INSTRUCTIONS

GEK-13572

TYPE SZL-1

IMPEDANCE INSERTER

GENERAL ELECTRIC COMPANY
CUSTOM POWER EQUIPMENT DEPARTMENT
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These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

TYPE SZL-1 IMPEDANCE INSERTER

INTRODUCTION

The impedance inserter is a special type three phase static circuit breaker. It protects equipment against damage caused by fault currents by stopping the flow of fault current at a magnitude slightly above its trip level. After the fault current is interrupted an impedance is inserted which limits the current conducted to the point of fault until a secondary protective device operates and isolates the fault. If the fault is cleared within 3 seconds, it automatically switches its main power SCRs to "ON" and the normal power flow is restored. The secondary protective device that operated to clear the fault also indicates the location of the fault.

The impedance inserter power circuit is divided into a main three phase power circuit and an impedance limited three phase power circuit. Its control circuit consists of solid state components assembled on printed circuit boards. See sketch #1 for a block arrangement of the power circuit and the control circuit.

During normal operation power flows through the main three phase power circuit. As previously mentioned, at the time a fault occurs the main three phase power circuit is turned "OFF in micro-seconds, the impedance limited power circuit is turned "ON" and reduced power flows to the fault. The control circuit provides a timing period that allows the limited fault current to flow for a maximum of 3 seconds. If the fault is cleared within the 3 second period so that the current in the power circuit has reduced to the control circuit reset level the main power circuit SCRs are turned "ON" and the impedance limited power circuit SCRs are turned "OFF". This causes the flow of power to be transferred back to the main three phase power circuit. If the fault is not cleared within the 3 second period, then both the main power circuit SCRs and the impedance limited power circuit SCRs are turned "OFF" and the flow of power stopped.

In order to turn "OFF" the main power circuit SCRs in micro-seconds when a fault occurs, a commutating capacitor circuit is connected to each SCR. A commutating capacitor circuit consists of a power capacitor, a reactor and a power SCR connected in series. The three components are then connected in parallel with each main power circuit SCR. At the time a fault develops the main power circuit SCRs are turned "OFF" in micro-seconds as follows: the gate signals to the main power circuit SCRs are stopped; the gate signals to the commutating circuit SCRs are started; the commutating circuit SCRs turn "ON" and the energy stored in the commutating capacitors discharges through the associated main power circuit SCRs in the reverse direction to its normal current flow and commutates the main power circuit SCRs to "OFF".

Actually the reverse current flow causes the current in each main power circuit SCR to reduce to zero and then to go negative momentarily as the carriers are swept out of the junction of the SCR. Then the current through the SCR instantly declines to zero and then the SCR turns "OFF". The commutating SCRs are turned "OFF" as follows: after the commutating capacitors are discharged currents flow into the capacitors from the power source and through the commutating SCRs to bring the capacitors voltages to the instantaneous source voltage; because of the circuit inductance the capacitor voltage will overshoot; this causes reverse current to flow through the commutating SCRs and they turn "OFF".

The impedance inserter is built in a 700 ampere frame size. It is installed in an enclosure that has a draw out mechanism. Two exhaust fans located in the top of the cubicle provide cooling air for the power circuit SCRs.

The impedance inserter's green, red and amber lights show through an opening in the enclosure door. The green light is located in the pushbutton section of the "POWER OFF" switch. The red light is located in the pushbutton section of the "POWER ON" switch. The amber light is used to indicate that the dc control power is turned "ON".

DESCRIPTION

The rating of the impedance inserter is:

Nominal Operating Voltage.....	208 Volts
Nominal Operating Current.....	700 Amperes
Phase.....	3
Frequency.....	60 Cycles
Current Trip Level Adjustment.....Min	700 Amp RMS
Max	900 Amps RMS
Cooling Air Required Through Main SCRs.....	Linear Feet Per Min

Mechanical

Frame Dimensions

Height.....	28 inches
Width.....	26 inches
Depth.....	22 inches

Weight..... 300 Pounds

Types of SCRs

CAUTION: Cooling air at _____ linear feet per minute must flow through the fins of the unit cell SCRs when the impedance inserter is carrying load current.

1. The unit cell SCR type 6RW76M04E01 is used in the main power circuit.

2. The SCR type 6RW71W is used in the power circuit commutating circuit and in the power circuit impedance limited circuit.

See drawings 0669D0863 sheet #1 for the power circuits and the interconnection wiring and sheet #2 for the control circuits.

DESCRIPTION

The impedance inserter consists of a three phase power circuit and a control circuit. The three phase power circuit is made up of three identical single phase power circuits. Each single phase power circuit consists of: a main power circuit; an impedance limited power circuit; two commutating capacitor circuits and six snubber circuits. The main power circuit has two power SCRs that are connected back to back and two reactors. A reactor is connected in series with each SCR. The purpose of the reactor is to limit the rate of rise of current through the SCR, limit the maximum short circuit current and magnetically decouple the main power circuit from the commutating circuit. A snubber circuit consisting of a resistor and a capacitor connected in series is connected in parallel with each main power circuit SCR. The snubber circuit limits the rate of voltage rise across the SCR when the SCR is turned "OFF". The impedance limited circuit consists of two power SCRs connected back to back, a stainless steel resistor connected in series with the power SCRs and a snubber circuit connected in parallel with each of the power SCRs. The impedance value of the stainless steel resistor has been selected to limit the fault current to 700-amperes on a 208 volt three phase power system. The impedance limited circuit is referred to as a by-pass circuit in the instructions.

A temperature detector protects the stainless steel resistors against excessive temperature rise that can occur if the impedance inserter is manually reclosed many times when a fault exists. If the stainless steel resistor temperature exceeds 220°C the temperature detectors normally closed contacts open and a back up circuit breaker trips. The temperature detector contacts close when the resistor temperature drops to 192°C ± 8°C.

Each commutating capacitor circuit consists of a power capacitor, a reactor and a power SCR connected in series. A commutating circuit is connected in parallel with each main power circuit SCR. The rating of the commutating capacitor is1000 micro-farads, 450 volts dc. Actually, two capacitors are connected in parallel to obtain the 1000 micro-farads rating. A snubber circuit connects across each SCR.

A charging circuit is provided for continually charging the commutating capacitors. The capacitors charge from 0 to 300 volts dc in less than 500 milliseconds.

The charging circuit consists of a transformer with seven isolated output windings. Six of the output windings connect to six full wave rectifier circuits and the rectifier outputs connect to the commutating capacitors: The output of the seventh winding provides a signal to the control circuit ac undervoltage circuit. If the ac power voltage drops below 100 volts, the impedance inserter will turn "OFF".

The control circuit consists of: seven printed circuit boards, three pulse type transformers, six current transformers and two lighted pushbuttons. The seven printed circuit boards are identified as follows: PCB-02075310, cards A, B and C; PCB-02075311, card E; PCB-02075312, card F; PCB-02075313, card G and PCB-02075314, card D. Two of the pulse type transformers are identified as transformers, T1 and T2; these are part of the oscillator #1 and oscillator #2 circuits respectively. The third pulse type transformer is identified as transformer, T3. Its part of the circuit that develops the gate signals for the commutating SCRs. Three of the current transformers are identified, CT1, CT2 and CT3. These current transformers are part of the circuit that develops the gate signals for the main power SCRs. The remaining three current transformers are identified CT-4, CT-5 and CT-6. These current transformers supply the intelligence for the control circuit overcurrent trip circuit. The two lighted pushbutton are identified "POWER OFF" and "POWER ON". A green light is for "POWER OFF" and a red light is for "POWER ON". In addition to the green and red lights an amber light is used to indicate the dc control power is "ON".

