INSTRUCTIONS

GEK-237

STATIC EXCITER REGULATOR
FOR
SYNCHRONOUS MOTORS
3S7931SA333

INTRODUCTION

The 3S7931SA333 static exciter regulator controls the power factor or reactive volt-amperes of an AC synchronous motor (or motors) by controlling its excitation. Silicon controlled rectifiers control power delivered to the motor field. The exciter regulator is completely static, having no moving parts or vacuum tubes to perform the regulating function. Relays and breakers are used only as protective devices.

RECEIVING, HANDLING AND STORAGE

Receiving and Handling

Immediately upon receipt, the equipment should be carefully unpacked to avoid damage. Particular care should be exercised to prevent small parts from being mislaid or thrown away in the packing material.

As soon as the equipment is unpacked, it should be examined for any damage that might have been sustained in transit. If injury or rough handling is evident, a damage claim should be filed immediately with the transportation company and the nearest General Electric Sales Office should be notified promptly.

Storage

If the equipment is not to be used as soon as it is unpacked, it should be stored in a clean, dry place and protected from accidental damage.. Particular care should be exercised to avoid storing the equipment in locations where construction work is in progress.

DESCRIPTION

The 3S7931SA333 is an excitation cubicle consisting of various panels and components built into a system. Each model is usually custom designed so that relaying, instrumentation, user connections and protective circuitry will satisfy the application. The basic control is very similar on all models.

The excitation cubicle includes three 3S7932MA226 SCR power rectifier units, a 3S7932MA221 AC (automatic) regulator panel, a 3S7932MA222 firing panel, a 3S7932MA224 (power factor) regulator panel, a 3S7932MA225 relay panel, a 3S7932MA227 limit circuit panel, a 3S7932MA229 switch and fuse panel, and various associated components that make up the particular system.

INSTALLATION

The exciter should be installed so that it is accessible from both front and back. Air circulation must be provided as indicated on the outline drawings furnished with the equipment.

All connections should be made per diagrams furnished with equipment. Read all notes on diagrams. Check all variations of application.

OPERATION

CAUTION: THE HEAT SINKS IN THE POWER RECTIFIER UNITS ARE AT ABOVE GROUND POTENTIAL.

Initial Operation

Wire check all connections per diagrams before applying power. Check all relays and contactors to make sure they are free to operate. Check fans on coolers to make sure they are free to rotate. Make sure all fuses are in place.

Set 1SS in "Off" position. Disconnect motor field or lock field breaker open. Apply power to equipment without running motor. Close relay power switch 9SW and control power switch 10SW. Output voltage should be zero. "Control Power" (16I) light should be on. All fans on circular coolers and doors should be operating. All "Fan OFF" lights (11L, 12L, and 13L) should be out, indicating air flow. All "Fan Motor" lights (107I and 108I) should be on. "Power Cir." light (17I) should be on. All other lights should be out.

Turn "Max. Lim." (12SW) and "Min. Lim." (11SW) off. Set "Max. Lim." adjust (7P) and "Max. Current Lim." adjust (4P) fully clockwise. Set "Min. Lim." adjust (6P) fully counterclockwise. Set "DC Reg." (Manual) adjust (5P) fully counterclockwise.

Switch 1SS to "Man." "Fir. Cir." light (18I) should come on. Output voltage should be less than 50 volts DC. "Ground" indicator lights (NGI and PGI) and "DC Output" indicator light (19I) should be dim.

Adjusting the "DC Reg." adjust (5P) should vary output DC voltage from less than 50 volts to approximately 400 volts. Jumper circuit 220 to circuit 221 temporarily at 15TB. This will energize DC voltage limit circuits. Turn on the "Max. Lim." circuit (12SW) and set maximum DC voltage limit with "Max. Lim." adjust (7P). (This is usually set at approximately 10% above the maximum steady-state voltage normally required by the motor field.) Turn on the "Min. Lim." circuit and set minimum DC voltage limit with "Min. Lim." adjust (6P). (This is usually set at a predetermined minimum field voltage that would normally prevent non-synchronous operation of the synchronous motor - slipping poles.) The exciter is now controlling output voltage and has limits set on its output. Remove jumper 220 to 221 circuit. Set "DC Reg." adjust (5P) for proper output DC voltage for starting synchronous motor. Return 1SS to "OFF" position and shut down equipment.

Reconnect motor field and start synchronous motor with 1SS in "Man." position. After motor has synchronized, it should be possible to vary the input power factor to the synchronous motor by varying the "DC Reg." adjust (5P). Set the "Max. Current Lim." adjust (4P) to limit the field current to a maximum. (This DC current limit is usually determined by the thermal limit of the motor field.)

For Power Factor regulation, adjust the regulator as follows: Run the synchronous motor under normal load while on "DC Reg." (Manual) control. Adjust the "DC Reg." adjust (5P) for desired power factor. The Reactive volt ampere adjusting transformer (RVT) should be set and locked at its mid-point, or voltage 69 to 72 equals voltage 72 to 71. Rotate the position of the power factor adjusting selsyn (PFS) until voltage across circuits 63 to 48 is zero. Lock PFS in this position. Now decrease excitation slightly (power factor less leading). Circuit 63 should go positive with respect to circuit 48. The voltage across 3Q transistor should decrease. Return excitation to proper value.

