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Manual for Electrical Operation of the Remote Mechanical Line, Building 234-5.

TO
C. B. Wagner

FROM
A. L. Vosmer

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G-88-D9 A.E.C. - G.E. RICHLAND, WASH

DON'T SAY IT --- *Write It !*

DATE February 5, 1957

TO Classified Files
Manual Control
3760 Bldg., 300 Area

FROM A. L. Vosmer
760 Building
700 Area

HW-21142 - MANUAL FOR ELECTRICAL OPERATION OF THE REMOTE MECHANICAL LINE

This confirms permission to destroy all extra copies of the subject manual. This manual was written for maintenance purposes in 1951 and is no doubt obsolete at this time. It is suggested you contact Mr. C. C. Hinson (Bldg. 2704-Z) to determine if it can be declassified.

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Richland, Washington
May 18, 1951

Mr. C. B. Wagner
Area Engineer
Electrical Division

MANUAL FOR ELECTRICAL OPERATION OF THE REMOTE MECHANICAL LINE, BUILDING 23[redacted]5

This document was prepared by the Electrical Division to aid in the interpretation of the Elementary Wiring Diagrams and to provide a manual for operating trouble that may develop in the circuits of the R.M.L. of Building 23[redacted]5.

It is not claimed that this document is 100 percent accurate or complete, or that it is in final form. The right is reserved to reissue the manual when the number of corrections and/or changes warrant.

A. L. Vosmer
Assistant Area Engineer
Electrical Division

ALV:ed

ELECTRICAL DIVISION INSTRUCTION 234-5 AREA
POWER SUPPLY SYSTEM FOR THE R.M. LINE (Dwg. H-2-12955)

GENERAL

The R.M. Line of 234-5 Building is fed from two sources of power of 440 volts and one source of power of 125 volt D.C. (All From 252-ZI Sub.). The work involved in the R.M. Line requires that the shutdowns while in operation be kept at a minimum. Due to this fact, the power system has been designed so that the 440 volt Emergency power supplies most of the equipment that is undesirable to have shut down while in operation.

NORMAL 440 VOLT SUPPLY TO R.M. LINE

This supply is fed from Bus #3, 252-ZI sub. through a 200 amp breaker, F6K302 to Task II Cubicle #29 thru a 100 amp. fused disconnect, to Task IV Cubicle #20 thru a 100 amp. fused disconnect, and to Task VI Cubicle #13 and Task VII Cubicle #10, thru a 100 amp. non-fused disconnect. All disconnects are located at duct level.

125 Volt D.C. Supply

This supply is fed from a 30 amp. breaker #12 on D.C. Panel P.B. 252-ZI sub.

It feeds Cubicle #2 Task I, Cubicle #4 Task II, Cubicle #6 Task III, Cubicle #20 Task IV and Cubicle #11 Task V.

EMERGENCY 440 VOLT SUPPLY TO R.M. LINE

This supply is fed from the Emergency Bus thru a 400 amp. breaker F6K404, and is run from the 252-ZI Sub. in two separate 3" conduits with 3-#4/0 wires in each conduit. These conduits run to col. 12 at "B" wall to a pull box and from the pull box to the distribution switchgear. This switchgear has 7 breakers in it. 1-15 amp, 4-70 amp, 1-90 amp. and 1-100 amp.

Listed here are these breakers and what they feed.

No.	Capacity	Switchgear "EE" Load
1A	70 amps.	3-15 KVA - 440/220 volt, 3 phase transformer
1B	70 amps.	3-15 KVA - 440/110 volt, 3 phase transformer
1C	90 amps	Spare
2A	100 amps.	Task III - Cubicle #16
2B	70 amps	Spare
2C	15 amps	Task V. - Cubicle #11
2D	70 amps.	Spare

220 VOLTS - 3 PHASE SUPPLY

This supply, as previously stated, is fed from 70 amp. breaker 1A thru the 440/220 volt transformer to the 220 volt, 3 phase, no neutral panel. This panel has 8 breakers in it. Reading from left to right (as shown on drawing #H-2-12955) these breakers, and what they feed, are listed here.

Breaker No.	Capacity	Load Rack No.	Outlets No.
1	15 Amps.	I	2
2	25 Amps.	II	4
3	15 Amps.	III	6
4	35 Amps.	IV	20
5	35 Amps.	V	22
6	25 Amps.	VI	11
7	70 Amps.	VII & VIII	45
8	15 Amps.		

110 VOLT - 3 PHASE SUPPLY

This supply is fed from 70 amp breaker #4 from the 440 volt emergency switchgear thru a 3 phase 440/110 volt transformer to the 110 volt 3 phase no neutral panel.

This panel has 8 breakers in it. Reading from left to right (as shown on drawing N-2-12955) these breakers and what they feed are listed below.

Breaker No.	Capacity	Panel "EC"	Rack Rack No.	Load Outlets No.
1	70 Amps		I	2
2	25 Amps		II	4
3	35 Amps		III	6
4	100 Amps		IV	20
5	25 Amps		V	11
	35 Amps	V	VI	13
	70 Amps		VII & VIII	10
	25 Amps		XII	18

CAUTION:

The following main voltages are ungrounded:

440V	3ø
220V	3ø
110V	3ø
110V	1ø
125V	D.C.

When testing for voltage indication, the test should be made from line to line rather than from line to ground.

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HW-21142

Richland, Washington
September 27, 1950

Electrical Division
Tech. I Training
9-20-50

<u>ELECTRICAL CONTROL OF EQUIPMENT IN HOOD #2</u>
<u>REFERENCE ELEMENTARY DIAGRAM H-2-12576</u>

<u>Control Desk Power</u>

Part of the equipment in Hood #2 can be controlled from either Desk 2 in Zone II or Desk 31 in Zone III. To control from Desk 2, push Power Selector Switch 47 S to energize Relay 42-K (C-14), which seals in. To control from Desk 31 push Power Selector Switch 48-S to energize Relay 43 K (C-14), which seals in. The circuits are interlocked so that both relays can not be energized at the same time. Lights on each Desk indicate which desk is controlling.

<u>Operation of Equipment</u>

All the equipment in Hood 2 is actuated by air cylinders which in turn are controlled through solenoid valves. The following table lists the valve numbers, switch number and location. Interlocks are explained in notes.

<u>Explanation of Notation</u>

42 K (C-14) - Relay 42 K is located in Cubicle No. 14
D-2 - Control Desk No. 2
"CW" - Clockwise rotation
"CCW" - Counter-clockwise rotation
L/S - Limit Switch
NC - Normally closed contacts
NO - Normally open contacts

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Electrical Division
Task I Training
9-20-50

	Action	Pressure	Valve Exhaust	Control Switch	Location	Interlock Note
Raise Turntable -	Zone II Operator	178V		5kS	D2	1,3,4
" "	Zone III "	173V		55S	D51	2,3,4
Lower Turntable -	Zone II Operator	179V		5kS	D2	1,3,4,5,6
" "	Zone III "	179V		55S	D51	2,3,4,5,6
Raise Temple Cam Leading Rod:		180V	181V	57S	D51	2,7
Lower " " " "		187V	182V	58S	D51	2,7
Rotate Turntable, 20	Zone III Op.	184V		65S	D51	2,8,9
" " "	" II "	184V		65S	D2	1,8,9
" " 40	" III "	184V		6kS	D51	2,8,9
" " 40	" II "	184V		67S	D2	1,8,9
" " 60	" II "	184V		66S	D2	1,8,9
" " 120	" II "	184V		61S	D2	1,8,9
Rotate Turntable Piston Return		185V				
Agitator #1 Rotation		186V		69S	D2	10
" 2 "		187V		69S	D2	10
" 3 "		188V		70S	D2	10
Wrench #1 Rotation "CW"		189V		76S	D2	11
" " "CW"		190V		71S	D2	11,12
Wrench #2 Rotation "CW"		191V		74S	D2	11
" " "CCW"		192V		73S	D2	11,12
Wrench #3 Rotation "CW"		193V		76S	D2	11
" " "CCW"		194V		75S	D2	11,12
Raise Cam		195V	196V	78S	D2	13,14
Lower Cam		196V	197V	79S	D2	13,14

INTERLOCK NOTES

1. Power Selector Switch 47S (D-2) should have been pushed previous to this operation to place control on Deck 2.

2. Power Selector Switch 48S (D-31) should have been pushed previous to this operation to place control on Deck 31.

3. Turntable elevation controls can not operate if table is turning. Normally closed contacts on 45 K, 46 K, 47 K and 48 K (all in C-14) are in series to prevent it. Also, Switch 55S 5 on Balance Deck 3 is in the series circuit to prevent elevating the turntable while weighing.

4. The valves for raising and lowering are controlled by Relays 28 K and 29 K (C-15) respectively. Each control relay is interlocked with the other to prevent simultaneous operation.

5. Through N. O. Contacts on 28 K (C-15), 13 K, 14 K, 15 K, 16 K, 17 K, and 18 K (C-14), the table can not be lowered between the operations of (1) Transferring solution from the Sample Cans to any reactor and (2) Transferring of the Sample Can's wash to Recovery (the latter being a dummy operation).

6. Through L/S 53S, the table can not be lowered except when the can is in the "Wrench Down" position.

7. Switch 55 S (D-31) turntable elevation must be turned to the "up" position before Sample Can Loading Hook can be operated.

8. The turntable rotation is accomplished through an air cylinder which on the out stroke indexs the table 20 degrees. The return stroke of the cylinder repositions the pusher for the next indexing. In units of 20 degrees up to 120 degrees rotation can be obtained by successive operations of the air cylinder. When one of the control buttons is pushed, a motor operated switch starts up and seals in. The contact sequence of the switch is arranged to successively energize valves 134V for indexing stroke and 135V for the return stroke; also, the contact sequence is arranged to stop and reset the motor operated switch depending on which degree of rotation was selected. Control relay series interlocks prevent starting a cycle of rotation while another is still operating.

9. Through L/S 56 S and Control Relay 44 K (C-14) the table cannot be rotated unless it is in the down position. Also, through a N.C. Contact of 58 K (C-2) the table can not be rotated unless the crane in Head #3 is in the center position.

10. Through L/S 67 S, the can must be in the "Agitator Down" position before the agitator air motor valves can be energized.

11. The "CW" and "CCW" circuits of the wrench air motor solenoid valve controls are serieded through cam positioning so both solenoid valves can not be energized simultaneously.

12. Through L/S 77 S and Control Relay 30 K, it is necessary, in order to operate #2 Wrench in the counter-clockwise direction, that the table be in

the "up" position and that the wrench had been rotated in the clockwise direction just previous. Similarly, Control Relays 51 K and 52 K are interlocked with #2 Wrench and #3 Wrench.

13. The action of the cam is as follows: Starting from a normal position with the wrenches down covering the opening, the cam is raised. As the cam is raised, the wrenches are rotated away from the opening and the agitators are rotated over the opening. Next, the cam is lowered, and the agitators are lowered into the sample cans. The next up stroke raises the agitators to a drain point, automatically stopping at this point. The cam is then raised to the upper limit. On the next down stroke of the cam the agitators and wrenches are rotated to the original position and lowered to the normal position.

14. Through L/S 77 S, it is necessary that the turntable be in the up position. The solenoid valves 195V and 196V are energized through Relay 50 K (C-15). Relay 50 K becomes energized through N.C. Contacts on 51 K and 52 K (both in C-15) and a closed contact on L/S 79 S; also, Relay 50 K seals in around the control switch. At the cam upper limit, L/S 82 S closes to energize 52 K (C-15) which in turn breaks the circuit to 50 K and sets up a circuit for Relay 51 K (C-15). Through L/S 81 S which is closed above, the dead center point, 51 K becomes energized and seals in when the pushbutton 80 S (D-2) is closed to lower the cam. After the cam is down, the circuit for 50 K is set up again because L/S 81 S and 82 S have opened and released Relays 51 K and 52 K respectively. To raise the cam again (agitators down at this time) the Relay 50 K is again energized as above. When the cam raises to the drain point, L/S 79 S opens one contact to de-energize 50 K and closes one contact to energize Relay 49 K (C-15), which seals in. The purpose of the 49 K Relay is to provide a circuit around the now opened contact of 79 S so that Relay 50 K can be energized when the Control Switch 78 S (D-2) is pushed to raise the cam from the drain point.

ELECTRICAL DIVISION

AJV:end

ELECTRICAL DIVISION [illegible]
ELECTRICAL CONTROLS FOR TASK I CRANE HOOD OPERATION
Reference, Elementary Diagram #E-2-13578, Sheets 7&20 & 22

GENERAL

The purpose of this crane is to remove the sample cans from the turntable in Hood #2 and take them to Hood #3 for survey and to dispose of them thru disposal port if they are found to be contaminated.

This crane has a gear shifting device on it that is operated by Solenoid valves which enables the crane to move horizontal or vertical as the operation requires. Valve #199V operates the horizontal shift and valve 200V operated the vertical shift. The crane can not be operated vertically and horizontally at the same time.

Turntable rotation interlocks 45K, 46K, 47K and 48K will prevent any crane movement unless those relays are de-energized. Also, overload relay 56K contact must be closed to move the crane.

There are two control switches on Desk 31 used to operate this crane. Switch 84S is for the purpose of moving the crane horizontally to left or right and 85S is for the vertical operation up or down.

All the limit switches for this crane are shown in the non-actuated position on the Elementary.

Listed below are these switches and when and how they are actuated.

(A) Crane upper limit switch #83S actuated when crane is in extreme up position
(B) Crane left limit switch #86S actuated when crane is in extreme left position.
(C) Crane center limit switch #87S actuated when crane is in the up position and in the center of Hood #3.
(D) Crane right limit switch 88S actuated when crane is in the extreme right position.
(E) Crane lower limit switch #90S actuated when crane is in extreme lower position.
(F) Hood #2 door switch #91S actuated when door is closed.

To operate the crane horizontally, the crane must be in the up position, this actuates L.S. 83S. By turning the switch 84S to the right or left a circuit is completed thru 83S, 84S1 and 2 and 85S5, energizing solenoid valve 199V which shifts crane mechanism to horizontal operation.

To operate the crane vertically, the crane has to be either in the center or at the extreme right end as the center L.S 87S or right L.S. 88S have to be actuated in order to complete a circuit thru one of them and 85S5 84S3, to operate Solenoid valve 200V to shift the gear to vertical operation.

(1) OPERATION OF CRANE TO THE RIGHT FROM EXTREME LEFT

Crane is in the up position which actuates 83S. This de-energizes 59K. A circuit is set up energizing 57K thru a N.C. contact on 59K, and 88S and 85S2 is in the off position. 58K is energized by a contact on L.S. 87S. Now by turning 84S to the right position a circuit is set up thru contacts on 83S, 84S7, 57K and 58K energizing coil 53K1 which moves the crane to the right until it actuates center L.S. 87S, which drops out 58K stopping crane. Before the crane can be moved any further to the right the turntable must be in the down position which actuates 56S (limit sw. on turntable) which energizes 44S and the Hood #2 door must be opened to de-actuate L.S. 91S. A circuit can then be completed thru contacts on 83S, 84S7, 57K, 44K, and 91S to coil 53K1 which will drive crane to the right where it actuates L.S. 88S dropping out 57K to stop the crane.

(2) LOWERING CRANE HOOK TO PICK UP SAMPLE CAN IN HOOD #2

By turning the control switch 85S to the lower position, Solenoid valve 20 V is energized as previously explained, shifting mechanism to vertical operation; also, a circuit is set up thru L.S. 88S, 85S7 and lower L.S. 90S energizing 53K1, allowing crane to lower until lower limit switch 90S is actuated stopping crane.

(3) RAISING CRANE HOOK TO PICK UP SAMPLE CAN IN HOOD #2

When crane was lowered in #2 operation limit switch 83S was de-actuated, closing contact on 83S in 59K coil circuit causing 59K to energize. By turning 85S to the raise position a circuit is completed thru 88S, 85S9, and a contact on 59K, energizing 53K2 which raises crane until upper limit switch 83S is actuated which stops the crane in the up position by de-energizing 59K.

(4) OPERATING THE CRANE TO THE LEFT FROM EXTREME RIGHT POSITION

At the completion of operation #2 upper limit switch 83S is actuated. By turning switch 84S to the left position Solenoid valve 19V is energized as explained previously, causing mechanism to shift to horizontal operation. Also, a circuit is completed thru contacts on 83S, 84S8 and left limit switch 86S energizing 53K2, which moves crane to the left until switch 84S is released or until left limit switch 86S is actuated which de-energized 53K2.

MISCELLANEOUS OPERATION

If it is desirable to lower crane when stopped at center position by limit switch 87S, 85S is turned to the lower position, this will shift the gear mechanism to vertical operation as previously explained.

The lowering process is begun thru 87S, 85S7 and lower limit switch 90S, energizing 53K1, allowing crane to start to lower. Relay 55K is energized at this same time thru 85S6 and 84S4 and sealing in thru 55K contact.

As the crane lowers 87S de-actuates and opens the original circuit but the circuit is still completed thru 55K, 85S7 and L.S. 90S and at this point 55K seals in again thru 57K, 58K and 55K for an independent seal-in circuit exclusive of the control switch 85S. The crane can then be lowered until lower limit switch 90S actuates, which stops the crane.

To raise the crane at this point, switch 85S is turned to raise and a circuit is completed thru 55K contact, 85S9 and 59K contact to energize coil 53K2 causing crane to raise until upper limit switch 83S is actuated, this de-energizes 59K dropping out 53K2 stopping crane.

Electrical Division
Task #1 Training

ELECTRICAL CONTROLS FOR UNT TRANSFER OPERATION
REFERENCE ELEMENTARY DIAGRAM H-2-12978

1. (a) The sequence switch in this operation is set up to index 9 times and then reset to its original position. By adjustments, this switch can be set to index up to 24 times.

(b) The purpose of this switch is to establish a sequence of operations to prevent mixing of two separate batches.

2. (a) The solenoid valves involved in this operation, control air to operate saran valves that are actually in the transfer lines. The solenoid valves are numbered 200 higher than the saran valve they operate. (Example) Saran valve 20 is operated by solenoid valve 210.

(b) Valves that are marked with an asterisk (*), are operated thru a switch in the "Automatic" position.

(c) Valves marked "U" are pressure regulated valves. The pressure to these valves is controlled by motors, which are operated by reversing switches and controllers. Listed here are the valves, switches, desks the switches are on, and the motor number.

Flow Regulated

Valves	Switches	Desk #	Motor #
208 U	29 S	D-4	17 D
228 U	35 S	D-4	18 D
248 U	41 S	D-5	19 D
268 U	101 S	D-5	20 D
278 U	20 S	D-2	15 D
288 U	107 S	D-6	21 D
298 U	23 S	D-2	14 D
308 U	120 S	D-6	22 D
318 U	26 S	D-2	16 D
345 U	32 S	D-4	23 D
346 U	38 S	D-4	24 D
347 U	44 S	D-5	25 D
348 U	104 S	D-5	26 D
349 U	110 S	D-6	27 D
350 U	123 S	D-6	28 D

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HW 21142
-11-

Electrical Division
Task I Training

WET TRANSFER OPERATION
USING [illegible] REACTOR

OPERATION (1)

Measuring H_2O into 3A Measuring Vessel

(a) Line valve 23.8 is energized when 258 S is pushed.
(b) Vent valve 260 is energized when 258 is pushed if 260 S is in automatic position.

OPERATION (2)

Solution Transfer from 3A Measuring Vessel to 30 Cutting Station

(a) Line valve 318 is energized by contact on 318-K (C2), which is energized by pushing 318-S
(b) Vacuum valve 319 is energized thru a contact on 319-K (C2), which is energized by 318-K (C2) when 319-S is in automatic position.
(c) Vacuum valve 216 is energized by 319-K (C2) if 216-S is in automatic position.
(c) Vent valve 260 is energized by 318-K (c2) when 260-S is in automatic position.

OPERATION (3)

To Transfer from 30 Cutting Station to 3E Sample

(a) 353-S1 push button is closed energizing 353-K1 (C2), Contactor relay.
(b) 353 line valve is energized thru contact on 353-K1 relay. (C2)
(c) 355 vacuum valve is energized thru contact on 353-K1, providing 355-S is in automatic position.
(d) 216 vacuum valve is energized thru contact on 353-K1 (C2), providing 216-S is in automatic position.
(e) 320 vent valve is energized thru contact on 353-K1 (C2), providing 320-S is in automatic position.

OPERATION (4)

To Transfer Solution from 3E Sample to 3D Cutting Station

(a) 353-S2 push button is closed energizing 353-K2 (C2) contactor.
(b) 353 line valve is energized thru contact on 353-K2 relay (C2).
(c) 319 vacuum valve is energized when 319-S is in automatic position, allowing 319K (C2) to be energized thru contact on 353-K2 (C2), which in turn allows 319 vacuum valve to energize thru contact on 319K (C2).
(d) 216 vacuum valve is energized when 216-S is in auto. position, thru contact on 319K. (C2)
(e) 354 vent valve is energized when 354-S is in auto. position thru contact on 353-K2 relay. (C2).

OPERATION (5) - Same as (3)   OPERATION (6) - Same as (4)

OPERATION (7) - Same as (3)   OPERATION (8) - Same as (4)

[redacted]

OPERATION (9) Sequence Switch in #3 position

Solution Transfer from 3D cutting Station to ID Reactor

(a) By pushing 202-S, a circuit is completed thru 11H SI and N.C. contact on 14K (C14) energizing 202-K (C2). A contact on 202-K closes energizing 202 line valve.

13-K (C14) is energized by 202-K contact thru N.C. contact on 344-K (C2). A N.C. contact on 13K opens, locking out 222K to prevent any transfer being made between 3D cutting station and ID reactor. A contact on 13K closes in 28K (C15) circuit to keep table in hood #2 in up position.

(b) Vacuum valve 203 will be energized thru contact on 202K if 203-S is in auto. position and interlocking relays 279K (C2), 299K (C2), 319K (C2), 351K1, 352K1, and 353K1 (C2) are de-energized. These relays prevent this operation of any solution in being transferred between any cutting station D or sample "E", or vice versa.

(c) Vacuum valve 216 is energized thru contact on 202K, if 216S is in auto. position.

(d) Vent valve 320 is energized by 202K when 320S is in auto. position.

OPERATION (10)

Add H.I. to IR Hold-Up Tank

(a) Electrical interlocks prevent this operation if H.I in hold-up tanks is being transferred to IR reactor, or if any transfer is being made between "E" sample or "D" cutting station or vice versa.

(b) Line valve 209 is operated thru N.C. contact 345K (C14), when 209S is pushed.

(c) Vacuum valve 254 is operated by sv. 205S when 254S is in the auto. position, providing relays 351K1, 352K1 and 353K1 are de-energized.

(d) Vacuum valve 274 is operated by 206S when 274S is in auto. position.

OPERATION (11)

Transfer HI in IR hold up tank to ID Reactor

(a) Electrical interlocks in this circuit prevent this operation if any transfer is being made between any of the cutting stations "D", the sample "E" and the reactor "I"

(b) Line valve 345 is operated thru a contact on 345K (C14) relay, which is energized by pushing switch 345-S

(c) Vacuum valve 203 is operated thru a contact on 345K, when 203S is in the auto. position and relays 279K, 319K, 351K1, 352K1 and 353K1 are de-energized.

(d) Vacuum valve 216 is operated thru a contact on 345K, if 216S is in auto. position.

OPERATION (11) cont'd.

(e) Vent valve 234 is operated thru 345 (C14) relay contact, if 234-S is in autometicoposition.

OPERATION (12) Sequence Switch Changes to #2 Position

Measuring MEO-3 into 3A Measuring vessel

(a) Line valve 259 is energized thru contact on 259 (C2), after 259K is energized by pushing sw 259.

(b) Vent valve 260 is energized by 259K if 260S is in the auto. position.

(c) 114S coil is energized thru 259K in series with contacts on 73K and 13K, which were set up in operation #9. This causes 114S to index to position #2.

OPERATION (13) Same as Operation #2

OPERATION (14) Sequence sw. changes to #3 position. Same as operation #9 except sequence sw. being in #2 position allows 75K (C15) to energize. 114S is then energized thru contacts on 73K, 13K (C15), 75K (C14), and 202K (C2), indexing to #3 position.

OPERATION (15)

Same operation as #12 except Sequence sw. will not index now, due to position #3 on sw. opening 114S5 in series with 259K (C2) contact to 114S coil.

OPERATION (16) Same as #2 Operation

OPERATION (17)

Same as operation #9 and 14 except that 75K contact is now open in series with 202K contact to 114S coil and will not allow 114S to index.

** OPERATION (18) Dummy Operation to Index sw. to #4 Position

By pushing button 344S, 344K (C2) is energized. 344K contacts (2) in series with 114S5, 73K and N.C. contact on 75K indexes 114S to #4 position. 344K N.C. contact opens 13K coil circuit, which will allow a transfer to be made from 3D cutting station to 2F reactor.

OPERATION (19)

Oxalate to 4A Measuring vessel

(a) Line valve 210 is energized by pushing sw. 210.
(b) Vent valve 214 is operated by 210S if 214S is in the auto. position.

OPERATION (20)

Solution Transfer From 4A Measuring Vessel to 1E Reactor

(a) Line valve 208 is energizing by closing 208S.
(b) Vacuum valve 203 is energized by 208S if 203S is in auto position, and if 279K (C2), 299K (C2), 319K, 351K1, 352K1, 353K1 relays are de-energized. These relays prevent this operation if any solution is being transferred between any cutting station "D" or sample "E" or vice versa.

OPERATION (20) Cont'd

(c) Vacuum valve 216 is energized by 205S if 216 S is in Auto. position.
(d) Vent valve 214 is energized by 205S if 214S is in auto. position.

OPERATION (21)

Transfer solution from 1B Reactor to F-Supernate measure

(a) Line valve 205 is energized by contact on 205K (C14), which is energized by pushing 205S if relays 305K, 405K, 605K, 245K, and 225K are de-energized. These relays prevent this operation if solution is being transferred from any of the other 5 reactors to F-supernate measure.

(b) Vacuum valve 337 is operated by contact on 337K (C14) after 337K is energized thru 205K, if 337S is in auto. position.

(c) Vacuum valve 316 is energized thru contact on 337K if 316S is in auto position.

(d) Vent valve 204 is energized by contact on 205K if 204S is in auto position.

OPERATION (22)

Transfer Solution Acid Wash to 4A Measuring Vessel

(a) Line valve 211 is operated by pushing 211S.
(b) Vent valve 214 is operated by 211S if 214S is in the auto position.

OPERATION (23) Same as Operation 20
OPERATION (24) Same as Operation 21
OPERATION (25) Same as Operation 22
OPERATION (26) Same as Operation 20
OPERATION (27) Same as Operation 21
OPERATION (28)

TRANSFER SOLUTION H_2O to 4A Measuring Vessel

(a) Line valve 213 is energized by pushing 213S.
(b) Vent valve 214 is energized by 213S if 214S is in the auto. position.

OPERATION (29) Same as Operation 20

OPERATION (30) Same as Operation 21

OPERATION (31) Sw. 114S indexes to #5 position

Solution Transfer from 1B reactor to F-Slurryheader

(a) Line valve 206 is energized thru 206K (C14) contact after 206K is energized by pushing button 206S in series, with contacts on 75, 22K, 23K, 24K, 26K, and 114S7. 114S7 was closed in position 4 of sequence switch. 75 is 1B agitator motor cr. and agitator motor has to be running to accomplish this operation.

Relays 22K, 23K, 24K, and 26K are interlock relays to block a transfer of solution from 1B reactor to the "F"-Slurry header, if another batch has been transferredfrom some other reactor to the slurry header and its sequence cycle has not been completed.

OPERATION (31) con't

(b) Vacuum valve 296 is energized by 307K contact if 296S is in the auto. position.

(c) Vacuum valve 327 is energized by 206K if 327S is in the auto. position.

(d) Vent valve 304 is energized by 306K contact if 304S is in the auto. position.

(e) When 206K is energized, a contact on this relay closes in 11KS coil circuit thru 73K contact causing 11KS to index to #5 position. This index de-energized 73K relay.

OPERATION (32)a)Index Sw. still in #5 position

"I" Slurry header to "J" Boat Station (start)

(a) Line valve 326 is operated when Slurry header agitator motor switch 1382 is in "on" position and when 326S is in start position. This also energized 326K.

(b) Vacuum valve 276 is energized thru contact on 326K and N.C. contact on 327K if 276S is in auto. position. If 327K is energized, this operation can not be accomplished as a transfer is then being made from "J" boat station to "G" Supernate header.

(c) Vacuum valve 356 is energized thru contact on 326K and N.C contact on 327K, if 356 S11s in auto. position.

(d) Vent valve 324 is energized thru contact on 326K in series with N.C. contact on 10K if 324S is in auto. position.

OPERATION (32)(b)

I- Slurry Header to "J" Boat Station (Fill)

(a) 326S in "Fill" position is in series with 1382 (Slurry header agitator motor sw.) energises 326K, 326 line valve, 327K and 327 vent valve, if 327S is in auto position. Vent valve 324 is operated thru contact on 326K and N.C. contact on 10K, providing 324S is in auto. position.

OPERATION (33)

"J" Boat Station to "G" Supernate Header

(a) Line valve 330 and 330K relay are energized by turning 330S to the "on" position

(b) Vacuum valve 333 is energized thru a contact on 333K, which is energized by 330S when 333S is in auto. position.

(c) Vacuum valve 316 is energized by contact on 333K if 316S is in auto. position.

(d) Vent valve 327 is energized by contact on 333K when 327S is in auto. position.

OPERATION (35) Sw. 11#S indexes to #5 position

(a) This operation the same as #31 except index sw. is moved to #6 position thru N.C. contacts 21K, 73K and 74K, and also thru closed N.O. contact on 327K to 11#S operating coil. When 11#S moves to #6 position 11#S closes energizing 74K relay.

OPERATION (36) Same as Operation 32

OPERATION (37) Sw. 11#S indexes to #7 position

(a) Same as operation #33 except 11#S coil is energized thru N.C. contact on 73K and closed N.O. contacts on 74K and 327K indexing 11#S to #7 position. This drops out relay 74K.

OPERATION (38) Same as Operation #34

OPERATION (39) Sw 11#S indexes to #8 position

(a) Same as operation #35 except indexes 11#S to #8 position.

OPERATION (40) Same as operation #32

OPERATION (41) Sw. 11#S indexes to #9 position which causes 11#S to reset to #1 position.

(a) Same as operation #37 except when 11#S indexes to #9 position, it closes 11#S8K causing 67K to energize thru this contact and 11#S8I. When 67K relay is energized, it energizes 11#S reset coil thru 67K contact causing 11#S to reset to #1 position.

OPERATION (42) Same as Operation #34

OPERATION (43) Same as Operation #21

OPERATION (44) "F" Supernate to "H" Recovery

(a) Line control valve 339 is energized by sw. 339S if 339S is in the auto. position. Line control valve 339 is energized by pushing sw. 339S

(b) Vent valve 336 is energized by 339S if 336S is in the auto. position.

(c) A vacuum will have to be applied to the recovery cross tank by the operator in order to make this transfer.

OPERATION (K)

"J" Heat Station to "I" Slurry Feeder

(a) It may be desirable to make this transfer sometimes, and when it is made, 325K contact in series with N.C. contacts 75K, 21K, and 74K to operating coil 11#S will cause 11#S to index. This will reduce the remaining cycles by 1.

(b) When 326S is turned to return position, 10K (C14) relay is energized. This closes a contact on 10K which energized line valve 326 and relay 326K.

(c) Vacuum valve 325 and relay 325K (C14) are energized thru a contact on 10K relay if 325S is in in the auto. position.

(d) Vacuum valve 296 is energized thru a contact on 10 K if 296S is in auto position.

(e) Vent valve 327 and relay 327K (C14) are energized by 326S in return position if 327S is in the auto. position.

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HW 21142

-17-

[illegible] CHEMISTRY OPERATION - USING ID REACTOR

Control Switches & Valve Numbers.
Location of switches shown in ( ) Followed by Sheet # of Elementary Dwg.

Transfers To	Line Control Sw.	Vacuum		Vent		Line		Sequence Operation
...ring Vessel 3A	258-? (CS13) 4			260*(CS13) 4		258 (CS13) 4		1
...tting Station	318? (D2) 4	319*(D2) 4	216*(D33) 5	260*(CS13) 4		318U(D2) 4		2,13,16
...mple	353-B1(CS9) 2	355*(CS10)2	216*(D33) 5	320*(D2) 4		353 (CS9) 2		3,5,7
...tting Station	353-S2(CS9) 2	319*(D2) 4	216*(D33) 5	354*(CS10) 2		353 (CS9) 2		4,6,8
...ector	202-? (D4) 4	203*(D4) 5	216*(D33) 5	320*(D2) 4		202 (D4) 4		9,14,17
...old-Up tank	209-S (CS1) 5	294*(CS7)11	274*(CS7)11			209 (CS1) 5		10
...ector	345-S (D4) 5	203*(D4) 5	216*(D33) 5	234*(CS8) 12		345U(D4) 5		11
...uring Vessel	259-S (CS13) 4			260*(CS13)4		259 (CS13) 4		12, 15
...very **	[illegible] 4							18
...uring Vessel	21?-S (CS1) 5			214*(CS8)11		210 (CS1) 5		19
...ector	20?-S (D4) 5	20?*(D4) 5	216*(D33) 5	214*(CS8)11		208U(D4) 5		20,23,26,29
...rmate Measure	205-S (D4) 5	337*(D34)11	315 (D33)10	204*(D4) 10		205 (D4) 5		21,24,27,30,43
...suring vessel	211-S (CS1) 5			214*(CS8)11		211 (CS1) 5		22,25
...suring vessel	213-S (CS1) 5			214*(CS9)11		213 (CS1) 5		28
...ry Header	206-S (D4) 13	296*(D33)9	329*(D7)12	204*(D4) 5		206 (D4) 12		31,35,39
... Station, start	326-S (D7) 11	276*(D33)8	356*(D7)11	324*(D7) 11		326 (D7) 11		32,36,40
" , fill	326-S (D7)			324*(D7) 11	327*(D7)11			32,36,40
...rmate Header	330-S (D7) 11	316*(D33)10	333*(D34)12	327*(D7) 11		330 (D7) 11		33,37,41
...ector	201-S (D4) 5	203*(D4) 5	216*(D33) 5	331*(D34)11		201 (D4) 5		34,38,42
...very	338-S (D34) 12			336 (D34)12		338 (D34) 12	339*( )12	44
...ry Header	326-S (D7) 11	325*(D7) 12	296*(D33) 9	327*(D7) 11		326 (D7) 11		[illegible]

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WET CHEMISTRY OPERATION USING 2B REACTOR

Control switches & Valve Numbers.
Location of Switches shown in ( ) Followed by Sheet # of Elementary Dwg.

