10/19	Stock	*11/15 197257	$15.00
22	--	Drills - Screws Nuts	Royall Incorp.	(C.D.)	**		10/12	10/19	Stock	*10/25 197260	$20.15
23	2	Drain Trap and Reducing Bushing	East Side Plumbing	(C.D.)	**		10/12	10/19	Stock	*11/2 197255	$3.00
24	1	Magnetic Contactor	Electric Wholesale Company	(2505A)	**		10/15	10/25	Stock	*11/20 198082	$5.00

*Item received.
**Expendable item Chrysler approval not required.

TABLE II (CONT.)
MATERIAL STATUS REPORT

ORDER NO.	QUANTITY	DESCRIPTION	MANUFACTURER	DATES (1956)					REMARKS		COSTS
				REQUISIT. TO CHRYSLER	CHRYSLER APPROVAL RECEIVED	REQUISIT. TO PURCH'SING	ORDER TO VENDOR	PROMISED DELIVERY			
25	8	Posts and Contial	Wedemeyer Company (R.B.)	**		10/16	10/16	10/18	*10/18	L2258	$4.38
26	6	Regulators	Nelson Company (C.H.)	**		10/16	10/25	1/15/57	*1/14/57	198069	$35.00
27	1	Graphite Cylinder	National Carbon Company (D.T.)	**		10/16	10/25	Stock	*11/7	198065	$35.00
28	22	Reamers and Pins	Royall Inc. (2505A)	**		10/19	10/29	Stock	*12/20	198958	$7.82
29	6	Torque Wrench Extensions	Apex Machine & Tool Company (C.D.)	**		10/19	10/29	Stock	*11/15	198959	$15.00
30	3	Alundum Cores	Norton Refractories (H.M.)	**		10/19	10/19	Stock	*10/26	196458	$25.35
31	2	V-Belt and Pulley	Sears, Roebuck and Company (C.D.)	**		10/17	10/17	10/17	*10/17	196436	$1.40
32	1	Diffusion Pump Oil	Consolidated Vacuum Corporation (G.F.)	**		10/22	10/29	Stock	*11/15	198966	$13.00
33	100'	Stainless Steel Tubing	Service Steel Company (G.F.)	**		10/23	10/23	11/3	*11/7	196456	$185.00
34	5	Duo-Seal Oil	Welch Scientific Company (C.D.)	**		10/24	11/1	Stock	*11/21	199443	$10.85
35	--	Chromel and Nickel Wire	Physics Stores (R.K.)	**		10/23	10/23	10/23	*10/23	02286	$.58
36	75'	Inconel-X Wire	Barnes-Gibson-Raymond (G.F.)	**		10/24	10/24	10/25	*10/25	196498	$5.00
37	3	Flanges	Crane Company (G.F.)	**		10/26	11/1	Stock	*12/20	199464	$12.00
38	3	Helium and Argon Gas	Plant Stores (C.D.)	**		10/26	10/29	10/29	*10/31	178410	$60.00
39	4 pc	Thoriated Tungsten	Welding Equipment & Supply Company (C.D.)	**		10/29	10/29	10/30	*10/31	198337	$5.84
40	5	1/2# Jars Handy Flux	C. A. Strelinger Company (C.D.)	**		10/30	11/9	11/20	*11/20	200925	$5.00
41	2	Switches	Wedemeyer Company (C.D.)	**		10/30	10/30	Stock	*11/1	L2323	$2.50
42	12	Stove Bolts	General Stores (L.Y.)	**		10/24	10/24	10/24	*10/24	178374	$1.00
43	5	Cylinders Helium	Plant Stores (C.D.)	**		10/31	11/2	11/7	Cancelled		
44	25	Pilot Light Assemblies	Wedemeyer Electronic Supply Company (D.B.)	**		10/31	10/31	Stock	*12/19	200918	$5.10
45	10	Buffing Wheels	W. W. Grainger, Inc. (R.K.)	**		10/31	11/9	Stock	*11/29	200920	$3.20

*Item received.
**Expendable item Chrysler approval not required.