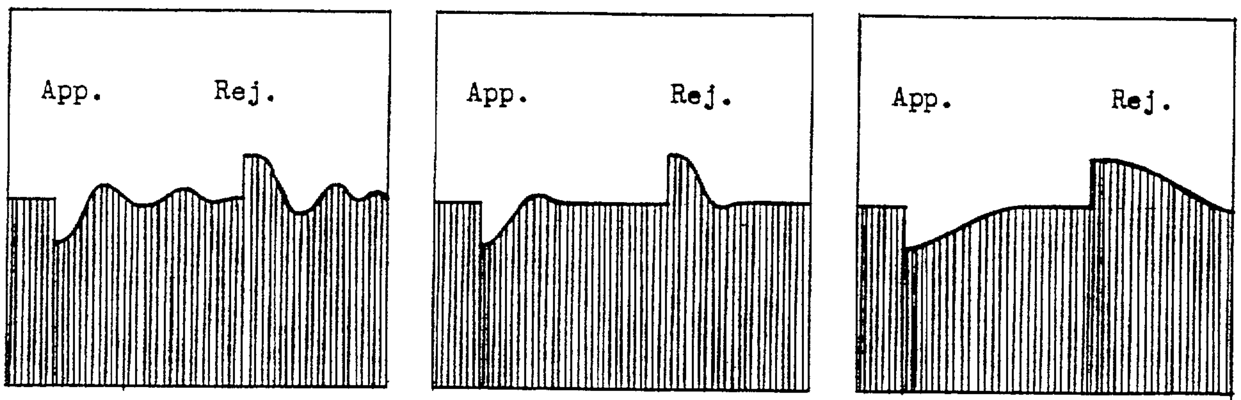
When 1SS is moved to "Auto" the regulator should control excitation to maintain the desired power factor.

For Reactive volt-ampere regulation, adjust the regulator as follows: Run the synchronous motor under normal load while on "DC Reg." (Manual) control. Set "DC Reg." adjust (5P) for unity power factor. Set the Reactive volt-ampere adjusting transformer (RVT) at its mid-point, or voltage 69 to 72 equal to voltage 72 to 71. Then adjust the power factor adjusting selsyn (PFS) for zero voltage across circuits 63 to 48 and lock. With the "DC Reg." adjust (5P) set the value of reactive volt-amperes which is to be held. Adjust the Reactive volt-ampere adjusting transformer (RVT) for zero voltage across circuits 63 to 48 and lock. Now decrease excitation slightly (less leading reactive volt-amperes). Circuit 63 should go positive with respect to circuit 48. The voltage across 3Q transistor should decrease. Return excitation to proper value.

When 1SS is moved to "Auto" the regulator should control excitation to maintain the desired reactive volt-ampere.

To adjust the "Stabilizing" circuits, it is necessary to observe input line voltage as load is applied and removed on the synchronous motor. The stabilizing should then be set for optimum response as shown in Figure 1. The "Stabilizing" adjust (3P) acts as a fine adjustment while the variations in capacity by changing jumpers at 3TB acts as a coarse adjustment. On some applications removing the jumper across 6X (G to H on 3TB) will improve transient response.

Adjusting regulator "Gain" (2P) will affect stabilizing. It is usually preferable to keep the gain of system as low as acceptable for the system. Lower Gain will make system more stable. Higher Gain will make system faster responding; however, it will become more difficult to obtain critical damping.



Under damped
Not enough Stab.

Critically damped
Optimum Stab.

Over damped
Too much Stab.

Typical oscillograms of recordings looking at amplified portion of motor AC line voltage.

Figure 1. Stabilizing Adjustment Recordings

Periodic Adjustments

The setting of the power factor adjusting selsyn (PFS) or the Reactive volt-ampere adjust (RVT) may be changed as requirements vary from time to time.

PRINCIPLES OF OPERATION

General

The exciter operates by taking power from the motor input source (or separate source), and rectifying and controlling the power to furnish DC excitation for the motor field. The figures that follow are typical for various functions. Figure 9 is a typical elementary diagram for a complete equipment. An exact elementary diagram is furnished with each particular model.