Transfers To	Line Control Sw.	Vacuum		Vent		Line		Sequence Operation
g Vessel 3A	258-S(CS13) 4			260*(CS13) 4		258 (CS13) 4		1
ng Station	318-S(D2) 4	319*(D2) 4	216*(D33) 5	260*(CS13) 4		318U(D2) 4		2,13,16
e	353-S1(CS9) 2	355*(CS10)2	216*(D33) 5	320*(D2) 4		253 (CS9) 2		3,5,7
ng Station	353-S2(CS9) 2	319*(D2) 4	216*(D33) 5	354*(CS10) 2		353 (CS9) 2		4-6-8
or	222-S (D4) 4	223*(D4) 6	236*(D33) 6	320*(D2) 4		222 (D4) 4		9,14,17
Up tank	229-S (CS2) 6	254*(CS7)11	274*(CS7)11			229 (CS2) 6		10
or	346-S (D4) 6	223*(D4)6	236*(D33) 6	234*(CS8) 12		346U(D4) 6		11
ring vessel	259-S (CS13)4			260*(CS13) 4		259 (CS13) 4		12,15
ry **	344-S (D2) 4							18
ring vessel	230S (CS2) 6			214*(CS8) 11		230 (CS2) 6		19
or	228-S (D4) 6	223*(D4) 6	236*(D33) 6	214*(CS8) 11		228U(D4) 6		20,23,26,29
ate Measure	225-S (D4) 6	337*(D34)11	316*(D33)10	224*(D4) 6		225 (D4) 6		21,24,27,30,43
ring vessel	231-S (CS2) 6			214*(CS8) 11		231 (CS2) 6		22,25
"	233-S (CS2) 6			214*(CS8) 11		233 (CS2) 6		28
ry Header	226-S (D4) 13	296*(D33)9	325*(D7) 12	224*(D4) 6		226 (D4) 12		31,35,39
tation, Start	326-S (D7) 11	276*(D33)8	356*(D7) 11	324*(D7) 11		326 (D7) 11		32,36,39
" , Fill	326-S (D7) 11	7)11		324*(D7) 11	327*(D7)11			32,11,11
ate Header	330-S (D7) 11	316*(D33)10	333*(D34)12	327*(D7) 11		330-D7) 11		33,37,41
or	221-S (D4) 6	223 (D4) 6	236 (D33) 6	331*(D34) 11		221 (D4) 6		34,38,42
ry	338-S (D34)12			336*(D34) 12		338 (D34)12	339*( )12	44
Header	326-S (D7) 11	325*(D7)12	296*(D33) 9	327*(D7) 11		326 (D7) 11		

UNIT CHEMICAL OPERATION USING 3B REACTOR

Control Switches & Valve Numbers
Location of Switches Shown in ( ) Followed by Sheet # on Flowsheet Dwg.

Instructions	Line Control Sw.		Vacuum		Vent		Line		Operation Sequence
) Vessel	238-S (CS12)	3			240*(CS12)	3	232(CS12)	3	1
tion	230-S (D2)	3	350*(D2) 3	216*(D33) 5	240*(CS12)	3	2800(D2)	3	2,13,15
	352-S1(CS9)	2	350*(CS10)2	216*(D33) 5	300 (D2)	4	352(CS9)	2	3,5,7
tion	352-S2(CS9)	2	299*(D2) 3	216*(D33) 5	354*(CS10)	2	352(CS9)	2	4,6,8
	242-S(D5)	4	243*(D5) 7	256*(D33) 7	300*(D2)	4	242(D5)	4	9,14,17
Tank	249-S(CS3)	7	254*(CS7)11	274*(CS7)11			249(CS3)	7	10
	347-S(D7)	7	243*(D5) 7	256*(D33) 7	234*(CS8)	12	347(D7)	7	11
) Vessel	239-S(CS12)	3			240*(CS12)	3	232(CS12)	3	12,15
"	343-S(D2)	4							16
) Vessel	250-S(CS3)	7			214*(CS8)	11	250(CS3)	7	19
	248-S(D5)	7	243*(D5) 7	256*(D33) 7	214*(CS8)	11	2480(D5)	7	20,23,26,29
e Measure	245-S(D5)	7	337*(D34)11	32*(D33)10	244*(D5)	7	245(D5)	7	21,24,27,30,43
) Vessel	251-S(CS3)	7			214*(CS8)	11	251(CS3)	7	22,25
"	253-S(CS3)	7			214*(CS8)	11	253(CS3)	7	26
der	246-S(D5)	13	296*(D33)9	325*(D7) 12	244*(D5)	7	246(D5)	12	31,35,39
ion Start Fill)	326-S(D7)	11	276*(D33)8	356*(D7) 11	324*(D7)	11	326(D7)	11	32,36,40
	326-S(D7)	11			324*(D7)	11	327*(D7)11		38,11,11
Header	330-S(D7)	11	316*(D33)10	333*(D34)12	327*(D7)	11	330(D7)	11	33,37,41
	241-S(D5)	7	243*(D5) 7	256*(D33) 7	231*(D34)	12	241(D5)	7	34,39,42
	338-S(D34)	12			336*(D34)	12	338(D34)	12	44
) Line	326-S(D7)	11	325*(D7) 11	296*(D33) 9	327*(D7)	11	326(D7)	11	

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UNH CHEMISTRY OPERATION USING 45 REACTOR

HW21142

-20-

Control Switches & Valve Number.
Location of Switches shown in ( ) Followed by Sheet # of Elementary Dwg.

Transfers To	Line Control Sw.	Vacuum		Vent		Line		Operation Sequence
...ng vessel	238-S(CS12) 3			240*(CS12) 3		238 (CS12) 3		1
...ng Station	298-S(D2) 3	299*(D2) 3	216*(D33) 5	240*(CS12) 3		2980(D2) 3		2,13,16
...o	352-S1(CS9) 2	355*(CS10)2	216*(D33) 5	300*(D2) 4		352(CS9) 2		3,5,7
...ng Station	352-S2(CS9) 2	299*(D2) 3	216*(D33) 5	354*(CS10) 2		352(CS9) 2		4,6,8
...	262-S(D5) 4	263*(D5) 8	276*(D33) 8	300 (D2) 4		262(D5) 4		9,14,17
...Up Tank	269-S(CS4) 8	254*(CS7)11	274*(CS7)11			269(CS4) 8		10
...or	348-S(D5) 8	263*(D5) 8	276 (D33) 8	234*(CS8) 12		340U(D5) 8		11
...ing vessel	239-S(CS12) 3			240 (CS12) 3		239(CS12) 3		12,15
...y "	343-S(D2) 4							18
...ing vessel	270-S(CS4) 8			214*(CS8) 11		270 (CS4) 8		19
...or	268-S(D5) 8	263*(D5) 8	276*(D33) 8	214*(CS8) 11		268U(D5) 8		20,23,26,29
...te	265-S(D5) 8	337*(D34)11	316*(D33) 10	264 (D5) 8		265 (D5) 8		21,24,27,30,43
...ing vessel	271-S(CS4) 8			214*(CS8) 11		271 (CS4) 8		22,25
"	273-S(CS4) 8			214*(CS8) 11		273 (CS4) 8		28
...r Header	266-S(D5) 13	296*(D33) 9	325*(D7) 12	264 (D5) 8		266 (D5) 8		31,35,39
...ation Start	326-S(D7) 11	276*(D33) 8	356*(D7) 11	324*(D7) 11		326 (D7) 11		32,36,40
" Fill	326-S(D7) 11			324*(D7) 11	327*(D7)11			32,36,40
...ate header	330-S(D7) 11	316*(D33)10	333*(D34) 10	327*(D7) 11		330 (D7) 11		33,37,41
...or	261-S(D5) 8	263*(D5) 8	276 (D33) 8	331*(D34) 12		261 (D5) 8		34,38,42
...ry	338-S(D34) 12			336*(D34) 12		338 (D34) 12	339*( )12	44
... header	326-S(D7) 11	325*(D7) 12	296*(D33) 9	327*(D7) 11		327 (D7) 11		

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Control switches & Valve numbers
Location of switches shown in ( ) Followed by sheet # of Elementary Dwg.

ransfers To	Line Control Sw.	Vacuum		Vent		Line		Sequence Operation
rving vessel	218-S (CS11) 2			220*(CS11) 2		218 (CS11) 2		1
ng Station	278-S (D2) 2	279*(D2) 2	216*(D33) 5	220*(CS11) 2		278U(D2) 2		2,13,16
	351-S1(CS9) 2	355*(CS10)2	216*(D33) 5	280*(D2) 3		351 (CS9) 2		3,5,7
ng Station	351-S2(CS9) 2	279*(D2) 2	216*(D33) 5	354*(CS10) 2		351 (CS9) 2		4,6,8
	282 S (D6) 3	283 (D6) 9	296*(D33) 9	280*(D2) 3		282 (D6) 3		9,14,17
ng Tank	289-S (CS5) 9	254 (CS7)11	274*(CS7)11			289 (CS5) 9		10
or	349-S (D6) 9	283 (D6) 9	296*(D33) 9	234*(CS8) 12		349U(D6) 9		11
ring vessel	219-S(CS11) 2			220*(CS11) 2		219 (CS11) 2		12,15
**	342-S (D2) 3							18
ring vessel	290-S(CS5) 9			214*(CS8) 11		290 (CS5) 9		19
	288-S(D6) 9	283 (D6) 9	296*(D33)9	214*(CS8) 11		288U(D6) 9		20,23,26,29
	285-S(D6) 9	337*(D34)11	316*(D33)10	284*(D6) 9		285 (D6) 9		21,24,27,30,43
uring vessel	291-S(CS5) 9			214*(CS8) 11		291 (CS5) 9		22,25,
"	293-S(CS5) 9			214*(CS8) 11		293 (CS5) 9		28
Header	286-S(D6) 13	296*(D33)9	325*(D7) 12	284*(D6) 9		286 (D6) 12		31,35,39
tation stark	326-S (D7) 11	276*(D33)8	356*(D7) 11	324*(D7) 11		326 (D7) 11		32,36,40
" Fill	326-S(D7) 11			324*(D7) 11	327*(D7)11			32,11,11
ate Header	330-S (D7) 11	316*(D33)10	333*(D34)12	327*(D7) 11		330 (D7) 11		33,37,41
	281-S (D6) 9	283 (D6) 9	296*(D33) 9	331*(D34) 12		281(D6) 9		34,38,42
ry	338-S (D34) 12			336*(D34) 12		338(D34) 12	339*( )12	44
Header	326-S(D7) 11	325*(D7) 12	296*(D33) 9	327*(D7) 11		326(D7) 11		X

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[redacted] 15A CHEMICAL OPERATION USING 6B REACTOR

Control Switches & Valve Numbers.
Location of switches shown in ( ) Followed by sheet # of Elementary Dwg.

Transfers To	Line Control ev.	Vacuum		Vent		Line		Operation Sequence
ring vessel	218-S (CS11) 2			220*(CS11) 2		218(CS11) 2		1
ng Station	278-S (D2) 2	279*(D2) 2	316*(D33) 5	220*(CS11) 2		278 (D2) 2		2,13,16
e	351-S1(CS9) 2	355*(CS10)2	316*(D33) 5	280*(D2) 3		351 (CS9) 2		3,5,7
ng Station	351-S2(CS9) 2	279*(D2) 2	316*(D33) 5	354*(CS10) 2		351 (CS9) 2		4,6,8
or	302-S (D6) 3	303*(D6)10	316*(D33) 9	280*(D2) 3		302 (D6) 10		9,14,17
up Tank	309-S (CS6)10	254*(CS7)11	274*(CS7)11			309 (CS6)10		10
er	350-S (D6) 10	303*(D6) 10	316*(D33)10	234*(CS8) 12		350S1(D6) 10		11
ring vessel	219-S (CS11)2			220*(CS11) 2		219 (CS11)2		12,15
**	342-S(D2) 3							18
ring vessel	310-S (CS6)10			214*(CS8) 11		310 (CS6)10		19
er	308-S(D6) 10	303*(D6)10	316*(D33)10	214*(CS8) 11		308U(D6) 10		20,23,26,29
nto	305-S (D6) 10	337*(D34)11	316*(D33)10	304 (D6) 10		305 (D6) 10		21,24,27,30,43
ring vessel	311-S (CS6)10			214*(CS8) 11		311 (CS6)10		22,25
"	313-S (CS6)10			214*(CS8) 11		313 (CS6)10		28
Header	306-S (D6) 13	296*(D33)9	325*(D7) 12	304 (D6) 10		306 (D6) 13		31,35,39
tation start.	326-S (D7) 11	276*(D33)8	296*(D7) 11	324*(D7) 11		326 (D7) 11		32,36,40
"	326-S (D7) 11			324* (D7) 11	324*(D7)11			32,33,41
nte Header	330-S (D7)11	316*(D33)10	333*(D34)12	327*(D7) 11		330 (D7) 11		33,37,41
tor	301-S (D6) 10	303*(D6) 10	316*(D33)10	351*(D34) 12		301 (D6) 10		34,38,42
ry	338-S (D34)12			336*(D34) 12		338 (D34)12	339*( )12	44
Header	326-S (D7) 11	325*(D7) 12	296*(D33)9	327*(D7) 11		326 (D7) 11		

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TO	LINE CONTROL SW.	VACUUM		VENT	LINE	NOTES
ring Vessel	212-S (Cs1) 5			214*(CS8)11	212(CS1)5	
"	232-S (CS2) 6			214*(CS8)11	232(CS2)6	
"	252-S (CS3) 7			214*(CS8)11	252(CS3)7	
"	272-S (CS4) 8			214*(CS8(11	272(CS4)8	
"	292-S (CS5) 9			214*(CS8)11	292(CS5)9	
"	312-S (CS6)10			214*(CS8)11	312(CS6)10	
	207-S (CS1) 5			214*(CS8)11	207(CS1)5	
	227-S (CS2) 6			214 (CS8)11	227(CS2)6	
	247-s (CS3) 7			214*(CS8)11	247(CS3)7	
	267-S (CS4) 8			214*(CS8)11	267(CS4)8	
	287-S (CS5) 9			214*(CS8)11	287(CS5)9	
	307-S (CS6)10			214*(CS8)11	307(CS6)10	
ber	215-S (D33) 5	216(D33)5			215(D33)5	Valves 216, 236, 256,276,296 & 316 are energized by switches of the same number turned to ON position.
	235-S (D33) 6	236(D33)6			235(D33)6	
	255-S (D33) 7	256(D33)7			255(D33)7	
	275-S (D33) 8	276(D33)8			275(D33)8	
	295-S (D33) 9	296(D33)9			295(D33)9	
	315-S (D33)10	316(D33)10			315(D33)10	
	205-S (D4) 5	203(D4) 5	216(D33)5	336(D34)12	205(D4) 5	Valve switches must be in the "On" position for valves 203, 223,243,263,283,303,216,236 256,276,296, 316 and 336 to operate. Valve switch for valves 204,224,244,264,284 & 304 must be in "off" position
	225-S (D4) 6	223(D4) 6	236(D34)12	336(D34)12	225(D4) 6	
	245-S (D5) 7	243(D5) 7	256(D33)7	336(D34)12	245(D5) 7	
	265-S (D5) 8	263(D5) 8	276(D33)8	336(D34)12	265(D5) 8	
	285-S (D6) 9	283(D6) 9	296(D33)9	336(D34)12	285(D5) 9	
	305-S (D6) 10	303(D6)10	316(D33)10	336(D34)12	305(D6)10	
	328-S (D34)12				328(D34)12	
Header	334-S (D34)11	333*(D34)12	316(D33)10	336(D34)12	334(D34)11	

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ELECTRICAL INSTRUCTIONS
(Elementary Drawing H-2-12362)

TASK II

Power For Task II

Task II has five sources of power fed from manually operated breakers at cubicles on duct level as follows:

110 V - 1 phase is fed from Breaker	202K	located at Cubicle	4
125 V - D. C. " " " "	201K	" " "	4
220 V - 3 phase " " " "	205K	" " "	4
440 V - 3 phase " " " "	272K	" " "	24
440 V - 3 phase " " " "	210K	" " "	24

Task II Uses 3 Amplidynes

Their purpose is the armature excitation of three D.C. Motors as follows:

D.C. Motor No.	Purpose of Motor	Motor Contactor	Amp. Used	Amp. Drive Motor	A.C. Amp. Drive Motor Cont.	Loc. of Cont.	Loc. of Amp.	Amp. Sw. No.	Con. Desk No.
204BB	Carriage Drive	Left-Right 225-K226K	201G	205B	208K	Cub.3	Cub.3	201 Start 202 Stop	10
206B	Cross Slide Dr	In -Out 243K-244K	202G	207B	209K	Cub.4	Cub.4	203 Start 204 Stop	10
202B	Dump Drive	Ret.-Dump 235K-237K	203G	212B	264K	Cub.24	Cub.24	286 Start 267 Stop	15

The amplidyne drive motors are 440 volt, 3 phase. A red lamp shows above control switches when the amplidynes are running.

The D.C. Motors are 115 volt 1/2 h.p. variable speed and drive through a gear reduction. The two contactors as shown above for each motor are for clockwise and counter-clockwise rotation.

Fill & Decant

For reference see elementary sheet #7, Task II. This section of Task II employs two 1/10 h.p. 220 volts 3 phase motors, marked #201 B and 203 B. These motors are located above the hood station in [illegible]. This station is operated at Desk #7. A green lamp #203L, [illegible] to the left of the fill and decant power switch, Desk #7, indicates that the main 220 volt breaker (3 phase) #205K (C-4 duct level) is on. When Switch #205 S, marked "Fill & Decant Power" is turned on a red lamp #201 L, above and to right of the fill and decant power

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switch, Buns.

The fill and decant mechanism may now be operated. Motor #201 B drives the tube elevation mechanism through a gear reduction. It is manually controlled by Switch #277 S, marked "Tube Elevation".

Motor #203 B drives the tube rotation mechanism through a gear reduction. It is manually controlled by Switch #278 S, marked "Tube Rotation". This switch is fed through a N.O. Contact of Relay 248 K (6-4). When the tube is raised to a certain height a cam operated Micro Switch #275 S closes, energizing Relay 248 K. A green Lamp #202 I also fed by a N.O. Contact of Relay 248 K indicates that rotation is permissive.

Tube rotation is possible only when it is raised to this certain height. The tube rotation mechanism has cam operated Micro Switches #287 S and 288 S which limit the rotation in either direction.

Carriage Drive

The carriage is driven through a gear reduction by Motor #204 B. (For motor control data see sheet #1).

Example of operation.

1. Press Switch Button #201 S (D10) controls Relay #208 K which is the contactor for Motor #205 B which drives the Lateral Feed amplidyne. A red Lamp #212 I appears above the button (201 S) indicating that the amplidyne (6-5) is running. Next press the "Lateral Feed Excitation" (Desk 10) Switch #209 S which energizes Relay #204 K, the D.C. field contactor of the Carriage Drive Motor #204 B. Red Lamp #206 I above the Lateral feed excitation switch indicates that the field of the Carriage Drive Motor #204 B is excited.

2. Station selector power is next turned on. This can be done at either of the Desks, #8, #9, #11 or #12. These switches are marked "Station Selector Power" on each desk and on Deck II elementary drawings they are numbered 221 S, 222 S, 223 S, and 224 S respectively. These switches control Relays 221 K, 222 K, 223 K, and 224 K. These relays are interlocked through their contacts in such a way as to make it impossible to energize more than one of them at a time. Therefore there can be station selector power at only one desk at a time. If station selector power is switched on at a certain desk while it is on at another desk, the station selector power is automatically cut off at the latter desk.

   Assume we are operating the carriage at Desk #9 and that the "Station Selector Power" button has been pressed. Relay 222 K is energized and there is station selector power available at Desk #9 only.

3 3. Switch #218 S marked "Station Selection" is turned to decided station, for example, Station #5. Relay 252 K (6-4), next level, becomes energized. (There are 10 stations in Head 3 and each station has a Relay, 251 K ---- 260 K; all located in Cubicle 4. (Elementary sheet #5 Desk II)

b. If the carriage is to the left of the desired station (5), the carriage must move to the right so the right button #228 S, of two switches marked "Lateral Feed Direction", is pressed. The carriage moves towards Station #5 at high speed. Switch #228 S is for right and Switch #227 S is for left directions of carriage travel. They are marked "Lateral Feed Direction". When the right lateral feed direction switch was pressed Relay 226 K, (contactor of Motor 204 B Carriage Drive), was energized. As the carriage nears Station #5 a cam operated Switch #243 S on the carriage drive is opened and Relay 243 K (C-3) is de-energized. A N.O. Contact of Relay 243 K opens the hold circuit of Relay 228 K (C-3). A N.O. Contact of Relay 228 K opens and the control of carriage travel is switched to another cam operated switch, for Station #5 it is Switch #252 S on the carriage drive. When Relay 228 K was de-energized a second N.O. Contact also opened allowing more resistance in the control field (F1-F2) of the lateral feed Amplidyne #201 C thereby diminishing the armature flux of Motor #204 B, causing it to so run slower. The carriage, at a reduced rate of speed, approaches Station #5 and stops at the station when Switch #252 S (mentioned above) opens.

For reference see elementary sheet #3, Rack II. If the carriage is not exactly in place for cross slide operation the carriage may be moved slightly in either direction. This is accomplished by pressing Button Switch 261 S for right or Switch 281 S for left directions. This switch is marked "Lateral Jog". There is a jog switch located on each of Desks 8-9-11-12.

For jog travel to right, the right button is used. This energizes Relay 231 K, located in Cubicle 3. Contacts on this relay energized Motor 204 B Contactor 226 K.

For jog travel to left, the left button is used, this energizes Relay 232 K, Cubicle 3, contacts on this relay energize the coil of Relay 229 K (Motor 204 B Contactor for left travel). Relays 231 K and 232 K are interlocked through their contacts in such a manner that they can not be energized at the same time.

The carriage may be moved at high or low speed to any point on its track without station stop interference by use of Switch 280 S, Desk 10 marked "Lateral Feed Manual Control". This switch is spring loaded for off position and must be in this position for station automatic operation as described above Switch 280 S has 5 positions including the off position. Two positions to right, marked (Right 1 2) operate the carriage to right at slow or high speed.

For reference see elementary sheets #3-5. Two positions to left marked (Left 1 2) for slow or high speed to left. When Switch 280 S is used to move the carriage to right, for instance at high speed, the switch is turned to "Right 2". High speed Relay 228 K is energized closing the contacts in field circuit F1-F2 of amplidyne which increases its output which increases the armature flux of Motor 204 B on carriage drive. Also when Switch 280 S is in this position the coil of Relay 232 K is energized. A contact on this relay closes the coil circuit of Relay 226 K which is Motor 204 B Contactor for travel for carriage to right. (See chart on sheet #1) If slow speed is desired to right, Switch 280 S is moved to position "Right". Relay 232 K is energized the same as before but Relay 228 K remains open and Motor 204 B runs slow, for reasons explained above. The carriage then moves slowly to the right.

The same conditions hold for left travel when Switch 239 S is turned to left or left 2 except 251 K Relay is used instead of Relay 252 K.

Carriage Emergency Stop

The carriage may be stopped at any point by pressing "Emergency Stop" on either of the Desks 8-9-11 or 12.

For reference see elementary sheet 84, Book II. When the emergency stop button is used the coil circuit of Relay 229 K (8-9) is de-energized.

A N.O. Contact on this relay opens the coil circuit of Relay 227 K. Contacts on Relay 227 K are in a control circuit of Relays 225 K and 226 K which are motor contactors for Motor 214 M (carriage drive). 226 K for right travel and 225 K for left travel.

Therefore regardless of which way the carriage is traveling, it may be stopped by the emergency button.

The emergency Relay 229 K may be re-energized by use of the "Reset" button. It is located near the emergency button on each desk.

On the elementary drawings the emergency buttons are Switches:

235 S on Desk 8	- Reset Switch	237 S
234 S on Desk 9	- " "	238 S
235 S on Desk 11	- " "	239 S
236 S on Desk 12	- " "	240 S

Cross Slide Drive Road 2

The same emergency stop and reset buttons as used in the operation of the carriage are also used for the cross slide drive. The same Relay 229 K has contacts in the cross slide Drive Motor 206 M control circuit. (For emergency stop of carriage, sheet 8-7).

The cross slide is controlled from:

Desk 8 by Switch 271 S marked "Cross Feed Station 1 - 2 - 3"
Desk 9 " Switch 272 S " " " " 4 - 5
Desk 11 " " 273 S " " " " 6 - 7
Desk 12 " " 274 S " " " " 8 - 9 - 10

The cross slide can be controlled from Desk 8 only if the carriage is positioned at Station 1, 2, or 3. To be controlled at Desk 9 the carriage must be at Station 4 or 5. To be controlled at Desk 11 the carriage must be at Station 6 or 7. To be controlled at Desk 12 the carriage must be at Station 8, 9, or 10. These conditions are accomplished by the use of a series of relays which interlock the carriage and cross slide controls.

For reference see elementary sheet 85, Book II.

For Station 1 it is	Relay	211 K)
" " 2 " "	"	212 K)
" " 3 " "	"	213 K)
" " 4 " "	"	214 K)
" " 5 " "	"	215 K)
" " 6 " "	"	216 K)

Cubicle 9

For Station	7	it is	Relay	217 K)			
"	"	8	"	"	"	218 K)	Cubicle 3
"	"	9	"	"	"	219 K)	
"	"	10	"	"	"	220 K)	

For reference see elementary sheets #3 and #4, Task II Example of operation from Desk 8, (Station 2): Assuming that the cross feed amplidyne switch on Desk #10 is on and the cross feed excitation switch (Desk 10) is on. A red lamp appears above each of these switches indicating that the cross slide may be operated.

If the Control Switch #271 S (Desk 8) is turned to "Pickup" Contacts #5 and #6 are closed and Contacts #7 and #8 are closed. Contact #5 and #6 energizes the cross slide Drive Motor #206 B Contactor #243 K through N.O. Contact of Relay 245 K. Relay 245 K is energized through Cam operated Switches 269 S ("In" limit) and 289 S."Pickup" position. The carriage travels in at high speed because of the closing of Contacts 7 and 8 of Control Switch 271 S. These contacts close the high speed Relay 246 K through closed cam operated Switch 270 S on cross slide drive. As the slide travels in the first switch to open is 270 S which drops out the high speed Relay 246 K. The carriage then moves in at a lower rate of speed until cam operated Switch 289 S opens, at this point the door is latched to the cross slide mechanism. When Switch 289 S opened it de-energized Relay 245. A N.C. Contact of Relay 245 in the coil circuit of Motor 206 B Contactor opened and caused the motor to stop.

If it is desired to deposite the door at the station the Control Switch 271 S is turned to "deposite". When the Control Switch is in this position, its Controls #1 & #2 are closed, #5 and #6 are closed and #7 and #8 are closed. The switch (271 S) has (through Contacts #5 and #6) closed the driving Motor Contactor 243 K through contacts of Relay 245 K the same as in "pickup". Also Contacts 7 and 8 closed the high speed Relay 246 K through Cam Switch 270 S the same as in "pickup". But Contacts #1 and #2 are now closed. They bridge the pickup Cam Switch 289 S so that the slide passes by this position and moves in further to the "deposite" position. The first switch to open is 270 S which slows down the slide. The slide continues in at slow speed until the Deposite Switch 269 S opens dropping out the Motor Contactor 243 K, as before. At this position the door is unlatched from the slide. The slide will now move out without the door.

The slide can then be moved out as before but without the door. The slide automatically stops at its full out position as a cam operated Switch 268 S, on cross slide drive, opens which de-energizes Relay 236 K (C-3). Relay 236 K has a N.C. Contact in the coil circuit of the Drive Motor #206 B Contactor 244 K (see sheet #1) which opens allowing the contactor to open thus stopping the slide.

Exceptions of cross slide operation exist at Stations 1, 9, and 10. (See Task II elementary sheet #3).

At Station #1 (Fill & Decant)

The cross slide will not operate unless Relay 248 K (C-4) is energized. A green lamp 202 I (D-7) connected through a N.O. Contact of Relay 248 K indicates when Relay 248 K is energized and also when the slide can be operated. The coil circuit of Relay 248 K is connected through a cam operated Switch 275 S (see elementary sheet #7, Task II). When the tube at Station #1 is raised to a certain

heighth, Switch #275 S is closed and Relay 248 K is energized.

It sums up to this: The cross slide will not move into Station #1 unless the tube, at this station, is raised to a certain heighth depending on the adjustment of the cam which operates Switch #275 S on the tube elevation drive.

Exception of cross slide operation at Station #9 (weigh station): The cross slide will not operate at Station #9 unless Relay #249 K (C-4) is energized, as an N.C. Contact of this relay is connected in the control circuit of cross slide Drive Motor #206 B. (See elementary sheet #3 of Task II).

Relay #249 K is energized by Contact #1 of Relay #242 K (C-4). Relay #242 K is a three contact sequence ratchet operated relay. (See elementary sheet #7 of Task II).

The coil of Relay #242 K is controlled by its own #2 and #3 Contact, a N.O. and a N.C. Contact of Relay #240 K (C-4), a N.O. Contact of Relay #249 K and a N.C. Contact of Relay #241 K (C-4).

Relay 240 K has three N.O. Contacts in the down travel control of the scale loader Drive Motor #203 B. Relay 240 K is only de-energized when the cam operated Switch #214 S is open which occurs when the scale loader is completely down.

Relay 241 K has three N.O. Contacts in the up travel control of the scale loader Drive Motor #203 B. Relay 241 K is only de-energized when the engage cam operated Switch #213 S or the disengage cam operated Switch #215 S is open.

Sequence of operation starting with the scale loader in completely down position.

At this point Cam Switch #214 S is open and Relay 240 K is de-energized. Contact 242 K1 is closed and Relay 249 K is energized therefore the cross slide will move in. The cross slide moves in to "deposite" as explained (sheet #5). The boat is now resting on the pins of the scale loader cage.

The scale loader Control Switch #216 S is turned to engage (explained on sheet #7 and elementary sheet #7 and #8).

The scale loader moves up with the boat and contents to be weighed. As the scale loader drive cam moves away from Cam Switch #214 S, it closes, energizing Relay #240 K. The N.O. Contact of Relay 240 K, in the coil circuit of sequence Relay 242 K, closes and the coil of 242 K is energized through the N.O. Contact of Relay 249 K which is already energized. Consequently the ratchet of Relay 242 K moves its rotor one notch which opens Contact 242 K1 and closes Contact 242 K2. The coil of 242 K is not energized because the N.C. Contact of Relay 241 K in series with 242 K2 is open because Relay 241 K is energized. When the scale loader drive cam opens the "engage" Switch #213 S, Relay 241 K is de-energized and the N.C. Contact of Relay 241 K in the coil circuit of 242 K is closed which energizes Relay 242 K and its rotor moves another notch. This opens 242 K2 and closes 242 K3. The N.C. Contact of Relay 240 K which is in series with the 242 K3 Contact in the coil circuit of 242 K is open because the cam Cam Switch #214 S is closed. Switch #214 S controls Relay 240 K.

When the scale loader drive cam opened the "engage" Switch #213 S the scale loader cage with boat and controls was engaged with the balance hook.

The scale loader can now be lowered. The scale loader Control Switch #216 S is turned to lower. It can be lowered only enough to allow weighing of the cage with its contents or the scale loader can be lowered all the way down. The cross slide can not be moved out until the scale loader is completely down. When the scale loader is moved completely down, cam operated Switch #214 S is opened, Relay 240 K is de-energized and the N.C. Contact in series with the now closed Contact 242 K3 is closed. The coil of 242 K is energized, its rotor moves another notch, Contact 242 K3 is opened and Contact 242 K1 is closed. This energizes Relay 249 K and the cross slide may be moved out.

Thus we have the condition mentioned at the beginning of this cross slide operation exception, the cross slide drive will only operate when Relay 249 K is energized.

Regardless of how the operator operates the scale loader mechanism, Relay #249 K will be energized when the scale loader is moved completely down.

Exception of operation (Dumping): Cross slide drive will not operate at Station #10 unless Relay 247 K (C-4) is energized. 247 K is energized by cam operated Switch #276 S2 on dump drive. When the dump hopper is in a position to receive, the cross slide may be moved in.