TABLE II (CONT.)
MATERIAL STATUS REPORT

ORDER NO.	QUANTITY	DESCRIPTION	MANUFACTURER	DATES (1956) REQUISIT TO CHRYSLER	CHRYSLER APPROVAL RECEIVED	REQUISIT TO PURCH'SING	ORDER TO VENDOR	PROMISED DELIVERY	REMARKS	COSTS
1	1	Balance Cover	Eberbach and Son Company (L.Y.)	**		11/1	11/14	Stock	*11/20 201768	$4.00
2	6	"O" Rings	Detroit Ball Bearing Company (2505A)	**		11/2	11/9	Stock	*11/21 200937	$4.50
3	2 pc	Neoprene Sheet Rubber	Detroit Rubber Company (2505A)	**		11/2	11/9	Stock	*11/16 200938	$4.00
4	1	"Conax" Packing Gland	Industrial Instruments and Supply Manf. Co. (L.Y.)	**		11/5	11/14	Stock	*11/23 201798	$7.00
5	40 pc	Copper Solder Caps	Taylor Supply Company (2505A)	**		11/5	11/14	Stock	*12/19 201812	$8.00
6	6	Yellow Brass Disc	Copper and Brass Sales, Inc. (G.F.)	**		11/8	11/8	Stock	*11/12 200230	$13.00
7	200'	#20 B & S Gage Duplex Chromel-alumel Thermocouple Wire	Wheelco Instruments Div., Minn. Honeywell General Electric Company (C.H.)	**		11/8	11/23	Stock	*12/4 200277	$26.00
8	225 ea.	Bolts and Nuts for Dexion Slotted Angle	Acme Steel Company, Dexion Division (C.H.)	**		11/8	11/14	Stock	*11/23 201797	$7.65
9	2	Bottles of Hydrogen Gas	Plant Stores (D.T.)	**		11/9	11/11	Stock	*11/14 178480	$9.20
10	--	Tees, Elbows, Reducers, Solder Connections	Taylor Supply Company (2505A)	**		11/12	11/16	Stock	*1/2 200231	$75.00
11	29	Brass Pipe - bushings, nipples, cross, couplings, tees	Plant Stores (C.H.)	**		11/15	11/17	Stock	*11/21	$5.00
12	1	3/4 x 3/4 x 3/8 CC Tee	Nelson Company (H.M.)	**		11/20	11/20	Stock	*11/20 L2479	$0.60
13	3	Diaphragms for Valve	Imperial Brass Manufacturing Company (G.F.)	**		11/20	11/29	12/17	*1/30/57 204174	$5.00
14	1	Ball Retainer for Valve	Rockwood Sprinkler Company (G.F.)	**		11/20	11/29	Stock	*12/28 204176	$2.00
15	3	"O" Rings	Detroit Ball Bearing Company (G.E.)	**		11/26	11/23	Stock	*11/27 203210	$3.00
16	50 pc.	"O" Rings	Detroit Ball Bearing Company (C.D.)	**		11/29	11/28	Stock	*1/25/57 203252	$6.00
17	1	Brooks Purge Meter	Smith Instrument and Equipment Co. (G.F.)	**		11/30	11/30	Stock	*12/17 203273	$15.00
18	6	Brass Stock	Copper and Brass Sales (2505A)	**		11/30	11/30	Stock	*11/30 203274	$30.00
19	7	Spring Valves and Diaphragm Valve	Taylor Supply Company (G.E.)	**		11/30	12/10	12/15	*1/22/57 205651	$2.50

*Item received.
**Expendable item Chrysler approval not required.