Power Rectifier Circuit

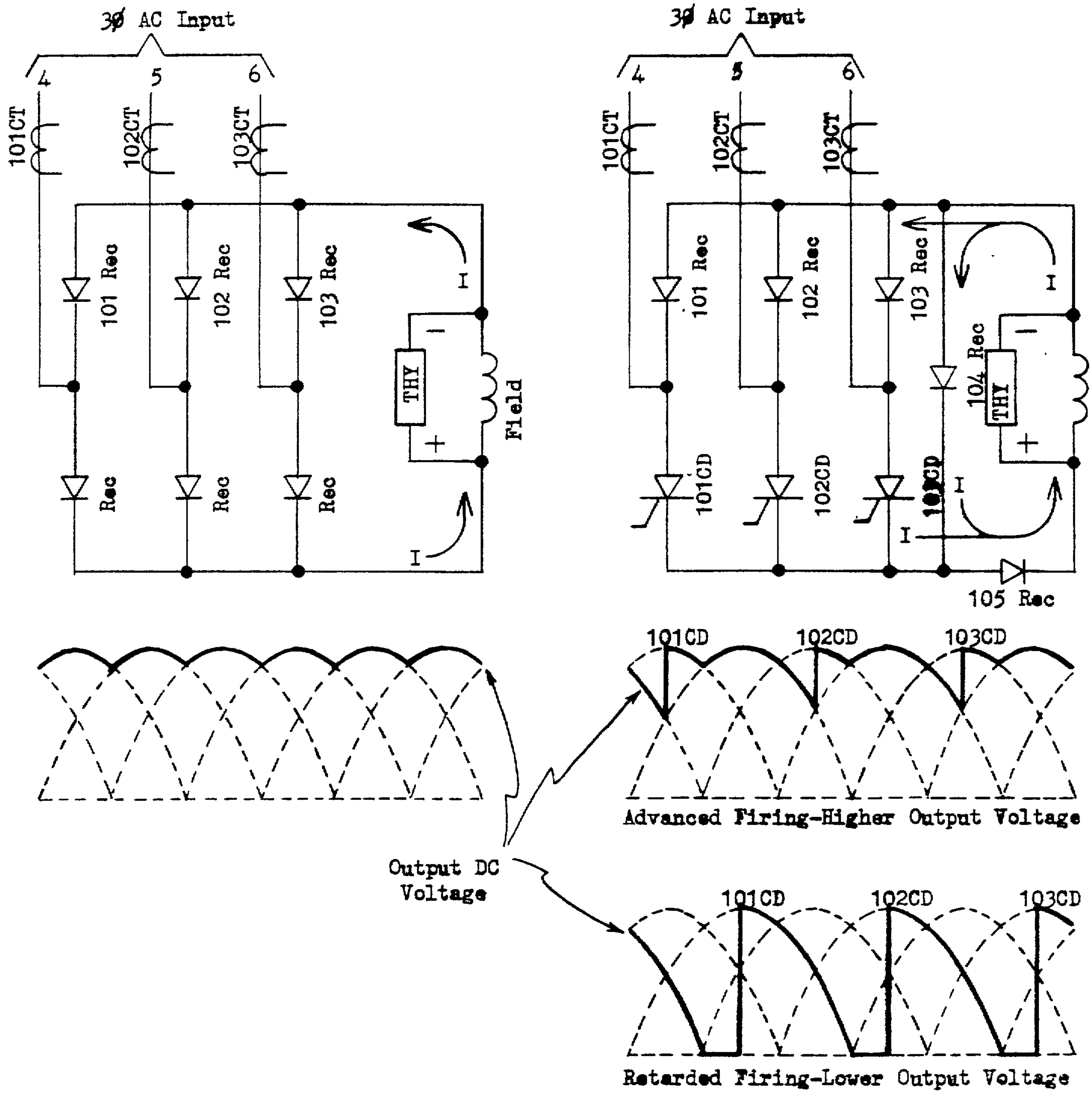
The excitation power for the motor field is furnished by three 3-phase full-wave bridge circuits operating in parallel. The first of the 3-phase full wave bridge circuits consists of 101 Rec, 102 Rec, 103 Rec, 104 Rec, 105 Rec, 101 CD, 102 CD, and 103 CD. See Figure 2(a). If conventional rectifiers were used in the bottom three legs instead of 101 CD, 102 CD,, and 103 CD, then the output DC voltage would be as shown in Figure 2(a). Replacing the conventional rectifier in the bottom legs with 101 CD, 102 CD, and 103 CD provides control of the output DC voltage by delaying the point on the supply voltage cycle where the respective legs conduct. See Figure 2(b). If the silicon controlled rectifiers (SCR's) (101 CD, 102 CD, and 103 CD) are fired early during the supply voltage cycle, the average output DC voltage is higher. If the SCR's are fired late during the supply voltage cycle, the average output DC voltage is lower. By phase controlling the SCR's as described above, the average DC output voltage can be controlled from near zero to approximately 400 volts DC, with a 360 volt 3 phase input.

When the SCR firing is retarded, the output DC voltage wave may go to zero during part of the cycle as shown in Figure 2(b); thus, the rectifier bridge will not be applying voltage to the field. Since the motor field is inductive, current must continue to flow. The "free wheeling" rectifier 104 Rec carries this field current during the OFF portions in the output DC voltage wave.

The "A", "B" and "C" power rectifier assemblies are operated in parallel to increase current rating. Each assembly is a 3-phase full wave rectifier circuit with associated components. All SCR's and rectifiers are matched to assure good current division. All input AC cables and DC output cables are matched to assure good current division. Reactors 101X, 102X, and 103X help provide current division, under transient and steady-state conditions. Firing all SCR's from common firing transformers (11T, 12T, and 13T) also helps provide good current division.

The rectifier in series with the DC output (105 Rec) is used to provide a higher reverse voltage rating against negative field current. Just before the motor synchronizes, the field breaker closes to apply excitation. The motor may slip several poles before it synchronizes (pulls into step). During this pole slipping there is induced an alternating field current (at slip frequency) that must flow in the field circuit. The positive or normal current will flow through the free wheeling rectifiers; however, there is no path for reverse field current. The Thyrite resistors (1THY, 2 THY, 3 THY, and 4THY) are provided to carry this reverse field current and at the same time hold the reverse voltage below the PRV rating of the rectifier bridge circuits. Resistors 110R and 112R divide this reverse voltage between the rectifier bridge and the series rectifier 105 Rec. Using the series rectifier increases the power rectifier circuit reverse voltage rating, thus allowing a reasonable size Thyrite resistor. The Thyrite resistors are sized to take operating voltage continuously, and to carry as much as three cycles of reverse current due to pole slipping.