Scale Loader (Weigh Station)

The scale loader is driven through a gear speed reduction by a three phase 220 Volt Motor #203 B. The motor is manually controlled by Switch #216 S (D-13) it is marked "Scale Loader Control". Current supply for Switch #216 S is from Switch #212 S (D-13) it is marked "Weight Control Power". A red Lamp #203 I above and to the right of the weight control power switch shows when the weight control power switch is on. A green Lamp #210 I above and to left of the weight control pwoer switch indicates that the main power (220 V-3 phase) is on.

Three N.O. Contacts of Relay 240 K (C-4) are connected between the "lower" contacts of Control Switch 216 S and the Drive Motor #203 B.

Three N.O. Contacts of Relay 241 K (C-4) are connected between the "engage" and "disengage" contacts of Control Switch #216 S and the Drive Motor #203 B.

A cam operated Switch #214 S controls Relay 240 K and stops the Drive Motor #203 B when the scale loader is in down position. (See elementary sheet #7 of Task II).

Two cam switches, Engage Switch #213 S and Disengage Switch #215 S control Relay #241 K. The Engage Switch #213 S causes Relay 241 K to drop open when the scale loader is in proper position to engage the cage with the balance hook.

The Disengage Switch #215 S causes Relay 241 K to drop open, stopping Motor #203 B at the proper point to disengage the cage from the balance hook.

Example of operation (see elementary sheets #7 and #8). Assuming that the "Weight Control Power" Switch #216 S is in position "Lower", which is its normal position when the scale loader mechanism is at rest, down Limit Switch #214 S is open and Relay 240 K is de-energized. The three N.O. Contacts of Relay 240 K which are connected between the contacts for "lower" of Switch #216 S and the Drive Motor 203 B are open. Therefore the motor is at rest. (This is the only timetthat the cross slide will move into this station to deposite the boat in the

scale cage).

When it is desired to load the balance, Switch #216 S is turned to "engage". The engage contacts of Switch #216 S close the Drive Motor #203 B circuit through the three N.O. Contacts of energized Relay #241 K. The scale loader moves up until Cam "Engage" Switch #213 S opens, de-energizing Relay 241 K which stops Drive Motor #203 B at the proper position to engage the scale cage with the balance hook. The scale loader is then lowered, by turning the Control Switch #216 S to "lower", leaving the scale cage hanging on the balance hook.

When the Control Switch #216 S is turned to "lower" its "lower" contacts energize the Drive Motor #203 B through the N.O. Contacts of Relay 240 K which is energized because the lower Limit Switch #214 S in the coil circuit of 240 K is closed. Motor #203 B now runs in the direction to lower the scale loader. The scale loader may be moved all the way down, if it is desired to move the slide out of the station without the matter which is to be weighed, or the scale loader can be moved partly down to allow weighing. (The slide will not move out unless the loader is completely down).

When the scale loader is moved completely down, cam operated Switch #214 S is opened and Relay 240 K is cam operated Switch #214 S is opened and Relay 240 K is de-energized, breaking contact between the Control Switch #216 S Contacts and the Drive Motor #203 B. It therefore stops when the scale loader is completely down.

DUMP MOTOR CONTROL

For reference see elementary sheet #6. The purpose of the dump mechanism is to convey the boat with its contents from Hood 9, Task II, to Hood 13, Task III, and dump its contents in a hopper. The dump mechanism is driven through a gear and chain speed reduction by Motor 202 B. (For control data see sheet #1).

Motor 202 B is located on top and at the east end of Hood #10. This motor is controlled by Switch #210 S on Desk 13 and is marked "Dump Control". Dumping is permissable only when green Lamp #225 I, marked "Dumping Permissive" is on. Since this operation is in connection with Task III it is interlocked through Relays #292 K and 250 K. When #292 K is de-energized and #250 K (C-24) is energized the green dumping permissive lamp burns. Relay #292 K is energized when the mixer motor (Task III) is running, the Chip Valve Switch #352 S1 and the Powder Valve Switch #317 S (Task III) are closed. While this process is in operation the dump mechanism will not operate. When this process in Task III is completed and the switches are turned off. Relay 292 K coil is de-energized.

Normally closed contacts on Relay #292 K are now closed and the "Dump Control" Switch (Desk #13) is energized. Relay 250 K became energized when 292 K was energized and is sealed in through its cam contact which is in series with a contact on Relay 238 K (C-24). Relay 238 K is controlled by a cam operated Switch #276 S1 on dump motor drive.

When the circuit is in the above condition the green lamp burns and dumping is permissable.

When the dump control switch is turned to dump Relay 235 (C-24) is energized. The dump motor starts and runs at high speed. A contact on 235 K parallels the seal-in contact on Relay 238 K so when Cam Switch #276 S1 opens, 250 K remains energized.

Switch 276 S1 opens just before the dumping position is reached. A normally open contact on 238 K opens which reduces the speed of the dump drive. The dump conveyor may be returned to its station at any time as there are no interlocks in this operation.

Vibrator (201 V1)

(For reference see elementary sheet #6). This vibrator is located at the west end of Hood 10. The purpose of the vibrator is to shake all of the contents from the boat when it is dumped. It is controlled manually by Switch #209 S on Desk 13 (Task II) and operates automatically when Relay 292 K is energized providing it is not being operated from Desk 13 Switch #209 S.

292 K is controlled in Task III. This circuit is explained in Dump Motor Operation, sheet #8.

When the vibrator is operated manually from Desk 13 it has a variable resistor (229 R) and a rectifier (209 RECT.) in series with its winding.

The resistor knob is marked "Vibrator Adjust". Its purpose is to vary the intensity of vibration. The rectifier allows the vibrator to operate on only half cycle which makes the vibrator more effective.

When the vibrator operates automatically the resistor is shunted and the vibrator operates with a constant intensity of vibration.

Furnace Control Power

For reference see elementary drawing E-2-12582. Control panel power (115 V, 1 phase) for all six furnaces in Task II is fed from Breaker #202 K (manual) on the door of Cubicle #4 (duct level). This power is fed down on wires #517 and #518.

From Breaker 202 K the control power is fed to six fused branch switches, one for each control panel. When these circuits are energized, green lamps marked 115 V AC Supply, burn on each panel. These lamps indicate power up to the "Panel Power" switches. When the panel power switches are turned on, a red lamp indicates "Panel Power" on each panel. The branch switches (fused) are located on the wall behind the control panels. The "Panel Power" Switches are on the panels.

The corresponding panel and branch switches (with fuses) are shown in the following chart.

Panel No.	Branch Switch No.	Panel Power Sw. No.	Fuse Nos.	
6	2001 S	2002 S	2001 F	2002 F
7	2101 S	2102 S	2101 F	2102 F
8	2201 S	2202 S	2201 F	2202 F
9	2301 S	2302 S	2301 F	2302 F
10	2401 S	2402 S	2401 F	2402 F
11	2501 S	2502 S	2501 F	2502 F

Furnace Power (General)

Furnace power (440 V 3 phase) for all six furnaces is fed from Breaker #210 K (manual) in Cubicle #24 (duct level). The feeders marked #516, #519, and #520 are brought into a wire gutter behind the furnace control panels. Here the 3 phase circuit is equally divided to serve the six furnace transformers. Each transformer is fed through a fused switch, mounted directly under the wire gutter. The hookup arrangement is shown in chart on the following page.

Furnace No.	Branch Sw. No.	Branch Sw. Fuse No.		Wire No. to Line Side of Switches		
1	2008 S	2003 F	2004 F	516	and	519
2	2108 S	2103 F	2104 F	516	"	519
3	2208 S	2203 F	2204 F	516	"	520
4	2308 S	2303 F	2304 F	516	"	520
5	2408 S	2403 F	2404 F	519	"	520
6	2508 S	2503 F	2504 F	519	"	520

The furnaces are resistance type - 10KW - 220 V. They are used with 10 KVA-440/220 V transformers. Furnace current is controlled by a saturable reactor connected in one of the lines between the 440 V switch and the furnace transformer.

The reactor is 10KVA-440 V AC-79 V DC. The reactor acts as a variable impedance. The impedance is varied inversely to the current (D.C.) flow. The greater the value of D.C. the less impedance is offered the furnace current. The final result being, as the D.C. is increased so the furnace current increases and as the D.C. decreases so does the furnace current. The direct current is supplied and controlled by the reactrol unit. For information on how the reactrol is controlled see the write up on L & N droop correction with reactrol panel and accompanying drawings. There are two programs of heating used. When the fluorination cycle is to be used the winding temperature controller is switched to the fluorination cycle cam unit by Switch #2004 S marked "Program Selector", or the oxidation cycle by turning the same Switch #2004 S to "Oxido" position. The winding temperature controller is then used with the oxidation program cam and slide-wire unit.

Important

A thyrite resistor is connected across the D.C. winding of the saturable reactor to avoid excessively high voltages in case of an open circuit. The thyrite resistor is connected as near as possible to the D.C. winding for safety.

Alarm

There are four alarms on each furnace, aspirator water, furnace vacuum, baffle over temperature and winding over temperature.

The aspiration water alarm circuits of all six furnaces are interlocked by contacts of Relay 293 K (C-23). Each furnace has an aspiration water electrode. If the water level becomes abnormally high the electrode is grounded by the water, exciting the grid of an amplifier tube in a furnace alarm unit #200 FA (C-23). This causes Relay #293 K to be de-energized.

Six N.O. Contacts of Relay 293 K causes a relay in the alarm circuits of every furnace in Task II to be de-energized. A NcO. Contact on each of these individual relays of each furnace feed the aspiration water valve switch and the furnace vacuum valve switch. Consequently if the aspiration water becomes too high on any one or all the furnaces the alarms of all the furnaces sound and the aspiration water and vacuum on all the furnaces is shut off.

The alarm horns on each of the furnaces can be silenced before the cause of the alarm is eliminated by turning the individual alarm switches on the furnace control panels to "reset" and then release.

No. 1 Furnace Control

For reference see elementary sheet #9. When green lamp #2011 I marked "A. C. Supply" is burning this shows that the service switch on the wall behind the panel is closed and fuses #2001 F and 2002 F are okay. Turn on Switch #2002 S marked "Panel Power". Indication Lamp #2001 I (red lamp marked "Panel Power") shows panel power is on. Indication lamp #2012 I marked "440 V AC" shows that the Furnace Power Switch #2008 S (mounted on the wall behind the panel) is on and that fuses #2003 and 2004 F are okay.

Also, when the Panel Power Switch #2002 S was turned on, the secondary of the reactrol transformer was closed to the line terminals of the reactrol by another pair of contacts of Switch #2002 S.

The "Program Selector Switch" has three positions, Oxidation, Manual and Fluorination. (Switch #2004 S)

Considering it in the oxidation position. The oxidation red indication Lamp #2003 I is on. When this switch is in the oxidation position it sets up the circuit to 2001 K in such a manner as to allow it to energize when Furnace Heating Switch #2003 S is turned to start. 2001 K then seals-in by one of its N. O. Contacts.

A normally open contact on Relay 2001 K also energizes the coil of the furnace current Contactor #2004 K (P-6) and also the anode voltage (reactrol) Contactor #2005 K (P-6) in series with a contact in the winding temperature controller and a contact in the baffle temperature controller.

Another N.O. Contact on Relay 2001 K completes the program cam drive motor circuit and the heating program is started. The program is completed manually by turning the Furnace Heating Switch #2003 S to off position. The program will repeat as long as Switch 2003 S is in the "on" position after starting. After the program has been turned off the program cam mechanism continues to run and stops when cam operated Switch #2002 opens. The oxidation program cam is then in the starting position for a repeat program operation.

The "Fluorination Gas" Switch #2005 S and the "Aspiration Water" Switch #2006 S are effective only when Relay 265 K (C-25) is energized. A normally open contact on Relay 265 K is connected in series with both of these switches.

Relay #265 K is controlled by a differential Pressure Switch #2010 S. This switch is mounted above the furnace.

When the Relay #265 K is energized and the Fluorination Gas Switch #2005 S is turned to oxygen, Contacts 2005 S1 and 2005 S3 close which energized the Solenoid Oxygen Valve #2001 V and also the Fluorination Gas Indicating Lamp #2006 I which burns dim.

When Relay #265 K is energized and the Fluorination Gas Switch #2005 S is turned to HF oxygen all the contacts on the switch close. In this position the solenoid of the Oxygen Valve #2001 V and the solenoid of the HF Valve #2002 V are both energized. The Fluorination Gas Indicating Lamp #2006 K burns bright.

The "Oxidation Gas" Switch #2007 S (also energized when Relay #265 K is energized) when in "on" position energizes the solenoid of the Oxidation Gas Valve #2003 V and also the Oxidation Gas Indication Lamp #2008 I.

The above switches and indication lamps are mounted on the Furnace Panel #6.

The oxygen, HF and Oxidation Gas Solenoid Valves are mounted in a row (above the windows) on the wall in front of the furnace.

For reference see elementary sheet #11. The "Aspiration Water" Switch #2006 S is effective only when Relay #263 K (C-23) is energized.

Relay #263 K is energized when Contact #FA2 of the furnace alarm unit #200 FA (C-23) is closed and "Alarm Test and Reset" Switch #2009 S is in the neutral position (this switch is spring loaded for neutral). (Explained on sheet #10)

The Aspiration Water Switch #2006 S controls (through N.O. Contacts of Relay 263 K) the Aspiration Solenoid Valve #2004 V and the Aspiration Water Indication Lamp #2016 I above the switch on Panel #6.

The same N.O. Contact on Relay #263 K which feeds the Aspiration Water Solenoid also feeds the "Furnace Vacuum" Switch #2011 S (controls Furnace Vacuum Valve #2005 V). More about the aspiration water and furnace vacuum control under heading "Furnace Alarm".

The "Air Cooling" Switch #500 S on Desk #8 controls the Air Cooling Solenoid Valve #215 V (above the furnaces) and the Air Indication Lamp #217 I mounted above the switch.

No. 1 Furnace Alarm

(For reference see elementary sheet #10 & #11) There are four origins of furnace alarm.

1. Aspiration water above normal level.
2. Over temperature recorded at baffle temperature controller.
3. Over temperature recorded at winding temperature controller.
4. Differential pressure switch opens.

Note:
The same Alarm Switch #2009 S, Horn #2001, and Reset Relay #2008 K are used on all four alarms.

If the aspiration water rises too high in the aspirator, an Aspirator Electrode #200 HWA is grounded by the water. This condition causes a contact in the Furnace Alarm Unit #200 FA (C-23) to open. When this contact opens it de-energizes Relay #293 (C-23). A N.O. Contact of Relay 293 K is connected between the coil of Relay 263 K and the Alarm Switch #2009 S which is in neutral position (in neutral position this circuit is closed). Then Relay #263 K is de-energized.

A N.C. Contact of Relay #263 K sounds the Alarm Horn #2001. Also another N.C. Contact of Relay 263 K lights the alarm water trap Indication Lamp #2018 I. To silence the horn, the alarm and reset, (Switch #2009 S) is moved to reset position momentarily, which momentarily energizes Relay #2008 K. A N.O. Contact of #2008 K energizes Relay 266 K (C-23) which seals-in through a N.O. Contact of its own and a N. C. Contact of Relay 263 K (de-energized). A N.C. Contact of Relay 266 K is opened which opens the horn circuit but the Aspirator Water Indication Lamp continues to burn until the aspiration water level is returned to normal. The aspiration water alarm will not sound when the Aspiration Water Switch #2006 S is off.

The action of Relay #293 K effects the aspiration water, vacuum control and aspiration water alarm on all six furnaces. An abnormal aspiration water level on any one of the furnaces causes Relay #293 K (C-23) to open.

. If an over temperature is recorded in the "Baffle Temperature Controller", a normally closed contact in this instrument opens which de-energizes Relay #2006 K (Panel #6). A N.C. Contact of Relay #2006 K closes which completes the Alarm Horn #2001 through a N.C. Contact of Relay #2009 K (P-6) (not energized). Also, alarm baffle over Temperature Indication Lamp #2009 I is lighted through a N.C. Contact of Relay #2006 K.

The horn may be silenced by momentarily moving the alarm and Reset Switch #2009 S to reset. This energizes the Reset Relay #2008 K (P-6) momentarily which energizes Relay #2009 K and it seals-in through a N.O. Contact of its own and a N.C. Contact of Relay #2006 K (the relay de-energized at the time the alarm sounded). When Relay #2009 K is energized the N.C. Contact, mentioned above, in the horn circuit is opened and the horn is silenced.

Indicating Lamp #2009 I continues to burn until the temperature is back to normal which energizes Relay #2006 K.

The "Winding Over Temperature Alarm" is similar to the Baffle Over Temperature Alarm in operation. Some equipment is common between the two (see note on sheet #26).

Some different relays are used. 2007 K (P-6) instead of Relay 2006 K and 2010 K (P-6) instead of Relay 2009 K.

No. 1 Furnace Vacuum Alarm

If the differential pressure of the furnace becomes abnormal and the contact of Differential Pressure Switch #2010 S (mounted on top of the furnace) opens, Relay #265 K (C-23) is de-energized. A N.C. Contact of Relay 265 K closes and completes the Alarm Horn #2001 circuit through a N.C. Contact of Relay #267 K (C-23). Also a N. C. Contact on Relay 265 K lights the alarm furnace vacuum Indicating Lamp #2017 I.

The horn is silenced by momentarily moving the alarm switch to reset. This momentarily energizes the reset Relay #2008 K. A N.O. Contact of Relay #2008 K energizes Relay #267 K (mentioned above).

Relay 267 K seals-in through a N.O. Contact of its own and a N.C. Contact of Relay 265 K (not energized). The N.C. Contact of Relay 267 K in the horn circuit opens and the horn is silenced.

The alarm furnace vacuum Indicating Lamp #2017 I continues to burn until the abnormal pressure condition is cleared and Relay #265 K is again energized.

As noted on sheet #11, a N.O. Contact of Relay #265 K feeds the Fluorination Gas and Aspiration Water Switches #2005 S and #2007 S. Therefore when the abnormal pressure condition occurs and the contact of Differential Pressure Switch #2010 S opens, these circuits are also de-energized.

TASK II - MODIFICATION

CROSS-SLIDE AND SCALE LOADER INTERLOCK

A change has been made in the interlock circuit of the cross slide and the scale loader so that it is not only necessary that the scale loader be in fully down position but the scale cage must also be disengaged from the balance hook before the cross-slide can be moved out of station #9. This is accomplished by the use of an additional relay and the normally open contacts of switches #214S and 215S. A N.O. contact of the additional relay appears in the control circuit of the cross-slide drive motor.

OPERATION OF INTERLOCKS

The scale loader operates as before (see elsewhere in this work). Refer to elementary E-2-12582, sheets 3 and 7.

Assume the carriage is at station #9 with its load to be weighed. The scale loader with scale cage are in normal position, that is down. The N.C. contact of the down limit switch #214S (Cam operated on loader drive) is open, holding the down control relay 240K(C4) de-energized and the N.O. contact of switch #214S is closed, holding the cross-slide interlock relay 294K(C4) energized. Contact 242KI of sequence relay242K(C4) is closed (remained so from the previous weighing operation), holding the cross-slide interlock relay 249K(C4) energized. The N.O. contact of relay 294K and the N.O. contact of relay 249K which appear in the cross-slide motor control circuit are, therefore closed, permitting the cross-slide to move into station #9. As the scale loader is started on its "up" travel, the N.C. contact of down limit switch #214S closes, energizing the down control relay 240K(C4), its N.C. contact opens which de-energizes relay 294K(C4) rendering the cross-slide inoperative. A N.O. contact of relay 240K (now closed) energized sequence relay 242K thru a close N.O. contact of relay 249K, causing contact 242KI to open and contact 242K2 to close. The opening of contact 242KI allowed relay 249K to drop out.

Note: Both cross-slide interlocking relays 249K and 294K are now de-energized.

The scale loader moves up to "engage" as switch 213S (Cam operated) opens, de-energizing the up control relay 241K(C4). A N.O. contact of relay 241K opens the motor control circuit and a N.C. contact closes, energizing, thru contact 242K2, sequence relay 242K. Contact 242K2 opens and contact 242K3 closes. The scale loader should now be moved slightly down to allow weighing, this does not effect the interlock circuit. After weighing the scale loader is moved up to "disengage" where switch 215S operates, its N.C. contact opens de-energizing the up-control relay 241K which stops the drive motor. The N.O. contact of switch 215S closed energizing thru closed contact 242K3, relay 242K which opens contact 242K3 and closes contact 242K1. The closing of contact 242KI energizes the cross-slide interlock relay 249K

The scale loader with the scale cage is now lowered to down position where down limit switch 214S operates. Its N.C. contact opens, de-energizing the down control relay 240K which stops the drive motor, its N.O. contact closes which energizes the cross-slide interlock relay 294K.

Both cross-slide interlock relays 249K and 294K are now energized, their N.O. contacts are closed permitting the cross-slide to move out of station #9.

TASK III ELECTRICAL INSTRUCTIONS

See Elementary H-2-12603
For Locations of Contactors see Elementary Legends

The following is an explanation of the Electrical Circuits in Task II in the order that they are first used in the operation.

For the explanation of the carriages and alarm system for furnaces, see Carriage #1, "Carriage #2" and "Alarm System".

CRUCIBLE LOADING

II.

D. (1) 110 volt power is fed from Breaker 302K in Cubicle #7. 125 volt DC Power is fed thru Breaker 301K in Cubicle #6. 220 volt, 3Ø power is fed thru breaker 303K in Cubicle #6. 440 volt, 3Ø power is fed thru breakers 304K and 341K in Cubicle #16.

There is an Indicating lamp for each of these sources of power on Desk #35.

(2) Desk Power button 301-S on Desk #14 closes relay 305K and 348K, which seals in and lights the indicating lamp 323-I. Now carriage #1 can be operated only from desk #14.

(3) Amplidyne #1, Field ON button, 3335(2)(4) closes relay 328K which seals in. Relay 328K lights indicating light 305I and provides power thru fuses 301F and 302F for motor and Amplidyne fields.

Amplidyne #1 start button, 3355(2)(4) closes relay 330K which seals in thru N.O. contacts on 330K and N.C. contacts on 329K overload relay, which starts motor 302B and lights indicating light 306-I.

(4&5) See Carriage Operation.

E.(1) The elevators and furnace bottom releases in Station #4 operate the same way as those in Stations #5 & #6. When carriage #1 is in Station #4, Cam switch 328S is closed. When elevator switch 357S is turned to UP position, relay 343K is energized thru Cam switch 328S. Relay 343K closes valve 311V, which raises the elevator. Elevator #4SW, 357S operates valves 312V and 313V in Down Position.

(2) Water Pressure switch 367S on Desk #35 operates a motor 308B that operates a water valve. When the Water Pressure switch is turned to raise, one coil of 352K is energized thru a limit switch 384S on the valve the thru overload relay 368K. Relay 352K starts the motor 308B and energizes indicating light 322-I. The motor opens the valve. When the Water Pressure switch is turned to lower, a reversing coil in 352K is energized thru a different limit switch, 383S. The motor reverses and closes the valve.

(3) The Furnace Bottom Release switch for Station #4, 358S operates 314 valve and 344K thru pressure switch 316S, which is later by-passed by contacts on 344K. Switch 316S is closed when elevator #4 is raised. Valve 314K operates a catch that releases the furnace bottom. Relay 344K has contacts that by-passes 316S, which allows the furnace bottom catch to remain open when the elevator is lowered.

CRUCIBLE LOADING

F. (1) Elevator Station #3 switch 356S(D35) is fed thru Cam position switch 327S (4) and 328S, and controls valves 309V (UP) and 310V (Down), which operates the elevator. The carriage has to be in either Station #3 or #4S before this elevator can be operated.

G. (1)&(2) See Task XII for General Conveyor Operation.

CRUCIBLE CHARGING

II.

A. (1)&(2) See Carriage Operation

(3) When the carriage is in #2 Station, Cam switch 326S is closed, feeding Elevator #2, switch 351S, which closes 304V when UP position, and valve 303V in Down position.

B. (1) Powder Dump Switch, 317SI,(D35) operates relay 292K(G24), thru Mixer motor contacts 342K(C6) in "hold position" by Mixer control switch 354S (D35), and Powder-Chem. Switch 352SI(D35) in the "closed position". Relay 292K also energizes 201 vibrator and 201 Powder Solenoid Valve. (Powder Task II to Mixer)

(2) No switches, or electrical interlocks on chemicals to Mixer.

C. (1) Powder-Chem. Switch 352(D35) is turned to "open" position. Closing 35282 energizing 305V and 306V, and turns on vibrator 302; also closing 35284 so Mixer motor 307S can now be reversed to Dump by turning 354S to Dump. Switch 352SI is now open and de-energizes 292K in Task II. (Powder & Chem. to Crucible).

(2) Powder & Chem. valve switch (352) is turned to "Close position", 352SI and 35283 are energized and 35282 and 35284 are de-energized. Valves 305 and 306 become de-energized. (S2) 305 is mech. a N.O. valve, 306 is mech. a N.C. Valve. (S4) stops mixer motor from Dumping.

D. (1) Chip valve switch 353(D35) is turned to open, 35382 energizing 307V a mech. N.O., and 308V a mech. N.C. and dumps chips in crucible if 354S is turned to "hold position".

E. (1) When Elevator switch 351S, Station #2 is turned to lower, valve 303V is energized thru Cam switch 326S and elevator switch 351S.

(2)(3) See Carriage Operation.

(4) When the carriage enters Station #1, 325S closes.

(5) Feeding elevator switch station #1, 350S, which energizes valve 301V in "up position", and valve 302V in "down position". The lid is put on automatically by mech. means when elevator is raised to maximum.

FURNACE CHARGING

III.

A. See Carriage Operation
C. (1) See E (E-(1)
(2) See E (2)

EVACUATION AND LEAK CHECK

IV.

A. (1) The Compressor is driven by motor 305B, which is controlled thru relay 340K and protected by relay 365K; across two terminals of the motor is a solenoid valve 363K in series with a pressure switch 405S. The control circuit has a double pole disconnect switch (3001S) and fuses (3001F and 3002F). Starting switch 3002S feeds current thru pressure switch 407S, thru temperature switch 3011S) thru overload contact (365K), thru the coil. When the motor starts an auxiliary contact of relay 340K lights indicating lamp 3001I.

(2) The vacuum pump is a 110 volt A.C. motor and is controlled thru relay 363K and protected by relay 371K. Across the terminals of the motor is indicating light 3006I. Relay 363KA(C-16) is a relay that is connected parallel to relay 363K(C-16). This relay 363KA has a N.C. contact in the 3019 valve circuit. These contacts are N.C. contacts and will open when the vacuum pump is started. When the pump is running, valve 3019V is de-energized and is closed. This valve is a vacuum release valve and it will only open when the vacuum pump is stopped.

The circuit for this motor will be from line 3017 thru 3044S stop button, thru 3045S start button, which is by-passed by seal-in contact of relay 363K, thru relay coils 363K and 363KA, thru N.C. contact of overload relay 371K to line 3018. Relay 363KA being energized keeps valve 3019V de-energized and closed, allowing the vacuum pump to pump down a vacuum.

Relay 363KA's N.C. contacts act as an interlock to prevent the motor from being started under a vacuum pressure. When the motor is stopped 3019V, vacuum release valve will become energized and open to allow the vacuum pressure to be released.

(7) The Furnace Operation switch energizes a relay 3015K for Furnace #1. 3016K for Furnace #2 and 3017K for Furnace #3, which connects the Pirani Gage to the furnace being used. It also feeds the operation selector switch when the valve operation switch is on automatic. When the valve operation switch is on manual, the furnace operation switches feed individual valve control switches. There are 18 switches, No. 3023 to 3040, controlling 18 valves, #3001 to 3018. Indicating lamps indicate that the furnace being used is on manual valve control. The different control circuits are interlocked so that only one furnace operation switch can be used at a time. Each furnace Operation switch furnishes the controlling current for a separate group of valves, which are directly controlled by the Operation Selector switch or the manual control switch.

(9) The Operation Selector switch energizes the valves that are needed in the different operations, providing that the valve operation switch is on automatic. Each position of the switch operates a different combination of valves.

FURNACE HEATING CYCLE

V.

A. (1) Flow switch 3001SF closes when water flows thru the frequency converter and closes relay 3018K.

FURNACE HEATING CYCLE cont'd

(2) The Tocco Unit drive motor is controlled thru relay 370K in Cubicle #16 and protected by overload relays 369K1 and 369K2 in Cubicle #16. The circuit is from line 17 thru the Stop button 3007S, thru the Start button or sealing contacts on 370K, thru contacts on overload relays 369K2, thru N.O. contacts on relay 3018K, which is energ. when water is flowing in 3001F converter, thru N.O. contacts on relay 3022K, which is energ. unless the thermal protective switch 3001TS in the converter opens to line 18. The Alarm switch has a contact that when in Test position, it by-passes the contacts on relays 3018K and 3022K for test purposes.

(3) Tocco Instrument switch 3009S furnishes the generator output voltage to the meters thru fuses 3003F and 3004F. When in the "off" position, the switch also shorts out the ammeter.

(4) The Tocco Field switch (3008S) energizes the auto transformer 3001T and lights indicating lamp 3004I. The auto transformer feeds rectifier 305 which feeds the generator field across which is Thyrite 302. This circuit is fused by 312F.

B. (1) The Three Furnace Heat switches are interlocked so that only one furnace may be used at a time. Each furnace is directly controlled by a relay 3002K for #1, 3004K for #2, 3006K for #3. Whenever one of these relays is closed an indicating lamp is lighted. Before one of these relays can operate, two relays must be energized. (3019K and 3024K for #1, 3020K and 3025K for #2, 3021K and 3026K for #3). Relays 3019K, 3020K, and 3021K are operated by flow switches in the water lines of the work coils. Relays 3022K 3024K and 3026K are operated by temperature controlled switches in the recorders.

The Furnace Heat switch also connects part of the Alarm system. See Alarm System.

VI. FURNACE COOLING

For Elevator #4, #5 or #6, see Page 1 and 2.
For Water Pressure switch see Page 2.

VII. FURNACE UNLOADING & REMOVAL

A. See Carriage Operation

B. (1) Elevator Station #7 switch is fed thru two parallel Cam switches, 331S and 340S. Switch 340S is closed when carriage #2 is in Station #7. Switch 331S is closed when carriage #1 is in Station #7. Thus the elevator can be operated only when one of the carriages are in Station #7. When the elevator #7, switch 368S is in Down position valves 327V and 328V are energized. When the switch is in UP position valves 325V and 326V are energized, providing that the plunger is UP, closing relay 355K and the vise is out, closing 359K. A selsyn transmitter is attached to the elevator and the selsyn receiver on Desk #35 indicates the position of the elevator for Cam cutting operation.

(5) The Vise is operated by 220 volt, 3Ø, motor which is controlled by reversing relay 360K and protected by relay 375K (cubicle #6). Vise switch 376S operates the motor one way in "IN" position and the other way in "OUT" position. Switch 377S and 377S2 are limit switches, one for each direction.

D. (1) The Chuck is a DC solenoid across which is 301 Thyrite. Before it can operate, the cleaning tongs must be engaging switch 3598, closing relay 345K. When the Chuck is controlled by switch 3806, both the switch and the relay have a contact in each line of the DC supply. The Chuck must be turned on before Carriage #2 can be operated.

(2) See Carriage #2 control

(5) The cutter is driven by a 220 volt, 3ϕ motor, which runs both directions (In and Out). The motor receives its power thru relays 357K and 358K, and is protected by overload relay 374K. It can be operated when the plunger is UP, closing relay 355K. The relays 357K and 358K are interlocked so that only one can operate at a time. There is a limit switch (3740) that has contacts in both the relay circuits to keep the cutter from going in too far and from coming out too far. Relay 359K operates when the cutter comes out and trip limit switch 37482. This puts 359K in series with 358K. 359K is more sensitive than 358K so 358K drops out and 359K closes.

(13) The Breakaway ram is controlled by two #7 Valves, 329V and 332V, which are energized by the breakaway switch 3798. One valve in for Down, and one is for UP.

(14) The Waste Chute flap is controlled by a rotating armature and two solenoids, 302 sol. and 303 sol. These solenoids are DC and are supplied by rectifiers 306 to 313, in Cubicle #16. When the Waste switch, 3818 is turned to the other position, it energizes one of the solenoids thru a limit switch 3888 or 3898 and thru the rectifiers. The flap is turned and the limit switch de-energizes the solenoid.

(24) The Plunger is operated by a 200 volt, 3 phase motor which is controlled thru relays 354K and 356K and protected by overload relay 373K. There are interlocks so that both 354K and 356K can be energized at the same time. When the Plunger button, 3708 is pressed, relay 356K is energized, starting the plunger Down, providing that 359K is closed. 359K closes when the cutter is Out. Relay 356K seals in when the button is pressed and the motor will run until limit switch 37182 opens. When 356K opens, a circuit is closed to 354K thru normally closed contacts on 356K and thru limit switch 37181. Relay 354K starts the plunger up again. When it reached the top, limit switch 37181 opens and relay 355K is put in series with 354K. As relay 355K is more sensitive than the other one, it closes and 354K opens stopping the motor; relay 355K is a safety feature that prevents elevator #7 from being raised when the plunger is being operated.

(25) Elevator #8 is raised and lowered by valves 330V and 331V which are controlled by elevator switch 3828.

TASK III
CARRIAGE #1

Sheets 1 & 2 of Elementary Diagram H-2-12603
The Control Circuits are 110 volts (line 17 to line 18)

All relays are in Cubicle #5 except 361K and 362K which are in Cubicle #6.