TABLE II (CONT.)
MATERIAL STATUS REPORT

ORDER NO.	QUANTITY	DESCRIPTION	MANUFACTURER	DATES (1956) REQUISIT. TO CHRYSLER	CHRYSLER APPROVAL RECEIVED	REQUISIT. TO PURCHSING	ORDER TO VENDOR	PROMISED DELIVERY	REMARKS		COSTS
1	2	RCA and AMP Tube	Consolidated Electrodynamics Corporation (G.A.F)	**		12/4	12/14	Stock	*12/26	203278	$4.00
2	1	Ashcroft Compound Gage	Smith Inst. and Equipment Company (W.S.)	**		12/5	12/14	Stock	*1/4/57	205339	$4.48
3	200	Thermocouple Insulators	Barber-Colman - Wheelco Instrument Division (C.H.)	**		12/5	12/21	Stock	*1/14/57	207188	$5.00
4	1	Helicoid Gage Movement	E. J. Becker Company (C.H.)	**		12/5	12/12	Stock	*1/2/57	205304	$3.25
5	1	Repair of McLeod Gage	F. J. Stokes Corporation (G.F.)	**		12/7	12/18	Stock	*12/17	205316	$29.00
6	2 tanks	Argon	Plant Stores (G.E.)	**		12/10	12/10	Stock	*12/12		$60.00
7	25#	Freon-12	J. Geo. Fischer and Sons, Inc. (G.F.)	**		12/11	12/11	Stock	*12/12	205354	$17.50
8	4	Cutting Blades for Hi-Duty Cutter	Copper and Brass Sales, Inc. (R.K.)	**		12/12	1/17/57	Stock	*1/24/57	210638	$4.00
9	7	V-belt for Power Hack Saw, Steel Rules, High-Speed Taps	Sears and Roebuck Company (R.K.)	**		12/12	12/18	Stock	*1/7/57	206889	$14.37
10	2	Hydrogen Cylinders	Plant Department (L.Y.)	**		12/12	12/13	Stock	*12/17		$9.20
11	500 grams	"Octain S"	Consolidated Vacuum Corporation (G.E.)	**		12/12	12/20	Stock	*1/11/57	207223	$20.00
12	1	Simplytrol Pyrometer Controller	Assembly Products Inc. (2505A)	11/30	12/13	12/14	1/21/57	Stock	*2/13/57	211665	$135.00
13	50 troy ounces	Easy Flo #4 Silver Solder	Welding Equipment and Supply Company (C.D.)	**		12/17	12/21	Stock	*1/4/57	207613	$30.50
14	1	Graphite Cylinder	National Carbon Company (D.T.)	**		12/17	12/27	Stock	*1/16/57	207976	$25.00
15	9	Temple Sticks	Welding Equipment and Supply Company (G.E.)	**		12/21	12/31	Stock	*1/21/57	208807	
16	1 1	Cobalt 60 Curie Source Handling Stick 6' long	Picker X-Ray Corporation (M.W.)	**		12/26	1/17/57	1/17/57	*2/26/57	210895	$210.00
17	--	X-ray Film and Chemicals	Picker X-Ray Corporation (M.W.)	**		12/26	1/4/57	1/17/57	*2/8/57	209009	$48.58
18	7	Photographic Trays and Time Clock	Eberbach and Son Company (M.W.)	**		12/27	1/4/57	Stock	*1/14/57	209005	$18.85
19	1# 1#	Silicic Acid, Powder Bismuth Trioxide, Powder	Eberbach and Son Company (M.W.)	**		12/27	1/4/57	Stock	*1/31/57	209006	$9.41

*Item received.
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TABLE II (CONT.)
MATERIAL STATUS REPORT