The following is a detailed description of the circuits on each printed circuit board:

1- PCB-0207A5310, cards A, B and C.

The circuits of the cards A, B and C are identical. The outputs of cards A, B, and C in conjunction with the outputs of oscillator #1 form the gate pulses for the main SCRs. The input signal of card A is from the current transformer CT-1 located in phase #1 of the power circuit.

The input signal to card B is from current transformer, CT2 located in phase #2 of the power circuit. The input signal to card C is from current transformer, CT3 located in phase #3 of the power circuit. The output pulses of cards A, B and C are timed to start at the current zeroes of their associated power circuits.

Due to the fact that the control circuits of cards A, B and C are identical, the control circuit of one card will be explained. As mentioned, the input signal to card A is from current transformer, CT-1 and it connects through pin 47 and 51 to diodes CR1 and CR2. The diodes change the 60 cycles sine wave from the current transformer, CT-1, to a 60 cycles square wave. When the square wave is positive going with respect to the common bus of card A the transistor Q1 turns "ON" and the transistor Q2 turns "OFF". Prior to the transistor Q1 turning "ON" the capacitor, C1, is charged to 20-volts and the capacitor lead that connects to the collector of transistor Q1 is positive. When the transistor Q1 turns "ON" the capacitor, C1, discharged through the transistor Q1 and momentarily reverses its polarity. This action develops a positive going pulse that goes through R7 to the base of transistor Q4. The transistors Q3 and Q4 and their associated components make up a monostable vibrator circuit. The "ON" time of the transistor Q4 is 160 micro-seconds when the rheostat, R14 is adjusted to equal 5,000 ohms. When the transistor, Q4, turns "ON" the voltage across R16 increases and turns "ON" transistor Q5. When the transistor Q5 turns "ON" the capacitor, C8, discharges through the primary of the transformer, T4 and the transistor Q5. A pulse, 160 micro-seconds wide, appears at each secondary output of transformer, T4. After a 160 microseconds that the timing circuit is adjusted for the transistor Q3 turns "ON" and transistor Q4 turns "OFF". The transformer, T4, core is reset by the 42 volts dc control power flowing through pin 31, R21, the transformer primary H2 to H1 to capacitor, C8. The capacitor, C8, is recharged through this circuit and a parallel circuit provided by R22.

When the square wave is negative going with respect to the common bus, the transistor Q1 turns "OFF" and the transistor Q2 turns "ON". The capacitor, C2, discharges through the transistor Q2 and this action develops a positive going pulse that goes through R8 to the base of the transistor Q4. Again a pulse appears at each secondary output of transformer, T4. These pulses are displaced by 180 electrical degrees from the first pulses.

2- PCB-0207A5311, Card E

The control circuits of card E contain an overcurrent trip circuit and a circuit that trips a back up circuit breaker if a fault exists for 3 seconds. This circuit picks up a reed type relay after 3 seconds and its contacts open the undervoltage relay circuit of the back up circuit breaker.

The power circuit currents are monitored by the current transformers CT-4, CT-5 and CT-6. Voltage signals proportional to current and in phase are sent from current transformers CT-4, CT-5 and CT-6 to card E, pins 35-37, pins 41-43 and pins 47-49 respectively. These signals are rectified and the outputs of the full wave rectifiers are paralleled and fed to a potentiometer R1.

During normal operation when the impedance inserter is turned "ON" the transistors Q2, Q4 and Q7 are turned "ON". When a fault occurs,the signal that appears across R1 increases and the transistor Q1 turns "ON". Next, the schmidt trigger circuit switches to "ON", the transistor Q2 turns "OFF" and the transistor Q3 turns "ON". When the transistor Q3 turns "ON" the voltage across the zener diode Z1 drops below its spillover voltage, the base voltage of transistor Q4 goes to zero and the transistor Q4 turns "OFF". The collector voltage of the transistor Q4 increases to near the 20 volts bus.

Simultaneously, four signals are sent out when the transistor Q4 turns "OFF".

1- A pulse goes through the capacitor, C2, and R13 to the base of the transistor Q8. The transistor Q8 turns "ON" for 20 micro-seconds and at this time the transformer, T3, develops gate pulses to turn "ON" the commutating capacitor circuits SCRs.'

2- A signal goes from pin 29 to turn "OFF" the oscillator #1 and the pulse circuits of cards A, B and C. This stops the gate pulses to the main power circuit SCRs and they turn "OFF".

3- A signal goes from pin 31 to turn "ON" the oscillator #2. This starts the gate pulse for the impedance limited circuit SCRs and they turn "ON".

4- A signal initiates the starting of the timing circuit consisting of R11, CR16, R14 and C3. If a fault remains for three seconds the unijunction transistor Q5 turns "ON".

When the unijunction transistor Q5 turns "ON" the transistor Q6 turns "ON" and the transistor Q7 turns "OFF". The transistors Q6 and Q7 and the associated components make up a monostable vibrator circuit. After a 20 micro-seconds timing period the monostable vibrator switches to its "OFF" state, the transistor Q7 switches "ON" and the transistor Q6 switches "OFF". In addition, when the unijunction transistor Q5 fires,a signal is sent out of pin 25 that turns "ON" the control circuit trip lock-out circuit located on card F.

When the current in the power circuit reduces below 600 amperes the schmidt trigger circuit switches to its reset mode and the control circuits return to the normal operating pattern.

3- PCB-0207A5312, card F

The control circuits of card F consists of the following circuits:

1- A circuit that locks-out the control circuit because of the following conditions occurring:
when the "POWER OFF" pushbutton is pressed; when an overcurrent fault exist for 3 seconds; when a dc control voltage undervoltage condition occurs and when fault signal is sent from the power inverter fuse monitoring circuit.

2- A circuit that turns "OFF" the lock-out circuit and allows the controls to turn "ON" the impedance inserter.

3- A circuit that provides a 0.6 second time delay period at the time the impedance inserter turns "OFF" due to a fault and this circuit prevents turning "ON" the impedance inserter until after the time delay period has elapsed. The purpose of this time delay period is to provide the necessary time required for recharging the commutating capacitors after a fault condition.

4- An ac undervoltage control circuit that turns "OFF" the impedance inserter if the ac power circuit voltage drops below 100 volts. If the ac power circuit voltage increases above 100 volts during the time the impedance inserter is turned "OFF" due to a low ac control voltage condition it will automatically turn "ON".

5- A circuit that receives the faults signal from the power inverter fuse monitoring circuit.

The above control circuits operate as follows:

1- The circuit that locks out the controls consists of the SCR1, its gate circuits and associated components. To turn ON the SCR1 a signal may be fed to its gate circuit from pin 19 through the diodes CR4 and CR5, R7 and R13 or a signal may be fed to its gate circuit from pins 21 and 27. When the SCR1 is turned "ON" the control circuit is locked out and the impedance inserter is "OFF". To turn "ON" the impedance inserter the POWER ON pushbutton must be pressed.