Carriage #1 is driven by a compound-wound DC motor (301B) which is controlled by an Amplidyne Generator (301G) which is driven by a 440 volt three phase motor (302B). This motor is controlled thru relay 330K and protected by overload relay 329K. Amplidyne start switch (335-S) and Amplidyne Stop switch (334-S) control relay 330K. Relay 329K has three coils, two for the protection of the 3 phase motor (302B) and one for the protection of the carriage drive motor (301B). Any-one of these coils will open the contact in the control of the 3 phase motor.

After the Amplidyne Start Button (335-S) has been pushed, starting the Amplidyne generator, the Amplidyne field button (333-S) must be pressed closing relay 328K, which connects the DC supply to the fuses (301F and 302F), hence to the Indicating light (3051) and to the contacts of the carriage control relays 316K and 317K. Relay 316K runs the carriage to the left and 317K runs the carriage to the right. Each of these two relays connects the DC supply to the field of the carriage motor and to the reference field of the Amplidyne Generator, but the polarity of the reference field is changed causing the current to flow in a different direction thru the armature of the carriage motor, producing a different rotation.

Relay 315K applies a greater reference voltage to the control field of the generator and thus increases the generator output and increases the carriage motor speed.

The carriage may be controlled from either Desk #14 or Desk #15. On Desk #14 the Desk Power button energizes relays 305K and 348K, which seals in an lights indicating light (323-I). The carriage may then be operated from Desk #14. If the Desk Power switch on Desk #15 is pressed, relays 305K and 348K are cut out and relays 306K and 351K are energized lighting indicating light 324-I and allowing the carriage to be operated at Desk #15. On each desk is a duplicate set of controls "Carriage #1 Manual Control", "Station Selector", "Direction Selectors Right and left, "Emergency Stop", and "Reset". There is also an "Emergency Stop" and a "Reset" on Desk #35. The three Reset buttons are parallel an in series with the Stop buttons to operate relay 331K, which seals in.

The Station Selector switches, 303S on Desk #14 and 314S on Desk #15 control seven relays (307K, 308K, 309K, 310K, 311K, 312K, and 313K). When relays 305K and 348K are energized by the Desk Power button, 301-S) on Desk #14, the Station Selector switch (303-S) on Desk #14 controls these seven relays. When Relays 306K and 351K are energized by the Desk Power button (302-S) on Desk #15, the Station Selector switch on Desk #15 controls the relays. Six of the seven relays are energized at a time. The seventh determines where the carriage will stop.

Located by the carriage motor is a Position Switch, composed of several micro switches that are operated by a combination of Cam wheels geared to the carriage drive. These switches work with the Selector switches to stop the carriage. They also allow the elevator to work only when the carriage is at that station being used and the limit carriage travel.

Seven of these Cam operated switches (325-S, 326S, 328S, 327S, 329S, 330Z and 331S) operate seven relays (319K, 320K, 321K, 322K, 323K, 324K, and 325K). Only one of these switches and relays open at a time. A different one opens at each station.

TASK III, CARRIAGE #1 cont'd.

Each of these relays has a contact in series with relay 314K. Paralled to each of these contacts is a contact on the corresponding relay that is operated by the position switch. Relay 314K has a contact in the control circuit of both the carriage motor control relays, 316K and 317K. When the carriage is running and reaches the station that opens the relay that corresponds to the relay opened by the Station Selector switch, the circuit to 314K is broken and the motor is stopped.

A similar circuit is set up to control relay 315K which changes the motor from low to high speed. This circuit is composed of a series of contacts, one from each relay operated by the Station Selector switch. Parallel to each of these contacts is a micro switch in the Position Switch. These micro switches operate in conjunction with the micro switches that open the relays at each station. However, the cams that operate them are notched so that they open just before the station control switches. Therefore, relay 315K will open just before relay 314K at any station the carriage is directed to and the carriage will slow up just before it stops. This makes it easier to stop the carriage in the spot where it is needed.

Before the carriage can be started the following conditions must be met:

1. The Amplidyne must be started by pressing switch 335S on Desk #14.
2. The Amplidyne Field must be turned on by pressing switch 333S on Desk #14.
3. The Desk Power switch on the Desk being used must be pressed, energizing relays 305K, 306K, 348K, 351K.
4. The Station Selector switch must be changed to a different station than the one it is at, closing relay 314K. (This is not necessary when using Manual Control).
5. The Reset button must be pressed to be sure that relay 331K (Emergency Stop circuit) is energized.
6. The elevator in Station #1 must be down closing 314S.
7. The elevator is Station #2 must be down closing 315S.
8. The elevator in Station #7 must be down closing 369S, which closes relay 353K.
9. The Direction selector button may now be pressed starting the carriage in the direction selected.

However, there are other conditions that may stop operation of the carriage in a certain direction. The Right Travel curcuit has a limit switch (323S) that prevents the carriage from hitting the end of its bed. The Left travel circuits has one too, 322S. Contacts of relays 326K, 327K, & 318K prevent the Direction Selector button from energizing 316K, while the Manual control is being used to energize 317K or vice versa.

In the Right Travel circuit are three parallel contacts on relays 326K, 313K, and 332K. Relays 313K is closed at all times except when the Station Selector switch is set on station #7. Relay 332K is closed except when carriage #2 is in station #7. Relay 326K is closed when the Manual Control is used to run the carriage to the right. Therefore, the circuit that runs carriage #1 to the right cannot be closed when the Station Selector switch is set on Station #7 and Carriage #2 is in Station #7, except by using the Manual Control.

In the left travel circuit is a N.O. contact on relay 362K. This was added to prevent the carriage from running into elevator #3, when it is down.

TASK III, CARRIAGE #1 Cont'd

Relay 362K is closed thru N.O. contacts on 321K, which are parallel to N.O. contacts on 361K and in series with N.C. contacts on 322K, which are by-passed by sealing contacts on 362K. Relay 361K is closed by switch 324-S, which is closed when the elevator is up. Relay 321K is closed at all times except when the carriage enters Station #3. Relay 322K is closed at all times except when the carriage enters Station #4. Thus, it can be seen that when the carriage is travelling to the left and the elevator #3 is down, opening realy 361K, the carriage will automatically stop. Now the carriage will have to travel to the right to Station #4 before it can travel left again. When the carriage enters Station #4, relay 322K opens, which closes the normally closed contacts and energizes relay 362K again, which seals in until 321K and 361K are both open again. (This arrangement is not too desirable for the following reason: - If the 110 volt power should be turned off or fail when the carriage is in Station #5, #6, or #7, the carriage cannot travel to the left until the relay 362K is reset by hand.).

The Manual Control switch operates relays 326K and 327K. The Station Selector switch and Position Switch are by-passed and the Direction Selector Buttons are by-passed. The carriage will run on fast or slow to either direction, as indicated on the Manual Control switch.

Relay 318K is a Safety factor that keeps relays 316K or 317K from remaining energized accidently after the Manual control has been returned to "Off". The extra contact and the time element involved does this.

When releasing Manual Switch 312S or 313S, or releasing 326K or 327K, it might be possible for 317K or 316K to remain energized. This could happen if the automatic took over thru closed contacts on 326K or 327K and closed contacts on 316K or 317K (before 314K became de-energized by carriage if it were between stations). So the 318K open contacts are in series with 326K and 317K or 327K and 316K to de-energize 316K or 317K on automatic when 326K or 327K are de-energized. 316K or 317K becomes de-energized and drops 318K, causing its contacts to close.

A TYPICAL OPERATION FROM DESK 14
OF CARRIAGE #1 TASK III
ELEMENTARY # H-2-12603

The Amplidyne drive motor must be turned on by switch 335-S(D-14). Field switch 333-S(D14) must be closed energizing relay 328K(C-5) which supplied the D.C. power to the unit.

The Desk Power switch 301-S(D-14) is closed energizing relays 305K and 348K(C-5), 305K C-5), also closes a N.O. contact and 323-I(D-14) indicating light will burn. Other contacts on 305K and 348K(C-5) close the N.O. contacts on the Station selector switch 303-S(D-14). These contacts being closed will energize relays 307K(C-5) to 313K(C-5).

The carriage is in Station #1 and Station #4 is desired. The Station Selector Switch 303S(D-14) is turned to Station #4. This energizes relays 307K, 308K, 309K, 311K and 312K and 313K. 310K is de-energized (these relays are in Cubicle 5), because Station 4 has been selected and 348K(c-5) contacts are open.

The carriage is in Station #1 so 325-S(Zone III) cam switch is open and 319K(C-5) is de-energized. Relays 320K to 325K(C-5) are energized because cam switches 326-S to 331-S (Zone III) are closed.

Slow down cam switches 306-S to 311-S (zone III) are closed but 305-S is open. These relays 315K(C-5) is energized from line 17, thru N.C. contacts 326K and 327K(C-5) Manual Control Relays, thru the N.O. contacts of 307K(C-5), thru the slow down cam switches 306S to 311-S (Zone III) thru relay 315K(C-5) to line 18.

Relay 314K(C-5 is energized thru N.O. contacts of 307K, 308K, 309K (C-5), because these relays are energized, thru contacts on 322K, 323K, 324K, and 325K (C-5) which are closed, because these relays are energized thru relay 314K(C-5) to line 18.

Relays 320K to 325K are energized because Cam switches 326S to 331S(Zone III) are closed. 325-S cam switch is open because the carriage is in Station #1.

Energizing 314K(C-5) relay closes a N.O. contact in the Travel circuit of the carriage. Elevators in Stations 1,2 and 7 must be down closing switches 314-S, 315-S, and 353K. These switches are located in the Hood.

Relay 331K(C-6) is energized by pushing Reset Button 306S(D-14). Energizing this relay closes a N.O. contact 331K(C-6) in the carriage travel circuit.

By pressing Direction Selector button, relay 317K(C-5) is energized thru N.O. contacts on 305K(C-5), N.O. contacts 318-S(D-14), N.C. Contacts on 319-S(D-14), N.C. contacts on 321-S(D-15), travel limit switch 323S(Zone III), N.O. contact 313K(C-5), N.C. Contacts 327K(C-6), thru the coil on 317K(C-5) right travel relay, the other side of this coil is fed thru 314K(C-5) contacts which are closed, thru 331K(C-6) reset relay contacts, thru 314-S, 315-S and 353-S (Zone III) to line 18.

Relay 317K(C-5 is held closed thru N.C. contact on 326K(C-6) and 318K(C-5) and thru N.O. contacts on 317K(C-5) which by-pass the Right button.

The control field of the Amplidyne Generator and the shunt field of the D.C. carriage motor are energized by the 317K(C-5) right travel relay. Contacts which are N.O. contacts and are closed when 317K is energized. This starts the carriage drive motor and the carriage begins to move to the right.

As the carriage approaches Station #4, 308-S (Zone III) slows down cam switch opens de-energizing realy 315K(C-5). This relay opens contacts in the speed circuit of the Amplidyne. This will slow the carriage motor down because it puts

All of the resistance into the control field of the amplidyne. The motor is now in slow speed because the out-put voltage of the generator is decreased.

Immediately following the decrease in speed, Cam switch 328 will open and de-energize relay 322K(C-5).

As 310K(C-5) is also open thru the Selector switch the circuit to 314K(C-5) is broken de-energizing 314K. When this relay is de-energized it opens 314K contacts in the travel circuit.. 317K(C-5) right travel relay is de-energized and it opens 317K(C-5) contacts in the control circuit of the amplidyne generator stopping the carriage.

Switch 322-S and 323-S(Zone III) are travel limit switches. 322-S is left travel limit and 323-S is right travel limit. When operating in the manual position these switches will prevent the carriage to over travel in either direction.

All Relays are in Cubicle #6
110 Volt Control Circuit from Lines 17 & 18.

CARRIAGE #2 (Elementary Sheet 3 & 4)

Carriage #2 is driven by a one speed DC compound wound motor (303B), which is controlled by an Amplidyne Generator (302G), which is driven by a 440 volt three phase (304B). This motor is controlled thru relay 339K and protected by over load relay 358K. The motor is started by pressing switch 349S (Amplidyne #2 Start). When it is running indicating lamp 308I is lighted.

Relay 337K supplies the DC voltage to the fuses and lights 307I. It is controlled by switches 347S (Amplidyne #2 Field-On) and 346S (Amplidyne #2 Field Off).

Relay 334K and 335K controls the carriage motor by exciting the shunt field of the motor and the control field of the Amplidyne Generator. 334K operates the carriage one direction "right". 335K reverses the motor and operates the carriage in the other direction "left". The reversing is accomplished by reversing the polarity of the Amplidyne Generator which reverses the polarity of the armature current of the carriage drive motor.

Switch 341S (Carriage #2 Control) contols relays 334K and 335K if conditions are right. The elevator in Station #7 (Can Cutting Station) has to be lowered, closing 353K. The Chuck has to be turned on. The cleaning forceps have to be raised to where micro switch 349S is engaged, closing relay 345K.

Let us assume that the carriage in Station #8, and we want to run it to the "left". We turn control switch 341S to "left" position and hold it. Relay 332K is closed by cam switch 340S and we have a circuit thru N.O. contacts on 332K, thru 341S, thru cam switch 344S (left limit), thru coil, thru N.O. contacts on 345K, thru N.O. contacts in Chuck switch 380S4, and thru N.O. contacts on 353K. The carriage motor is energized when 335K closes and the carriage moves to the "left" into cam switch 340S opens at Station #7, dropping relay 332K. If further left travel is needed, the control switch 341S may be returned to neutral position and relay 333K will be energized thru N.C. contacts on 332K. Relay 333K has contacts that by-pass those on 332K and allows the carriage to travel to the left until limit switch 334S opens.

When the control switch is turned to "Right" position, 334K is energized thru cam switch 345S, thru control switch 341S, thru cam limit switch 342S, thru the coil, thru 345K , thru 350S4, thru 353K.

The carriage moves to the "right" until cam switch 345S opens at the Waste Canning Station. To travel on to station #8, return the Control switch to neutral, energized relay 336K which by-passes 359S and allows the carriage to move to the "right" until the cam limit switch 342S opens.

COMPRESSOR (Panel Board #12)

The compressor is driven by a 2-hp, 3ϕ, 220V. motor. The main source of supply is Breaker 303K, Cubicle #6, Sheet #1. Across the motor leads are a pressure switch in series with a solenoid valve which controls the high and low pressure of this unit.

The control is fed thru a separate switch 3001 behind the panels. When the main switch 3001S is closed, a light 3001I appears on the control board above the

switch 3002S. 3002S is a manual operated On and Off switch. When it is turned "on" the control circuit is completed thru 407S pressure switch, thru 301TS temperature switch, thru the contacts of the overload coil, the coil of 340K.

Elementary Sheet 5 & 6

STATION #1, Desk 35

Elevator Station No. 1 is controlled by two water pressure solenoid valves. One valve 301V is down and the other 302V is "up".

When carriage #1 is in Station #1 cam switch 325S is closed, allowing switch 350S to be energized in either the "up" or "down" position. When the switch 350S is closed in "down" position, the circuit is completed from line 17 thru cam switch #1 thru 350S thru the solenoid valve 301V to line 18.

When in "up" position, it is completed from line 17 thru cam switch #1 (325S) thru 350S thru 302V to line 18.

CRUCIBLE LOADING STATION #2 (Desk 35)

Elevator station #2 is controlled by two water pressure solenoid valves 303V "down" and 304V "up", sheet #5.

These valves operate when carriage one is in Statinn #2. This closes cam switch 326S thru switch 351 to either valve 303V "down" or 304V "up" to line 18.

CHIP VALVE & MIXER VALVE (desk 35)

When carriage #1 is in elevator Station #2 and switch 351S is in the "up" position and chip valve switch 352S2 is closed, it completes the circuit thru chip valves 305V and 306V. "This operation can only be done when switch 351S is in the "up" position".

The mixer valve can only be operated when motor 307B is running. With the motor running and switch 351S in the "up" position, the circuit is from line 17 thru 326S, thru 351S (up position), thru 353S2 mixer valve switch, thru a contact on relay 342K, this contact closes when the mixer motor is started thru 307V and 308V to line 18.

Vibrator 302 operates thru a contact on 342K, which is the starting relay for 307B mixer motor. Rectifier 317 supplies the dc for this vibrator. 301 vibrator operates directly thru 355S (Desk 35.) DC is supplied thru rectifier 314. 355S also lights indicating light 321I when the circuit is complete.

ELEVATOR STATION #3

When carriage #1 is in Station #3 cam switch 327S is closed, operating valves 309V and 310V. These are operated by closing 356S, Desk 35. These valves 309V "up" or 310V "Down" control the elevator.

ELEVATOR STATION #4 (Desk 35)

When carriage #1 is at Station #4 cam switch 328S closes. When switch #357S, Desk 35 is turned to the "up" position, relay 343K is energized closing contact 343K which in turn energizes valve 311V, which causes the elevator to go up.

Turning switch 357S to "down" position energizes valves 312V and 313V. These valves are not energized thru 328S cam switch. Thus elevator #4 can be lowered at any time but can only be raised when 328S cam switch is closed.

FURNACE BOTTOM RELEASE, Station #4 (Desk 35)

This is controlled by a solenoid valve 314V. It is energized thru 358S, thru a pressure switch 316S in Hood 13CV. At the same time relay 344K is enegized, closing contact 344K that aprallel pressure switch 316S keeping valve 314 Energized until 358S switch is open. Pressure switch 316S closes when elevator #4 is raised.

ELEVATOR STATION #5 (Desk 35)

This elevator works the same as Elevator Station #4 except that the circuit is now thru cam switch 329S, thru 360S, Desk 35, thru 346K, closing 346 contact energizing 315V. This is when switch 360S is in "up" position. In "down" position, valves 316V and 317V are energized directly thru 360S.

FURNACE BOTTOM RELEASE ELEVATOR #5, Desk 35

Control switch 361S energizes relay 347K, closing contact 347K, which energizes 318V thru contacts on pressure switch 362S, Hood 13 CV. 347K also closes contacts 347K which by passes pressure switch 362S, allowing valve 318V to stay energized until switch 361S is opened. Pressure switch 362S is closed when elevator is raised.

ELEVATOR STATION #6, Desk 35

This elevator works the same as 4 & 5. Control switch 363 is in the "up" position feeding thru from cam switch 33[illegible]S energizing relay 349K, closing contacts 347K, energizing 318V.

In "down" position, valves 320V and 321V are energized directly from Line 17 thru the "down" position on the control switch 373S, thru valves 320V and 321V to line 18.

FURANCE BOTTOM RELEASE #6 (Desk 35)

This release operates the same as 4 & 5 control switch 364S energizes 350K relay and 322 valve, thru pressure switch 365S, which is by-passed by contacts on 350K relay until 364S is opened, de-energizing relay 350K. Pressure switch 365S closes when elevator is raised.

WATER PRESSURE

Motor 308S is a 220V., 3Ø motor. It is a Bodine motor and is controlled by a reversing relay 352K and an overload relay 368K. It is operated by a switch 367S on Desk 35. This motor operates a valve which controls the water pressure.

When lowering water pressure, the current is fed thru 367S lower position thru a lower limit switch 383S, thru the coil on 352K, thru O.L. contacts 368K to line 10.

To raise pressure 367S is in "raise" position and current is fed thru 367S, thru 384S, thru the coil on 352K, thru O.L. contact 368K to line 10.

BOOSTER PUMP

The booster pump is operated by two valves, 323 and 324V and controlled by switch 366S, located on Desk 35. However, before it will operate the elevator must be in the "up" position in either station 4,5, or 6. This closing either contact 343, 346, or 349. These contacts are connected in parallel to each other and are all connected in series with switch 366S.

MIXER (307B, Desk #35)

The mixer is driven by motor 307B, a three phase 220 volt Bodine motor. It is controlled thru relay 342 and protected thru relay 367. It is controlled by switch 354 on Desk #35, and when it is running indicating light 309 is on. When it is running one way it mixes and when reversed it dumps. Switch 354 Desk #35 does the controlling. The mixer will not run in the right direction to mix unless the chip valve switch 352 is in "open" position. The control circuit is thru 352S4, thru 354S, thru relay coil and thru contacts on overload relay 367. The control circuit to "dump " is thru the other pole of switch 354, thru reversing coil and thru overload contact.

WATER PRESSURE (desk #35 - Motor 308B)

Motor 308B operates a valve that controls the water pressure. It is controlled by switch 367 Desk #35, and two limit switches in Hood 13 CV where the motor is. 308B is a three phase, 220 volt Bodine motor, with a reversing relay (352K) and overload relay 368K. When lowering water pressure control current is fed thru 367S, thru lower limit switch 383S, thru the coil and thru contacts on the overload relay 368K. To raise the pressure, current is fed thru 367S, thru raise limit switch 384S, thru the raise coil and thru contacts on the overload relay 368K.

PLUNGER (Desk #15, Motor #309B

The plunger motor is 220 volts, 3 phase, controlled by two relays which run it in opposite directions. When plunger switch 370 is closed, relay 356 will be energized providing that the cutter is in out position. Relay 356 starts the plunger down. When the plunger reaches a certain position it operates switch 371, cutting out 356K and energizing relay 354K, starting the plunger up again. When it hits the top 371S operates again and cuts out 354K and energizes 355K, closing contacts in the control circuits of the "cutter" and of the down control of Elevator #7.

The control circuit is fed thru N.C. contacts on overload relay 373K, thru 370S (which is by-passed by holding N.C. contacts on 356K) thru N.C. contacts on 354K, thru contacts on 359K (closed when cutter is out), thru 356K and thru limit switch 371S2. When 371S2 opens, relay 354K is energized thru N.C. contacts on overload relay 373K, thru N.C. contacts on 356K, thru coil of 354K and thru switch 371S, which by-passes coil 355K. When the plunger reaches the top and 371S opens, relay 355K is put in series with relay 354K. As 355K is more sensitive than 354K, it will close and 354K will drop out stoping the motor, unless 370S is held down repeating the complete action.

CUTTER (Desk #15, Motor #310B)

The cutter is operated by a three phase, 220 volt motor and operates in two directions "in" and "out". The motor receives its power thru two relays, 357K and 358 K and is protected from overload by relay 374K. It can be operated when the plunger is up energizing relay 355K.

When switch 373S (cutter) is turned to "in", the circuit to relay 357K is closed thru N.C. contacts on O.L. relay 374K, thru 37332, thru N.C. Contacts on 358K (directional interlock), thru coil, thru limit switch 374S1 and thru N.O. contacts on relay 355K. When limit switch 374S1 isopened, the cutter stops. When 373S is turned to "out" relay 358K is energized thru O.L. contacts on 374K thru 373S1, thru N.C. contacts on 357K (directional interlock), thru the coil, thru N.C. contacts in limit switch, thru N.O. contacts 355K. When the cutter is out limit switch 374S2 opens energizing relay 359K and causing relay 358K to fall out. 359K is in series with 358K but has more impedance and is more sensitive.

VISE (Motor 311-B, Desk #35)

The vise is operated by 220, 3 phase motor which is controlled thru reversing relay 360K and protected by O.L. relay 375k. Switch 376S controls the motor. When in "in" position, the relay is energized thru 376S, thru limit switch 377S1, thru coil (220 volt), thru contacts on overload relay 375K. When switch is in "out" position, 376S energizes a reversing coil thru limit switch 377S2.

BREAKAWAY (Desk #15)

The breakaway is an (air) plunger that is operated by two valves which are controlled by switch 379S. "Down" position oprates one valve and "up" position operates the other.

CHUCK (Desk #15

The chuck is a DC magnet. Across the coil is a thyrite resistor. Switch 380S on Desk #15 controls the magnet. This switch must be on before carriage #2 can be operated. It breaks both sides of the DC line. Also, relay 345K has contacts on both sides of the circuit. This relay is closed only when the cleaning tongs are engaging switch 359S. When the chuck is on light 328I on Desk #15 glows.

WASTE CHUTE FLAP (desk #15)

The waste chute flap is operated by two DC solenoids that get their current from Rectifiers 30€ to 313 in Cubicle #16. Switch 381S operates these solenoids. One pulls the flap one way till it opens switch 388S, the other pulls the flap the other way untill switch 389S opens.

ELEVATOR STATION #8

The elevator is controlled by two valves 330V and 331V which are operated by switch 382S. One valve raises the elevator the other lets it down. No interlocks.

P-Panel
c-Cubicle

FREQUENCY CONVERTOR & FURNACE OPERATION

The frequency convertor is a high frequency generator driven by a 440, 3ϕ motor, 312B (sheet #8). The motor is controlled thru relay 370K (sheet #8 and protected by 369K1 and 369K2 (sheet #8). 370K, 369K1 and 369K2 are located in cubicle #16. The convertor is started by 3006S, sheet #8, and stopped by 3007S (sheet #8). These push buttons are located on Panel #14. However, there are several safety features in this control circuit. Water must be flowing thru the frequency convertor closing flow swithc 3001 SF (sheet #13) and energizing 3018K (sheet #13), also closing contact 3018K (sheet #8). The Thermal protective switch 3001TS, Panel14 (sheet #13) in the frequency convertor must be closed, energizing 3022K (sheet #13), closing contact 3022K (sheet #8).

FREQUENCY CONVERTER & FURNACE OPERATION

Alarm switch will by-pass contact 3018K, and 3022K (sheet #8) in test position, allowing motor to run for test purposes only. This alarm switch has a spring return to neutral and must be in neutral position before any of the control relays 3018K to 3026 (sheet #13) can be energized. This alarm switch is located on Panel #14.

The control is fed from line #17 thru stop button 3007S, thru start button 3006S, (which is by-passed thru holding contact in 370K) thru the coil, thru N.C. contact 369K1, thru 369K2, thru N.O. contacts on relay 3018K, thru normally open contacts on relay 3022K, thru normally open contacts on spare alarm relay 3023K (sheet #8) or thru a jumper in relay not used to line 18. This control circuit starts the 440 volt motor.

The generator field is supplied thru rectifier 305 (sheet #8) by 3001T auto transformer (sheet #8), which is controlled by switch 3008S (sheet #8). Panel #14 (This is the field frequency convertor switch) circuit is fused by 312F (sheet #8) from line 18. Light 3004I will burn when 3001T transformer is energized. Fuses 3003F and 3004F (sheet 8) are the protective fuses for the meters. The output current is transmitted to the meters from current transformer 3002T (sheet 8). Switch 3009S (sheet 8) cuts the voltage off the meters and shorts out the C.T. 3002T.

Three work coils are supplied by this generator. However, they are interlocked so only one may be operated at a time. When one switch is turned on, it breaks the circuit to the other coils.

Relay coil 3006K supplies Furnace #1 (sheet #8)
" " 3004K " " #2 " "
" " 3002K " " #3 " "

These relays are located behind panel #29. Before a furnace can be operated water must be flowing thru the work coils and the controlling contact in temperature records must be closed.

Furnace heat switch 3012S contacts 1,2,3, and 4 close in the on position. Contacts 1 and 2 energize relay 3002K contactor, and close two N.O. contacts in the work coil circuit. Contact 3 closes in the alarm circuit. Contact 4 closes and energizes valve 3021V, which allows it to open and water flows thru the work coil.

Furnace heat switches 3010S and 3011S are the same as 3012S, except that 3010S energizes relay 3006K and 3011S energized 3004K.

Contacts 5,6,7, and 8 of the above switches are closed in the "off" position. Contacts 1,2,3, and 4 are closed in the "on" position.

For example, a selection of Furnace heat, switching 3010S to the "on" position will close contact 1,2,3 and 4 but will open contacts 5,6,7 and 8. The contacts act as an interlock to prevent the heating of another furnace at the same time Furnace #1 is being heated. Switches 3011S and 3012S being in the "off" position keep the contacts 5,6,7, and 8 off both switches closed, allowing a circuit to relay 3006K to be completed permitting the furnace to heat.

Thus to close relay 3002K (sheet #8) and start furnace #1, the circuit must be as follows:

From line 17 thru N.C. contacts in switch 3010S (Furnace #3, heat), sheet #8, thru N.C. contacts on switch 3011S (Furnace heat #2, thru N.O. contacts in switch 3010S (furnace heat #1), thru N.O. contacts on relay 3024K (sheet #13) which is closed when 3001RC1 (sheet #13) is closed, then thru N.O. contacts on relay 3019K (sheet #13) which is closed when flow switch 3001SF is closed thru the coil 3002K

[redacted]

(sheet #8) to line 18. A duplicate circuit lights 3026-I Indicating light.

FURNACE OPERATION

Switch 3042S is the disconnect for the 110 V. panel power. Switch 3043S is the panel power switch and is located on panel 15. This switch is spring loaded with an "off"-ON" and Neutral. When the switch is turned on, it energizes relay 3008K panel 15 and completes the circuit thru N.O. contact 3008W, thru switch contact 3043S1 and 3043S2.

When the main switch 3042S is on, indicating light 3029-I will burn, this shows circuit is complete to relay 3008K.

When 3008K is energized, it closes 3008K on one side of the line (3017), also 3008K on the other side of the line (3018) which lights 3030-I.

This circuit 3017 and 3018 feeds all instrument circuits, relay circuits, a valve circuit, vacuum pump motor and alarm circuits that work with an control the induction furnaces.

VACUUM PUMP 3135 (Panel 12)

Switches 2018S (Valve operation) 3019S operation selector switch, panel 12, sheet #12.

Furnace Operation	#1	3020S	)
" "	#2	3021S	)--Sheet #12
" "	#3	3022S	)

All work together and are interlocked so that only one furnace unit can work at a time.

These furnace operation switches control which furnace shall be run and which valves shall open. The operation selector switch 3019S, panel #12, opens and closes valves that are associated with the furnace to be operated, as their operation is called for by the different position on the operation selector switch, namely, pump down, leak detection, admit argon, and heat.

The purpose of 3018S, panel #12 (sheet #12) is to determine whether the valves shall be operated automatically or individually operated manually.

Indicating lights	3031-I	Furnace #1
	3032-I	" #2
	3033-I	" #3

Will burn to show that valves must be closed manually.

Relay 3015K, panel #15 (sheet #12) is energized by turning Furnace #1 switch to "on" position, providing switches 2 and 3 are on the "off" position. This relay closes 3015K (two contacts) sheet #11, that connect the Pirani Gage Meter to the Pirani Gage (inst.)

Relay 3016 does the same as above for furnace #2 and also 3017K does the same for furnace #3.

ALARM SYSTEM, TASK III, TOCCO UNIT
ELEMENTARY DWG. #H-2-12603 (Sheet #13)

There are eight (8) different sources of alarm on the Tocco Unit and its auxillary equipment.

1. Flow switch 3001 SF (located behind Tocco Unit) de-energizes relay 3018K(P14) when there is no water flowing to the frequency converter.
2. Flow switch 3002SF (Zone 3) de-energizes relay 3019K (P14) when there is no water to the work coil of furnace #1.
3. Flow switch 3003 SF (zone 3) de-energizes relay 3020K (P14) when there is no water to the work coil of Furnace #2.
4. Flow switch #3004 SF (Zone 3) de-energizes relay 3021K (P14) when there is no water to work coil of furnace #3.
5. Thermal switch 3001 TS (in Generator) de-energizes relay 3022K (P14) when the frequency converter over heats.
6. Bailey recorder, 3001RC (Panel 13) de-energizes relay 3024K (P14) when furnace #1 indicates over temperature on Bailey Recorder.
7. Bailey Recorder 3002 RC (Panel 14) de-energizes relay 3025K (P14) when furnace #2 indicates an over temperature on Bailey Recorder.
8. Bailey recorder 3003 RC (Panel 15) de-energizes relay 3026K (P14) when furnace #3 indicates over temperature on Bailey recorder.

Sheets 8 & 13)

The switches and relays shown on page #1 of this write up are designed in the control circuits to protect the Tocco Generator and its auxilliary equipment from damage by over heating. Also, to sound an alarm and light a lamp to indicate when and where the trouble is.

The master control switch of the Alarm system is 3041S located on Panel #15. This switch is a three position spring loaded switch designed to return to neutral position when released. Listed below is the positions of this switch and the operations they perform.

#1. Neutral Position: Contact #1 is closed. This is the position of the switch when everything is normal and the Tocco is working.
#2. Test Position: Contacts 3,4,5,6,7 & 8 are closed. In this position all the interlocks are set up in such a manner as to allow the horn to blow and the indicating lights to burn bright, showing that the alarm system is working properly, providing panel power switch 3043S(P-15) is in the "on" position.
#3. Reset position: Contacts 1&2 are closed. This position of the switch will energize any relay that has been de-energized by one of the switches listed on page #1 and stop the horn from blowing. It does not prevent the light from burning bright as the trouble has to be cleared before this can be accomplished.

When 3041S is in the neutral position 3051S1 is closed. If the Tocco Generator windings are at a normal temperature and the proper amount of water is flowing in the cooling system of the Tocco Generator and in the work coils, 3001SF, 3002SF, 3003SF, 3004SF and 3001TS switches are closed. These switches energize 3018K(P14) 3019K(P14), 3020K(P14), 3021K(P14) and 3022K(P14) relays respectively. Also if the Bailey Recorders are not registering an over temperature 3001RC1, 3002RC1 and 3003-RC1 contacts are closed. This energizes 3024K(P14), 3025K(P14) and 3026K(P14) relays. The above mentioned switches and contacts are used only when the work coil they represent is in operation.

ALARM SYSTEM, TASK III, TOCCO UNIT
ELEMENTARY DWG. #H2-12103 (sheet 8&13) cont'd.

Although all three work coils may be used, only one is permitted to operate at any one time. Due to this fact and because all three work coils operate alike, (except for contact, switch and Relay numbers) only work coil #1 operation will be illustrated here.

OPERATION OF TOCCO CONTROL OF #1 WORK COIL

3013S Frequency converter water switch is turned on. This energizes the solenoid valve #3020 to supply water to the converter allowing Tocco to start. (See Furnace Heating cycle write-up for further information on Tocco Start-up.)