ORDER NO	QUANTITY	DESCRIPTION	MANUFACTURER		DATES (1957)					REMARKS		COSTS
					REQUISIT. TO CHRYSLER	CHRYSLER APPROVAL RECEIVED	REQUISIT. TO PURCHASING	ORDER TO VENDOR	PROMISED DELIVERY			
1	2	Pipe and Croloy Tubing	Babcock and Wilcox Company	(G.E.)	**		1/2	1/10	Stock	*1/22	207534	$41.66
2	4	Tubes	Fisher Scientific Company	(M.W.)	**		1/2	1/14		*4/29	207550	$20.00
3	1	Portable Winch	Sears, Roebuck and Company	(G.F.)	**		1/4	Canceled				$8.45
4	20	Molybdenum Hacksaw Blades	Chas. A. Strelinger Company	(G.E.)	**		1/7	1/14	Stock	*1/17	210505	$12.20
5	10ea	Vacuum Valves	Vacuum-Electronic Engineering Company	(G.F.)	1/8	1/10	1/10	1/10	1/11	*1/24	209610	$260.50
6	6 ea	Thermocouple Glands with Teflon Sealant, Insulator Sets	Conax Corporation	(C.H.)	**		1/9	1/9	Stock	*1/17	209609	$33.30
7	1 8 sheets	Magnifier Emery Paper Grit	Eberbach and Son Company	(W.S.)	**		1/9	1/9	Stock	*1/9	L2780	$2.30
8	1	RCA Tube	Wedemeyer Electronic Supply Company	(G.F.)	**		1/16	1/16	1/16	*1/16	L2800	$3.00
9	1	Pulley	Air Associates Inc.	(G.F.)	**		1/15	Canceled				
10	9	Assembly, Lens, Bulbs, Fuses	Wedemeyer Electronic Supply Company	(C.H.)	**		1/18	1/18	1/18	*1/18	L2808	$2.39
11	2 doz.	O-Rings	Detroit Ball Bearing Company	(C.D.)	**		1/18	1/24	Stock	*1/31	212343	$6.00
12	1	"Symposium on Metallic Materials for Service at Temperatures above 1600 F" (ASTM Special Technical Publication No. 174)	American Society for Testing Materials	(G.F.)	**		1/22	1/29	Stock	*2/11	212891	$3.50
13	6	Fuses	A.A. Electric Wholesale Supply Company	(R.H.)	**		1/21	1/21	Stock	*1/22	211411	$1.50
14	72	Swagelok Tube Fittings	Crawford Fitting Company	(G.E.)	**		1/22	1/29	Stock	*2/6	212892	$8.10
15	6	Pressure Gages	Smith Instrument Company	(G.E.)	**		1/22	1/30	Stock	*2/8	212893	$12.00
16	---	Hi-Duty Tube Fittings, Poly-Flo Tube Fittings, Brass Pipe Fittings	Taylor Supply Company	(G.E.)	**		1/22	1/30	Stock	*3/27	212903	$47.00
17	---	Steel Spur Gear, Gear Rack, Pillow Blocks, Screw Collars	Boyer-Campbell Company	(G.F.)	**		1/25	Canceled				$4.40
18	[illegible]	Ventilating Blower	W. W. Grainger, Inc.	(C.H.)	**		1/25	2/1	Stock	*2/8	213433	$10.50
19	2.5'	Black Steel Pipe	Federal Pipe and Supply Company	(G.F.)	**		1/25	2/1	Stock	*2/4	211484	$16.75
20	2	Cylinders of Hydrogen Gas	Plant Department	(D.T.)	**		1/25	1/29	Stock	*2/1	253012	$9.20
21	600#	Plumber's Pig Lead	Detroit Lead Smelting & Refining Co.	(R.K.)	**		1/29	2/6	Stock	*2/8	213253	$100.00

*Item received.
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TABLE II (CONT.)
MATERIAL STATUS REPORT

ORDER NO.	QUANITY	DESCRIPTION	MANUFACTURER	DATES (1957)					REMARKS	COSTS
				REQUISIT. TO CHRYSLER	CHRYSLER APPROVAL RECEIVED	REQUISIT. TO PURCH'SING	ORDER TO VENDOR	PROMISED DELIVERY		
22	3 rolls	Electrical Tape	Puritan Electric Company (R.K.)	**		1/30	2/5	Stock	*2/6 211493	$6.00
23	1 jar	Cleaning Fluid for Leroy Pen	Ulrich's Bookstore (R.K.)	**		1/30	1/30	Stock	*1/30 L2900	$.50
24	2	Mechanical Drawing Pencils	Ulrich's Bookstore (R.K.)	**		1/31	1/31	Stock	*1/31 L2893	$3.50
25	3 bags	Cement, Lime, Zonolite	Fingerle Hollister Wood Lumber Company (R.K.)	**		1/31	1/31	Stock	*1/31 213203	$7.00
26	4	Stove Pipe, Elbows	Shaefer Hardware Company (R.K.)	**		1/31	1/31	Stock	*1/31 213202	$6.00