2- The circuit that turns "OFF" the lock-out circuit and allows the impedance inserter to turn "ON" consists of transistor Q3, capacitor C3 and the resistors R9, R11 and R12. When transistor Q3 is turned "ON" by a signal from card G to pin 31 the charge on the commutating capacitor, C3, discharges and causes current to flow in the reverse direction through SCR1, forces the SCR1 to current zero and slightly reverse and then it turns "OFF".

3- The 0.6 second timing circuit consist of transistors Q1, Q2, Q4 and Q5, SCR2 and the associated circuit components. During normal operation when the impedance inserter is turned "ON" the transistor Q4 and SCR1 are turned ON and the charge on capacitor C1 is kept close to zero. Also the transistors Q2 and Q5 are turned "ON", and transistor Q1 is turned "OFF".

3- (Cont'd)

When a fault occurs and the card D transistors Q4 turns "ON" and Q5 turns "OFF", the card F transistor Q4 turns OFF, SCR 2 turns "OFF" and the capacitor C3 start to change. This turns "ON" transistor Q1 and in turn transistors Q2 and Q5 turn "OFF". When transistor Q1 is turned "ON" a signal is sent from pin 47, to card D, pin 5 to keep the main SCRs turned "OFF", a signal is sent from pin 37 to card G,pin 27 to keep the by-pass SCRs turned "ON", and a signal is sent from pin 17 to card E, pin 27, to continue timing the 3 second timing circuit of the control trip circuit. After the approximately 0.6 second, the transistor Q1 turns OFF and allows transistors Q2 and Q5 to turn "ON". The associated control circuits will switch and turn "ON" the main SCRs and turn "OFF" the by-pass SCRs.

4- The ac undervoltage circuit consists of the zener diode Z1, resistors R4, rheostat R5, and capacitor C2. When the ac control voltage is normal the zener diode Z1 will spill over and provide a signal to the base of the transistor Q2. Transistors Q2 and Q5 are turned "ON". At this time there will be no signal on pins 17, 37 and 47. A signal is on pin 51 and is sent to card G, pin 23. When the ac control voltage drops below 100 volts the zener diode Z1 stops conducting and this turns OFF transistors Q2 and Q5.

5- A fault signal from the fuse monitor circuit is received on pin 1. The signal goes from pin 1, R23, CR7, CR6, pin 3 to pin 27 and turns ON the lock-out circuit SCR1. At the same time a signal from pin 1, R23, CR7, CR8, C4, pin 7 goes to the card E, pin 21,and develops gate signal pulses for the commutating SCRs. In micro-seconds the main SCRs are turned OFF.

4- PCB-0207A5313, Card G

The circuits on card G consist of the following:

1- The oscillator #2 transistor circuits. The transformer, T2, that is part of the oscillator #2 is located on a separate control board. The oscillator #2 develops six isolated ac voltages from the 42 volts dc control voltage. The six isolated ac voltage are rectified and each rectifier output is 10 volts dc. These six dc voltage supply the gate signals for the by-pass SCRs.

2- A circuit that provides a 200 milli-second time delay after pressing the "POWER ON" pushbutton before the main SCRs turn "ON". During the 200 milli-second period the by-pass SCRs are turned ON. The purpose of turning "ON" the by-pass SCRs first and then the main SCRs is to allow the initial excitation currents to the power inverter ZIG-ZAG transformer to be limited below the trip level of the impedance inserter.

3- Circuits that clamp the oscillator #2

4- Circuits that unclamp the oscillator #2.
The above circuits operate as follows:

1- The 200 milli-second time delay circuit is initiated when the "POWER ON" pushbutton is pressed and transistor Q7 turns ON. The capacitor, C1, is charged through transistor Q7, and R17. The unijunction transistor Q8 turns "ON" after 200 milli-seconds. When the transistor Q8 turns "ON" it causes several other transistors to switch and the final result is the main SCRs turn "ON". The above timing circuit stops when transistor Q5 turns "ON" and turns "OFF" transistor Q7. The transistor Q5 is turned "ON" when the control lockout circuit turns "OFF", and a signal is sent from card F, pin 35 to card G,pin 5. Also a signal from the collector of Q5 of card D provides a second signal to assure that transistor Q5 turns "ON".

2- The oscillator #2 is clamped when either transistor Q3 is turned "ON" or transistor Q9 is turned "ON". The transistor Q3 is turned "ON" when the transistor Q4 is turned "OFF" and transistor Q10 or Q11 is turned "OFF".

3- The oscillator #2 is unclamped when the transistor Q3 is turned "OFF" and the transistor Q9 is turned "OFF"

5- PCB-0207A5314, card D

The following circuits are located on card D:

1- A 42 volts dc source from the inverter connects to pin 33 (positive) and pin 17 (negative). The power source is used for the control circuit 42 volts control bus. Power for the 20 volts dc control bus is developed from the 42 volts by the zener diode Z1 and its associated circuit R5 and C2.

2- A control circuit connects to the transformer, T1, located on a separate board. The combination form the oscillator #1. The oscillator #1 develops six isolated ac voltages and each ac voltage is rectified and equal 10 volts dc. Each of these six dc voltages are combinated with a pulse from the cards A, B and C and form the gate pulse for the main SCRs.

3- A dc undervoltage circuit is developed by the zener diode Z2 and its associated components. When the 42 volts dc control voltage drops below 33 volts the zener diode stops conducting, this causes the transistor Q3 to turn "OFF". A signal close to 42 volts at pin 13 turns "ON" card F-SCR1 and, in turn, the control circuit locks-out and turns "OFF" the impedance inserter.

4- The control circuit "POWER OFF" transistor clamp circuit. When the transistor Q4 is turned "ON" it clamps the oscillator #1 and the cards A, B and C pulse circuits, and pick up the reed relay that lites the "POWER OFF" lite and closes the alarm circuit.

5- The control circuit "POWER ON" transistor circuit. When the transistor Q5 turns "ON" it lites the red indicating lamp, and simultaneously a signal is sent from pin 11 to card G to assure that the bypass SCRs are turned OFF.

6- A circuit that sends a pulse to the cards A, B and C to initiate starting the pulse from transformers T4. This circuit consist of C3, R10 and CR8.

PRINCIPLES OF OPERATION

General

The impedance inserter power and control circuits are shown on the elementary diagrams 0669D0863, sheets #1 and #2.

Prior to turning "ON" the impedance inserter the 42 volts dc control power and the 208 volts ac control power must be "ON". This turns "ON" the dc undervoltage control circuit and the ac undervoltage control circuit. These circuits must be "ON" before the impedance inserter can be turned "ON".

An amber lite, when "ON" indicates that the DC control power is "ON". When the impedance inserter is "OFF" a green "POWER OFF" lite is lit. To turn the impedance inserter "ON" press the "POWER ON" pushbutton. The red "POWER ON" lite should turn "ON".

The impedance inserter power circuit turns "ON" as follows: First, the by-pass SCRs turn "ON" and insert impedance into each power line. This impedance limits the maximum load current to 700 amperes per line. Second, after a time delay period of 200 milli-seconds the main SCRs are switched "ON" and at this time the bypass SCRs are switch "OFF". Load currents up to the selected trip level can flow. The trip level is adjustable between 700 to 900 amperes RMS (980-1275 amperes peak).