The current transformers in series with the AC input (101CT, 102CT, and 103CT) provide current signals for the current limit circuit. Each CT has a loading resistor (104R, 105R, and 106R) to change the current signal to a proportional voltage signal. These voltages, proportional to individual phase currents, are then rectified and applied to the current limit circuit in



(a) 3Ø Bridge Without SCR's

(b) 3Ø Bridge with SCR's

Figure 2. Power Rectifier Bridge Circuit Using Silicon Controlled Rectifiers (SCR's)

parallel. The current limit circuit is thus sensitive to the highest individual phase current.

Each 3-phase rectifier circuit has an RC filter across the input AC phases, and also across the output DC. These RC filters absorb voltage transients (spikes) as may occur due to high rate of change of current when the SCR's fire. (107R, 101C, 108R, 102C, 109R, 103C, 111R, and 104C).

Firing Circuit

An SCR is similar to a thyratron tube in that it remains non-conductive until a firing pulse of current is applied through its gate to cathode junction. If the anode is positive with respect to the cathode when the pulse is applied, the SCR will conduct and remain conducting until the anode voltage goes negative and the anode current goes to zero. By delaying the firing pulse during the period when the anode is positive, the SCR is phase controlled as described in Figure 2.

When operating SCR's in parallel, as the power rectifiers bridges are on this equipment, it is best to fire the SCR's from a common source (11T, 12T, and 13T). This prevents any transient current unbalance, as would occur if all SCR's were not fired simultaneously. Transformers 11T, 12T, and 13T are energized by smaller trigger amplifiers 1CD, 2CD, and 3CD. SCR 1CD then fires 101 CD in all three power rectifier assemblies. The firing of 101 CD and 1CD (for one phase) is illustrated in Figure 3 and is typical for all three phases.

The control of the phase shift for the firing circuit is accomplished by a saturable reactor (1SX). Firing occurs at the point on the supply voltage positive half-cycle when the reactor gate has accumulated enough volt-seconds to saturate. The AC voltage across 19 to 21 is applied across 1SX gate circuit. Rectifier 31 Rec blocks voltage during negative half-cycle. At some point during the positive half-cycle 1SX will saturate. Its reactance will drop sharply because of the square-loop core material - Figure 3(a). Most of the input voltage then transfers to the resistors 14R and 11R - Figure 3(b).

The voltage across 11R is clamped by 6ZD at 37 to prevent overvoltage on 1CD gate. Rectifier 26 REC blocks the small voltage that appears at 34 before 1SX saturates. When the pulse of voltage (Figure 3-d) is applied to 1CD gate, the resulting gate current will cause 1CD to "fire" and conduct current from the anode-to-cathode. This anode current will apply voltage to 11T-primary for the remainder of the positive half-cycle - Figure 3 (e).

The same voltage (Figure 3-e) will appear on all secondary windings of 11T. This voltage is clamped to 6 volts by 101ZD; thus, producing a square pulse of voltage for 101CD gate. The 101 CD SCR in all three power rectifier assemblies will then fire together, following 1CD. The firing of the power SCR's produces controlled field voltage as shown in Figure 2.

Control of the phase shift firing circuit is affected by controlling the saturating point of 1SX on each positive half-cycle. This saturating point is determined by the amount that the reactor flux was reset on the preceding negative