*Item received.
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TABLE II (CONT.)
MATERIAL STATUS REPORT

ORDER NO.	QUANTITY	DESCRIPTION	MANUFACTURER	DATES (1957) REQUISIT. TO CHRYSLER	CHRYSLER APPROVAL RECEIVED	REQUISIT. TO PURCH'SING	ORDER TO VENDOR	PROMISED DELIVERY	REMARKS	COSTS
1	1	Graphite Cylinder	National Carbon Company (D.T.)	**		2/1	2/7	Stock	*2/18 214393	$25.00
2	6	Flashlite Cells	Plant Stores (C.H.)	**		2/4	2/4	Stock	*2/5 253040	$0.60
3	24	Booklet Boards	Ulrich's Bookstore (R.K.)	**		2/4	2/4	Stock	*2/4 L-2950	$3.00
4		Work to be done in Building 8	Plant Department (G.F.)	**		2/6				
5	1	Switch	Wedemeyer Electronic Company (W.S.)	**		2/5	2/5	Stock	*2/5 L-2953	$1.00
6	2	Square D Breaker	Electric Wholesale Supply Company (C.H.)	**		2/11	2/11	Stock	*2/11 213284	$3.00
7	9	Signicos, GC Hardware, Terminals	Wedemeyer Electronic Supply Company (C.H.)	**		2/11	2/11	Stock	*2/11 L-2948	$9.50
8	10'	Nickel Tubing	C. A. Roberts Company (C.H.)	**		2/11	1/31	Stock	*4/1 213214	$10.00
9	2	Veeco Vacuum Valves	Vacuum Electronic Manufacturing Co. (G.F.)	**		2/11	2/11	Stock	*2/13 213292	$62.00
10	100	Hi Temperature Insulating Tubing	McDaniel Refractory Porcelain Company (C.H.)	**		2/12	2/20	Stock	*3/4 216603	$10.00
11	3	Chuck Keys, Grind Wheel	Sears, Roebuck and Company (G.E.)	**		2/13	2/21	Stock	*3/4 216298	$4.02
12	40	Front and Rear Ferrules	Crawford Fitting Company (G.E.)	**		2/13	2/20	Stock	*3/6 216604	$4.00
13	1	Cylinder of Ethane Gas	The Matheson Company, Inc. (D.T.)	**		2/13	2/20	Stock	*3/7 216602	$34.00
14	--	Signicos, Belden Wire	Wedemeyer Electronic Supply Company (C.H.)	**		2/15	2/15	Stock	*2/15 L-2988	$3.68
15	1	Repair of Phillips Guage	Consolidated Electrodynamics Corporation (G.F.)	**		2/15	2/15	Stock	*3/6 215139	$3[illegible].00
16	25#	Freon-12	J. Geo. Fischer and Sons, Inc. (G.F.)	**		2/15	2/12	Stock	*2/13 215114	$10.00
17	1	Bellows for Valve	Robertshaw-Fulton Controls Company (G.F.)	**		2/15	2/13	Stock	*3/11 215123	$30.00
18	1	Brush for Variac	General Radio Company (H.M.)	**		2/15	2/25	Stock	*3/11 217094	$1.00
19	25	Alnico II Magnets	Indiana Steel Products (M.W.)	**		2/18	2/25	Stock	*3/4 217097	$5.65
20	--	Copper Tubing, Copper Elbows	Plant Stores (G.E.)	**		2/19	2/21	Stock	*2/22 253108	$12.00
21	2	Flashlights	Wedemeyer Electronic Supply Company (G.E.)	**		2/19	2/26	Stock	*2/28 217552	$6.50
	10	Batteries								
22	2.5'	Vycor Tubing	Corning Glass Works (H.M.)	**		2/19	2/26	Stock	217553	$12.72