The impedance inserter can be turned "OFF" by pressing the POWER OFF pushbutton. It will turn "OFF" automatically if any of the following conditions should occur:

1. If the currents in the power circuits reach the selected trip level.

2. If the 42 volts dc control voltage decreases below 33 volts, the dc undervoltage circuit will cut-off and turn "OFF" the impedance inserter.

3. If the 208 volts ac control voltage decreases below 100 volts, the ac undervoltage circuit will cut off and turn "OFF" the impedance inserter.

4. If a signal is received from the fuse detector circuit indicating trouble in the power inverter.

The impedance inserter operates as follows for each of the above conditions:

1. If the trip level is exceeded the power circuits switch in micro-seconds from the main SCRs to the bypass SCRs thus inserting impedance into each power line. At the time the trip signal occurs a 0.6 second timing period is initiated and provides time to re-charge the commutating capacitors. After this timing period has elasped and providing that the load current has reduced below the trip circuit reset level (600 amperes) the impedance inserter will automatically switch from the bypass SCRs to the main SCRs.

2. If the fault has been cleared the main SCRs will remain "ON". If the fault reoccurs the above trip cycle will be repeated. It is possible under certain operating conditions that as many as five trip and reclosure cycles may repeat before the 3 seconds time delay circuit turns "ON" the control circuit lockout circuit SCR. After the lockout circuit is turned "ON" the impedance inserter will turn "OFF". The POWER ON pushbutton must be pressed to turn "ON" the impedance inserter.

3. If a signal is received from the fuse monitoring circuit that indicates trouble in the power inverter the control circuit lock out circuit will turn "ON" and the impedance inserter will turn "OFF" in micro-seconds. To turn "ON" the impedance inserter the "POWER ON" pushbutton must be pressed.

Detailed Operation

1- SWITCHING THE POWER ON

The following is a description of the operation of the control circuit starting with turning "ON" the impedance inserter. Each component is identified by the letter and number appearing on the drawing and, in addition, a letter indicating the card on which the component is located. As an example "D-Q1" indicates that the component is transistor Q1 and is located on card D.

1- Cont'd

Under normal operating conditions, when the "POWER ON" pushbutton is pressed the transistors G-Q6 and G-Q7 turn "ON". When transistor G-Q7 turns "ON" the following occurs:

1. It provides a seal-in circuit for G-Q6.

2. It starts the timing circuit that turns "ON" the unijunction transistor G-Q8 after a time delay period of 200 milli-seconds.

3. It turns "ON" the transistor G-Q4.

The transistor G-Q4 turns "OFF" the transistor G-Q3. This unclamps the oscillator #2 and it turns "ON". When the oscillator #2 turns "ON" it sends gate signals to the by-pass SCRs. The bypass SCRs turn "ON" and allow excitation currents limited to 700-amperes to flow to the power inverter ZIG-ZAG transformer. The ZIG-ZAG transformer excitation currents are directed through the impedance inserting circuits to avoid these currents reaching the trip level of the impedance inserter and turning it "OFF".

When the unijunction transistor G-Q8 fires a signal is sent from card G, pin 1 to card F, pin 31, to turn "OFF" the control SCR, F-SCR1, of the lock out circuit. When F-SCR1 turns "OFF" the following occurs:

1. Transistor D-Q4 turns OFF and transistor D-Q5 turns ON. When D-Q4 turns OFF the oscillator #1 is unclamped and the cards A, B and C pulse circuits are unclamped. Gate signals are sent to the main SCRs and they turn "ON".

2. A signal is sent from card F, pin 35 to card G, pin 5, and this signal turns "ON" transistor G-Q5. When G-Q5 turns "ON" it turns OFF transistor G-Q7. This breaks the seal-in circuit around transistor G-Q6 and G-Q6 turns "OFF". Circuit redundancy provides a second signal that develops when transistor D-Q5 turns "ON" and this signal is sent from card D, pin 11 to card G, pin 3, to be assured that the seal-in circuit is broken and transistor G-Q6 turns "OFF". After transistor G-Q6 and G-Q7 turn "OFF" the 200 milli-seconds timing circuit is stopped, transistor G-Q4 turns OFF and transistor G-Q3 turns ON. When transistor G-Q3 turns "ON" it clamps the oscillator #2 to the "OFF" mode. This turns "OFF" the gate signals to the bypass SCRs and they turn "OFF" at the next current zeroes. The impedance inserter is now turned "ON" and it will remain "ON" until it is either manually or automatically tripped.

2. OVERCURRENT TRIP

The following is a description of the control circuit operation due to an overcurrent fault:

The current transformers CT4, CT5 and CT6 are located on the input power studs and are used to monitor the line currents of phases #1, #2 and #3 respectively. The outputs of the three current transformers are fed to three full wave rectifiers located on the card E. If a fault occurs and the line currents increase to or above the trip level the main SCRs will switch "OFF" and the bypass SCRs will switch "ON" in micro-seconds.

During normal operation card E transistors E-Q2, E-Q4 and E-Q7 are turned "ON" and transistors E-Q1, E-Q3, E-Q5, E-Q6 and E-Q8 are turned "OFF". When a trip occurs the transistors E-Q1 and E-Q3 switch to "ON" and the transistors E-Q2, E-Q4 and E-Q7 switch to "OFF". When the transistor E-Q4 switches to "OFF", simultaneously signals are sent to the following circuits:

1- A signal is sent from card E, pin 29 to card D, pin 25. This signal turns ON transistors D-Q6 and D-Q4 and turns "OFF" transistor D-Q5. When D-Q4 switches "ON" the oscillator #1 and the pulse circuits of cards A, B and C are clamped. The gate signals to the main SCRs are stopped.

2- A signal is sent to turn "ON" transistor E-Q8. Transistor E-Q8 and its associated circuit develops six isolated gate pulse signals for the commutating SCRs. The commutating SCRs turn "ON" and commutate the main SCRs "OFF" in micro-seconds.

3- A signal is sent from card E, pin 31 to card G, pin 31 to unclamp the oscillator #2 by turning "ON" transistor G-Q4 and turning "OFF" transistor G-Q3. Gate signals are sent to the bypass SCRs and they turn"ON".

4- A signal initiates the 3 second time delay circuit E-R11, E-CR16, E-R14 and E-C3. If the fault remains for 3 seconds the unijunction transistor E-Q5 fires and a signal is sent to turn "ON" transistor E-Q6 and F-SCR1. When E-Q6 turns "ON" the reed relay picks up and trips a back-up circuit breaker. When F-SCR1 turns "ON" it locks out the control circuit.

During normal operation and prior to transistor D-Q4 switching "ON" and transistor D-Q5 switching "OFF" the 0.6 second time delay circuit located on card F is setup as follows:

Transistor F-Q4 and SCR F-SCR2 normally remain in the "ON" mode. Capacitor F-C1 is discharged. The card F, pin 49 that the collector of F-Q4 and anode of F-SCR2 connect to is approximately 0.5 volts from common. The transistor F-Q1 is turned OFF.

At the time transistor D-Q4 switches to "ON" and transistor D-Q5 switches to "OFF" the capacitor F-C1 starts to charge and immediately turns "ON" transistor F-Q1. After a 0.6 second timing period the transistor F-Q1 turns OFF. When transistor F-Q1 is turned "ON" the transistors F-Q2 and F-Q5 are turned "OFF" At this time a signal from card F, pin 47 to card D, pin 5 keeps transistor D-Q4 turned "ON". This assures that the oscillator #1 and the cards A, B and C pulse circuits remain clamped. Thus, no gate signals can be developed for the main SCRs.