Flow switch 3001SF is closed energizing relay 3018K(P14). 3002FS (Work Coil Switch) is closed energizing 3019K(P14). Bailey recorder 3001RCI contact is closed energizing 3024K(P14). When 3018K, 3019K and 3024K are energized each one opens a N.C. contact in the Reset relay circuit and also One each in the horn circuit. They also open the N.C. contacts in the indicating light circuits for lights 3016I, 3017I, and 3034I. This causes the lights to burn dim as these contacts when open cause the current for these lights to flow thru the entire resistance in the circuit.

In case of a failure of water (for instance) to work coil #1, flow switch 3002SF switch opens. This de-energizes 3019K and when 3019K de-energizes a N.C. contact on this relay in series with a N.C., contact on 3030K(P13) completes a circuit to the horn, causing it to blow and at the same time a circuit is completed thru another N.C. Contact on 3019K to the light cutting out part of the resistance of the circuit, causing the light to burn bright.

The horn will continue to blow until alarm switch 3041S is turned to reset position setting up contacts 3041S1 and 3041S2.

When 3019K is de-energized, one of its N.O. contacts in series with the coil that operates the work coil contactor opens, causing the breaking of the circuit to the work coil.

When 3041S is turned to reset position, 3027K and 3028K(P13) contactor coils are energized momentarily. This causes 3030K to be energized thru a N.C. contact on 3019K and a N.O. contact on 3027K and seals its self in thru one of its own N.O. contact. When 3030K is energized the N.C. contact of this contactor opens in the horn circuit causing the horn to stop blowing. Light 3019I will continue to burn bright until a sufficient amount of water is flowing thru the work coil to close 3002SF flow switch, which energizes 3019K opening a N.C. contact in the light circuit putting all the resistance in the circuit.

SOURCES OF POWER TASK IV
ELEMENTARY DWG. H-2-12731 (Elementary sheet #1)

110V. A.C. 1ø Fed from Breaker 401K, Cubicle 20
125V. D.C. Fed from Breaker 402K, Cubicle 20
220V. A.C. 3ø Fed from Breakers 403K-404K, Cubicle 20
440V. A.C. 3ø Fed from breakers 425K, 509K, Cubicle 20

110 volt breaker 401K, lights indicating light 401I(C20), when the breaker is closed
125 volt D.C. breaker 402K, lights indicating light 402I(C-20), when it is closed.
220 volt, 3 phase breaker 403K (C-20) lights indicating light 403I (D-19) when it is closed.
220 volt, 3 phase breaker 404K(C-20), lights indicating light 404I when it is closed.
440 volt, 3 phase breaker 325K(C-20) lights indicating light 423I(D-19) when it is closed.

TASK IV CARRIAGE DRIVE OPERATION (Sheet #3 of elementary)

The carriage drive 404B is a ½ hp. D.C. motor and is controlled by an Amplidyne Generator 401G. This Generator is driven by motor 405B which is a 440 volt, 3 phase motor and is controlled by relay 416K(C-20) and overload relay 419K(C-20). Relay 419K has two overloads in the control circuit of the 440 volt motor, 405B. It also has an overload in the control circuit of the 125 volt D.C. carriage motor (404B). An overload in either motor 405B or 404B will open the N.C. contacts on relay 319K(C-20), causing the 440 volt motor 405B to stop.

By pressing the Amplidyne "Start" (D-19), we complete a circuit from line 512A thru 5043S (future installation), thru the seal in contacts of relay 419K(C-20), thru the N.C. contacts on overload relay 419K(C-20), thru the coil of 416K relay (C-20) to line 519A. Completing this circuit will start motor 405B and indicating light 408I(D-19) will burn when the motor is running.

After the Amplidyne Generator is running, Field Switch 409S(D-19) is turned on which energizes relay 411K(C-20) seals in thru contacts of its own, which supplies D.c. thru fuses 401F and 402F. An indicating light 407I(C-20) will burn and D.C. will be supplied to contacts of 412K(C-20) and 413K(C-20), which are Travel relay contacts. Each of these two contacts when closed supply D.C. to the field of the carriage drive motor and to the control field of the Amplidyne Generator.

The carriage control switch is turned "ON" 414S(D-19), energizing 414K relay (C-20) and it seals in thru its own N.O. contacts. It also closes N.O. contacts 414K and lights an indicating light 409I(D-19). This relay also closes N.O. contacts 414K in the "Left" and right travel circuits.

Switch 410S(D-19) is a position switch, left Fast, Left Slow, right Fast and right Slow. It has six contacts, 5 and 6 are for "Left" travel and 3 and 4 "right" travel. Contacts 1 and 2 are in fast speed circuit of the Amplidyne. These contacts are closed in fast speed but are open in slow; this cuts in all the resistance in the control field of the Generator, causing the carriage motor to operate in slow speed.

After the carriage control switch is turned on, we turn the carriage travel switch 410S(D-19) to any one of its four positions. For instance, If we want to travel to the left fast we select left fast on 410S(D-19). This closes contacts 5,6 and 1,2. Out circuit is then thru the contacts 5,6, which are left travel fast thru N.O. contacts on relay 314K which closed when relay 314K was energized by turning the carriage control switch "ON" 414S(D-19) thru the coil of our left travel relay 412K(C-20) thru N.C. contacts on the left travel limit

Elementary Sheet # 3 cont'd

switch 453S. Thru the contacts 430K(C20) which were closed when we pressed reset button 437S, energizing 430K(C-20) relay. The travel circuit is now complete.

Energizing 412K(C-20) closes the N.O. contacts 412K in the field circuit of the carriage motor, also in the field circuit of the amplidyne contacts 1 and 2 of switch 410S(D-19) are closed because we are in left travel fast circuit. This cuts 402R and part of 403R resistance out of the control circuit, allowing the carriage to travel fast.

Contacts 1,2 of switch 410S(D-19) are only closed in the Fast speed of either right or left travel.

Pressing the emergency Stop 434S(D-19) button will stop the carriage in any position because relay 430K(C-20) will become de-energized and will open contacts 430K(C-20) in the travel circuit. To start the carriage again the Reset button must be pressed, which energizes 430K and 431K; Closing contacts 430K in the travel circuit.

TASK IV
FOR REFERENCE SEE ELEMENTARY #12731 (sheet #3)

COMPRESSOR MOTOR 401B

This motor is 2 hp., 3 phase, 220 volt and is controlled by contactor 406K(C20) and overload relay 405K (C-20).

There are three types of protection for this motor.

1. 401-S (Zone III) is a high pressure switch with N.C. contacts that will open on a high pressure setting. This will open the control circuit of the motor and it will stop.
2. 403-S (Zone III) is a temperature control with N.C. contacts which will open at a definite setting. This also will open the control circuit to the motor
3. Contacts 405K(C-20) are N.C. contacts in the overload relay which opens the control circuit of the motor in case of overload on the motor.

402-S switch (D-18) is a lock type switch with an "on" and "off" position. With this switch in the "on" position the circuit will be from 508C thru 402-S(D-18), thru N.C. contacts 403S (temp. Control (Zone III) thru N.C. contacts 401-S (Zone III) (high pressure) thru N.C. contacts on overload relay 405K(C-20), thru the coil of 406K(C-20) contactor to line 510C. Indicating light 405-I (D-18) will burn when this circuit is complete and motor 401B will run.

REFRIGERATOR DOOR MOTOR, TASK IV

Elementary Sheet #3

The refrigerator door motor is a 220 volt 3ϕ reversing motor fed from the main breaker 403-K(C-20), thru contactor 409-K(C-7). There are 2 limit switches which are on "up" travel limit and a "down" travel limit. These are located in the control circuit of the motor. They prevent over travel of the door in either "up" or "down" position. There are two push buttons for this motor 425-S(D-18) is for closing the door and 433-S is to open the door. These two switches are momentary contact and do not have any seal in contacts. This allows the door to be open or closed to the desired height by releasing the buttons.

The control circuit is from line 509 thru either 425-S(D-18) or 433-S(D-18), thru the normally closed contacts on either "up" or "down" limit switch thru the contactor coil thru the N.C. contact of the overload relay to line 508.

For Reference See Drawing H-2-12731 (Elementary Sheet #3)

TONG SQUEEZE MOTOR 406-B (Task IV)

This motor is a 1/12 HP., 3 phase, 220 volt, reversible motor, it is fed from relay 403K(C-20) and is controlled by contactor 417K(C-7) and protected by overload relay 418K(C-7).

The control circuit of this motor has a 2 position switch 416S(D-19) which opens and closes the tongs. There are also two limit switches. 457-S is "open" tongs and 458-S "close" tongs. Also in the control circuit there is a N.O. contact 431K which is contact of the "Reset" relay.

Pressing the "Reset" button energizes reset relays 430-K(C-20) and 431K(C-20) which seals in thru the N.O. contacts of 431-K(C20) relay. When this relay is energized it closes 431K(C-20) contacts in the control circuit of the tong squeeze motor.

The control circuit of this motor is as follows: From line 510 thru 416S switch (D-19), thru the N.C. contacts of the limit switch that is being used, either open or close, thru the coil of 417K(C-7) relay, thru N.C. contacts 416K(C-7)

TONG SQUEEZE MOTOR 406-B, (Task IV) cont'd

over load relay, thru 431-I(C-20) reset contacts which are closed to line 509. Indicating light413-I(D-19) will burn when the motor is running. By pressing the Emergency Stop button 434-S(D-19) Reset relays 430K(C20) and 431K9C-20) are de-energized, causing the contacts 431-K(C-20) in the control circuit of the motor to open. The motor will cease to operate. To start it again it will be necessary to press the Reset button (D-19).

This reset button has N.O. contacts in the carriage motor, Tong Squeeze motor and Tong Elevator motor. The Emergency Stop button will open the control circuits of all of these three motors.

TONG ELEVATOR MOTOR 407-B (Task IV)

Elementary Sheet #4

This motor is a 1/8 hp., 3 phase, 220 volt reversible motor; It is fed from 403K (C-20) breaker and is controlled by contactor 466K(C20) and is protected by overload relay 465-K(C;20).

Switch 419-S(D-18) is for the tong operation "up" and "down". Contacts 1 and 2 are for "up" contacts, 3 and 4 are for "down. There are two limit switches, one for "up" and one for "down".

The control circuit is from line 510 thru 419-S(D-19), thru either one of the N.C. contacts of the limit switch thru the coil of 466-K(C-20) contactor thru N.C. contacts 365K-(C-20) overload relay, thru N.O. contacts of Reset Relay C-20) to line 510. By pressing the emergency "stop" button Reset Relays 430-K and 431 (C-20) will be de-energized, opening 430K(C-20) contact in the Control circuit of this motor. The Reset button must be operated before this motor can start again.

MOTORS FOR FURNACE #1
ELEMENTARY H-2-12731, (Sheet #5)

Motor #	Main Breaker No.	Motor Contactor	Overload Relay No.	Switch No.	Motor Size
412-B-Rough Pump	403K--C-20	435-K--C-7	434-K--C-7	4066-S--P-18	1/2HP. 220V,3ø
413-B-Core Pump	403K--C-20	437-K--C-7	436-K--C-7	4065-S--P-18	1/2HP. 220V,3ø
414-B Refrig Pum. Vacuum	403K--C-20	439-K--C-7	438-K--C-7	4067-S--P-18	1/2HP. 220V,3ø
415-B Bottom Lift #1	403K--C-20	441-K--C-7	440-K--C-7	429-S - D-19	1/4HP. 220V,3ø

MOTORS FOR FURNACE #2
ELEMENTARY H-2-12731, (Sheet #6)

417-B Rough Pump	403K- C-20	446K - C-7	445K - C-7	4071-S -P-20	1/2HP. 220V,3ø
418-B Fore Pump Vacuum	403K- C-20	448K - C-7	447K - C-7	4072-S P-20	1/2HP. 220V, 3ø
419-B Refrig Comp	403K- C-20	450K - C-7	449K - C-7	4073-S P-20	1/2HP. 220V,3ø
420-B Bottom Lift #2	403K- C-20	452K - C-7	451K - C-7	430-S D-19	1/4HP. 220V,3ø

MOTORS FOR FURNACE UNIT #3
ELEMENTARY H-2-12731, Sheet #7

422 B Rough Pump	403K- C-20	457K - C-7	457K - C-7	4076-S P-22	1/2HP. 220V,3ø
423-B Fore Pump	403K C-20	459K - C-7	458K - C-7	4077-S p-22	1/2HP. 220V,3ø
424 B Refrig.Comp Vacuum	403K C-20	461K - C-7	460K - C-7	4078-S P22	1/2HP. 220V,3ø
425-B Bottom Lift #3	403K C-20	463K - C-7	462K - C-7	431-S D-19	1/4HP. 220V,3ø

MOTORS FOR FURNACE #1 Cont'd

412-B, 413-B, 414-B has a fused disconnect switch for the control circuit. This switch is located behind the panel and is marked 4106-S. This control circuit also has a N.O. contact of Reset Relay 430K(C-20). This relay must be energized, closing this contact. This is done by pressing the Reset button on Desk #19.

Each motor has an indicating light which are in series with N.O. contacts of the motor contactor. This light will burn when the motor is running. These lights are 4096-I, 4097-I and 4098½I, and are located on Panel #18. When either motor 412-B or 413-B are in operation, valves 405V or 406V are energized opening these valves. These valves are oil seal-in valves.

Bottom lift motor 415-B is a 1/4 HP.,200 volt, 3 phase reversible motor that is controlled by 441-K(C-7) and protected by overload relay 440K(C-7). Switch 429-S(D19) is a two position switch, "up" and "down".

435-S, located on motor is an up and down limit switch with N.C contacts.

With switch 429S closed in the "up" position, the circuit will be from the switch 429-S thru N.O. contacts 442K(C-7), thru the coil, thru N.C. contacts of overload relay 440K(C-7), thru 430K(C-20) reset relay contacts back to line 509.

When the bottom lift has reached its highest point of travel it opens the "up" contacts of limit switch 435-S (Zone III).

The above explanation applies to Unit 2 and 3 also, but with different switches, contactors, etc.

August 7, 1950

TASK IV
(Elementary Dwg. # H-2-12731)

Electrical Operation of Gages Controllers and alarms for Unit No. 1.

General

Close Switch 4001 S (on wall behind panels) to supply 110 V AC to panels. Indication with Lamp 4029 I on Panel No. 19.

Turn Switch 4002 S (P-18) "110 Volt AC Panel Power" to start position and release. Relay 4012 K energizes and seals in. Power on is indicated by Lamp 4001 I (P-18).

With the Panel Power on, the following circuits are completed:

1. 4001 K Relay (P-17) is energized. Contacts close to supply voltage to filaments in the 4003 CC Reactrol (P-19).

2. 4002 RC Pressure Recorder (P-18) is energized.

3. 4001 RC Temperature Recorder (P-18 is energized (note chart motor is on separate circuit.)

4. 4029 M Vacuum Gage is illuminated.

5. 4009 K Relay (P-18) is energized through contact 4001 RC2 which is closed below 450 C.

6. 4010 K Relay (P-18) is energized through contact 4001 RC3 which is closed below 200C. With Relay 4010 K energized, the 4001 V (Vent Valve) can be opened.

7. All other valves in the vacuum system can be operated with their respective switches. This does not include the cooling water valves.

Instrument Power

Close Switch 4013 S (P-18) to supply 110 Volt AC power to the 4001 CC Miller Gage Amplifier. Indication on by Lamp 4015 I (P-18).

Close Switch 4017 S (P-18) to supply 110 Volt AC power to the Thermocouple Pressure Gages and 4002 CC (P-18) contactless controller. Indication on by Lamp 4021 I (P-18).

Furnace Power

Close Switch 4070 S (on wall behind panels) to supply 440 volt single phase power for the furnace transformer. Indication on by lamp 4113 I (P-19). The primary voltage of the furnace transformer 4005 T is controlled through a Saturable Reactor 4015 X. The Reactor controlling DC circuit is through the Reactrol.

Anode and Filament Power for the Reactrol is obtained through Transformer 4016 T (P-19). Filament voltage is applied when the 4001 K Relay is energized (see item 2 under General). Anode Voltage is applied when the 4005 K Relay (P-18) is energized (see 9+14 of Elementary M-2-1273)

Pump and Compressor Controls

Close Switch 4106 S (on wall behind panels) to supply 220 volt control voltage for the mechanical pumps and compressor motors. An interlock through Limit Switch 435 S on the Bottom Lift requires the lift to be in the up position to complete the circuit. Also, the emergency stop Relay 430 K (C-20) controlled from Desks #19 or #20 has to be energized.

Close 4066 S (P-18) to start Roughing Pump indicated on by Lamp 4097 I (P-18).
Close 4065 S (P-18) to start Fore Pump Indicated on by Lamp 4096 I (P-18).
Close 4067 S (P-18) to start Vacuum Refrigerator indicated on by 4098II (P-18).

Cooling Water Valves

Diffusion Pump Cooling

Close Switch 4020 S (P-18) to open Solenoid Valve 4009 V (E-11). Indicated open by Lamp 4024 I (P-18). If alarm sounds see section under Alarms.

Furnace Cooling

Close Switch 4085 S (P-18) to open Solenoid Valves 4008 V, 4041 V, 4042 V, 4043 V. Indicated open by Lamp 4022 I (P-18). To complete this circuit, it is necessary that the furnace temperature is above 20 C or that the Outgassing Timer has timed out. (See description under Automatic).

Vacuum Valves

To operate the vacuum valves operate the following switches on Panel 18.

Valve		Sw. No.	Lamp No.
4001 V *	Vent Valve	4005 S	4006 I
4002 V	Roughing Valve	4006 S	4007 I
4003 V	Fore Pump Isolation	4007 S	4008 I
4004 V	Rough Pump Isolation	4008 S	4009 I
4005 V	Fore Pump Valve	4009 S	4010 I
4006 V	By Pass Valve	4010 S	4011 I
4007 V	Hy Vacuum Valve	4011 S	4012 II

*Valve 4001 V is interlocked through Relay 4010 K so that the valve cannot be opened if temperature in the furnace is above 200°.

Heating Controls with Manual Operation

Place Switch 4003 S (P-18) "Program Selector" in Manual position. 110 volts AC power is supplied to the chart motor 4002 B in the Temperature Recorder 4001 RC (P-18).

A. Diffusion Pump Heater

Turn Switch 4012 S (P-18) to ON position. Two interlocks in the line circuit to the 4012 S Switch requires:

1. 75 microns maximum pressure within the furnace. Accomplished through Relay 476 K (C-21) and contact in the 4002 CC Contactless Controller (P-18).

2. Cooling water flowing around the Diffusion Pump. Accomplished through Relay 474 K (C-21) and contact in the 4002 SF Flow Switch (E-11).

Indication of voltage supplied to the heater is shown by Lamp 4014 I (P-18).

The amount of current flowing in the heating element is controlled with the Variac 4001 T (P-18) and indicated with the Ammeter 4001 M (P-18).

B. Furnace Heater

Refer to Furnace Power above. To apply voltage to the furnace transformer, if conditions under Furnace Power have been met, it is only necessary to apply energy to the anode terminals of the Reactrol. By energizing Relay 4005 K (P-18) the anode will be energized through the relay contacts. In order to energize the 4005 K Relay the following conditions must prevail:

1. 4003 S2 Contact closed. Switch in Manual position
2. 4002 RC2 Contact closed. Furnace Pressure less than 10-4.
3. 518 K Relay energized. Bottom Electrode Cooling Water on
4. 473 K " " Furnace Body " " "
5. 519 K " " Furnace Base " " "
6. 475 K " " Top Electrode " " "
7. 471 K " " Furnace Temp. below over temperature alarm point.
8. Turn Switch 4004 S (P-18) to start position and release. The Relay 4005 K will seal in around 4004 S1 Contact.

If for any reason the 4005 K Relay is de-energized due to lack of one of the above conditions, it will be necessary to turn the 4004 S Switch to the start position again.

Heating Controls with Automatic Operation

Place Switch 4003 S (P-18) "Program Selector" in Automatic position. Contacts 4003 S1 are closed which supplies 110 volt AC power to the timing

devices providing Contact 4007 RC1 (in Pressure Recorder P-17) is closed. The 4007 RC1 Contact will close when a rough vacuum is obtained in the system.

A. Diffusion Pump Heater

Operation for this heater in the same for either Automatic or Manual see above description.

B. Outgassing Period

When the pressure is reduced to the range of 10^{-5}, Contact 4002 RC1 (in Pressure Recorder P-18) closes to energize Relay 4002 K which seals in around a N. C. Contact on Relay 513 K. Relay 513 K becomes energized through Contact 4002 K and seals in. Another 4002 K Contact energizes the clutch in the Timer 4001 TR (P-18) and it seals in. Another 4002 K Contact energizes the timer motor. At the end of timing period, a contact closes to energize Relay 4003 K. This relay will remain energized until after the annealing operation unless the reset Switch 4080 S is pushed. Indication that the clutch is energized in Timer 4001 TR is shown by Lamp 4002 I (P-18).

In the event the pressure increased above the 10^{-5} range closing the outgassing period, Contact 4002 RC1 opens which de-energizes 4002 K Relay and stops the timer motor. After the pressure is again reduced and the 4002 RC1 Contact is closed, the Relay 4002 K does not become energized due to the N.C. Contact on Relay 513 K which is still energized. The operator can now do one of two things.

1. Push Switch 4079 S on Panel 18 which releases the 513 K Relay allowing Relay 4002 K to energize and continue the time cycle where it left off.

2. Push Switch 4080 S (P-18) which releases in addition to the 513-K Relay the clutch in the timer. This will start the outgassing time from zero.

C. Heating Period

When Relay 4003 K became energized at the end of the outgassing period, a N.O. Contact closed in the 4005 K Relay coil circuit. The 4005 K Relay Contacts apply power to the furnace through the reactrol. Other elements in this 4005 K Relay coil circuit that must meet certain conditions are:

1. 4002 RC2 Contact closed. Furnace Pressure less than 10^{-4}.

2. 518 K Relay energized. Bottom Electrode Cooling Water on

3. 473 K Relay energized. Furnace Body Cooling Water on

4. 519 K Relay energized. Furnace Base Cooling Water on

5. 475 K Relay energized. Top Electrode Cooling Water on

6. 471 K Relay energized Furnace temperature below alarm point.

7. 4006 K Relay must be de-energized.

With the 4005 K Relay closed a circuit is completed through its own N.O. Contact, a 4003 K N.O. Contact, the 4001 Cam 2 Contact, and the 4001 Cam 3 Contact, to the motor in the 4001 Cam Controller P-18. The Cam Controller will rotate until 1000 C point is reached at which point the 4001 Cam 2 Contact opens and the motor stops.

The furnace is now energized and the Cam Controller set to regulate through the reactrol at 1000 C.

A contact on the 4002 K Relay (which is energized when the pressure is down to 10^{-5}.) closes with a N.C. Contact on the 515 K to energize the 514 K Relay. It seals in around the 515 N.C. Contact.

When the furnace temperature reaches 1000 C 4001 RC1 Contact closes and energizes Relay 515 K which seals in.

Another 514 K Contact energizes the clutch on the Heating Timer 4002 TR (P-18) which seals in. Another 514 K Contact energizes the timer motor. At the end of the timing period, a contact closes to energize the 4006 K Relay which seals in around the 4001 RC1 Contact keeping the clutch of the timer energized.

In the event the temperature of the furnace dropped below 1000 C and the 4001 RC1 Contact opened, the timer would reset so that the complete time period would start when the 4001 RC1 Contact closed again.

In the event the pressure increased above the 10^{-5} range during the heating period, Contact 4002 RC1 opens which de-energizes 4002 K Relay and the 514 K Relay and stops the timer motor. After the pressure is reduced and the 4002 RC1 Contact is closed the 4002 K Relay becomes energized because 4003 K Contact is closed. A 4002 K Contact closes but the 514 K Relay can not become energized because the 515 K N.C. Contact is open. To start the timer the operator can do one of two things.

1. Push Switch 4001 S to de-energize 515 K thus allowing the 514 K Relay to operate and a N.O. Contact start the timer motor.

2. Push Switch 4002 S to completely reset the timer to zero time.

D. Annealing Period

When the 4006 K Relay became energized, a N.O. Contact closed to complete the circuit to the 4001 B Motor in the 4001 Cam Controller (P-18). The Cam rotates until the temperature setting is 450 C at which point the 4001 Cam 3 Contact opens to stop the motor.

A N.C. Contact on 4006 K Relay opens to de-energize the 4005 K Relay and cut off the power to the furnace.

After the furnace cools to 450 C, the 4001 RC2 (Temperature Recorder P-18) Contact closes and energizes 4009 K. A N.O. Contact closes to energize 4005 K

again and apply power to the furnace to maintain the 450 C temperature. Another N.O. Contact on 4009 K in series with a N.O. Contact on 4006 K completes the circuits to the timer clutch and motor through contacts of the 516 K Relay. The 516 K Relay is energized through a N.O. Contact in 4002 K Relay (when pressure is below 10^{-5} range)and a N.C. Contact on the 517 K Relay. 517 K becomes energized when 516 K Contacts close.

In the event the temperature gets above 450 C the 4009 K Relay de-energizes and the timer stops. It starts as soon as the temperature is corrected.

In the event the pressure rises above 10^{-5} the 516 K Relay de-energizes to stop the timer. When the pressure is connected the timer does not start again due to the 517 K Relay remaining energized. To start the timer the operator can do one of two things:

1. Push 4083 S (P-18) to continue the timing cycle.

2. Push 4084 S (P-18) to reset the timer to zero and start the Annealing Period over.

Alarm Operation

For the normal set up the following relays will be energized thru the Contact 4019 S1 (Alarm Test Reset P-18). 4019 S1 is closed in the normal position, open in test position, closed in reset position:

1. Thru 401 RC 4 (Temperature Recorder P-18), 471 K is energized unless Furnace is overheated.

2. Thru 4002 RC3 (Pressure Recorder P-18), 472 K is energized when Pressure is below 10^{-5}.

3. Thru 4001 SF, 473 K is energized if Furnace Body cooling water is flowing.

4. Thru 4002 SF, 474 K is energized if Diffusion Pump cooling water is flowing.

5. Thru 4007 SF, 475 K is energized if Top Electrode cooling water is flowing.

6. Thru 4008 SF, 518 K is energized if Botton Electrode cooling water is flowing.

7. Thru 4009 SF, 519 K is energized if Furnace Base cooling water is flowing.

A. Furnace Pressure Alarm. (See page 14 of elementary)

Relay 472 K is de-energized until Pressure is reduced to 10^{-5} range and Contact 4002 RC3 closes. With 472 K de-energized, Lamp 402K I (P-18) is bright; also, Relay 478 K becomes energized thru a N.C. Contact on 4011 K Relay. 478 K Relay seals in and its N.C Contact prevents the horn from sounding. After

[redacted]

pressure is in the 10^{-5} range, the 4011 K Relay is energized and seals in. The purpose of the 4011 K Relay is to prevent the alarm from sounding until the pressure is reduced to 10^{-5} for the first time. Also, with the pressure in the 10^{-5} range Relay 472 K becomes energized which releases 478 K and the 4028 I Lamp becomes dim.

In the event the pressure increases above 10^{-5} and Contact 4002 RC3 opens 472 K becomes de-energized. A N.C. Contact on 472 K in series with a N. C. Contact on 478 K completes the circuit to sound the horn. At the same time another N. C. Contact on 472 K Relay shunts out a resistance to allow Lamp 4028 I to show bright. To cut off the sounding horn, the 4019 S (Alarm Switch P-18) is turned to reset which energizes Relay 477 K. A N. O. Contact on 477 K in series with a N. C. Contact on 472 K completes the circuit to energize 478 K. The N. C. Contact of 478 K opens to break the circuit to the horn. Releasing the Alarm Switch to normal de-energizes 477 K but Relay 478 K sealed in around the 477 K Contact and remains energized.

When the pressure is corrected, the 472 K Relay becomes energized and the alarm circuits become normal again.

B. Other Alarms

The other six alarm circuits function in the same manner as the Pressure Alarm described above with the exception of the 4011 K Relay. These remaining alarms will function immediately the abnormal condition occurs. It should be noted that the 4002 S Panel Power Switch (P-18) has a set of contacts in parallel with 4019 S2 which energizes the reset Relay 477 K. This prevents the horn from sounding but the indicating lamps will show abnormal conditions.

REFRIGERATOR ALARM SYSTEM, TASK IV

Elementary H-2-12731, Sheet 27

All the contactors listed below are mounted behind panel #17.

Switch 4042K is a 110 volt ac disconnect switch supplying 110 volt to Recording Instrument 4008-RC1 and also supplies 110 volts to Rectifier 4001-R.

Switch 4065S is a 6-volt disconnect switch which feeds the alarm circuit relays, all of them except 4038K, which is 110 volts. This 4038K relay coil is connected in series with a normally open contact 4064S2 which is the Alarm, Test, Reset Switch (P-17), and is connected across the load side of disconnect switch 4042K.

Switch 4066S is a disconnect switch which supplies 6-volts to Task VI.

Alarm, Test, Reset Switch 4064S is a spring loaded switch which returns to Alarm position when it is released. Special notice should be taken that there are two different voltages in this switch. Contact #2 is 110 V. contact, and contacts 6 and 10 are 6 volt contacts.

In Alarm position contacts 2 and 6 are closed and 10 is open. In Test Position, contacts 2,6, and 10 are open.

In reset position contacts 2,6 and 10 are closed.

When 4064S(P-17) is in alarm position contacts 2 and 6 are closed. Contact 2 energizes 110 volt relay 4038K(P-17). This relay when energized opens a contact in the circuit of relay 4041K and also opens 2 N.C. contacts of 4038K. These two contacts are in series.with each other and are in the horn circuit.

Contacts 6 is a contact for 6 volt relays 4037K and 4043K, and closing it in the alarm position energizes these relays. Relay 4037K opens N.C. contacts in relay 4040K, seal in circuit. This relay being de-energized keeps its own N.C. contacts in the horn circuit closed, but 4037K opens a N.C. contact in the light circuit 4093I(P-17).

Contact 4008RC1(P-17) temperature recorder is set to open when the temperature rises above 55 °F.

In the event the above happens, relays 4037K and 4043K will become de-energized. De-energizing these relays N.C. contact 4043 and 4037K are closed, relay 4040 is de-energized because contact 10 in switch 4064S(P-17) is open in the alarm position and 4040K N.C. contacts are closed, completing a circuit to horn 4004 and also to light 4093I(P-17). The horn will blow and light will burn.

By putting alarm switch in Reset position contact #10 of this switch is closed. Contact 2 is closed and contact 6 is closed but relays 4037K and 4040K are de-energized, because the contact 4008RC1 is still open breaking the circuit to contact 6 of the switch. Putting the switch in reset position energizes relay 4039K; energizing 4039K relay closes its own contact in the 4040K relay circuit, this relay has N.O. contacts in this same circuit and it seals-in around 4039K contact. 4040K relay has a set of N.C. contacts which open when 4040K becomes energized, this will stop the horn from blowing but alarm refrigerator light 4093I will continue to burn because a N.C. contact of relay 4037K relay is still closed with relay 4037K relay de-energized. This light will continue to burn until the temperature is corrected and contact 4008RCI in the temperature recorder closec.

Also in the Alarm System there is an alarm sounded in case of a 110 volt power supply failure. In the event this happens, the 110 volt supply is cut off of the rectifier but the alarm system is still maintained by the circuit from the 6 volt dc battery.

REFRIGERATOR ALARM SYSTEM, TASK IV (cont'd)

In normal operation of this system, 40648Z(P17) contact is closed when the alarm test reset switch is in alarm position. This energizes relay 4038K which has 2 N.C. contacts connected in series with light 4094I(P-17) and the horn. Relay 4038K also has a N.C. contact in the circuit of relay 4041K, but this contact only plays a part in the resetting of the alarm.

If the voltage fails, relay 4038K will become de-energized and the 2 N.C. contacts 4038K will close in the horn circuit, causing the horn to blow and light 4094I(P-17) will burn.

By turning switch 40648 to reset position, 40648Z will close, but 4038K relay will remain de-energized. This relay remains de-energized because 110 volt power has not been restored. 4038K has a set of contacts in the 4041K relay which are N.C. contacts. 40648 10 will close in the reset position, energizing 4041K relay and it seals in around its own N.O. contacts; this relay also opens the N.C. contact 4041K in the horn and the horn stops blowing, but the alarm test light will burn until power is restored to the 110 volt circuit, energizing 4038K and opening the N.C. contacts in the 4041K relay circuit and also the 4038K contacts in the light circuit.

Alarm Test is performed by turning switch 40648 to test position. This will open contacts 2, 6, and 10 of switch 40648(P-17). Relays 4038K, 4037K and 4039K become de-energized. This will complete a circuit to the alarm refrigerator light 4093(P-17), thru N.C. contacts 4040K thru N.C. contacts of 4043K, 4037K, 4094I and the horn will blow. Another circuit will be set up thru N.C. 4041K, thru 2 N.C. contacts 4038K, thru light 4093I (alarm refrigerator Test). Both 4094I and 4093I will burn in alarm test position.

It will only be necessary to let the alarm test reset switch return to the neutral position to stop the horn and also to turn out both indicating lights.

This is done in the following manner:

Contacts 2 and 6 of switch 40648(P-17) will close energizing relays 4037K, 4038K, and 4043. 4037K relay being energized opens 4037K contact in the light circuit 4093I, causing it to go out. 4043K and 4038K being energized at the same time will open N.C. contacts 4043K and 4038K causing the horn to stop blowing; also, 4038K will open the N.C. contact 4038K in the light circuit 4094KI(P-17) causing this light to go out.