*Item received.
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TABLE II (CONT.)
MATERIAL STATUS REPORT

ORDER NO.	QUANTITY	DESCRIPTION	MANUFACTURER	DATES (1957) REQUISIT. TO CHRYSLER	CHRYSLER APPROVAL RECEIVED	REQUISIT. TO PURCHASING	ORDER TO VENDOR	PROMISED DELIVERY	REMARKS	COSTS
23	8 pcs.	Thoriated Tungsten Rod	Welding Equipment and Supply Company (G.E.)	**		2/19	2/26	Stock	*3/8 217554	$20.00
24	--	Dark Room Equipment	Sears, Roebuck and Company (C.H.)	**		2/20	2/26		*4/1 217546	$34.60
25	9	Sheets of Emery Polishing Paper	Eberbach and Son Company (W.S.)	**		2/25	2/21	Stock	*2/21 L-2995	$1.17
26	3	Amphenol Plug, Amphenol Shills	Wedemeyer Electronic Supply Company (C.H.)	**		3/1	2/20	Stock	*2/20 L-5011	$0.44
27	2	Rings for Ring Joint Flanges	Crane Company (G.E.)	**		2/26	3/5	Stock	*3/25 217369	$8.00

*Item received.
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TABLE II (CONT.)
MATERIAL STATUS REPORT

ORDER NO.	QUANTITY	DESCRIPTION	MANUFACTURER	DATES (1957) REQUISIT. TO CHRYSLER	CHRYSLER APPROVAL RECEIVED	REQUISIT. TO PURCH'SING	ORDER TO VENDOR	PROMISED DELIVERY	REMARKS		COSTS
1	1	Kodak Tray Siphon	Purchase Camera, University of Michigan (C.H.)	**		3/4	3/11			219477	$5.00
2	10'	Stainless Steel Tubing	C. A. Roberts Company (C.H.)	**		3/4	3/11	Stock	*3/26	219479	$5.00
3	2	Cylinder of Propane Gas and Connection	The Matheson Company, Inc. (D.T.)	**		3/4	3/11	Stock	*3/18	219497	$36.00
4	3	Purge Meters and Flowmizer Meter	Process Controls Company (H.M.)	**		3/4	3/11	Stock	*4/9	219498	$52.00
5	50# --	Wiping Rags Drills, Screws, Nuts, Acid Core Solder	Royall Inc. (C.D.)	**		3/6	3/13	Stock	*3/25	220085	$17.76
6	1	Remote Foot Control for Welder	Liquid Carbonic Company (C.D.)	**		3/6	3/13	Stock	*4/1	220082	$72.00
7	12	Shop Aprons	Sears, Roebuck and Company (C.D.)	**		3/6	3/13	Stock	*3/22	220093	$14.00
8	1	Air Vent Blower	W. W. Grainger, Inc. (C.H.)	**		3/6	3/12	Stock	*3/20	220081	$10.00
9	4	Cylinders of Argon, Oxygen, Acetylene	Plant Stores (C.D.)	**		3/6	3/9	Stock	*3/11		$65.00
10	6	Pipes, Flanges, Caps	Taylor Supply Company (D.T.)	**		3/7	3/13	Stock	*4/12	220074	$45.28
11	4	Pipe, Caps, Coupling	Service Steel Division (D.T.)	**		3/7	3/13	Stock	*3/27	220075	$14.00
12	1 gal.	Thermon	J. E. Leslie Company (C.H.)	**		3/7	3/13	Stock	*3/25	220076	$8.50
13	1	Poppet Type Pressure Relief Valve	Nelson Company (D.T.)	**		3/7	3/13	Stock	*4/3	220077	$2.50
14	--	Paint, Roller, Tray, and Elastic Glazing Compound	Sherwin-Williams Company (R.K.)	**		3/12	3/11	Stock	*3/11	219520	$7.30
15	8	Globe Valves, Check Valves, Tube Fittings	Taylor Supply Company (D.T.)	**		3/8	3/19	4/19	*4/12	221204	$30.25
16	10	Gallons of Lubricating Oil	General Stores (D.T.)	**		3/8	3/12	Stock	*3/15	253195	$12.00
17	--	Chain, Repair Links	F. P. Miller Company (R.K.)	**		3/8	3/11	Stock	*3/13	217383	$10.00
18	1	Cylinder of Helium	General Stores (G.E.)	**		3/12					$17.00
19	1	Roll Film Developing Tank	Central Camera Company (C.H.)	**		3/13	3/20	Stock	*4/1	221459	$10.00
20	3 pts.	Paint, Waterlox	The Mackraft Shops (G.F.)	**		3/15	3/14	Stock	*3/14	219549	$2.85
21	2	Storage Battery Hydrometer	Eberbach and Sons (C.H.)	**		3/13	3/18	Stock	*3/25	L-5143	$2.00
22	20 pr.	Lens	Liquid Carbonic Corporation (R.K.)	**		3/18	3/25	Stock	*4/5	222227	$14.60