Following an overcurrent trip the bypass SCRs are turned "ON" by signals from oscillator #2 which are actuated by a signal from Card E, pin 31. This signal exists until the card E trip circuit resets. The trip circuit resets when the load current drops below 600 amperes. To assure that sufficient time is available for re-charging the commutating capacitors, a second signal associated with the 0.6 second timing circuit is sent from card F, pin 37 to card G, pin 27. This signal turns "ON" transistor G-Q10. The transistor G-Q11 will be "ON" providing the ac control voltage is normal. The transistor G-Q3 is turned "OFF" and the oscillator #2 is unclamped, thus allowing it to supply gate pulses to the bypass SCRs.

The bypass SCRs will remain "ON" until after the elapse of the 0.6 seconds timing period and until the trip circuit has reset. The trip circuit resets when the fault current drops below 600 amperes. If both of the above conditions are met within a 3 second period, the power circuit will switch from the bypass SCRs to the main SCRs. If the conditions are not met within the 3 second period the control circuit will lockout at the elapse of the 0.6 second timing period following turning "ON" of the control SCR, FSCR1. The control SCR, FSCR1 turns on when the uni-junction transistor E-Q5 fires.

3- TRIP SIGNAL FROM INVERTER FUSE MONITORING CIRCUIT

The following is a description of the control circuit operation when a trip occurs due to a fault signal from the power inverter fuse detector circuit. When a fault signal is sent from the power inverter to card F, pin 1,the following occur simultaneously:

1. The control SCR, FSCR1 is turned ON. This causes the control circuit to lockout as previously explained and the gate signals to the main SCRs stop.

2. A signal is sent from card F, pin 7,to card E, pin 21 turning "ON" transistor E-Q8. This causes a pulse to go through the primary of transformer T3. The outputs of transformer T3 send a gate pulse to each of the commutating SCRs. The commutating SCRs turn "ON" and drive the main SCRs "OFF" in micro-seconds.

3. A signal is sent from card F, pin 9, to card G, pin 15. The transistor G-Q9 turns ON and clamps the oscillator #2 "OFF".

   The signal which indicates a fault condition in the inverter must be removed from card F, pin 1, before the impedance inserter can be turned "ON" by the "POWER ON" pushbutton.

4- TRIP DUE TO DC UNDERVOLTAGE

If the 42 volts dc control voltage drops below 33 volts, the impedance inserter will turn "OFF". First the zener diode, D-Z2 stops conducting, next D-Q3 turns "OFF", then a signal from card D, pin 13, to card F, pin 21, turns "ON" F-SCR1. When FSCR1 turns "ON" the control circuit is locked out. The main SCRs turn "OFF" at the next power circuit current zero.

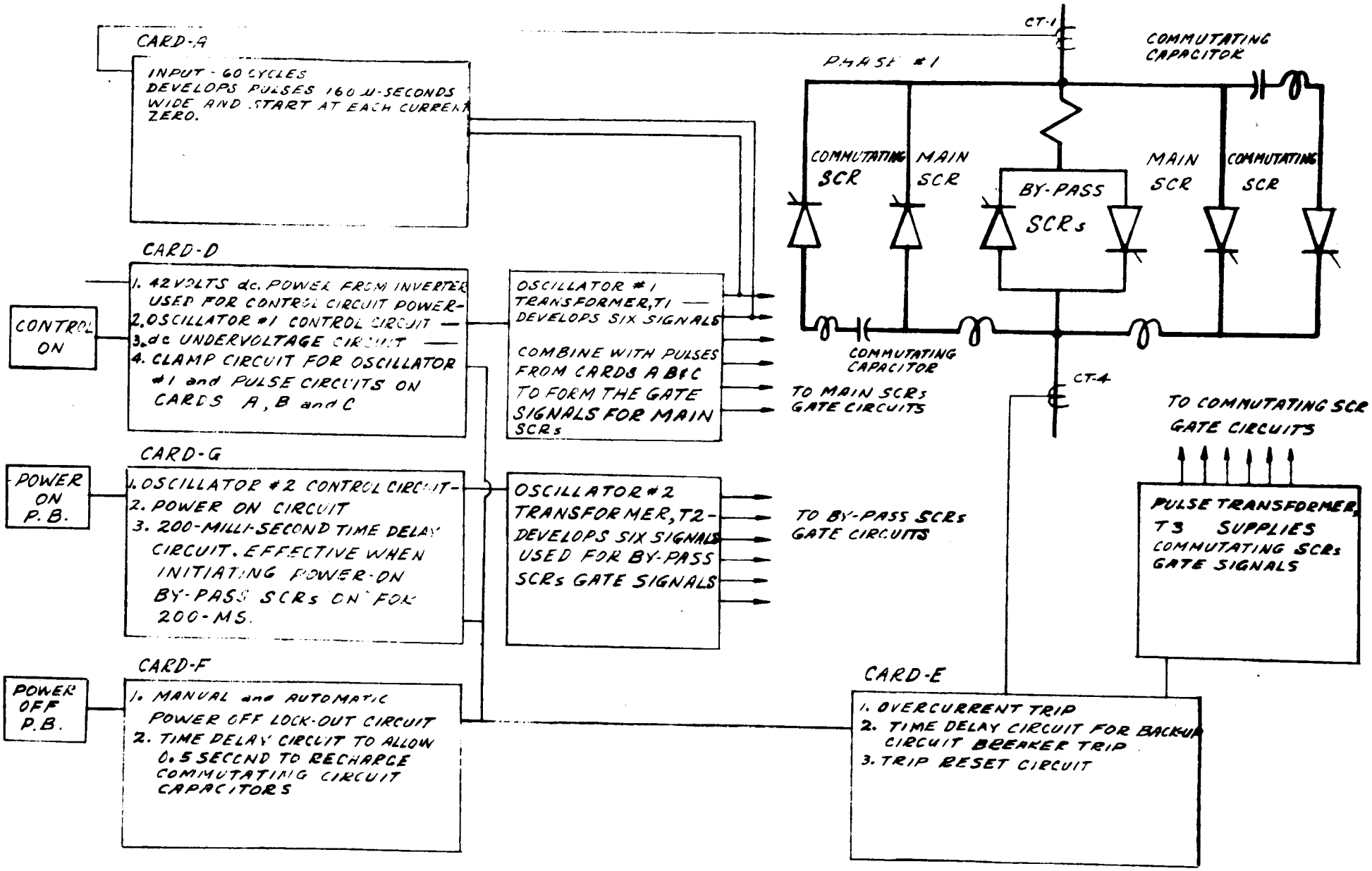
5- TRIP DUE TO AN AC UNDERVOLTAGE

If the 208 volts ac control voltage drops below 100 volts the impedance inserter will turn "OFF". If the ac control voltage remains below 100 volts for more than 3 seconds, the control circuit will lockout and it will be necessary to press the "POWER ON" pushbutton to turn "ON" the impedance inserter. If the ac control voltage rises above 100 volts within a 3 second period the impedance inserter will turn "ON". When the ac control voltage drops below 100 volts the zener diode F-Z1 stops conducting. Next,transistors F-Q2 and F-Q5 turn "OFF". A signal is sent from card F, pin 47, to card D, pin 5, thus turning "ON" transistor D-Q4. When transistor D-Q4 turns "ON" the oscillator #1 is clamped and the gate signals to the main SCRs are stopped.