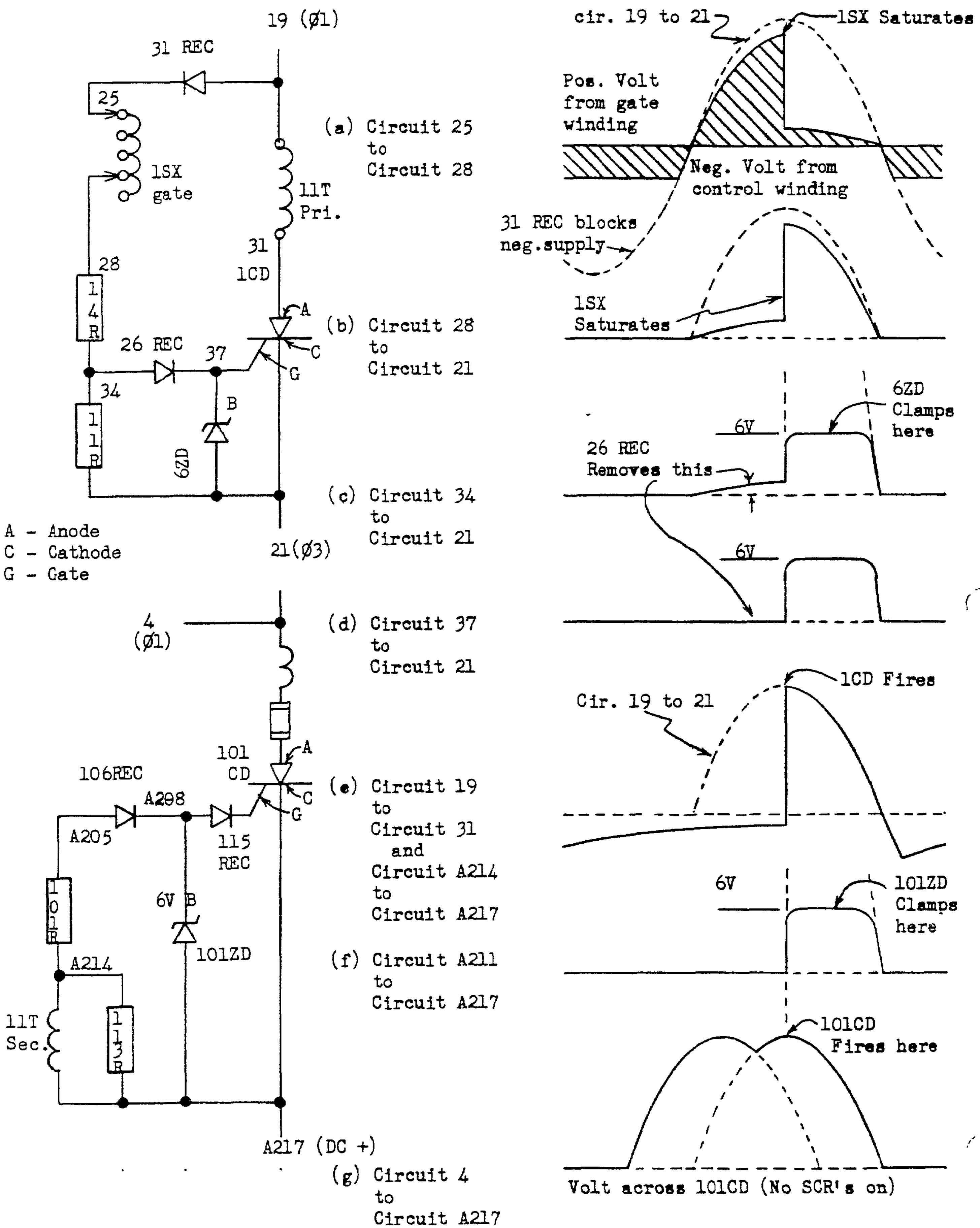


Figure 3 SCR Firing Circuit (For 101 CD)

half-cycle. If control windings provide a large reset voltage during the negative half-cycle, then the gate winding must accumulate a large amount of volt-seconds on the next positive half-cycle before it will saturate. This would cause retarded firing and lower output voltage. If the control windings provide a small reset voltage during the negative half-cycle, then the gate winding must accumulate very little volt-seconds on the next positive half-cycle before it saturates. This would cause advanced firing and higher output voltage.

Increasing the voltage across the control windings of the firing reactors (1SX, 2SX, and 3SX) thus decreases the static exciter average DC output voltage. Decreasing the voltage across the control windings of the firing reactors increases the output voltage. Control Windings for the firing reactors (1SX, 2SX, and 3SX) are in the AC voltage regulator (term. 6-7-8), the DC voltage regulator (term. 9-10), the maximum DC voltage limit (term. 11-12), the minimum DC voltage limit (term. 13-14), and the maximum current limit (term. 15-16).

AC Voltage Regulator

The AC voltage regulator provides automatic operation for controlling power factor or VARS as required. The term "AC voltage regulator" is a carry-over from a similar circuit used to control AC voltage in a generator. The term "Automatic" regulator would be more accurate as on this exciter for a synchronous motor it provides automatic regulation of the power factor or reactive-volt-amperes, according to the setting of the power factor regulator sensing circuit.

A typical diagram of the AC regulator is shown in Figure 4. The input to the AC regulator is an error signal voltage across 63 to 48. This error signal calls for increasing excitation if 63 becomes more positive, and decreasing excitation if 63 becomes less positive. This error signal voltage produces an error current through 4R and the base-to-emitter circuit of 1Q. An amplified error voltage appears across 5R. Transistors 2Q and 3Q are emitter followers to amplify the power level of the voltage at circuit 60. Circuit 51 then follows circuit 60 and produces reset voltage for the firing reactors. The firing reactors thus see the voltage across transistor 3Q. Relay ACR opens the reactor control circuits when operating on "manual" control (DC regulator). The collector of 3Q is connected to -30 volts while the bottom side of the firing reactors is connected to -24 volts. This means that if 3Q turns full-on, calling for maximum excitation, then 51 can go more negative than 47 to provide reverse control current. This increases the maximum output of the static exciter by forcing the firing reactors to saturate early in their firing cycles.

Rectifiers 9, 10, 11, 12, 13, and 14 Rec; Reactor 1X and capacitor 6C provides a DC power supply for the AC Regulator. Zener diodes 1ZD and 2ZD provide a regulated -24 volt and -30 volt bus. Rectifiers 25 Rec, 24 Rec, and 23 Rec shunt possible reverse base current around respective transistors. Capacitors 4C, 5C, and 11C and the 3P potentiometer provide feedback for stabilizing the system.