The switch being in this alarm position is now set-up , ready for an alarm.

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TASK IV - PRELIMINARY H-2-12731

Sheet #8, Hood 17S

All working units in this hood are worked with Helium valves. Explaination of limit switches will be explained later in this write-up. All switches are located on Desk #20.

Equipment	Switch No.	Control Valve	Limit Switch	Location
Clamp	475 S	411 V	None	Hood 17-S
Punch	476 S	412 - 413V	None	Hood 17-S
Brush	479 S	416 - 417V	477S - 478S	Hood 17-S
Hammer	473 S	None	474S - 480S	Hood 17-S
Hammer trip	481 S	414 - 415V	None	Hood 17-S
Main Helium supply	482S	418V	None	top of Hood 17S

Switch 482S is the main valve supply switch. This switch permits helium to be admitted up to the intake side of each valve in Hood 17S. This switch must be in the "on" position before any of the valves will operate.

The clamp is operated and controlled by switch 475S and valve 411V. There are not any interlocks in the clamp control circuit.

The punch is operated and controlled by switch 476S and valves 412V and 413V. There are no interlocks. These valves control the operation of the punch "Up" and "Down".

The brush is also valve operated and is controlled by switch 479S. It has two limit switches 477S is the left limit and 478S is the right limit switch. The brush is also interlocked thru 480S so that is will not operate unless the hammer is in the "up" position. The brush will always return to the right position. With the brush in the right position limit switch 478S is closed so by pressing 479S brush button, the circuit is completed, thru 477S limit switch, thru 478S limit switch, thru 480S, thru relay 542K. This relay 542K has N.O. contacts which seal in around right limit switch 478S, permitting the brush to complete its travel to the left. Relay 542K also has a N.O. contact which closed when it energized permitting valves 416 and 417V to be energized. This brush has two valves which operate the left and right travel of the brush.

The hammer is a three-phase, 220 volt reversible motor, number 431B. It is controlled by contactor 511K and protected by overload 541K.

Switch 473 (D-20) has a down and up position. It has two limit switches, 474S is an up limit and switch 480S is a down limit and 474S is an up limit switch. The hammer can be operated up and down by switch 473S.

The purpose of the tripping button 481S is to energize valves 414V and 415V. These valves control the tripping mechanism of the hammer. Before the hammer can be tripped, the right limit switch 478S for the brush must be closed and the brush must be in the right position.

The hammer motor does not have anything to do with the actual tripping of the hammer. It just operates the hammer up and down so the hammer can be tripped from any height.

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April 7, 1950

ELECTRICAL OPERATION

TASK V

(Elementary Dwg. #12581)

The electrical operation for Task V is as follows:

General

To energize 110 volt AC control circuit, close Breaker 501-K on Cubicle #11. A red Pilot Lamp 501-I Desk #30 indicates circuit is on.

To energize 125 volt DC circuit close Breaker 502-K on Cubicle #11. A green Pilot Lamp 502-I on Desk #30 indicates the circuit is on.

To energize the 220 volt 3 phase power circuit close Breaker 503-K on Cubicle #11. A green Pilot Light 503-I on Desk #30 indicates the circuit is on.

Rotating Chute

The Swing Chute can be rotated in and out of position with an air motor controlled by Solenoid Valve 506-V. 506-V is energized by control Switch 512-S on Desk #22.

Elevating Jack

To raise Jack turn Switch 515-S on Desk #22 to raise position which energizes Solenoid Valve 507-V. Valve 507-V can not be energized unless Limit Switches 516-S and 518-S located on Hood #20 are closed.

To lower Jack turn Switch 515-S on Desk #22 to LOWER position which energizes Solenoid Valves 508-V and 510-V.

Lathe Chuck

To grip component turn Switch 509-S on Desk #22 to CLOSE position which energizes Solenoid Valve 501-V.

To release component turn Switch 509-S on Desk #22 to OPEN position which energizes Solenoid Valve 502-V.

Lathe Drive (variable speed)

To operate Lathe Drive:

1. Push Button 507-S on Desk #22 energizes Contactor 507-K which starts Amplidyne Drive Motor (2½HP) 503-B. The Amplidyne Generator is 502-G. Overload Relay 509-K is in the control circuit of 507-K. A red Pilot Lamp 507-I on Desk #22 will indicate when Motor 503-B is running.

2. Push Button 503-S on Desk #30 energizes Relay 503-K which in turn:

   a. Provides excitation voltage (125V DC) to field coil of Lathe Drive Motor 504-B (1½HP). Field voltage control is thru Variable Resistor 507-R on Desk #22. A red Pilot Lamp 503-I on Desk #30 indicates excitation voltage is applied.

   b. Energizes Relay 512-K which applies voltage to the Drive Motor 504-B from the Amplidyne Generator 502-G. Speed control is obtained thru the Variable Resistor 508-R. Other elements in the Amplidyne circuit are Resistors 516-R - 510-R - 511-R - 512-R; Fields F1, F2, F5, F7, F8; Rectifier 503 RECT, and Capacitor 502-C.

      Voltage current and speed of the drive motor are indicated on Desk #22. The speed is obtained thru a Tachometer Generator 503-G mounted on Drive Motor 504-B. A Speed Range Switch 525-S is also on Desk #22.

      To shut down the Lathe Drive Push Buttons 502-S on Desk #30 and 508-S on Desk #22.

Tool Feed Up and Down

To raise tool feed turn Control Switch 514-S on Desk #30 to RAISE position which energizes Contactor 514-K providing Limit Switch 521-S permits. Contactor 514-K energizes Motor 505-B (1/6HP) to drive carriage up.

To lower tool feed turn Control Switch 514-S on Desk #30 to LOWER position which energizes Contactor 515-K providing Limit Switch 522-S permits. Contactor 515-K energizes Motor 505-B to drive carriage down.

A Rectifier #504 RECT thru Transformer 501-T supplies DC potential to the winding of Motor 505-B for braking. Normally closed contacts on Contactors 514-K and 515-K remove the DC potential when the motor is driving up or down.

Limit Switches 521-S and 522-S are mounted to limit travel of carriage. Overload Relay 513-K is also in the control circuit of Contactors 514-K and 515-K.

Tool Feed In and Out (Away from or toward operator)

To move tool feed out turn Control Switch 317-S on Desk 30 to OUT position which energizes Contactor 517-K providing limit Switch 523-S permits. Contactors 517-K energizes Motor 506-B (1/6HP) to drive carriage out.

To move tool feed in turn Control Switch 517-S on Desk 30 to IN position which energizes Contactor 518-K providing Limit Switch 524-S permits. Contactor 518-K energizes Motor 506-B to drive carriage in.

A DC potential from Rectifier 504 RECT is applied to the windings of Motor 506-B for braking. Normally closed contacts on the Contactors 517-K and 518-K remove the DC potential when the motor is driving in or out.

The Limit Switches 523-S and 524-S are mounted to limit the travel of the carriage. Overload Relay 516-K is also in the control circuit of Contactors 517-K and 518-K.

Tool Feed Side to Side

To operate the Tool Feed Side to Side:

1. Push Button 506-S on Desk #22 energizes Contactor 506-K which starts Motor 501-B (2HP) to drive Amplidyne Generator 501-G. Overload Relay 508-K is in the control circuit of 506-K. A red Pilot Lamp 506-I on Desk #22 indicates the Amplidyne Drive Motor 501-B is running.

2. Push Button 504-S on Desk #22 energizes Relay 504-K which provides excitation voltage (125V DC) to field coil of the Tool Feed Drive Motor 502-B ($\frac{1}{4}$HP). The field voltage can be regulated with the Variable Resistor 501-R on Desk #30. A red Pilot Lamp 504-I on Desk #22 indicated excitation voltage is applied.

3. To move tool feed to the left turn Control Switch 510-S on Desk #30 which energizes Relay 510-K providing Limit Switch 519-S permits. Relay 510-K in turn applies the voltage from the Amplidyne Generator 501-G to Motor 502-B. Speed control is obtained through the Variable Resistor 502-R on Desk #30. Note that Resistors 501-R and 502-R are operated together thru Mechanical connections. Other elements in the Amplidyne circuit are Resistors 515-R, 504-R, 505-T, 506-R, Fields F1F2, F3F6, F7F8, Rectifiers 501 RECT, 502 RECT, and Capacitor 501-C.

4. To move tool feed to the right turn Control Switch 510-S on Desk #30 to to the RIGHT position which energizes Relay 511-K providing Limit Switch 518-S permits. Relay 511-K also applies voltage from the Amplidyne Generator to the Drive Motor 502-B but with polarity reversed. Speed control is the same as in 3 above.

   Limit Switches 519-S and 518-S are mounted to limit the travel of the Tool Feed.

   To shut down the Side to Side motion of the Tool Feed Push Buttons 501-S and 503-S on Desk #22.

Tool Position

Three selsyn units will indicate the position of the tool. The selsyn transmitters are mounted on the carriage. Selsyn 507-B indicates up and down movement; Selsyn 509-B indicates in and out movement; and Selsyn 511-B indicates side to side movement. The Selsyn Receivers will be mounted.

Receiver 508-B indicates up and down movement; Receiver 510-B indicates in and out movement, Receiver 512-B indicates side to side movement.

TASK V - JACK MOTOR HOOD 18
Elementary H2-12381, Sheet 5

All contacts, relays, and switches are in or on Desk 21.

Turn switch 526S, balance power switch, to "on" position. The jack motor switch is 2 switches, 554S and 556S combined. The jack motor switch can be turned to either raise or lower - by advancing farther on the "raise" or "lower" position, switch 556S will control the Speed of the Jack Motor.

There are two contacts in limit switch 5556. Contact 55581 is the top limit and will open when the jack has raised to a certain height, stopping the motor. The down limit contact 55582 will only allow the jack to come down so far.

Motor 519S Jack motor is a 1/20 hp., 125 volt dc, reversible motor. The only current protection for this motor are 2 fuses, 515F and 516F. One in each side of the dc line.

520K-(D-21) is a 110 volt, ac, reversible contactor and the coils of this contactor are 110 volt ac, but the contacts are in the 120 volt dc, motor speed control circuit and also, one in the field circuit of the motor

In the coil circuit of the reversing contactor there are two N.O. contacts of Jack motor switch 554S. Contact 55482 is in the "raise" circuit and 55481 is in the lower circuit.

Also in the above circuit, there are two contacts in limit switch 5556(Z-3). 55581 is the "raise" limit contact. 55282 is the lower limit contact.

In the dc speed control circuit there are two variable resistors, 554RA and 554RB connected in series. Jack motor switch 556S (D-21) controls the speed of the Jack motor thru different taps of the resistors.

Putting Balance Power switch 526S to the on position completes a circuit to the field of the motor thru a resistor 556R which energizes the dc motor field.

By turning Jack Motor switch 554S to "raise" 520KI becomes energized, closing two N.O. contacts 520KI in the speed control of the motor and a N.O. contact 520KI in the field circuit of motor 519S, this contact cuts out resistance 556R and allows full voltage to the field coil. At the same time switch 554S was turned to "raise" position a circuit was completed to motor 519 thru all of the resistance of 554RA and 554RB. The motor is now traveling at slow speed. As the Jack motor switch is advanced to the right in the raise position, the resistance in the circuit is cut out allowing the motor to travel at higher speed. There are 4 different speeds after the motor is changed from low speed. These speeds are in either lower or raise position.

The above condition also exist in the lower circuit of this motor.

In the "lower" position, 520KI contactor becomes de-energized opening all of the 520KI contacts in the speed control of the motor circuit.

All 520K2 contacts in the motor circuit close because 520K2 contactor coil is energized.

Switching from raise to lower also reverses the polarity in the motor armature circuit.

Power for Task VI (Elementary Drawing H-2-21443, Sheet #1)

Task VI has three sources of power fed from manually operated breakers at cubicals 13 on duct level as follows:

110 volt, 1ø, fed from breaker 690K located in cubicle 13.
220V, 3ø, is fed from breaker 689K located in cubicle 13.
440V, 3ø, is fed from breaker 688K located in cubicle 13.

Conveyor Power - (Elementary Drawing Sheet 1)

220V. 3ø manually control breaker 689K(C13) turned to "on", energizes wires 508, 509, and 510. Green light 601I(D25) will be energized.
Line side of relays 601K1, 601K2, 605K1, 605K2, 612K1 and 612K2(C8) (elementary sheet 2 and 5) are energized by energizing relay 667K(C13). To energize relay 667K press any one of conveyor power reset switches 670S(D37), 668S(D36), 666S(D25. Relay 667K seals its self in by one of its normally open contacts through conveyor power normally closed emergency stop switches 669S(D37), 667S(D36), 665(D25). Green light 647I(D36) will now be energized.

To de-energize relay 667K(C13) press anyone of conveyor power emergency stop switches and relay 667K will drop. Green light 647I will now be de-energized.

CONTROL POWER (Elementary drawing Sheet 1)

110V. manually control breaker 690K(C13) turned to "ON", energizing wires 517 and 518. Green light 600I(D25) and 6000I(P24) will be energized.

OPERATING PROCEDURE

Step I.

A. Turn on Die Storage Lube motor. (Elementary sheet #6)

Die storage lube motor is 220V, 3ø, energized through normal open contacts of 621K(C8) relay. 621K is energized through normally closed contacts of overload 620K and 612S(D36) Die storage lube motor switch turned "on". Red light 616I(D36) will now be energized.

B. Operate the jet mechanism to lubricate die.

The jet mechanism is operated by a solenoid operated clutch. Solenoid 601 is for right station, solenoid 603 is for left storage station. Solenoid 601 is energized through normal open contact of relay 622K, which is energized through limit switch 619S1 which closed when lift is down in right storage station, and 613S(D36) turned to "Right" storage station. Red light 617I(D36) will be energized.

Solenoid 603 is energized through normally open contact of 623K relay, which was energized when (elementary sheet #7) lifter is down in left storage station and switch 613S(D36)turned to "left" storage station. Red light 619I(D36) will be energized.

Step 2. (Preparation and Checking of the punch)

A. Turn on lubricant pump (Elementary Sheet #4)

Punch storage lube motor is 220V, 3ø energized through N.O. contacts of 610K(C8) contactor. 610K(C8) is energized by turning switch 608S(D25) Punch lub motor) to "on" through N.C. overload 609K(C8). Red light 609I(D25) will now be energized.

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B. (Operate Jet Mechanism to Lubricate punch)

The jet mechanism is a solenoid operated clutch. Solenoid 600 is for the "forward" station and solenoid 602 is for "Rear" station. Solenoid 600 is energized by turning switch 609S(D25) to "forward Station". Solenoid 602 is energized by turning switch 609S(D25) to "Rear Station".

Step 3. (Inspection of the die)

A. Lift the die to the chain conveyor (Elementary #6)

Assuming the die to be inspected is in the "right" die storage station, 618V will operate the lift cyclinder. 618V is energized by turning switch 618S(D36) to "up" thru N.O. contacts of 614K(C13) relay, which closed when the chain conveyor is over the "right" storage station. Relay 616K(C13) will be energized at this time and remains so as long as there is a die in the station. 619S2 (Down limit) is open and is held open when Lifter is down in "right" storage station. Switch 619S(Right down limit) will be closed, energizing 622K(C13), energizing red light 617I(D36). Red light 610I(D36) will be energized, indicating chain conveyor is over "right" storage station.

If the die to be inspected is in the "left" storage station.

(Elementary Sheet #7). Valve 619V operates "left" die storage lift and 619V(E23) is energized in the same manner as the right die storage lift.

B. Move the die with the chain conveyor to the station beneath the inspection hood (Elementary sheet #5).

Die conveyor is driven by 220V, 3ϕ motor 603B(E23) and is energized through N.O. contacts of reversing contactor 612K1 and 612K2(C8). Assume the die conveyor is over the "right" storage station (As was explained in Step 3.A), then relay 612K2(C8) "left" travel must be energized to move the die to inspection station. Relay 612K2(C8) is energized by turning switch 610S(D36 die conveyor spring loaded) to "left", through N.C. contacts of 619K, 618K (C13), 659K(C19), N.O. contacts of 662K-661K(C19), 603K, 623K, 624K(C13), 671S (right dies storage station up limit), N.O. contact of 633K (C19)

662K energized when water supply is on.
661K energized when stripper is up
603K energized when horizontal conveyor is out of assembly station.
623K energized when "left" die storage lift is down.
624K energized when there is a die in "left" storage station.
633K energized when chute is down.
Motor 603B is now energized and conveyor will travel to "left". When die reaches inspection station, operator releases switch 610S(D36) and conveyor stops.

C. Return the die to its storage station and lower it in the storage station.

The die conveyor must now travel to the right. Relay 612K(C8) (Right travel) must now be energized. Relay 612K1(C8) is energized by turning switch 610S (D36) Die conveyor) to "right" through N.C. contacts of 699K, 664K(C19), 698K, 697K, 614K, 615K(C13), 659K(C19), N.O. 662K, 661K(C19), 603K, 623K, 624K(C13), 671S, 633K(C19), which all energize in the same manner as was explained for "left" travel. Motor 603B will now be energized. Conveyor will now travel to the "right" until cam operated limit switch 611S10 (stripping station die conveyor reverse) closes. Unless operator presses and holds die conveyor by-pass switch 673S(D36), which will allow the

conveyor to pass the stripping station, Assembly station, and left die storage station. When the conveyor reaches limit switch 6118-1 (Right die storage station conveyor reverse) it closes energizing 697K(C13), which seals in through its N.O. contact and N.C. contact of 314K(C13). Conveyor will now reverse automatically through N.O. contacts of 697K(C13) and will move to "left" until die centers over "right" die storage station. At this time cam operated switch 61182 (right die storage conveyor stop) closes, energizing 614K which seals in by its own N.O. contact dropping 697K(C13) stopping conveyor. Turn right die storage switch 6188(D36) to "down" position and die will be returned to right die storage station. Red light 6171(D36) will again be energized.

Step 4. (Move the screw conveyor to the assembly station and raise the head to its proper height. (Elementary Sheet #3).

The horizontal screw conveyor is driven by 220V, 3ø, motor, 600B(H23) which is energized through N.O. contacts of reversing contactor 601K and 601K2(C8). Assume the horizontal conveyor is in rear cleaning station. Cam operated limit switch 60182(H23) Cleaning Stop) will be open. Red light 602I(D25) will be energized. To move the screw conveyor to assembly station 601K2(C8) (out travel) must be energized. Relay 601K2(C8) is energized by turning switch 600S (Punch conveyor D25) to "out", thru over load 600K(C8), N.C., 608K(C13), N.O. 666K, 684K(C19), 603K(C13), 665K(C19).

666K energized when horizontal conveyor is not in forward station.
684K energized when " " " " " rear "
603K " " " " " " " assembly station
665K " " " " " " " forward storage station.

Conveyor will now move "out" until cam operated limit switch 6018-3 (rear storage station H23) opens, dropping relay 684K(C19) stopping conveyror. To continue on to assembly station, operator must press switch 6748-2(D25) Punch conveyor by-pass) which by-passes 665K(C19), 603K(C13) and 684K(C19) Rear, Assembly, and Forward station). Conveyor will again move "out". Operator must release switch 6748-2(D25) Punch conveyor by-pass) as soon as conveyor is past rear storage station, to allow conveyor to stop at assembly station. By this time cam operated limit switch 6018-3(H23) will again have closed energizing 684K(C19) completing the circuit. When conveyor reaches assembly station cam operated limit switch 60186 (assembly station stop) will open, dropping 603K(C13) stoping conveyor. Red light 606I(D25) will now be energized. 606I(D25) will now be energized.

B. Raise the conveyor head to the proper height, elementary sheet #3

The vertical conveyor is driven by 220V 3ø motor 601B(H23) and is energized through N.O. contact of reversing contactor 605K1 and 605K2(C8). To raise the vertical conveyor 605K1(C8) must be energized. 605K1(C8) is energized by turning switch 6028(D25) Punch conveyor vertical) to "Raise", through overload 604K(C8), N.C. 603K(C13), N.O. 663K, 694-C19)
663K energized when die conveyor is not at assembly station
694K " when vertical conveyor is not up to assembly stop.
Vertical conveyor will now raise until cam operated limit switch 6038-3 (punch conveyor vertical assembly stop) opens, dropping 694K, stopping vertical conveyor. Green light 648I(D25) will now be energized.

C. Move the screw conveyor head to straddle the punch.

Assume the punch to be inspected is in the "forward" storage station. The horizontal conveyor must again be moved out. By turning spring loaded switch 600S(D25) to "out" and pressing conveyor by-pass switch 6748-2(D25) horizontal, conveyor will again move out as explained in Step 4.A. Horizontal conveyor will again stop when head straddles punch. Red light 605I(D25) will be energized.

D. Lower the conveyor head to its extreme postion so as to remove the punch from the detents.

To lower the vertical conveyor 605K2(C8) must be energized. 605K2(C8) is energized by turning switch 602S(D25 Punch conveyor vertical) to "lower" through overload 604K(C13), N.C. 665K(C19) N.O. contact of 607K(C13) energized when vertical conveyor was raised, and pressing switch 674S-1(D25 conveyor by-pass switch) conveyor will now lower until cam operated limit 603S-1(E23 Convyeor bottom limit) opens, dropping 607K(C13) stopping conveyor. Green light 607I(D25) will now be energized.

E. Move the punch below the cleaning hood entrance.

To move the punch under the cleaning hood, the horizontal conveyor must now be moved "in" by energizing 601K1(C8). Relay 601K1(C8) is energized by turning switch 60 S(D25 punch conveyor horizontal) to "in", through overload 600K(C13), N.C. 607K(C13), N.O. 683K(C19) which is energized when conveyor is not under cleaning hood. Conveyor will now travel in until cam operated limit switch 601S-2 (cleaning stop rear limit) opens, dropping 683K(C19) stopping conveyor. Red light 602I(D25) will now be energized.

F. Raise the punch into the cleaning hood.

To raise the punch the vertical conveyor must again be used. 605K1(C8) is energized by turning switch 602S(D25 Punch conveyor vertical) to "Rise", through overload 604K(C8, N.C. 683K(C19), N.O. 640K(C19), which is closed when vertical conveyor is down. Conveyor will now raise until cam operated limit switch 603S-5 (cleaning stop) opens, droping 640K(C19) stopping conveyor. Green light 607I(D25) will now be energized.

G. Lower the punch and return to its storage station.

The conveyor is lowerd by turning switch 602S(D25) to "Lower" and pressing 674S-1(D25 Punch conveyor by-pass) through N.C. 683K(C19) and N.O. 607K(C13), which is energized when conveyor is in up position. Conveyor will now lower until cam operated limit switch 603S-1(bottom Limit) opens, dropping 607K CC13) stopping conveyor. Green light 607I(D25) will now be energized. To return the punch to its storage station, the horizontal conveyor must be used and the same procedure followed as explained in Step 4. A.)

Step 6. (Introduction of the piece into the equipment.)

A. Pick up the punch with the screw conveyor.

To pick up the punch the horizontal and vertical conveyors are used, and is operated by the same procedure as the inspection of the punch as explained in Step 4.A--D.

B. Carry the punch to the forward loading station.

Assuming the punch to be used is in the forward storage station, horizontal conveyor must travel out. Relay 601K2(C8) must be energized by turning switch 600S(D25) Punch conveyor horizontal) to "out" through overload 600K(C13), N.C. contacts of 607K(C13), N.O. contacts of 666K, 684K(C19), 603K(C13).

666K energized when horizontal conveyor is not in forward load.
684K energized when horizontal conveyor is not in rear storage.
603K energized when horizontal conveyor is not in Assemb. station.

Conveyor will now move out until cam operated limit 601S-5 (Horizontal

[redacted]

forward load stop) open dropping 666K(C19) stopping conveyor. Red light 605I(D25) will be energized.

C. Raise the punch with the vertical conveyor into the loading station.

To raise the vertical conveyor 603K1 must be energized by turning switch 602S(D25) Punch conveyor vertical) to "Raise", thru overload 604K(C8), N.O. contacts of 668K(c19), which is energized when conveyor is down. N.C. 665K (C19) conveyor will now raise until cam operated limit switch 603S-4 (Conveyor forward load stop up) opens, dropping 668K(C19) stopping conveyor. Green light 645I(D25) will be energized.

D. Advance the head of the general conveyor with the piece into (H23) directly over the punch and place it on the punch.

For operation of the general conveyor, refer to (Task 12).

Step 7A - Raise the die storage station

Either die can be used and the same procedure is used to raise the "Right" or "left" die, as explained in Step 3. A.

B. Drag the die to the assembly station with chain conveyor.

The chain conveyor must now travel to the "left" and is energized in the same manner as was explained in Step 3.b.) Conveyor must travel through and slightly past assembly station, and then stopped by operator releasing switch 610S(D36 Die conveyor), and turning same to "right". (This is necessary because the automatic centering cam operated limit switches only operate when entering the station from the "left".) Conveyor will move to right until cam operated limit switch 611S-11 (Assembly station conveyor reverse) closes, energizing 664K(C19) which seals in on one of its N.O. contacts and N.C. of 663K(C19) conveyor now automatically reverses through N.O. contact of 664K(C19), and moves to left enough to center. At this time cam operated limit 611S-5 (assembly station stop) closes, energizing 663K(C19) which seals in through one of its N.O. contacts dropping 664K(C19) stopping conveyor.

C. Remove the punch from the loading station and convey to assembly station.

The vertical and horizontal conveyor must be used for this, and they are energized in the same manner as explained in Step 4. B&E. The horizontal conveyor must travel in until slightly past assembly station and then stopped by operator, releasing switch 600S(D25 Horizontal conveyor) and turning to "out". This is necessary to properly center punch with die, conveyor will only stop automatically at assembly station when moving out. Conveyor will move out until cam operated limit switch 601S-6 (Conveyor assembly station stop) opens, dropping 603K(C13) stopping conveyor.

D. Using the chain conveyor draw the die into the pressing station. Elementary Sheet #5.

The chain conveyor must be moved to the left. Relay 612K2(C8) must be energized by turning switch 610S(D26 die conveyor) to "left", through N.C. 619K, 618K-(C13), 659K(C19), N.O. 662K, 661K(C19), 603K, 623K, 624K-(C13). 671S (Right die up limit), 677S (Chute down limit). The above N.O. contacts are closed as explained in Step 3. b. Conveyor will travel to left until cam operated limit switch 611S-7 (Press station conveyor reverse) closes, energizing 618K(C13) which seals in thru its N.O. contacts and N.C. contacts of 619K(C13), conveyor will now reverse automatically thru N.O. contact of 618K(C13) and will move to right, centering die at pressing station; When

die is properly centerd cam operated limit 611S-8 (Pressing station conveyor stop) closes, energizing 619K(C13) dropping 618K(C13), stopping conveyor. Red light 615I(D36) will now be energized.

Step 8A. Turn on Motor of the pump unit and set the selector switch to deliver oil to press, Elementary Sheet #7.

The oil pump is driven by 7½ HP. motor, 220V, 3ϕ, #605B, and is energized through N.O. contacts of 626K(C13) contactor. Relay 626K(C13) is energized by turning switch 624S(D37 Oil pump) to "on" through overload 625K(C13). Red light 621I(D37) will then be energized. The oil is delivered to the press by energizing 621V(M23) by turning switch 625S(D37 Press control) to "Rise" and the switch 642S(D37) Oil flow control) to "Press", thru N.C. contacts of 660K(C19), N.O. 619K(C13), which is energized when conveyor stopped at press station. The press will now raise and the press cam will close around the die forming a vacuum seal and the induction coil will move around the die.

B. Turn on Vacuum pump. Elementary Sheet #9

The vacuum pump is driven by 220V, 3ϕ motor 607B, and is energized through N.O. contacts of 644K(C8) contactor. 644K(C8) is energized by turning switch 664S(D37) vacuum pump) to "on", through overload 643K(C8), N.C. 628K(C19), N.O. contact 630K(C19), which closed when press is up and forms the seal.

C. Turn on water to the Tocco Unit, capacitor and heat coil.

The water is turned on by energizing 624V and 625V, both valves are energized thru N.O. contacts of 630K(C19) which close automatically when press reaches the up position, closing limit switch 626S (press up limit). Red light 622I(D37) will also energize at this time.

D. Turn on Tocco unit, Elementary sheet #8

The Tocco is a M.G. set driven by 50 HP., 440V. 3ϕ motor 606B. The 440V, 3ϕ is fed from manually controlled breaker 688K(c13). When turned "on" will energize green light 60[illegible]1I(P24), lines 516, 519, 520 line side of 623K(C13) and control circuit for Tocco motor N.O. contacts of 632K(C13) when closed energizing Tocco motor 606B. Relay 632K is energized by turning switch 6029S (P24 Right frequency converter starter) to "automatic", through overloads 631K1 and 631K2(C13), N.C. contacts of 627K(C19), N.O. contacts of 639K, 630K(C19)

639K energized when converter is not above operating temp.
630K energized when press is up and induction coil is around die.

Red light 623I(D37) will now be energized. Relay 632K can also be energized by turning switch 6029S(P24) to "on" and alarm test switch 6047S15 turned to "test". By-passing 639K, 627K, 630K. Or with switch 6029S(P24) turned to "on" thru N.O. 639K(C19) which is closed if temperature of generator is not above operating temp. By-passing 627K, 630K(C19).

E. When the pressure has decreased to proper amount, turn on current in the induction coil.

The work coil is energized thru N.O. contacts of 6033K(P24) which is energized by turning switch 6027S(P24) to "automatic" thru N.C. contacts of 627K, 629K (C19). N.O. contacts of 645K, 642K(C19), 6035K(P24), 641K (C19)

645K energized when pressure decreased to proper amount
642K energized when proper amount of water is flowing in converter.
646K energized when proper amount of water is flowing in coil and capacitors.
6035K energized when switch 6027S(P24) is turned to "automatic".
641K energized when die is not above operating temperature.

Red light 6003I(P24) will now be energized. Relay 6033K can also be energized by turning switch 6027S(P24 Heat control selector) to "Manual", energizing 6034K(P24). Red light 6002I(P24) will be energized. On manual control the voltage output is controlled manually through rectifier 6000(P24), which is fed through variable resistor on N.O. contacts of 6034K(P24) which is energized when switch 6027S(P24) is set at "Manual" control. On "automatic" control 6035K(P24) will be energized thru switch 6027S(P24) turned to "automatic The output will be controlled thru voltage regulator 4VR1(P24) automatically. (For circuit drawing and operation of voltage, regulator 4VR1 refer to drawing 95J9A, the Ohio Crankshaft Company).

INSTRUMENTATION FOR TOCCO

The instrumentation consits of K.V. A.R. meter, K.W. meter, Amp meter and volt meter. The voltage supply is fed from output side of high frequency converter through fuses 6000F and 6001F, thru switch 6028S-1(P24 Instruments) turned "on", meter lights 6024I, 6025I, 6026I and 6027I(P24 will then be energized. The current to the meters is fed from secondary of current transformer 6000 C.T.(P24) thru KVAR and amp meter in series. With instrument switch 6028S-1(P24) turned "off", the secondary of the current transformer is shorted, and the meter lights are not energized.

C. When the die reaches the proper temperature, N.O. contacts 6001RC-S5 (Elementary Sheet 9 & 10) will close, energizing 647K(C19) energizing red light 634I(D37) thru N.O. contact of 645K(C19) which close when the proper vacuum was reached. At this time operator presses switch 633S (D37 Press automatic cycle) energizing 650K(C19), thru N.O. contacts of 645K and 647K(C19) which close as explained above. N.C. 652K(C19) and seals in by its N.O. contacts, energizing microflex timer motor and 651K(C19), thru switch 634S-1(D37 Press cycle) turned to "automatic". At this time 677K(C19) will de-energize by the opening of N.C. contact of 650K(C19) (Elementary sheet #7), and N.C. contact of 651K(C19) will open in press control circuit. Switch 635S(D37 press oil pressure) must also be in the "Raise" position (elementary sheet #10). The press oil pressure is controlled by 220V. 3Ø motor 608S and is energized thru reversing contactors 655K1, 654K2(C8) with the press oil pressure switch turned to "R ise", 654K(C8) will be energized thru overload 653K(C8) and N.O. contacts of 645K, 647(C19), which closed as explained above. 619K(C13) which energized when die conveyor stopped in pressing station and N.C. 636S (press pump high pressure limit) pressure will continue to raise until limit switch 636S opens. At the end of the microflex time cycle 650K(C19) de-energizes dropping 651(C19), energizing 629K(C19) and 623 valve. (Elementary Sheet #7) releiving press pressure and dropping 6033K(P24) load contactor to Tocco. The automatic time cycle need not be used if the operator wishes to use manual operation. Switch 634S(D37 Press cycle) turned to "Manual" will open N.C. contacts 652K(C19) by-passing automatic time cycle.

D. Start cooling helium flowing through pressing station.

To start cooling 627 Valve (press cooling) must be energized and is energized by turning switch 625S(D37) press control) is turned to "lower" thru N.O. contacts 648K(C19) 627K(C19)

648 energized when N.O. contact 6001RC-S6 closed in instrument.
627K energized when switch 625S(D37) was turned to "lower".

After the die cools to the proper temperature, 6001RC-S6 contacts open, dropping

648K(C19), energizing 628K(C19), de-energizing 649K(C19) Which is a DC relay energized through 600 Rect. (C19) and is time delay opening 3 seconds to alow vacuum system to vent before press lowers, also de-energizing 644K(C8), stopping vacuum pump and energizing 622 Valve (press lower) through normal closed 644K(C8), 649K(C19), 648K(C19, 660K(C19), N.O. 619K(C13) which closed when conveyor stopped in pressing station. Press will now lower to the bottom opening limit switch 641S de-energizing 659K(C19) energizing Red light 635I(D37) and relay 677K(C19), de-energizing 623V and 629K(C19)-press automatically stops. At the end of the cycle switch 625S(D37 Prese oil pressure) must be turned to "lower" energizing 654K2(C8), starting motor 608B thru N.C. 660K, 652K, 651K(C19) motor will run until low pressure limit switch opens, dropping 654K2(C8), press is again back to normal ready for next cycle.