In addition, a signal from pin 17 is sent to card E, pin 27, this signal initiates the 3 second timing period that a fault is allowed to remain before the control circuit is locked out. The operation of the 3 second timing period in the trip circuit has been explained under the sub-heading, Overcurrent Trip.

6- MANUAL TURN OFF

Pressing the "POWER OFF" pushbutton causes a signal to be sent to card F, pin 27, through FR6, F-CR5, FR7 and FR-13 to turn "ON" FSCR1. When F-SCR1 turns ON it locks out the control circuit. The main SCRs turn OFF at the next power circuit current zeroes.


CARD-A
INPUT - 60 CYCLES
DEVELOPS PULSES 160 M-SECONDS WIDE AND START AT EACH CURRENT ZERO.
CT-1
COMMUTATING CAPACITOR
PHASE #1
COMMUTATING SCR
MAIN SCR
BY-PASS SCRs
MAIN SCR
COMMUTATING SCR
CARD-D
1. 42 VOLTS dc. POWER FROM INVERTER USED FOR CONTROL CIRCUIT POWER-
2. OSCILLATOR #1 CONTROL CIRCUIT —
3. dc UNDERVOLTAGE CIRCUIT —
4. CLAMP CIRCUIT FOR OSCILLATOR #1 and PULSE CIRCUITS ON CARDS A, B and C
CONTROL ON
OSCILLATOR #1 TRANSFORMER, T1 — DEVELOPS SIX SIGNALS
COMBINE WITH PULSES FROM CARDS A B & C TO FORM THE GATE SIGNALS FOR MAIN SCRs
TO MAIN SCRs GATE CIRCUITS
COMMUTATING CAPACITOR
CT-4
TO COMMUTATING SCR GATE CIRCUITS
CARD-G
1. OSCILLATOR #2 CONTROL CIRCUIT-
2. POWER ON CIRCUIT
3. 200-MILLI-SECOND TIME DELAY CIRCUIT. EFFECTIVE WHEN INITIATING POWER-ON BY-PASS SCRs ON FOR 200-MS.
POWER ON P.B.
OSCILLATOR #2 TRANSFORMER, T2 - DEVELOPS SIX SIGNALS USED FOR BY-PASS SCRs GATE SIGNALS
TO BY-PASS SCRs GATE CIRCUITS
PULSE TRANSFORMER, T3 SUPPLIES COMMUTATING SCRs GATE SIGNALS
CARD-F
1. MANUAL and AUTOMATIC POWER OFF LOCK-OUT CIRCUIT
2. TIME DELAY CIRCUIT TO ALLOW 0.5 SECOND TO RECHARGE COMMUTATING CIRCUIT CAPACITORS
POWER OFF P.B.
CARD-E
1. OVERCURRENT TRIP
2. TIME DELAY CIRCUIT FOR BACKUP CIRCUIT BREAKER TRIP
3. TRIP RESET CIRCUIT

GENERAL ELECTRIC

0669D086 CONT ON SHEET 2 SH NO. 1

TITLE WIRING DIAGRAM

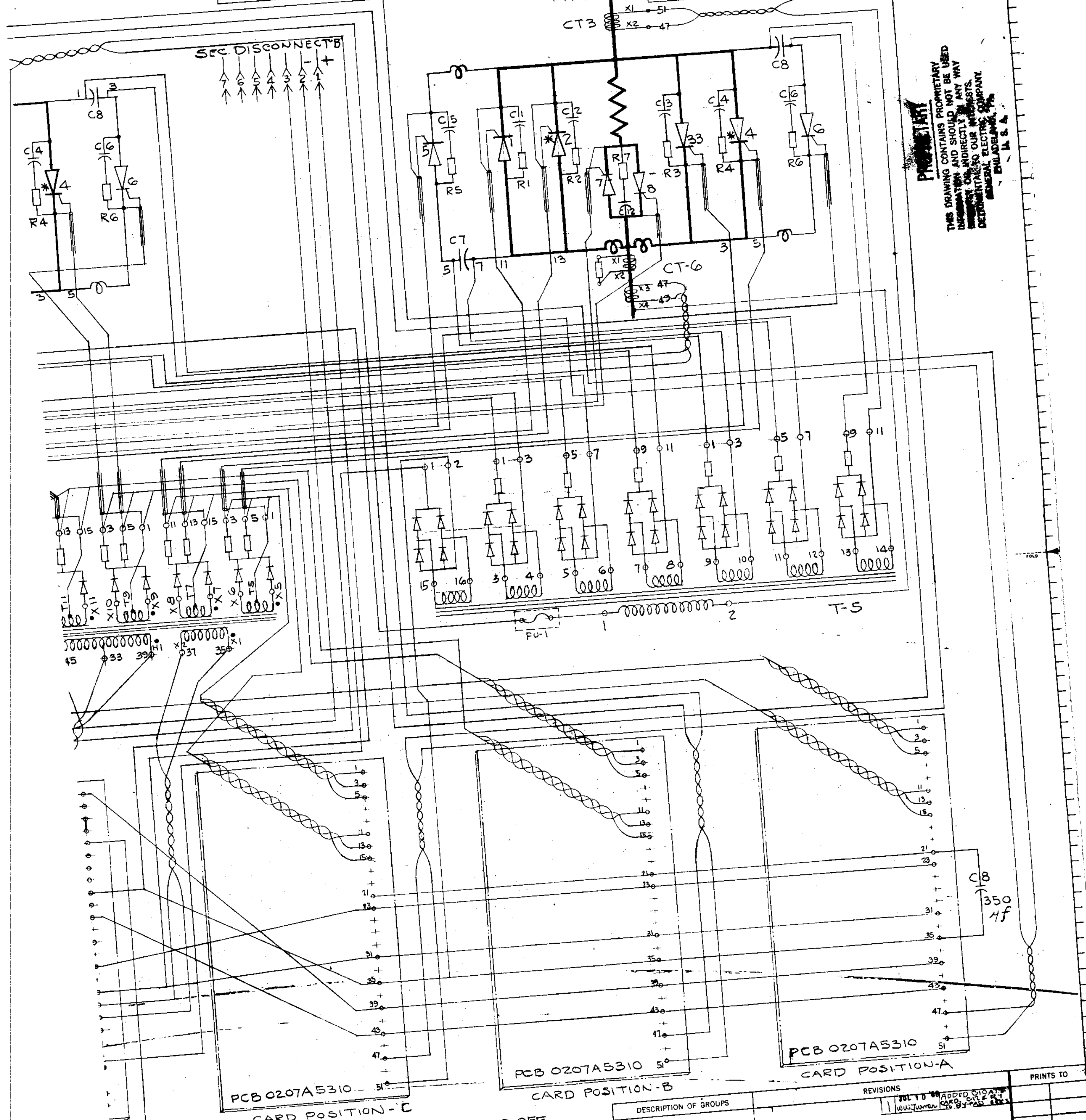
FIRST MADE FOR STATIC IMP. INSERTER TYPE 526

CONT ON SHEET	SH NO.	
	1	ELEMENTARY WIRING DIAGRAM
	2	ELEMENTARY WIRING DIAGRAM

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS: FRACTIONS	DECIMALS	ANGLES
	✓	+ −	+ −	+

REV NO. O



THIS DRAWING CONTAINS PROPRIETARY INFORMATION AND SHOULD NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO OUR INTERESTS. GENERAL ELECTRIC COMPANY PHILADELPHIA, PA. U.S.A.