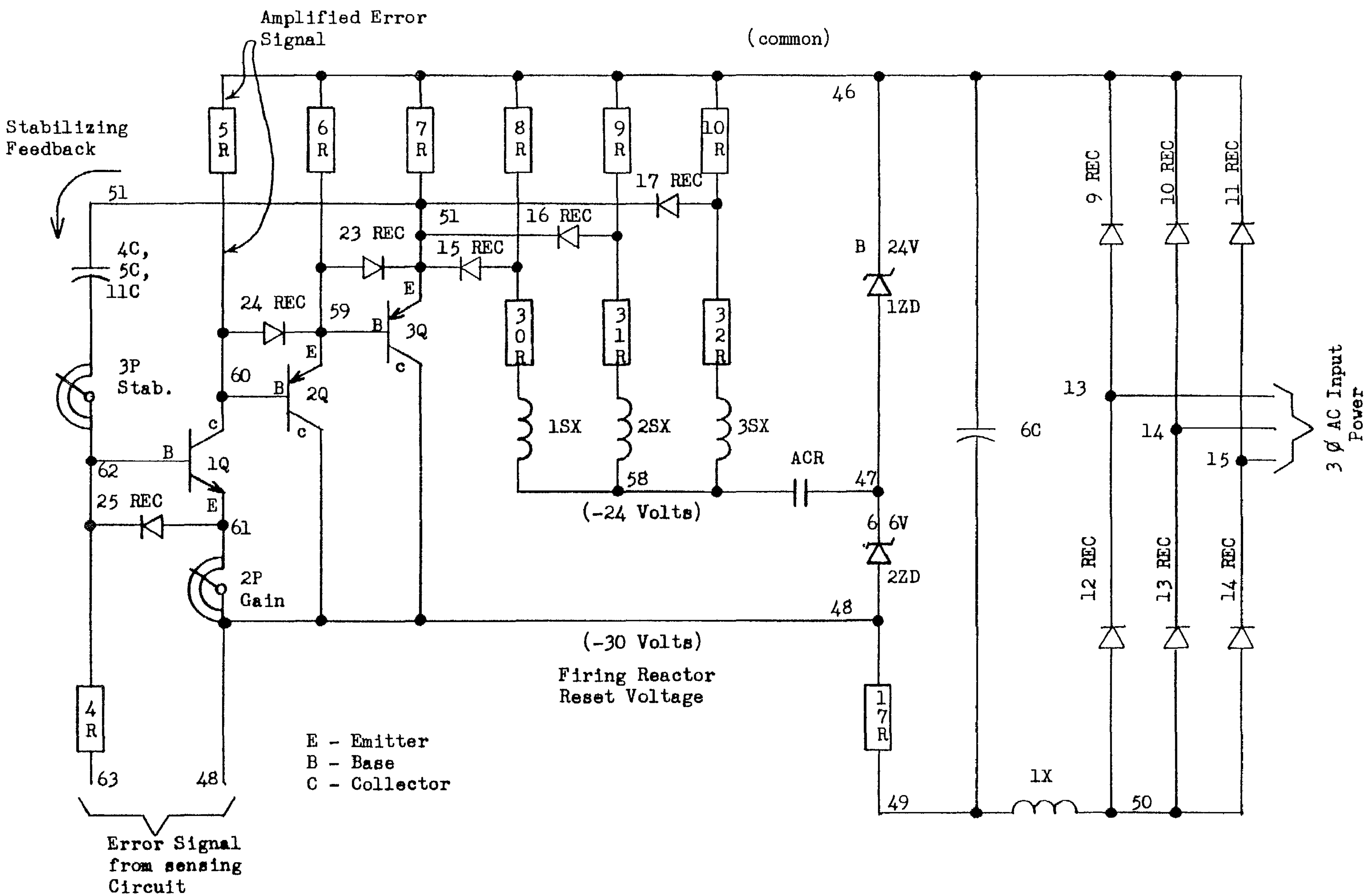


Figure 4 AC Voltage Regulator

Should the positive error voltage at 63 increase, as would occur if the motor power factor went more lagging due to increased load, then more error current will flow through 1Q base-to-emitter. Collector-to-emitter current through 1Q will then increase by an amplified amount. Circuit 60 to 48 voltage will decrease. Circuits 51 to 48 voltage will also decrease, reducing the DC control (reset) voltage applied to the firing reactors. The reactors will then saturate earlier on their next respective positive half-cycle, firing all SCR's earlier and increasing the average DC voltage applied to the motor field. Motor field current will then increase to bring the power factor back (more leading) and correct the original error. During the above action the RC stabilizing circuit (4C, 5C, 11C, and 3P) will feed back the changing output voltage signal to transiently oppose the initial error. This dampens the regulating action and allows the system to return to normal power factor smoothly without oscillating. Should the power factor go more leading due to dropping motor load, the opposite of the above action would take place.

Power Factor Regulator

The Power Factor Regulator can be adjusted to operate as a power factor control or as a reactive volt-ampere control. Referring to the typical elementary diagram Figure 9, the vector Diagram - Figure 5 illustrates operation as a power factor control.

The regulator acts to keep the power factor angle ϕ constant under various conditions of load on the motor. To regulate power factor the Reactive KVA adjuster (RVT) is set at its mid-point ($69 \rightarrow 72 = 72 \rightarrow 71$). The Power Factor adjusting selsyn (PFS) is then set so that voltage $69 \rightarrow 71$ leads or lags the voltage $L1 \rightarrow L3$, by the power factor angle ϕ to be regulated.

When operating at a medium load (Figure 5-b), the regulator is maintaining the power factor angle ϕ, due to the phase relationship of $69 \rightarrow 71$ and $L1 \rightarrow L3$ per the setting of PFS. The current (I_2) in line L2 leads the $N \rightarrow L2$ voltage by angle ϕ. Under this condition the vectors $69 \rightarrow 70 = 70 \rightarrow 71$, except for slight error signal required by the regulator. This keeps excitation at the proper value to keep vector $72 \rightarrow 70$ ($I_2 \times 1R$) at right angles with $69 \rightarrow 71$, thus maintaining power factor angle ϕ.

Should more load be added to the motor, L_2 current will increase and become less leading. Voltage $72 \rightarrow 70$ would swing clockwise and increase in magnitude (Figure 5-b). The increase voltage (14T) would exceed the decrease voltage (15T) by a large amount. This would cause a large error signal into the AC regulator calling for increased excitation. The increased excitation will make the power factor angle on the motor become more leading to correct error and arrive at a steady condition for the heavier load - Figure 5-c. The power factor angle ϕ would still be maintained.

Should load be dropped from the motor, the opposite of the above action would take place, as illustrated in Figure 5. The system would then arrive at a steady condition (a).