The press oil volume is controlled by 220V. 3ϕ motor 609B and is energized thru reversing contactor 657K1 and 657K2(C8), which is energized through the same group of relays as the press oil pressure motor contactor and spring loaded switch 638S(D37 Press oil volume), the use of this motor is to control the volume of oil delivered to press for controlling speed of press.

TOCCO ALARM SYSTEM (Elementary Sheet #12

The Tocco alarm circuit consists of six (6) alarm relays, six reset relays, Alarm test switch and horn. Relay 662K(C19) is on water supply, 646K(C19) heat coil water flow, 642K(C19) frequency converter, water flow, 641K(C19) die over temp. alarm, 639K(C19) frequency converter over temp. alarm, 687K(C19) diff. pressure H23C and H23F. The alarm circuit is fed 110 volts from wires 517 and 518. Clear light 6004I(P24) will light when circuit is energized. In normal operation the alarm relays 662K(C19), 646K, 642K, 641K, 639K, 687K(C19 are energized and reset relays 670K, 691K, 692K, 693K, 695K, 696K(C19) are de-energized, and alarm switch 6047S(P24) is normally open. (This switch is spring loaded and will return to alarm position when released). Assume the water supply is cut off, pressure switch 646S will open, de-energizing 662K(C19). Red light 6039I will become bright, as 662K(C19) normally closed contacts by-pass part of resistance that is in series with light and horn will blow, thru normal closed contacts 662K and 670K(C19) to silence horn, operator must turn spring loaded switch 6047S-1 to reset energizing 670K(C19) and it will seal in thru its own normal open contact and normal closed 662K(C19). Red light will contaimue to burn bright until water supply has been turned back on and pressure switch 646S closes energizing 662K(C19), dropping 670K(C19) restoring circuit to normal. Heat coil water flow and frequency converter water flow switch are by-passed by normal closed contacts 630K(C19), keeping 646K and 642K(C19) energized with no water flowing in the heat coil and frequency converter with the press down. This is required because the water flow is automatically turned on when the press reaches the top and will keep the alarm circuit normal with the press down. 630K(C19) is so interlocked that the Tocco can only be started with the press down, by turning alarm switch 6047S to test and at this time the horn will sound because with the alarm test switch turned to test, all its normal closed contacts open de-energizing all alarm relays. In case of an alarm on anyone of the alarm relays in normal operation, the horn is energized in the same manner as explained before on the water supply, and is reset in the same manner. Also, an alarm caused by failure of water flow in heat coil frequency converter or water supply will automatically drop the load to Tocco and an alarm on the frequency converter over temperature will automatically stop Tocco, An alarm on the die over temp, will automatically drop the load to Tocco.

STEP 9 - UNLOADING OF THE DIE ASSEMBLY

A. Move the die to stripping station, set the switch to deliver oil to the stripping station. (Elementary Sheet #11).

The die is moved to the stipping station with the chain conveyor; the same procedure is used to move the conveyor into the stipping station as explained in Step 3-C. To deliver oil to the stripping station, 642S(D37) must be turned to "stripping" position energizing 660EC19 and red light 637I(D37).

B. Increase the pressure to the stripping station as required to move the cyclinder full length of stripping stoke.

Switch 643S-1(D37, stripper control, turned to "lower" energizing 628V thru 675S(H23C Stripper of 2-3/4" limit), which is closed when stripper is up, N.C. contact of 660K(C19) which energized when 642S(D37) oil flow control) was turned to "stripping". N.O. 617K(C13), which closed when chain conveyor stopped in stripping station. Operator must now turn switch 635S(D37) press oil pressure) to "raise", energizing 654KI(C8) thru N.C. 636S (High Pressure Limit), N.O. 617K(C13) which closed as explained above and overload 653K(C8). Pressure will rise until limit switch 636S (high pressure) opens, dropping 654KI(C8). Stripper will now lower until limit switch 675S (stripper at 2-3/4" limit) opens, de-energizing 628V. To release pressure, turn switch 642S(D37) Flow control) to "press". Stripper automatically raises.

C. Move the Die Assembly to Assembly Station and Lower the Punch.

The die assembly is moved to the assembly station with the chain conveyor, and the punch is lowered with the vertical conveyor. The same procedure is used to operate the conveyors as explained in Steps 3C & 4.

D. Move the Die to Stripping Station and Remove the Piece from the Dies.

When the die is again in the stripping station switch 642S (D37 Oil Flow control) must be turned to "stripping"; Chute must be run to "up" position. The chute is driven by 220V. 3ϕ motor, 619S and receives its power from the same source as conveyor motors (Elementary Sheet 1) and is energized thru N.O., reversing contactor 676KI and 676K2(C8), to run the chute up 676KI(C8), must be energized thru switch 676S(D37) Chute Control, turned to "up". Overload 675K(C8) N.C. 634K(C19), N.O. 617K(C13) which is energized when chain conveyor is in stripping station. When chute reaches limit switch 678S (Chute up limit), it closes, energizing 634K(C19) droping 676 KI(C8) stopping motor. With the chute up limit switch 678S closed, energizing 634K(C19) by-passes limit switch 675S (stripper 2-3/4" limit) allowing the stripper to lower full length of stroke. If full pressure of stripper does not remove the piece from die, operate hammer on top of stripper. Switch 644S(D37) Air Hammer) "pressed" energizes 630V thru N.O. 660K, which is closed when Oil Flow control is turned to stripping. To relieve pressure, turn switch 643S(D37 Stripper control) to "raise", turn switch 642S(D37) Oil Flow control) to "Press" and switch 676S(D37) Chute control) to "down". When chute reaches limit switch 677S (bottom limit) it closes, energizing 633K(C19) stopping chute motor.

STEP 10. Dry Cleaning in Hood (23C) Elementary 2-21443, sheet 13.

A. Open Door

The door is opened with an air cylinder controlled by 635V(H23C) energized

thru normally closed contacts of 682K(C8) and switch 651S(D38) turned to "open".

B. Raise Lifter to top.

Lifter is driven by 220V, 3ϕ motor 610B and is energized thru normal open contacts of reversing relay 672K1 and 672K2(C8). To raise lifter 672K1(C8) must be energized thru normally closed contact 649S(H23e, turn table "up" limit). Switch 648S(D38 Lift control) turned to "raise" and overload 671K (C8). When lifter reaches top cam operated limit switch 649S (up limit) opens, dropping 672K1 stopping motor.

C. After piece has been placed on lifter with general conveyor, lower the lifter to bottom.

To lower the lifter 672K2(C8) must be energized thru normally closed contact of 674K(C19), switch 648S(D38 Lift control) turned to "lower" and overload 671K(C8). When lift reaches the bottom cam operated limit switch 650S(H23c Down limit) closes energizing 674K(C19), dropping 672K2(C8) stopping motor.

D. Close door.

The door is closed by energizing 634V thru switch 651S(D38 Door control), turned to "close". Air cylinder closes door.

E. Turn on Blower.

The blower is driven by 220V, 3ϕ motor 613B(H23F) and is energized thru normal open contacts of 682K(C8). Relay 682K(C8) is energized thru normally open 678(C19), which is closed when door to (H23c) is closed. This interlock is to keep blower motor de-energized when door is not completely closed. Normally open 687K(C19) which is closed when (hood 23c) is at required diff. pressure. Normally open 662S(H23F Diff. pressure switch), which closes when required diff. pressure is reached. Switch 655S(D38 Blower motor) turned to "on" and overload 681K(C8), red light 641I(D38) will also be energized. At any time when the Diff. pressure is not at the required pressure, 687K(C19) will de-energize stopping blower motor and will sound an alarm on the Tocco Alarm system.

F. Turn on Turn table.

The turn table is drive by 220V. 3ϕ motor 612B(H23C)is energized thru normally open control 680K(C8). Relay 680K(C8) is energized through overload 679K(C8), normally open, 674K(C19) which closed when lifter reached the bottom and switch 654S(D38) turned "on". Red light 640I(D38) is also energized.

G. Turn on blast nozzles (Elementary Sheet #14)

Valve 632V operates nozzle #1 Valve, 631V operates nozzle #2. 632V is energized through normally open contacts of 687K(C19), 680K(C8, 682K(C8) and 678K (C19), which are all energized as explained above in step 11. E&F. Switch 656S(D38 Blast control) turned to No. I. Red light 643I(D38) is also energized.

631V is energized through the same relays as No. 1. and switch 656S(D38 Blast control) turned to "No. 2.". Red light 642I is also energized. Both 631V and 632V can be energized at the same time by turning blast control switch 656S(D38) to No. 1 & 2.

H. Operate shaker motor (Elementary Sheet #14)

The shaker is driven by 220V. 3ϕ motor 614B(H23F) and is energized through normally open contacts of 686K(C8). Relay 686K(C8) is energized through over-

load 685K(C8) and switch 657S(D38 Shaker motor) turned to "on".

Step II. Cleaning of the punch.

A. After the punch has been returned to its storage station set selector switch 679S-1(D25) to "drain".

B. Spray the surface with alcohol. (Elementary Sheet #4)

The alcohol supply is controlled by valve 636V and is energized thru switch 660S (float switch), switch 679S-4(D25 Selector) set at "Drain" and "pressing" switch 680S (Alcohol valve D25), green light 644I will energize. Also, 637V will be energized through N.O. 679S-2 (Selector switch), N.C. 606S (Forward station cleaning D25), N.C. 605S (Rear station cleaning D25), N.C. 615S (Right die cleaning), N.C. 617S (Left die cleaning). 637V is an alcohol recirculating valve.

The "purge, "flush", "wash" and "dry" are operated by turning switch 606S (forward station) or 605S (Rear station) to the respective positions thru N.C. 665K, 668K(C19) and switch 679S (selector) to "normal". The die cleaning station is operated in the same manner as the punch cleaning. (Elementary Sheet #6).

OXYGEN CONCENTRATION ALARM
Elementary H2-21443 Sheet 15

The instrument is fed from manually operated breaker 5001K (P5 Back Wall), energizing wires 5017 and 5018. When in the "on" position green light 5001I will be energized. The alarm circuit is fed from Panel 17, 6 volts thru 5003S(P5), energizing wires 5047 and 5048.

In normal operation 5002K(P5) and 5003K(P5) are energized thru normally closed contacts of 5001 R.C. (instrument) and normal open 5002S-1 (Test switch) which is closed with switch set at "normal".

At time of an alarm normally closed, contact 5001R.C.(P5) opens de-energizing 5002K, energizing "bell" thru normal closed 5002K and 5005K(P5). To silence bell turn test switch 5002S to "reset", energizing 5004K and 5005K(P5), thru normally open 5004K, 5005K(p5), seals in on one of its own normally open contacts silencing bell. Red light 5002I(P5) will be energized. When trouble has been corrected, 5001RC will again close energizing 5002K(P5), de-energizing 5005K(P5) and red light 5002I(p5) alarm is again normal.

To test alarm, test switch 5002S is turned to "test" de-energizing, 5002K and 5003K(P5) energizing, bell thru normal closed 5003K and 5006K(P5). Red light 5003I will be energized. To silence bell, turn test switch 5002S to "Normal".

TASK VII
ELECTRICAL INSTRUCTIONS

Elementary H-2-12397

Reference Elementary Sheet #1 & #2

OPERATION OF WORK UNIT #1

Check indicating lamps for voltage supply (Panel #26).
Green lamp #7001-I indicates 110V. 1ø, Breaker #701K(C10) closed.
" " 7002-I " 220V. 3ø " #702K(C10 "
" " 7003-I " 440V. 3ø " 703K(C10) "

Elementary Sheet #4

Check panel power disconnect #7009S (wall behind panel) must be "on"
" " " " " (Fuses #7006F and #7007F).
Check 220V. motor control circuit disconnect #7008S (wall behind panel) for "on".
" " " " " " Fuses #7004S and #7005S.

Turn the "Panel Power Unit #1" switch #7010S to "start" (momentarily). This switch is spring loaded for neutral position. Contact #7010S1 is a N.C. contact. When switch #7010S is turned to "start", #1 contact remains closed and contact #2 closes. No. 2 contact energizes relays #7001K(P27 and #7012K(P27) relays #7001K(P27) and #7012K(P27) seals-in thru a N.O. contact of relay #7012K and the N.C. contact of the panel power unit #1 switch #7010S. When Unit #1 is turned off contacts #1 and #2 or switch #7010S are both opened and relays #7001K (P27) and 7012K(P27) are de-energized.

Two N.O. contacts of relay #7001K(P27) energize lamp #7012I(P26), indicating panel power "on".

OPERATION OF UNIT #1

Two N.O. contacts of relay #7001K(P27) energizes the 110V. supply circuit for the following equipment of Unit #1:

See elementary sheets 4,5,6,7, and 13

Tripod motor #706B (1/70 HP. 110V 1ø) controlled by switch #708S(D28), Relay 709K(C10) limit control for the elevator motor 705B, Solenoid #701 (control permissive Unit for elevator motor).
Solenoid valve #703V (Rough pump bleeder and indicator lamp.)
" " 704V (High Vac. air supply " " ")
" " 705V (Roughing " " " " ")
" " 706V (Transfer " " " " ")
" " 707V (Unit #1 for pump ISO air supply and indicat. lamp)
" " 708V (" " Fough " " " " " " " ")
" " 709V (" " Fore " Bleeder and indicator lamp)
" " 710V (Manifold ISO air supply " " ")
" " 711V ("X" Gas admission)
" " 712V (Heluim admission)

Diffusion Pump 701HR and interlocking controls. Heat control and measuring instrument circuits for Unit #1. Another pair N.O. contacts of elay #7001K(P27) energize the 110V. supply for the unit #1 alarm system. A pair of N.O. contacts of relay 7012K(P27) energize the 110V. supply for the Tocco alarm system when unit #1 is in use. A. N.O. contact of relay 7012K(P27) connects the alarm horn #7001 to the unit #1 alarm system when Unit #1 is in use.

REFER TO ELEMENTARY SHEET #3

The disconnect #7008S, refered to above is fed from two legs of the 220V, 3ø breaker #702K(C10). Disconnect 7008S furnishes the control voltage

OPERATION OF UNIT #1 cont'd

for the following motors of Unit #1:

Motor#	HP	Volts	Phase	Feed Breaker & Cubicle #	motor Contactor & Cubicle No.	Control Switch & desk N .	Indication Lamp No.	Remarks
702B	½	220	3	702K(C10)	705K(C10)	701S(D27)	703I(D27)	
703B	½	220	3	" "	706K(C10)	702S(D28)	704I(D28)	Fore pump sealing va
704B	½	220	3	"	707K(C10)	703S(D27)	705II(D27)	Rough pump valve 702V
705B	½	220	3	"	708K(C10)	704S(28)	"""	Reverseabl

Assuming breaker 702K(C10) and disconnect 7008S (behind control panel) are closed, refrigerator motor 702B will run when switch 701s(D27) marked "compressor is turned "on". Switch 701S(D27) energizes motor contactor 705K(C10). Relay 774(C10) is the over current protection for motor 702B. The compressor indicatin lamp 703I(D27) is energizd from two legs of the motor feeds.

Switch 702S(C28) marked "fore pump" energizes motor contactor &706K(C10) which energizes motor 703B and the fore pump sealing valve 701V (Unit #1). Also, fore pump indicating lamp 704II(28). The current protection relay 775K for motor 703B is in cubicle #10.

Switch 703S(D27) marked "rough pump" energizes motor contactor 707K(C10) and energizes motor 704B, rough pump sealing valve 702V and the indicating lamp 705I(D27).

The above motors are located on the vacuum equipment rack. Their control circuits are not interlocked with other pieces of equipment.

UNIT #1 ELEVATOR MOTOR #705B
Elementary sheet #3 and #4

This motor is 1/2 HP, 220V, 3ϕ with reversible contactor 708K(C10). The purpose of the elevator motor is to lower and raise the bell jar which contains the induction heat coil. The N.C. contact of the current limit relay #777K(C10) for this motor is connected in the common line side of the two operating coils of contactor 708K(C10). The up-coil of contactor 708K(C10) is controlled by the up contact of manual switch 704S(D28), thru a N.C. contact of vacuum raise permissive switch 707S (Hood 25). A N.O. contact of up-limit relay 709K(C10) and the N.C. current limit contact. The down-coil of the contactor 708K(c10) is controlled by the down contact of a manual switch 704S(D28), thru the arm-down permissive limit switch 705S(N.C.)(Hood 25). The N.C. contact of down limit switch 706S (hood 25) and the N.C. current limit contact of relay 777K(C10.

OPERATION OF ELEVATOR MOTOR

Consider the bell jar assembly in the up position. The bell jar can be moved down providing the following conditions exist:
N.C. contact of the current limit relay 777K(C10) is closed.
N.C. " " " down limit switch 706S is closed. (It is closed when the bell jar is up, as it is now).
N.C. Contact of the down permissive switch 705S is closed (it will be closed if the product transport arm is swung out of the down peth of the bell jar), and switch 704S(D28) is turned to "lower". When the bell jar assembly is fully down, down limit switch 706S opens interupting the down coil circuit of motor contactor 708K(C10).

To move the bell jar assembly up, the following conditions must exist:
N.C. contact of the current limit relay 777K(C10) is closed

N.O. Contact of the up-limit relay 709K(C10) is closed because it is actuated by the up-limit switch 709S which is closed when the bell jar is down, as it is now.

N.O. contact of the vacuum raise permissive switch 707S is closed if the inside of the bell jar is at atmospheric pressure and the manual switch 704S(D28) is turned to "raise". The bell jar raises until the up-limit switch 709S opens, de-energizing the up-limit relay 709K(C10). The N.O. contact of relay 709K(C10) opens, interupting the up-coil circuit of contactor 708K(C10). The up-coil circuit cannot be completed if the inside pressure is low enough to hold the vacuum raise permissive switch 707S open.

TOCCO DRIVE

Requirements for operation of motor 701B, elementary sheets #2 and #13.

Before the Tocco drive motor can be started, the panel power switch 7010S(P26), for unit #1, or switch #7010S for unit #2, is turned to "start", momentarily. This operation is explained on Sheet #1 for Unit #1. Red lamps 7012I(P26) indicates panel power on. The alarm switch #7003S(P28) is spring loaded for "alarm" position and normally remains in this position, its contacts #2, #6 and #9 are closed. These alarm circuits are explained under "Unit #1 Alarm" sheets #8, #9 and #10. The Tocco "cooling water control" switch 7026S(P26) must be turned "on". Red lamps 7038I(P28) burns dim indicating cooling water switch is "on". When the proper amount of water is flowing in the Tocco cooling system, a N.O. contact of flow switch 7009SF (located at the Tocco) closes, energizing the Tocco alarm 755K(C10).

The Tocco over-temperature alarm relay 756K(C10) is held, energized by a N.C. contact of thermal switch 7012TS (located at Tocco, which is actuated by over-temperature of the Tocco. Switch 7012TS opens if the temperature becomes abnormally high. When the Tocco temperature is normal "over temperature" indicating lamps 7039I(P28) burns dim. The coil circuit of the contactot 704K(C10) for motor 701B can now be completed through a N.O. contact of relay 755K(C10). A N.O. contact of relay 756K(C10), motor over-current protection relay 773K(C10), and the motor "stop" switch 7002S(P26) when the "Start" switch 7001S(P26) is pressed.

If the Tocco water flow diminishes, flow switch 7009SF opens de-energizing relay 755K(C10). Motor 701B stops as its control circuit is interupted by the N.O. contact of relay 755K(C10). The same holds true in case of Tocco over-temperature, as relay 756K(C10) is de-energized. In case of excess motor current, the current limit contact of the current limit relay 773K(C10) opens the motor control circuits.

Requirements for connecting Unit #1 heat coil to Tocco. For automatic heat control Elementary Sheet #6 and 13).

Before the heat coil can be energized, the following conditions must be met: Unit #1 "capacitor and coil water" switch 7023S(P26) must be turned "on". When the proper amount of water is flowing in the heat coil cooling system, A n.o. contact of flow switch 7001SF is closed energizing the heat coil water alarm relay 721K(C10). "coil Water" indicating lamp 7020I, normally burns dim. When the proper amount of water is flowing in the capacitor cooling system, A N.O. contact of flow switch 7002SF is closed, energizing the capacitor water alarm relay 722K(C10). The capacitor water indication lamp 7021T burns dim. A N.C. contact of the temperature controller 7001RC holds the tripod over-temperature alarm relay 726K(C10) energized. The tripod over-temp. alarm lamp 7025I burns dim. The coil circuit of the heat control relay 7003K(P27) can now be completed when the heat control switch 724S(D27) is turned "on", temp. controller

switch 7012S is in "auto" position, contact 7001RC2 is closed (contact 7001RC2 is closed when the temperature controller is calling for heat), thru N.O. contacts of the energized alarm relays 721K(C10), 722K(C10) and 726K(C10). The heat coil control relay 7003K is located on back of panel 27. The heat coil contactor 7005K is mounted on the inside of the west wall of the panel cubicle. Contactor 7005K is energized by a N.O. contact of relay 7003K. When the above series of contacts are closed, relay 7003K is energized, also relay 7005K. Two N.O. contacts of relay 7005K connected in parallel, when closed, completes the unit 1 heat coil circuit to the Tocco generator. The above setting give automatic heat control as contact 2 of heat controller 7001RC opens and closes.

The automatic heat indicating lamp 721-I(D27) is energized when contacts 5 and 6 of the temperature controller switch 7012S and a N.C. contact of relay 7003K close. Therefore when the heat controller calls for heat, the N.C. contact of relay 7003K opens and the lamp goes out. The lamp indicates the circuit set-up for automatic control. Yellow lamp 701-I(D27) energized by a N.O. contact of relay 7003K indicates "heat on".

As mentioned on Sheet #6 of this work, the diffusion pump is turned "on" by manual switch 720S(D28) but the pump is not energized until relay 7002K(P27) is energized, which occurs when the proper volum of vacuum is reached in the "fore line". The coil of relay 7002K(P27) is energized thru a contact of relay K1 in the contactless control unit 7001CC.

OPERATION OF UNIT #1 HEAT COIL

Manual Heat Control — See Elementary Sheet #6

Requirements for connecting unit #1 heat coil to the generator for manual heat control.

Turn "Manual Heat" switch 7013S(P26) to "on". Turn "temperature control" switch 7012S(P26) to "Manual" position. A closed contact of each of these switches in series, bypass the #2 contact of the heat controller 7001RC. The circuit is now completed thru the same N.O. contacts of relays 721K(C10), 722K(C10) and 726K(C10) to the coil of relay 7003K(P27), as it was for automatic operation. Relays 721K(C10), 722K(C10) and 726K(C10) are energized by the same means and for the same reason as they were for automatic operation. The only difference in the two settings being that the heat controller 7001RC contact #2 is out of the circuit. The heat is now controlled by the operator by turning the manual temperature switch 7013S to "on" or to "off" positions. Red lamp 7011I(P26) marked "unit #1 Manual Heat" indicates the temperature controller switch 7012S(P26) is in manual position. It does not indicate heat on or off. Yellow lamp 701I(D27) is energized thru a N.O. contact of relay 7003K(P27) and indicates "heat on".

TOCCO GENERATOR #701G

Elementary Sheet #2

7.5KW, 220V., 34 amp., 10,080 Cy/sec. Freq. (Ohio Crankshaft Co.)

The output of the generator is controlled by field flux variation. The field flux is controlled manually or automatically (field voltage regulator). Which is used, depends on the position of the gen. field control switch 7004S(P26).

MANUAL FIELD CONTROL

For manual control, switch 7004S(P26), marked "Gen. Field Control" is turned to "Manual" position and switch 7005S(P26) marked "Gen. Field" is turned "on".

Contacts #1 and #2 and #3 and #4 of switch 7004S(P26) close, completing the circuit thru fuse 7001F and contact #1 (closed) of switch 7005S(P26) to transformer 7001T(P26) (variac). Amber lamp 7005I(P26) marked "Man. Field" indicates transformer 7001T energized. The output of transformer 7001T is directly connected for variable input to rectifier 7001 Rect. (P26). Contacts #5 and #6 and #13 and #14 of switch 7004S)P26) also closed, connecting the generator field to the rectifier #7001(P26) rect. The variable output of the transformer is controlled by a knob and dial (P26), marked "field control Man.". Thus, the manual controlled magnetude of the current from the transformer is rectified and fed to the generator field for variable field flux effecting the gen. output. A thrite resistor #701 connected across and near the gen. field prevents excessive high voltages in case of an open circuit.

AUTOMATIC FIELD CONTROL
Elementary Sheet #2

For automatic field control, switch 7004S(P26) marked "Gen. Field control" is turned to "auto" and switch 7005S(P26) marked "Gen. field" is turned to "on". The generator and generator field are then connected to a field voltage regulator #7001VR. There are two inputs to the regulator switch, 7004S(P26) contacts numbers 9, 10, 11 & 12 close, completing the circuit from two legs of the three phase load side of the tocco drive motor contactor #704K(C10) to the power transformer T1 of the regulator. Contacts numbers 17 and 18 and 19 and 20 of switch #7004S(P26) close, completing a reference voltage circuit from the output terminals of the generator, through fuses 7002F, 7003F (3 amp) to the isolating transformer #TF of the regulator. Contact numbers 7, 8, 15 and 16 of switch 7004S(P26) close, connecting the generator field to the regulator. The circuit is now set-up for automatic generator output. For further information see descriptive bulletin and Operating Instrustructions 95J9A. Ohio Crankshaft Co. (This Bulletin and drawing are part of the instruction book).

TOCCO GENERATOR
INSTRUMENTATION

Meters Used:

No. 7001M, 5 amp, 220 volt, function Varmeter (5-0-5 Kilovars)
No. 7002M, " " " " Wattmeter (0-10 Kilowatts)
No. 7003M, 0-5 A.C. amps " Ammeter (0-50 amps)
No. 7004M, 0-400A.C. volts " Voltmeter (0-400 volts)

For generator output readings, switch 7007S(P26) marked "Gen. Instruments" is turned "on". When this switch is "on" the potential circuit for the instruments is completed through a closed contact of switch 7007S(P26), and two 3-amp, 220V. fuses (numbers 7002F(P26), 7003F(P26) to the generator output terminals. The potential leads of the KVAR meter are connected directly across the instrument potential circuit. The potential leads of the KW meter are connected in series with a 7400 ohm resistor across the instrument potential circuit. The voltmeter is connected in series with a resistor across the instrument potential circuit.

The current circuit for the KVAR, KW, and ammeter is the secondary of a current transformer 7002T(P26), connected in the output circuit of the generator. When the "Gen. Instrument" switch is turned "off", the instrument potential circuit is opened and the current transformer secondary is shunted and grounded. Each of the four meters have a clear dail lamp 7006I, 7007I, 7008I and 7009I, panel 26. These lamps burn when the 110V. A.C., 1ø supply breaker 701K(C10) is "on". This instrument net-work is used when the generator output is manually or automatically controlled.

UNIT 1 DIFFUSION PUMP
Elementary sheets 4-13

The unit #1 diffusion pump circuit is interlocked with the diffusion pump water flow alarm thru a N.O. contact of relay 723K(C10) (See alarm sheet 9 of this work) and two N.O. contacts of relay 7002K(P26) controlled by the bell jar vacuum measuring system. (see elementary sheet 5). Therefore relays 723K(C10) and 7002K(P27) must be energized for operation of the diffusion pump.

OPERATION

Alarm switch 7003S(P28) is in "alarm" position (normal). Switch 720S(D28) marked "Diffusion Pump" is turned "on". Relay 723K(C10) is energized when the proper amount of water is flowing in diffusion pump cooling system as the contact of flow switch 7003SF (Vac. equip. rack) is closed.

Relay 7002K)P27) is energized when a pre-determined valve of vacuum has been pulled on the bell jar. Relay 7002K(P27) is actuated by a contactless relay 7001CC(P27) which responds to signals received from the vacuum gage measuring system of the fore-pump line.

After the diffusion pump switch 720S(D28) is turned on, the diffusion pump operates automatically thru relay 7002K(P27). However, the diffusion pump may be turned off at any time by the operator by turning off switch 720S(P28).

UNIT I DIFFUSION PUMP CONTROL
Elementary Sheet 4 & 5

As mentioned above the diffusion pump 701 HR is turned "on" by manual switch 720S(D28) but the pump is not energized until relay 7002K(P27) is energized. Relay 7002K(P27) interlocks the diffusion pump circuit with the vacuum on the "fore" line. The purpose of this interlock is to have a certain value of vacuum (about 75 microns) drawn in the bell jar before the diffusion pump becomes effective in drawing a greater vacuum in the bell jar.

Meter 702M(D28) indicates the "fore" line vacuum, it is actuated by a milivolt current received from a thermal gage tube 7001TG in the "fore" line. This motor, in reality a milivolt motor (0-96 milivolts) calibrated in microns (500-0 microns) has a sensing coil build into it, not electrically connected to the meter circuit. The sensing coil is in the control grid circuit of an oscillator type (6SJ7) in the contactless controller 7001CC.

The coil is so placed in the meter so that when the pointer of the meter moves toward zero microns, a flag attached to the pointer moves out of the coil thereby changing its permeability, effecting a rise in voltage of the control grid. When the meter indicates about 75 microns, the oscillator conducts sufficient current to close a relay K1 (in the contactless controller). A N.O. contact of relay K1 energizes the coil of relay 7002K(P27). Two N.O. contacts of relay 7002K(P27) complete the diffusion pump circuit.

ALARM SYSTEM

All of the alarm relays are in cubicle #10 (duct level).

There are three alarm systems in Task VII, one for each unit and one for the Tocco. The three systems use the same horn, #7001(P28), the same alarm switch 7003S(P28). There are three main alarm reset relays, 757K(C10) for unit #1, 758K(C10) for unit #2 and 759K(C10) for the Tocco. The purpose of these main reset relays is to energize the reset relays of the individual alarm circuits.

The main reset relays are energized at the same time, momentarily, when the panel power is turned on for either unit or when the alarm switch 7003S(P28) is turned, momentarily, to "reset".

Each alarm circuit has its individual alarm relay and its alarm reset relay, also an indicating lamp for example:

The Tocco has two alarms, the water flow alarm using alarm relay 755K(C10), water flow alarm reset relay 760K(C10) and water flow alarm indicating lamp 7038I(P28). The over-temperature alarm using alarm relay 756K(C10), over-temperature alarm reset relay 761K(C10) and the over-temperature indicating lamp 7039I(P28).

Elementary Sheet #15 TOCCO ALARM

The 110 volt supply for this system is supplied thru a N.O. contact of relay 7012K(P27) which is energized when unit #1 is in use or thru a N.O. contact of relay 7017K(P25) which is energized when unit #2 is in use. When both units are used, both relays are energized (their contacts parallel).

OPERATION

Assume that the alarm switch 7003S(P28) is in alarm position (normal). Contact 700389 is closed energizing the feed side of switches 7009SF and 7012TS (located at Tocco unit). Flow switch 7009SF is actuated when the proper amount of water is flowing in the Tocco cooling system energizing the water flow alarm relay 755K(C10).

Temperature switch 7012TS is actuated by an over-temperature condition of the Tocco and de-energizes the over-temperature relay 756K(C10). When the water flow and temperature of the Tocco are normal, relays 755K(C10) and 756K(C10) are energized, the water alarm indicator lamp 7038I(P28) and the over-temperature indicator lamp 7039I(P28) burn dim, the alarm horn 7001(P28) does not sound.

The Tocco alarm main reset relay 759K(C10), the T cco water alarm reset relay 760K(C10) and the Tocco over-temperature alarm reset realy 761K(C10) normally remain de-energized.

Example of operation (refer to Tocco drive operation Sheets 3 & 4

Suppose the water flow in the Tocco cooling sytem diminishes or a cut off, the contact of flow switch 7003SF opens, relay 755K(C10) is de-energized. A N.O. contact of relay 755K(C10) opens the Tocco drive motor control circuit, a N.C contact shunts part of the water flow indicator lamp 7038I(P28) resistor causing it to burn bright. Another N.C. contact of relay 755K(C10) closes the alarm horn 7001 circuit thru a closed contact of the water valve switch 7026S (P28), and a N.C. contact of the tocco water alarm reset relay 760K(C10) which (mentioned above) is not energized.

The horn ca be silenced by turning the alarm switch 7003S(P28) to reset" momentarily which momentarily energizes the Tocco main reset relay 759K(C10), a N.O. contact of relay 759K(C10) energizes the Tocco water flow alarm reset relay 760K(C10) which seals-in thru one of its own N.O. contacts and a N.C. contact of relay 755K(C10) (de-energized at beginning).

The horn is silenced but the water flow indicating lamp 7038I remains bright until water (normal) flow is restored in the Tocco Generator, cooling system. When the water flow is restored to normal, flow switch 7009SF contact closes, energizing the Tocco water alarm relay 755K(C10). The N.C. of relay 755K(C10)

which shunted part of the resistance in the water flow indicating lamp circuit, opens allowing full resistance in the circuit. The lamp burns dim, indicating normal water flow. The N.C. contact of relay 755K(C10) thru which the Tocco water alarm reset relay 760K(C10) sealed-in, opens dropping relay 760K(C10) out. The N.C. contact of relay 760K(C10) thru which the N.C. contact of relay #755K(C10) energized the alarm horn is closed. The alarm circuit is again normal.