NOTE:- POWER-ON AND POWER-OFF ARE ILLUMINATED PUSH BUTTONS

(1) P.C.B. WITH COMPONENTS SHOWN IN FIG-3 SHEET-2

(2) * MAIN SCR 2&4 OMITTED *

(RED) SIMILAR TO P-1 EXCEPT MAIN SCR 12&14 etc. ARE ADDED

DESCRIPTION OF GROUPS

REVISIONS: 1 JUL 10 '68 ADDED CIOAF CARD, C12 & R7 TO BY-PASS REACT. W.W. Turner

PRINTS TO

MADE BY W.W. Turner June 22 67

ISSUED JUL 10 1967

APPROVALS

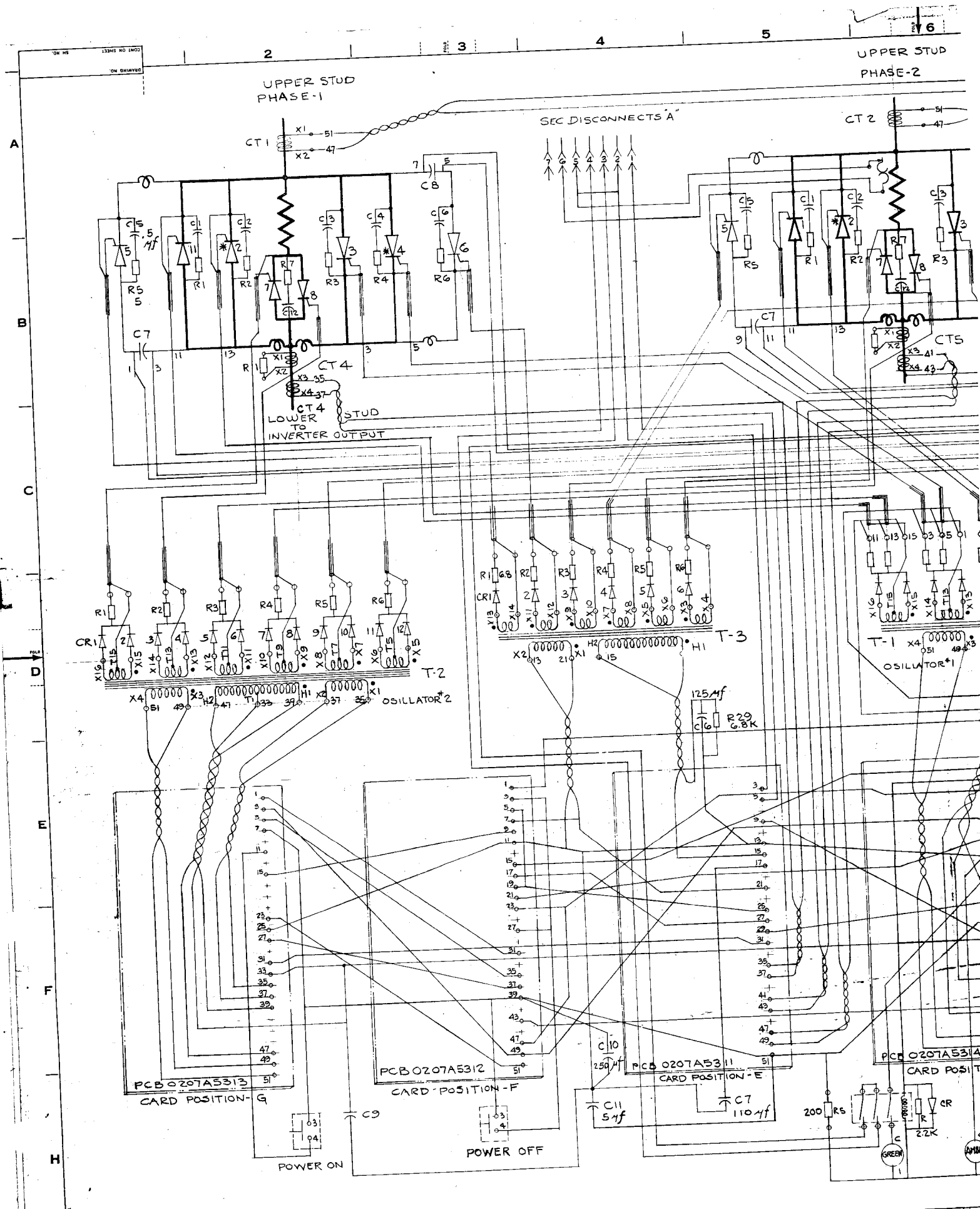
SWGR DIV. OR DEPT.

PHILA LOCATION

SP-A

0669D0863 CONT ON SHEET 2 SH NO 1

7 8 9 10


UPPER STUD
PHASE-1
UPPER STUD
PHASE-2
SEC DISCONNECTS "A"
CT1
CT2
CT4
CT5
CT4 LOWER STUD TO INVERTER OUTPUT
T-1
T-2
T-3
OSILLATOR #1
OSILLATOR #2
PCB 0207A5313
CARD POSITION-G
PCB 0207A5312
CARD POSITION-F
PCB 0207A5311
CARD POSITION-E
POWER ON
POWER OFF
R29 6.8K
200 RS
2.2K
GREEN