*Item received.
**Expendable item, Chrysler approval not required.

TABLE II (CONT.)
MATERIAL STATUS REPORT

ORDER NO.	QUANTITY	DESCRIPTION	MANUFACTURER	DATES (1957) REQUISIT. TO CHRYSLER	CHRYSLER APPROVAL RECEIVED	REQUISIT. TO PURCHSING	ORDER TO VENDOR	PROMISED DELIVERY	REMARKS	COSTS
23	6	Teflon Sealants	Conax Corporation (C.D.)	**		3/20	3/27	Stock	*4/9 222585	$6.00
24	1	Aro Wrench	Aro Equipment Corporation (C.H.)	3/18	3/19	3/19	3/25	Stock	*3/27 219587	$180.00
25	2	Valve and Diaphragm	F. C. Teal Electric Company (C.H.)	3/18	3/19	3/19	3/21	Stock	*4/8 219589	$17.50
26	--	Wire Solder, Soldering Paste, Mill Files	Sears, Roebuck and Company (C.D.)	**		3/20	3/29	Stock	*4/5 223054	$2.49
27	6	Left Hand Hose Nuts	Liquid Carbonic Corporation (C.D.)	**		3/20	3/27	Stock	*3/29 222586	$1.00
28	2	Stationary Contacts Movable Contact	Don Blackburn Company (C.H.)	**		3/20	3/20	Stock	*3/25 219593	$2.00
29	1	Seamless Welding Pipe Cap	Taylor Supply Company (H.M.)	**		3/21	3/27	Stock	*4/1 222506	$3.70
30	1	Craftsman Ratchet Wrench	Sears, Roebuck and Company (C.D.)	**		3/22	3/29	Stock	*4/17 223032	$4.75
31	--	Parts for Ball Valve	Rockwood Sprinkler Company (C.D.)	**		3/22	3/29	Stock	*4/24 223031	$10.00
32	1	Push Valve	King Engineering Company (C.H.)	**		3/22	4/3	Stock	*4/9 223543	$6.00
33	4	Pressure Gages	Royall Inc. (C.H.)	**		3/25	3/29	Stock	*4/15 223051	$10.00
34	8'	Graphitite "G" Rods	Graphite Specialties Company (G.E.)	**		3/29	3/28	Stock	*4/5 221746	$20.00
35	5	Cylinders of Helium	Air Reduction Company (L.C.)	**		3/29	3/26	4/26	221730	$100.00
36	3	Interval Timer, Print Tongs	Purchase Camera Shop (L.Y.)	**		4/5	3/29	Stock	*3/29 221756	$9.77

*Item received.
**Expendable item, Chrysler approval not required.