The N.O. contact of relay 755K(C10) which appears in the control circuit of the Tocco motor circuit is now closed and the Tocco can again be started.

UNIT #1 ALARM
Elementary Sheet #13

Unit #1 has seven alarms as follows:

Over pressure alarm using relays	#720K	Reset relay	#728K		
Heat coil water " " "	721K	"	"	729K	
Capacitor " " " "	722K	"	"	730K	
Diffusion pump water alarm "	723K	"	"	731K	
Heat trap under temp. " "	725K	"	"	733K	
Tripod over temp. " "	726K	"	"	734K	
Pressure "X" Gas & Helium "	727K	"	"		

Note: Relay 727K(C10) is energized and sealed-in thru one of its own contacts after the "X" gas or helium has been used. Over pressure will not sound on alarm unless this relay is energized because the horn circuit is completed thru a N.O. contact of relay 727K(C10). Unit #1 uses main reset relay 757K(C10) which is energized when the alarm switch 7003S(P28) is turned to reset. Relay 757K(C10) energizes all the above reset relays. The reset relay, which is in the circuit which caused the alarm seals-in thru a N.C. contact of the alarm relay which is de-energized when the alarm occured. Thus, the horn is silenced. Part of the indicating lamp resistance of this particular alarm circuit is shunted causing the lamp to burn bright.

EXAMPLE OF ALARM WHEN CAPACITOR WATER FAILS

All reset relays are normally de-energized. When the capacitor cooling water flow diminishes or is cut off, the contact of flow switch 7002SF opens de-energizing the capacitor water flow alarm relay 722K(C10). A N.C. contact of relay 722K(C10) closes, completing the alarm horn 7001 circuit thru a N.C. of reset relay 730K. Another N.C. contact of relay 722K(C10) shunts part of the indicating lamp 7021I(P28) resistor causing it to burn bright. The horn is silenced by turning the alarm switch 7003S(P28) to "reset" momentarily. This momentarily energizes the main reset relay 757K(C10). A N.O contact of relay 757K(C10) energizes the capacitor water flow alarm reset relay 730K(C10) which seals-in thru one of its own N.O. contacts and a N.C. contact of the capacitor water flow alarm relay 722K(C10) (now de-energized). The N.C. contact of the reset relay 730K(C10) which appeared in the horn circuit above is opened silencing the horn but the indicating lamp continues to burn bright until the water flow is restored, which will re-energize the capacitor water flow alarm relay 722K(C10). The lamp again burns dim as the circuit becomes normal.

TOCCO AND UNIT #1 ALARM TEST
Elementary sheet 2, 13 & 15

To test the alarm circuit, alarm switch 7003S(P28) is turned to "test" position.

(this switch is spring loaded for "alarm" position). When the alarm switch is in "test" position the N.C. contacts 2, 6 and 9 are open. Contact numbers 1,3,4,5,7,8,11 and 12 are closed.

Contact numbers 6,7,8 and 11 are in the unit #2 alarm system and are not considered at this time.

N.C. contact #9 and N.O. contact #1 and #12 are involved in the Tocco alarm system. When the test is made, N.C. contact #9 opens de-energizing the Tocco water flow alarm relay 755K(C10) and the Tocco over-temperature alarm relay 756K(C10). The N.O. contacts of these two relays appearing in the Tocco motor drive control circuit are bridged by the now closed #1 contact of the alarm switch which, if the Tocco is running, prevents it from stopping. The alarm horn #7001(P28) circuit is completed by the #12 contact of the alarm switch (now closed) thru a N.C. contact of relay 755K(C10) and a N.C. contact of the Tocco water alarm reset relay 760K(C10) (normally remains de-energized). The Tocco water alarm indication lamp 7038I burns bright as part of its resistor is shunted by a N.C. control of relay 755K. A.N.C. of the Tocco over-temperature alarm relay 756K(C10) completes the alarm horn circuit thru a N.C. contact of the Tocco over-temperature, alarm reset relay 761K(C10) (normally remains de-energized) as the Tocco over-temp. alarm lamp 7039I(p28) burns bright when part of its resistor is shunted by a N.C. contact of relay 761K (C10).

Alarm switch 7003S(P28) contacts 2,3,4 and 5 and are involved in the Unit #1 alarm test circuit. (all reset relays are de-energized). When the test is made, N.C. contact #2 opens and contacts 3,4, and 5 close. When contact #2 opens it de-energizes the contacts of the pieces of equipment which actuate the alarm relays. (see sheet #[illegible] of this work). Therefore, when the test is made all the alarm relays are de-energized.

When the over-pressure alarm relay 720K(C10) is de-energized one of its N.C. contacts, energized by contact #3 (now closed) of the alarm switch completes the alarm horn circuit thru a N.C. contact of the over-pressure alarm reset relay 728K(C10). Over-pressure alarm indicating lamp 7019I(P28) burns bright as part of its resistor is shunted by a N.C. contact of relay 720K(C10).

When the heat coil water alarm relay 721K(C10) is de-energized one of its N.C. contacts which is energized by the coil and capacitor cooling water switch 7023S()26) - or if it is not "on" by contact #4 (now closed) of the alarm switch, completes the alarm horn circuit thru a N.C. contact of the coil water flow alarm reset relay 729K(C10) coil water alarm indicating lamp 7020I(P28) burns bright as part of its resistor is shunted by a N.C. contact of the coil water alarm relay 721K(C10).

When the capacitor water flow alarm relay 722K(C10) is de-energized one of its N.C. contacts which is energized by the coil and capacitor cooling water switch 7023S(P26), or if it is not "on" by contact #4 (now closed) of the alarm switch completes the alarm horn circuit thru a N.C. contact of the capacitor water flow alarm reset relay 730K(C10). Capacitor water flow alarm indicating lamp 7021I(P28) burns bright as a N.C. contact of relay 722K(C10) shunts part of its resistor.

When the diffusion pump water flow alarm relay 723K(C10) is de-energized, one of its N.C. contacts if fed by the diffusion pump cooling water valve switch 7208(D28) or if it is "off" by contact #5 (closed in test position) of the alarm switch 7003S(P28), completes the alarm horn circuit thru a N.C. contact

of the diffusion pump water alarm reset relay 731K(C10). Diffusion pump water alarm indicating lamp 7021I(P28) burns bright as part of its resistor is shunted by a N.C. contact of relay 723K(C10).

When the heat trap under temperature alarm relay 725K(C10) is de-energized, one of its N.C. contacts fed directly from the alarm 110V. supply, completes the horn circuit thru a N.C. contact of the heat trap under temperature alarm reset relay 733K(C10). The heat trap under temperature alarm indicating lamp 7024I(P28) burns bright as part of its resistor is shunted by a N.C. contact of relay 725K (C10).

The remaining alarms operate in the same manner as the individual relays, as noted on sheet 8, became de-energized

TASKS III, VI and VII

TOCCO GENERATOR FIELD AUTOMATIC CONTROL
VOLTAGE REGULATOR TYPE 4VR1A
OHIO CRANKSHAFT CO., DWG. 95J9A
Elementary E-2-12597 - Sheet No. 2

When controlled automatically, the Tocco generator field is connected as the load in the anode circuit of two thyratron tubes (E1-C3J) referred to as tube No. 1 and tube No. 2. These tubes are connected for full wave rectification. The plate current is supplied by a 300 volt secondary of the power transformer T1. This winding is center tapped to provide 150 volts to each thyratron plate. The full wave rectification is accomplished as follows:

When the plate of tube 1 is positive, it will conduct. The plate of tube 2, at this time is negative and will not conduct. During the next half cycle, the plate of tube 2 swings positive and will conduct, but tube 1, its plate being negative at this time will not conduct. Regardless of which tube fires, the current always enters the field from terminal #17 and returns to the secondary center tap on line #2. No. 17 is positive and #2 is negative with a maximum of 125 V. DC across them.

The thyratrons have control grids by which the field current is controlled. The grid bias voltage is controlled by a voltage phase shift circuit net work. The voltage for the net-work is supplied by the secondary T2-S2 of transformer T2, which is fed from a secondary of power transformer T1. The voltage of primary T2 is in phase with the plate voltage but the voltage applied to the voltage phase shift net-work is 180° out of phase with the plate voltage. This is important later on.

The phase shift voltage circuit consists of two 10K-2-1 watt resistors and two A.C. windings of a saturable reactor. These are arranged in pairs, a resistor and a winding in each pair, connected in series across the output leads of the secondary T2-S2. The grid bias voltage for each thyratron is taken from the center point (the point between the resistor and the winding) of each of these pairs. The cathods of the thyratrons are connected to the center tap of the secondary T2-S2, (the winding from which the source of bias voltage is derived) thus completing the grid circuit.

Considering one of these pairs and the thyratron which it serves, the voltage appearing across the resistor is 90° out of phase with the voltage appearing across the reactor winding when the winding has its maximum impedance. This makes the applied grid voltage 90° out of phase with the plate voltage since, as noted before, the applied voltage from the secondary T2 S2 is already 180° out of phase with the voltage applied to the plate.

As the impedance of the A.C. reactor winding is decreased (as it does when the D.C. is increased in its D.C. winding) it causes the grid voltage to shift more in phase with the plate voltage. As the grid voltage shifts nearer in phase with the plate voltage its magnetude becomes more effective in causing a larger slug of current to pass the thyratron, and thru the generator field circuit. The other phase shift pair with the tube it serves behaves the same way on the next half cycle.

The D.C. for the saturable reactor control winding is supplied by transformer T3. This current is rectified by tube No. 6 (5y3) and filtered by resistors R16, R17 and the capacitor C5. The D.C. voltage is held near constant (105V) by tube No. 4 (0c3/vr105). This current as applied to the reactor D.C. winding is controlled by tube No. 3 (6SJ7) an amplifier. The reactor D.C. winding is connected in the plate circuit of tube No. 3. The current which passes tube No. 3 and thus flows thru the reactor winding is controlled by the control grid of tube No. 3. The voltage applied to this grid is the resulting voltage of two

voltages. The voltage taken from the D.C. supply (D.C. mentioned before) controlled by the potentiometers (P1) which will have a fixed maximum setting. This voltage appears across resistor R14 and is the turn-on voltage.

The other voltage is taken from the isolating transformer T4 and is rectified by tube No. 5 (6x5) and the resistors R8 and R9. This voltage appears across resistor R5 and is the cut-off voltage, that is, it is opposite in polarity to the turn-on voltage or the voltage across resistor R14. The resulting voltage which emerges from these two voltages is applied through the current limit resistor R12 to the grid of tube No. 3 and determines the current amplitude passed by the tube and consequently the current flow in the reactor D.C. winding .

Tube No. 3 is the only tube in the regulator which receives only D.C. voltages.

R.M. LINE ELECTRICAL INSTRUCTIONS
(For Reference See Dwg. #H-2-21405)

TASK XII

General

Task XII consists of two (2) electric motor driven conveyors that are separately controlled by push buttons on the Zone 2 side of the R.M. Line feeding from a control feedrail. Conveyor #1 is located in the east part of Hood #28 performing the necessary handling of equipment in Zone 4 between Hood #13 and Hood #28T. Conveyor #2 takes over at #28T and handles the equipment in Zone 4 between Hood #28T and Hood #27. Due to the stairway at Section 18 it was necessary to separate the control feedrail on the Zone 2 side and therefore a transfer switch was designed at this point to transfer from the control push button east of the stairway, to the one west of the stairway. The power for the motors driving these conveyors are fed from feedrails with sliding contacts.

The power supply for this task is 110 volts 3 phase fed from a 15 amp. breaker (1201 K) on Cubicle #18 on the Duct Level.

There are 8-110 volt 3 phase motors in Task XII that run the conveyors and the auxiliary equipment, also a transformer (1201 T) that supplies voltage to a rectifier (1201) to feed D.C. to two legs of the motors for braking purposes when the motors are not energized from their normal source. The exact operations that these conveyors perform may be obtained by reading page #45 of book #HW-18271.

Listed below are the 8 motors on Task XII, their HP and number, what they drive and the contactor numbers that energize them and what cubicle the contactors are in.

Motor No.	H.P.	Driving	Contactor No.	Cubicle No.
1201 B	1/8	Conv. #1, Lat. Drive, High Speed	1202 K	C 17
1202 B	1/8	Conv. #1, Lat. Drive, Slow Speed	1203 K	C 17
1203 B	1/15	Conv. #1, Vertical and Horizontal Arm Drive	1204 K	C 17
1204 B	1/70	Conv. #1, Bucket Drive	1209 K	C 17
1205 B	1/70	Conv. #2, Bucket Drive	1212 K	C 17
1206 B	1/15	Conv. #2, Vertical and Horizontal Arm Drive	1213 K	C 17
1207 B	1/8	Conv. #2, Lateral Drive, High Speed	1218 K	C 17
1208 B	1/8	Conv. #2, Lat. Drive, Slow Speed	1219 K	C 17

Item #1 -- See Sheet #1 of Chart.

In order to operate Motor #1203 B (Conveyor #1 Arm Drive) in the up direction 1205 S push button is pushed which energizes 1205 K coil thru Slide Contact 1206 BB. When 1205 K is energized Motor #1203 B is energized by 1204 K and Solenoid Valve 1202 Sol. is energized by one leg of the motor (wire #564) the other side of the Sol. coil being energized by 1205 S thru Slide Contact 1213 BB, 1261 BB and N.C. Contacts 1207 K and 1208 K causing the shifting mechanism to move to the vertical drive position.

Item #2

In order to operate #1203 B (Conveyor #1 Arm Drive) in the down direction, 1206 S Push Button is pushed which energizes 1206 K Coil thru Slide Contact 1207 BB. When 1206 K is energized Motor #1203 B is energized by 1204 K and Solenoid Valve #1202 Sol. is energized by one leg of the motor (wire 564). The other side of the Solenoid Valve Coil is energized by 1205 S thru Slide Contact 1213 BB, 1261 BB and N.C. Contacts 1207 K and 1208 K. Motor 1203 B will continue to run as long as Switch 1206 S is held in until Limit Switch 1210 S is actuated.

Item #3

In order to operate Conveyor #1 Arm Drive in the horizontal position to extend, Switch 1207 S must be pushed, which energizes 1207 K Coil thru Slide Contact 1208 K and Solenoid Valve 1201 Sol. is energized by one leg feeding the motor (wire 564). The other side of coil for Solenoid Valve is energized by 1207 S thru Slide Contacts 1260 BB and 1214 BB and N. C. Contacts 1206 K and 1205 K causing the shift of motor drive to horizontal position. The retract mechanism will work until 1207 is released or until Limit Switch 1211 S is opened.

Item #4

In order to operate Conveyor #1 Arm Drive in the horizontal position to retract, Switch 1208 S must be pushed, which energizes 1208 K thru Slide Contact 1209 BB. When 1208 K Coil is energized, Motor #1203 B is energized by 1204 K and Solenoid Valve 1201 Sol. is energized by one leg feeding motor (wire 564). The other side of Solenoid Valve Coil is energized by 1208 S thru Slide Contacts 1214 BB and 1260 BB and N.C. Contacts 1205 K & 1206 K causing the shift of motor drive to the horizontal position. The retract mechanism will work until Push Button 1208 S is released or until Limit Switch 1212 S is actuated or opened.

Item #5

Due to the stairway at Section #18 it was necessary to divide the control feedrail in Zone 2 that controls Conveyor #2. A switch was designed to be installed at this point to select which of the split feedrails are used. This is Switch #1233 S and is fed from lines 516 & 517. To control from Control Box #2 this switch energizes 1229 K Coil #1, 1230 K Coil #1 and 1231 K Coil #1. To control from Control Box #3 Switch 1233 S energizes Coil #2 of the above mentioned contactors.

All of the Conveyor #2 operations are the same as for #1 except for different motor numbers, contactors, switches, and providing which way the selector switch is thrown.

Item #6

Conveyor #2 Vertical Arm Drive up may be controlled wither from #2 or #3 Control Box according to which way Selector Switch #1233 S is turned.

Controlling From Box #2

By pushing 1221 S (fed from line 615) 1214 K is energized thru Slide Contact 1226 BB and N.O. Contact 1230 K1, the other side of 1214 K Coil is fed from line 517. Solenoid Valve 1204 Sol. is energized by one leg of motor 1206 B

or wire #628. The other side of 1204 Sol. is energized when 1221 S is pushed thru Slide Contact 1233 BB, 1283 BB and thru N.O. Contact 1229K1, and N.C. Contacts 1216 K and 1217 K causing mechanism to shift to the vertical position. Motor #1206 B will continue to drive the vertical arm up until 1221 S is released or up Limit Switch 1225 is actuated.

Controlling From Box #3

By pushing 1237 S (fed from line 699) 1214 K is energized thru Slide Contact 1326 BB and N.O. Contact 1230 K2, the other side of 1214 K Coil is fed from line 517. Solenoid Valve 1204 Sol. is energized by one leg of Motor 1206 B (wire #628). The other side of 1204 Sol. being energized when 1237 S is pushed thru Slide Contacts 1333 BB, 1283 BB and N.O. Contact 1229 K2 and N.C. Contacts 1216 K and 1217 K, causing the mechanism to shift to vertical operating position. Motor #1206 B will continue to raise the arm until 1237 is released or 1225 S Limit is actuated.

Item #7

Conveyor #2 vertical arm drive down may be controlled either from #2 or #3 Control Box according to the position of Selector Switch #1233 S.

Controlling From Box #2

By pushing 1222 S (fed from line 615) 1215 K is energized thru Slide Contact 1227 BB and N.O. Contact 1230 K1, the other side of coil of 1215 K is fed from line 517. One side of Solenoid Valve Coil 1204 Sol. is fed by one leg of Motor #1206 B (wire #628) and the other side is fed from line 615 thru Slide Contacts 1233 BB, 1283 BB, N.O. Contact 1229 K1, N.C. Contacts 1216 K and 1217 K when 1222 S is pushed causing mechanism to shift to vertical drive. Motor 1206 B will continue to run the arm drive in the down direction until 1222 S is released or Limit Switch 1226 S is actuated.

Controlling From Box #3

By pushing 1238 S (fed from line 699) 1215 K is energized thru Slide Contact 1327 BB and N.O. Contact 1230 K2, the other side of 1215 K Coil is fed from line 517. One side of Solenoid Coil 1204 Sol. is fed from one leg of Motor #1206 B (wire #628) and the other side is fed from line 699 thru Slide Contacts 1333 BB, 1283 BB, N.O. Contact 1229 K2, N.C. Contacts 1216 K and 1217 K when 1238 S is pushed causing mechanism to shift to vertical drive. Motor 1206 B will continue to run the arm drive in the down direction until 1238 S is released or Limit Switch 1226 is actuated.

Item #8

Conveyor #2, horizontal arm drive to extend may be controlled from either #2 Control Box or #3 Control Box accofding to the position of Selector Switch #1233 S.

Controlling From Box #2

By pushing 1223 S (fed from line 615) 1216 K Coil is energized thru Slide Contact 1228 BB and N.O. Contact 1230 K1, the other side of the coil is fed from line 517. One side of Solenoid Valve Coil #1203 Sol. is fed by one leg of Motor #1206 B (wire #628) and the other side is fed from line 615 thru Slide Contacts 1234 BB, 1282 BB, N.O. Contact 1230 K1, N.C. Contacts 1214 K and 1215 K,

when 1223 S is pushed causing the mechanism to shift to horizontal drive. Motor #1206 B will continue to drive the arm in the extend direction until 1223 S is released or Limit Switch 1227 S is actuated.

Controlling From Box #3

By pushing 1239 S (fed from line 699) 1216 K is energized thru Slide Contact 1328 BB and N.O. Contact 1230 K2, the other side of the coil is fed from line 517. One side of Solenoid Valve Coil 1203 Sol. is fed by one leg of Motor 1206 B (wire #628) and the other side is fed by line 699 thru Slide Contacts 1334 BB, 1282 BB, N.O. Contact 1230 K2, N.C. Contacts 1214 K and 1215 K when 1239 S is pushed causing mechanism to shift to horizontal drive. Motor 1206 B will continue to drive the arm in the extend direction until 1239 S is released or Limit Switch 1227 S is actuated.

Item #9

Conveyor #2, horizontal arm drive to retract may be controlled from either #2 or #3 Control Box according to the position of Selector Switch #1233 S.

Controlling From Box #2

By pushing 1224 S (fed from line 615) 1217 K Relay Coil is energized thru Slide Contact 1229 BB and N.O. Contact 1230 K1, the other side of coil is fed from line 517. One side of Solenoid Valve Coil 1203 Sol. is fed by one leg of motor lead (wire #628) and the other side is fed from line 615 thru Slide Contacts 1234 BB, 1282 BB, N.O. Contact 1230 K1, N.C. Contacts 1214 K and 1215 K causing the mechanism to shift to the horizontal drive. Motor #1206 B will continue to drive the arm in the retract direction until 1224 S is released or Limit Switch 1228 S is actuated.

Controlling From Box #3

By By pushing 1240 S (fed from line 699) 1217 K Relay is energized thru Slide Contact 1329 BB and N.O. Contact 1230 K2, the other side of coil is fed from line 517. One side of Solenoid Valve Coil #1203 is fed from one leg of motor (wire #628) the other side is fed from line 699 thru Slide Contacts 1334 BB, 1282 BB, N.O. Contact 1230 K2, N.C. Contacts 1214 K and 1215 K causing the mechanism to shift to the horizontal drive position. Motor 1206 B will continue to drive the arm in the retract position. Motor 1206 B will continue to drive the arm in the retract position until 1240 S is released or Limit Switch 1228 S is actuated.

Equip. Driven	By Motor No.	Power Supplied From	Which is Controlled By	Which is Fed From	And Feeds	Other Side of Coil Fed From
Conv. #1, Lat. Drive, High Speed to Left	110 volt 3 phase Motor #1201B	110 volt lines, 516, 517 & 518. Thru Contactor 1202K and Slide Contacts 1241BB, 1242 BB & 1243BB in Hood 28	Push Button No. 1201S	110 volt line 516, thru Slide Contact 1201BB in Zone 2 Feedrail	1202K Coil #2 thru Slide Contact 1204BB in Zone #2 Feedrail	110 volt line 517, thru N.C. Contact on O.L. Relay #1221K
Conv. #1, Lat. Drive, High Speed to Right	110 volt 3 phase Motor #2201B	110 volt lines, 516, 517 & 518 thru Contactor 1202K and Slide Contacts 1241BB, 1242 BB & 1243BB in Hood 28	Push Button No. 1202S	110 volt line 516,,thru Slide Contact 1201BB in Zone 2 Feedrail	1202K Coil #1 thru Slide Contact 1205BB in Zone #2 Feedrail	110 volt line 517, thru N.C. Contact on O.L. Relay #1221K
Conv. #1, Lat. Drive, Slow Speed to Left	110 volt 3 phase Motor #1202B	110 volt lines, 516, 517 & 518 thru Contactor 1203K and Slide Contacts 1244BB, 1245BB & 1246BB in Hood 28.	Push Button No. 1203S	110 volt line 516, thru Slide Contact 1201BB, in Zone 2 Feedrail	1203K Coil #2 thru Slide Contact 1202BB in Zone #2 Feedrail	110 volt line 517, thru N.C. Contact on O.L. Relay #1222K
Conv. #1, Lat. Drive, Slow Speed to Right	110 volt 3 phase Motor #1202B	110 volt lines, 516, 517 & 518 thru Contactor 1203K and Slide Contacts 1244BB, 1245 BB & 1246BB in Hood 28	Push Button No. 1204S	110 volt line 516, thru Slide Contact 1201BB, in Zone 2 Feedrail	1203K Coil #1 thru Slide Contact 1203BB in Zone #2 Feedrail	110 volt line 517, thru N.C. Contact on O.L. Relay #1222K
Conv. #1, Vert. Arm Drive Up (See Item #1 on write up sheet)	110 volt 3 phase Motor 1203B	110 volt lines, 516, 517 & 518 thru Contactor 1204K and Slide Contacts 1247BB, 1248 BB & 1249BB in Hood 28	N.O. Contact on 1205K (See Item #1 on write up sheet)	110 volt line 516 thru Slide Contact 1256BB and up Limit Switch 1209S	1204K Coil #1	110 volt line 517, thru N.C. Contact on O.L. Relay 1223K
Conv. #1, Vert. Arm Drive Down (See Item #1 on write up sheet)	110 voltq 3 phase Motor 1203B	110 volt lines, 516, 517 & 518 thru Contactor 1204K and Slide Contacts 1247BB, 1248 BB & 1249 BB in Hood 28	N.O. Contact on 1206K (See Item #2 on write up sheet)	110 volt line 516, thru Slide Contact and down L.S. 1210S	1204K Coil #2	110 volt line 517, thru N.C.Contact on O.L. Relay 1222K

Equip. Driven	By Motor No.	Power Supplied From	Which is Controlled By	Which is Fed From	And Feeds	Other Side of Coil Fed From
Conv. #1, Arm Drive to Extend (See Item #3 on write up)	110 volt 3 phase No. 1203B	110 volt lines 516, 517 & 518 thru Contactor 1204K and Slide Contacts 1247BB, 1248 BB & 1249BB in Hood 28	N.O. Contact on 1207K (See Item #3 on write up)	110 volt line 516, thru Slide Contact 1256BB and extend Limit Switch 1211S	1204K Coil #1	110 volt line 517, thru N.C. Contact O.L. Relay 1223K
Conv. #1, Horz. Arm Drive to Retract. (See Item #4 on write up)	110 volt 3 phase No. 1203B	110 volt lines 516, 517 & 518 thru Contactor 1204K and Slide Contacts 1247BB, 1248 BB & 1249BB in Hood 28	N.O. Contact on 1207K (See Item #4 on write up)	110 volt line 516, thru Slide Contact 1256BB and Retract L.S. 1212S	1204K Coil #2	110 volt line 517, thru N.C. Contact on O.L. Relay 1223K
Conv. #1, Bucket Dr. to Open	110 volt 3 phase Motor #1204B	110 volt lines 516, 517 & 518 thru Contactor 1209K and Slide Contacts 1257BB, 1258BB & 1259BB in Hood 28.	Push Buttons 1213S & 1214S in series.	110 volt line 516, thru Slide Contact 1201BB in Zone #2 Feedrail	1209K Coil #2 thru Slide Contact 1210BB	110 volt line 517, thru N.C. Contact on O.L. Relay 1224K
Conv. #1, Bucket Dr. to Close	110 volt 3 phase Motor #1204B	110 volt lines 516, 517 & 518 thru Contactor 1209K and Slide Contacts 1257BB, 1258 BB, & 1259BB in Hood 28	Push Button 1215S	110 volt line 516, thru Slide Contact 1201BB in Zone #2 Feedrail	1209K Coil #1 thru Slide Contact 1211BB	110 volt line 517, thru N.C. Contact on O.L. Relay 1224K
Conv. #2, Bucket Dr. to Open Controlled from #2Sta. (See Item #5 on write up sheet)	110 volt 3 phase Motor #2205B	110 volt lines 516, 517,& 518 thru Contactor 1212K and Slide Contacts 1279BB, 1280 BB and 1281BB in H-28	Push Buttons 1218S & 1219S in series in #2 Control Box	110 volt line 615which is fed from line 516 thru N.O. Contact 1229K1 & Slide Contact 1221BB	1212K Coil #2 thru Slide Contact 1230BB and N.O. Contact 1229K1	110 volt line 517, thru N.C. Contact on O.L. Relay 1225K
Conv. #2, Bucket Dr. to Close Controlled from #2Sta. (See Item #5 on write up sheet)	110 volt 3 phase Motor #1205B	110 volt lines 516, 517 & 518 thru Contactor 1212K & Slide Contacts 1279BB, 1280 BB & 1281BB in Hood 28	Push Button 1220S in #2 Control Box	110 volt line 615 which fed from line 516 thru N.O. Contact 1229K1 & Slide Contact 1221BB	1212K Coil #1 thru Slide Contact 1231BB & N.O. Contact 1229K1	110 volt line 517, thru N.C. Contact on O.L. Relay 1225K

Equip. Driven	By Motor No.	Power Supplied From	Which is Controlled By	Which is Fed From	And Feeds	Other Side of Coil Fed From
Conv. #2, Vert. Arm Drive Up (See Item #6 on write up)	1206B	110 volt lines 516, 517 & 518 thru 1213K Contactor & Slide Contacts 1269BB, 1270BB & 1271BB	N.O. Contact 1214K	Line 516 thru Slide Contacts 1278BB & 1274BB & up L.S. 1225S	1213K Coil #1	Line 517 thru O.L. Contact 1226K
Conv. #2, Vert. Arm Drive Down (See Item #7 on write up)	1206B	110 volt lines 516, 517 & 518 thru 1213K Contactor & Slide Contacter1269BB, 1270BB & 1271BB	N.O. Contact 1215K	Line 516 thru Slide Contacts 1278BB & 1275BB & down L.S. 1266S	1213K Coil #2	Line 517 thru O.L. Contact 1226K
Conv. #2, Horz. Arm Drive Ext. (See Item #8 on write up)	1206B	110 volt lines 516, 517 & 518 thru 1213K Contactor & Slide Contacts 1269BB, 1270BB & 1271BB	N.O. Contact 1216K	Line 516 thru Slide Contacts 1278BB, 1276BB & extend L.S. 1227S	1213K Coil #1	Line 517 thru O.L. Contact 1226K
Conv. #2, Horz. Arm Drive Retract (See Item #9 on write up)	1206B	110 volt lines 516, 517 & 518 thru 1213K Contactor & Slide Contacts 1269BB, 1270BB & 1271BB	N.O. Contact 1217K	Lines 516 thru Slide Contacts 1278BB, 1277BB & Retract L.S. 1228S	1213K Coil #2	Line 517 thru O.L. Contact 1226K
Conv. #2, Lat. Drive, High Speed to Left Controlling from Control Bx #3 (See Item #5 of write up)	1207B	110 volt lines 516, 517 & 518 thru Contactor 1218K & Slide Contacts 1263BB, 1264 BB & 1265BB	1241S Push Button in Control Box #3 thru Slide Contact 1324BB & NO. Contact 1231K2	Line 699 which feeds from line 516 thru 1229K2 & Slide Contact 1321BB	1218K Coil #2	Line 517, thru O.L. Contact 1227K
Conv. #2, Lat. Drive, High Speed to Left Controlling from Control Box #2 (See Item #5 on write up)	1207B	110 volt line 516, 517 & 518 thru Contactor 1218K & Slide Contacts 1263BB, 1264 BB & 1265BB	1229S Push Button in Control Box #2 thru Slide Contact 1224BB & NoO.Con.1231K1	Line 615 which feeds from lines 516 thru 1229K1 & Slide Contact 1221BB	1218K Coil #2	Line 517, thru O.L. Contact 1227K

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Equip. Driven	By Motor No.	Power Supplied From	Which is Controlled By	Which is Fed From	And Feeds	Other Side of Coil Fed From
Conv. #2, Lat. Drive, High Speed to Right Controlling From Box #3	1207B	110 volt lines 516, 517 & 518 thru Contactor 1218K & Slide Contacts 1263BB, 1264 BB & 1265BB	1242S Push Button in Control Box #3, thru Slide Contact 1325BB & N.O. Contact 1231K2	Line 699 which feeds from line 516 thru 1229K2 & Slide Contact 1321BB	1218K Coil #1	Line 517 thru O.L. Relay Contact 1227K
Conv. #2, Lat. Drive High Speed to Right Controlling from Box #2	1207B	Same as above.	1230S Push Button in Control Box #2 thru Slide Contact 1225BB & N.O. Contact 123K1	Line 615 which feeds from line 516 thru N.O. Contact 1229K1 & Slide Contact 1221BB	1218K Coil #1	Same as above.
Conv. #2, Lat. Drive, Slow Speed to Left Controlling From Box #3	1208B	110 volt lines 516, 517 & 518 thru Contactor 1219K and Slide Contacts 1266BB, 1267 BB, & 1268BB	1243S Push Button in Control Box #3 thru Slide Contact 1322BB & N.O. Contact 1231K2	Line 699 which feeds from line 516 thru 1229K2 & Slide Contact 1321BB	1219K Coil #2	Line 517 thru O.L. Relay Contact 1228K
Conv. #2, Lat. Drive, Slow Speed to Left Controlling from Box #2	1208B	Same as above	1231 Push Button in Control Box #2 thru Slide Contact 1222BB & N.O. Contact 1231K1	Line 615 which feeds from line 516 thru N.O. Contact 1229K1 & Slide Contact 1221BB	1219K Coil #2	Same as above
Conv. #2, Lat. Drive Slow Speed to Right Controlling Fre from Box #3	1208B	Same as above	1244S Push Button in Control Box #3 thru Slide Contact 1323BB & N.O. Contact 1231K2	Line 699 which feeds from line 516 thru 1229K2 & Slide Contact 1321BB	1219K Coil #1	Line 517 thru O.L. Relay Contact 1228K

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Equip. Driven	By Motor No.	Power Supplied From	Which is Controlled By	Which is Fed From	And Feeds	Other Side of Coil Fed From
Conv. #2, Lat. Drive, Slow Speed to Right Controlling from Box #2	1208B	110 volt lines 516, 517 & 518 thru Contactor 1219K & Slide Contacts 1266BB, 1267 BB & 1268BB	1232S Push Button in Control Box #2 thru Slide Contact 1223BB & N.O. Contact 1231K1	Line 615 which feeds from line 516 thru No0. Contact 1229K1 & Slide Contact 1221BB	1219K Coil #1	Line 517 thru O.L. Relay Contact 1228K

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