GENERAL ELECTRIC

0669D0863

CONT ON SHEET FINAL SH NO. 2

TITLE WIRING DIAGRAM

FIRST MADE FOR STATIC IMP. INSERTER TYPE SZL-1

1	ELEMENTARY WIRING DIAGRAM
2	ELEMENTARY WIRING DIAGRAM

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+ −	+ −	+ −

PROPRIETARY

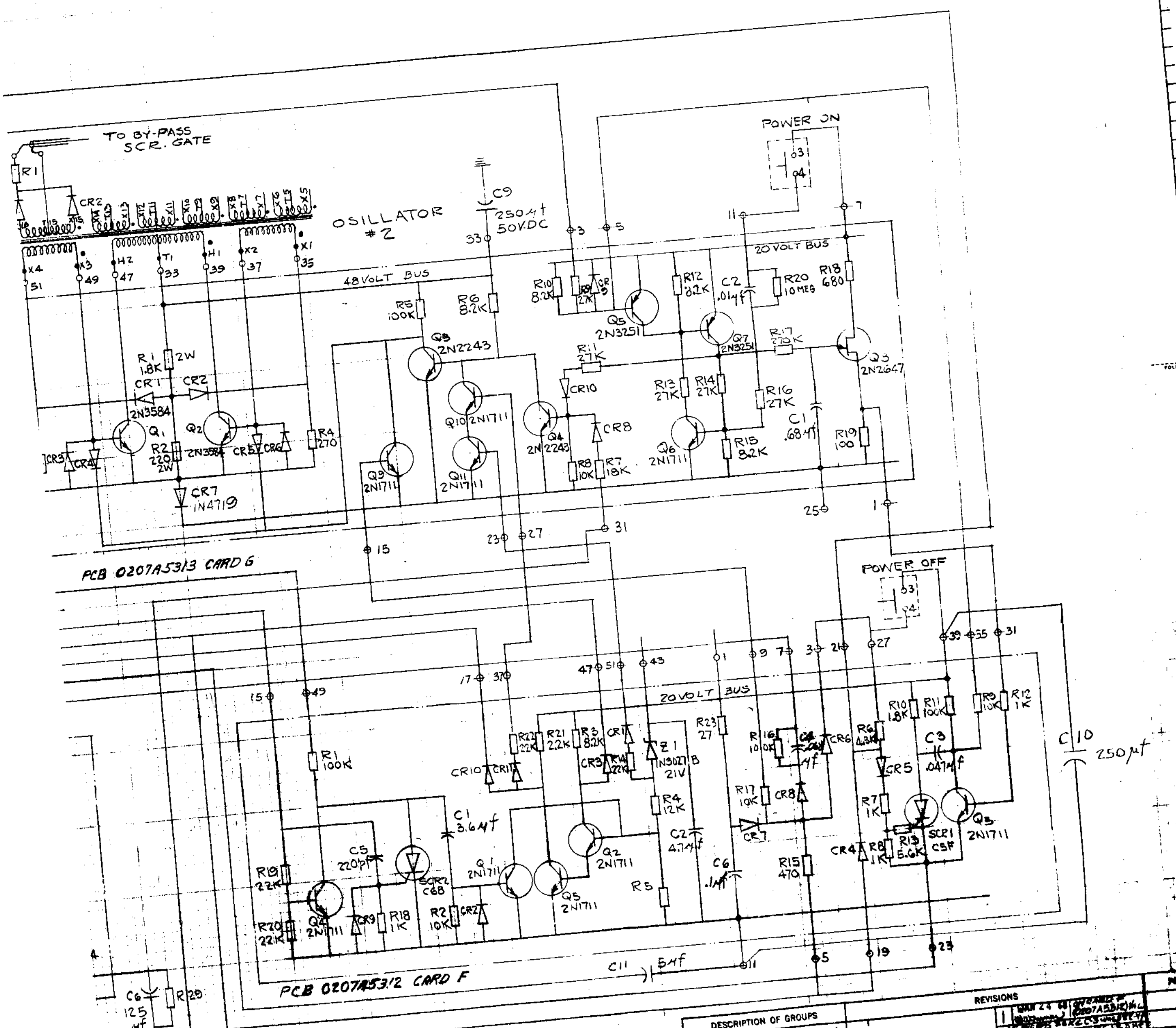


FIG-3

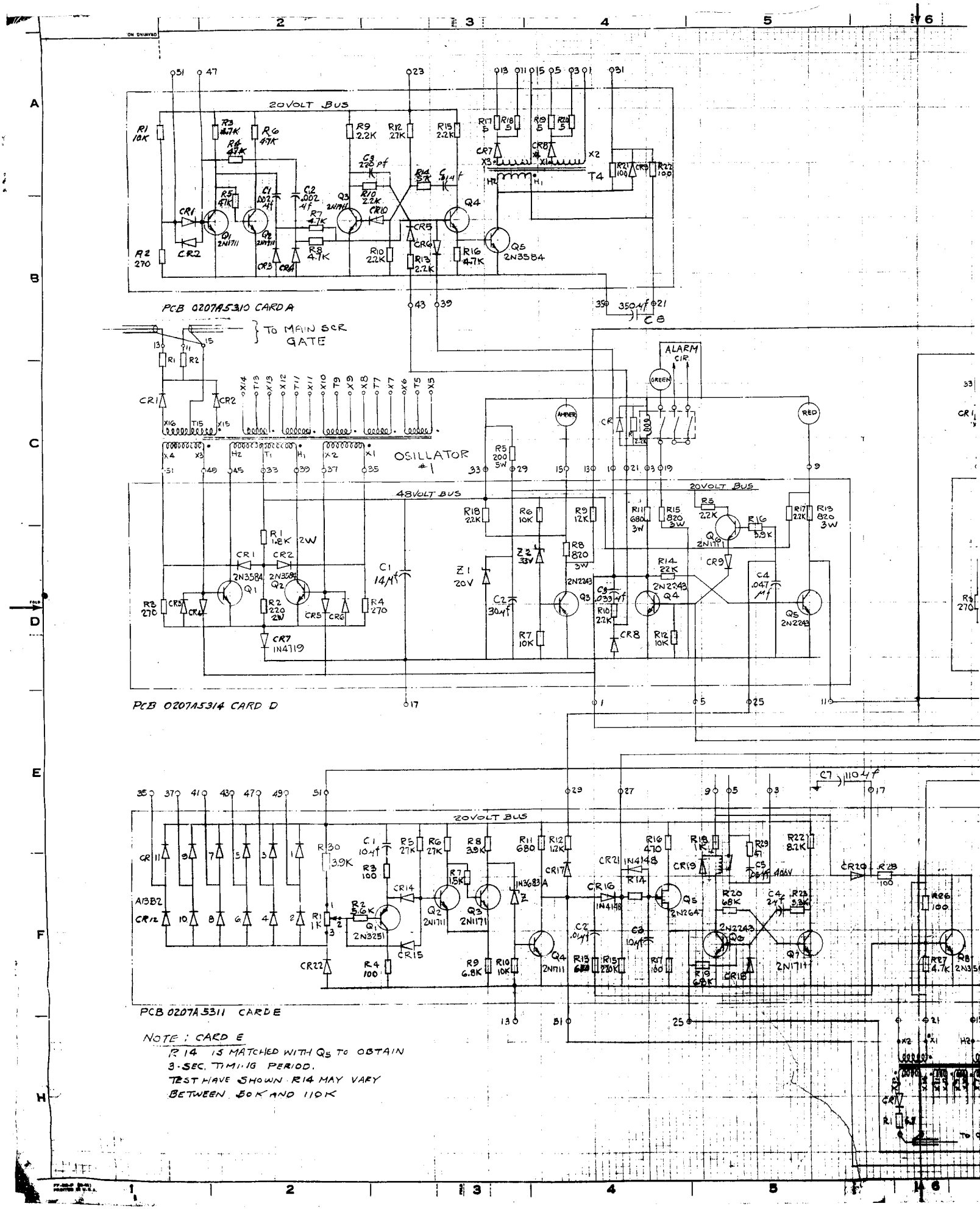
DESCRIPTION OF GROUPS

REVISIONS

1	MAR 24 '68
2	JUN 24 '68
3	JUL 1 '68 REV. CARDS TO AGREE WITH ... CHGS ON P.C.B. ...

MADE BY June 6 1967

APPROVALS


20VOLT BUS
PCB 0207A5310 CARD A
TO MAIN SCR GATE
ALARM CIR
GREEN
AMBER
RED
OSILLATOR #1
48VOLT BUS
20VOLT BUS
PCB 0207A5314 CARD D
20VOLT BUS
PCB 0207A5311 CARD E
NOTE : CARD E
P 14 IS MATCHED WITH Q5 TO OBTAIN
3-SEC. TIMING PERIOD.
TEST HAVE SHOWN R14 MAY VARY
BETWEEN 50K AND 110K