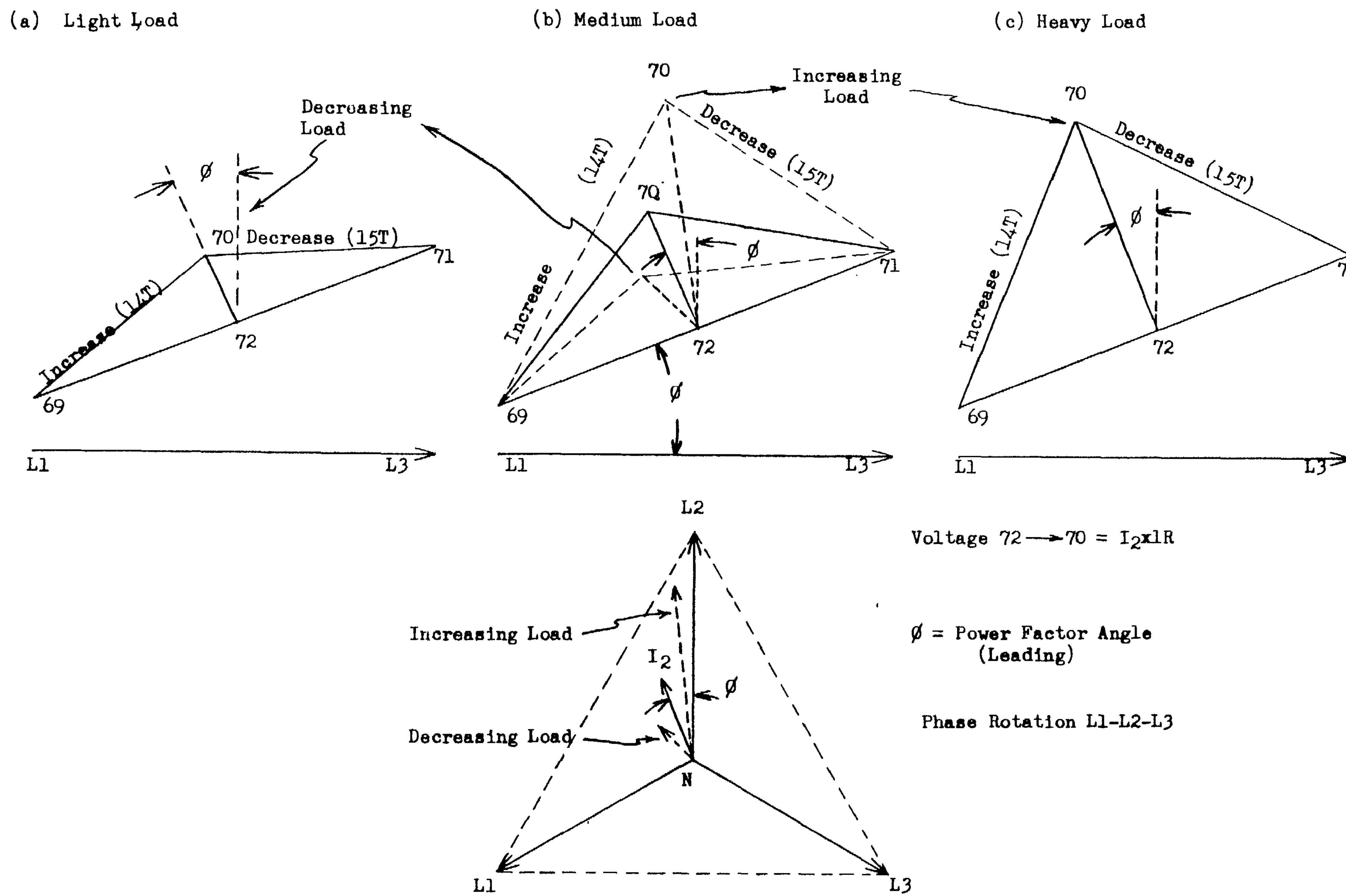


Figure 5 Vector Diagram Illustrating Power Factor Control

Referring to the typical elementary diagram Figure 9, the vector diagram Figure 6, illustrates operation as a Reactive-Volt-Ampere Control.

The regulator acts to keep the reactive-volt-amperes (KVAR) constant under various conditions of load on the synchronous motor. To regulator kilovars (KVARS) the power factor adjusting selsyn (PFS) is set for zero phase shift - 69 ⟶ 71 in phase with L1 ⟶ L3. The Reactive-Volt-Ampere adjuster (RVT) is then set with 72 nearer 71 or in the 72' position (for leading, KVARS). The regulator will then act to keep 72 ⟶ 72' (vector proportional to KVARS) constant, allowing only 72 ⟶ 70 (vector proportional to KW) to vary with load.

When operating under a steady medium load (Figure 6-b) all voltages are such that the increase voltage (14T) exceeds the decrease voltage (15T) by only a small error as required by the regulator to maintain proper excitation. Should more load be added to the motor, L2 current will increase and become less leading. Voltage 72' ⟶ 70 will swing clockwise and increase in magnitude. (Figure 6-b). The increase voltage (14T) will exceed the decrease voltage (14T) by a large amount. This will cause a large error signal into the AC regulator calling for increased excitation. The increased excitation will make the motor become more leading to correct the error and arrive at a steady condition for the heavier load - Figure 6-c. Although the new power factor angle Ø will be different, the KVARS (72 ⟶ 72') will still be maintained.

Should load be dropped from the motor, the opposite of the above action would take place, as illustrated in Figure 6. The system would then arrive at a steady condition (a).

Several motors can be controlled from the exciter if required. For these applications the L_2 current from individual motors is fed through a totalizing CT (TCT). The regulator will then maintain an average power factor, or reactive-volt-ampere for the group. Balancing between individual motors could be provided by series field resistance (Field Rheostat).

DC Regulator and Limit Circuits

The DC Voltage Regulator provides "Manual" control similar to a field rheostat. The DC voltage regulator provides constant excitation by regulating the average DC voltage to the field, regardless of AC line volt, power factor, KW or KVAR changes. When operating on DC Regulator (Manual Control) relay ACR transfers control of the firing reactors (1SX, 2SX, and 3SX) from windings 6-8 in the AC regulator to windings 9-10 in the DC Regulator. See Figure 7.

The output voltage from the static exciter is fed into the DC regulator through reactor 2X. The filtering action of 2X and 19R produces a DC voltage across 19R that is proportional to the average field voltage. This voltage is applied through 20R to 3ZD, setting the reference voltage at 238 at 36 volts. The opposite end of the firing reactor control windings is connected to 5P, which acts as a voltage divider. If the voltage at 234 (which is proportional to field voltage) is too high an error voltage will appear across the reactor control windings to reduce excitation. The DC regulator thus is a bridge type circuit. The NO contact of ACR applies field voltage to the maximum and minimum DC voltage

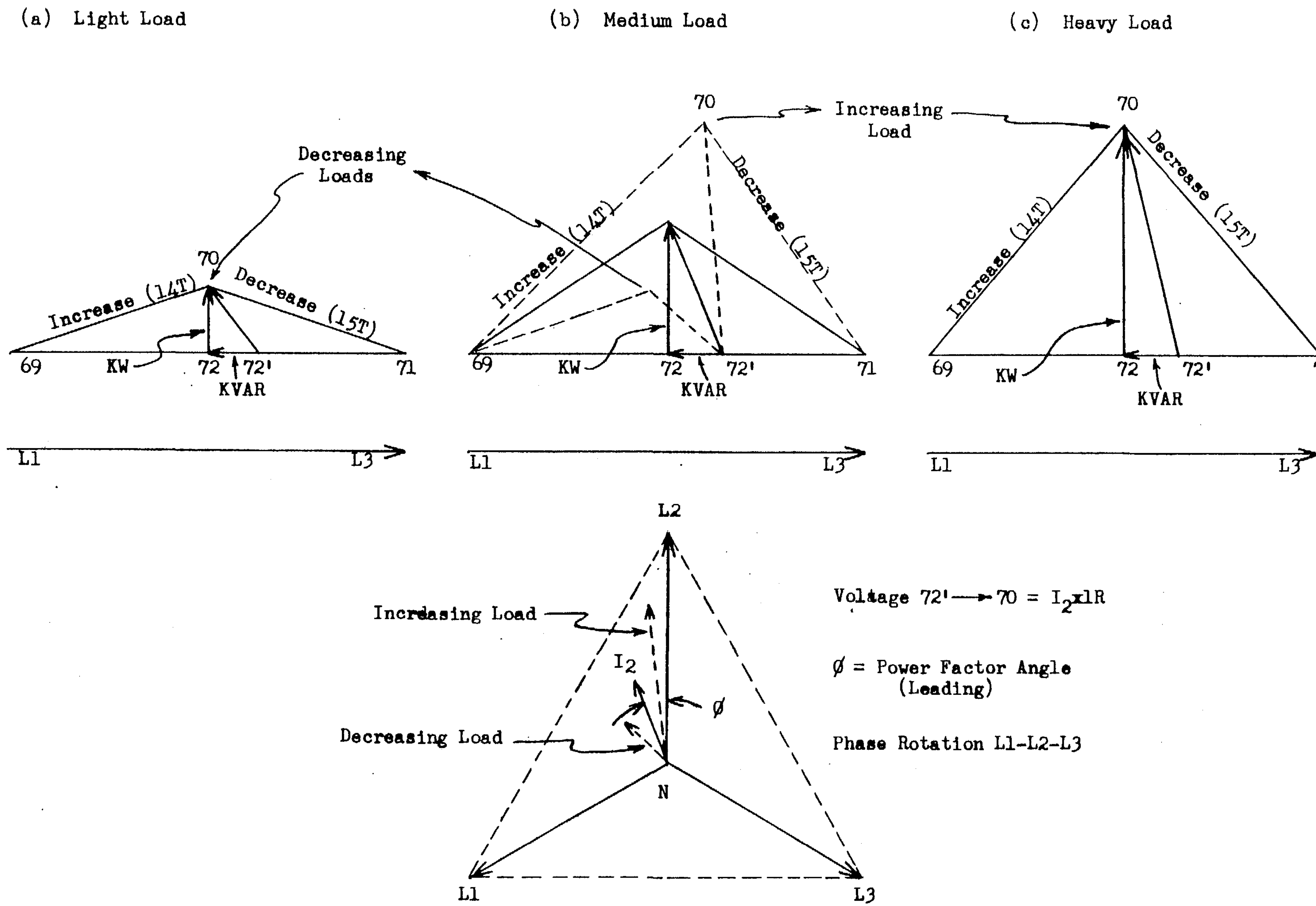


Figure 6 Vector Diagram Illustrating Reactive-Volt-Ampere Control

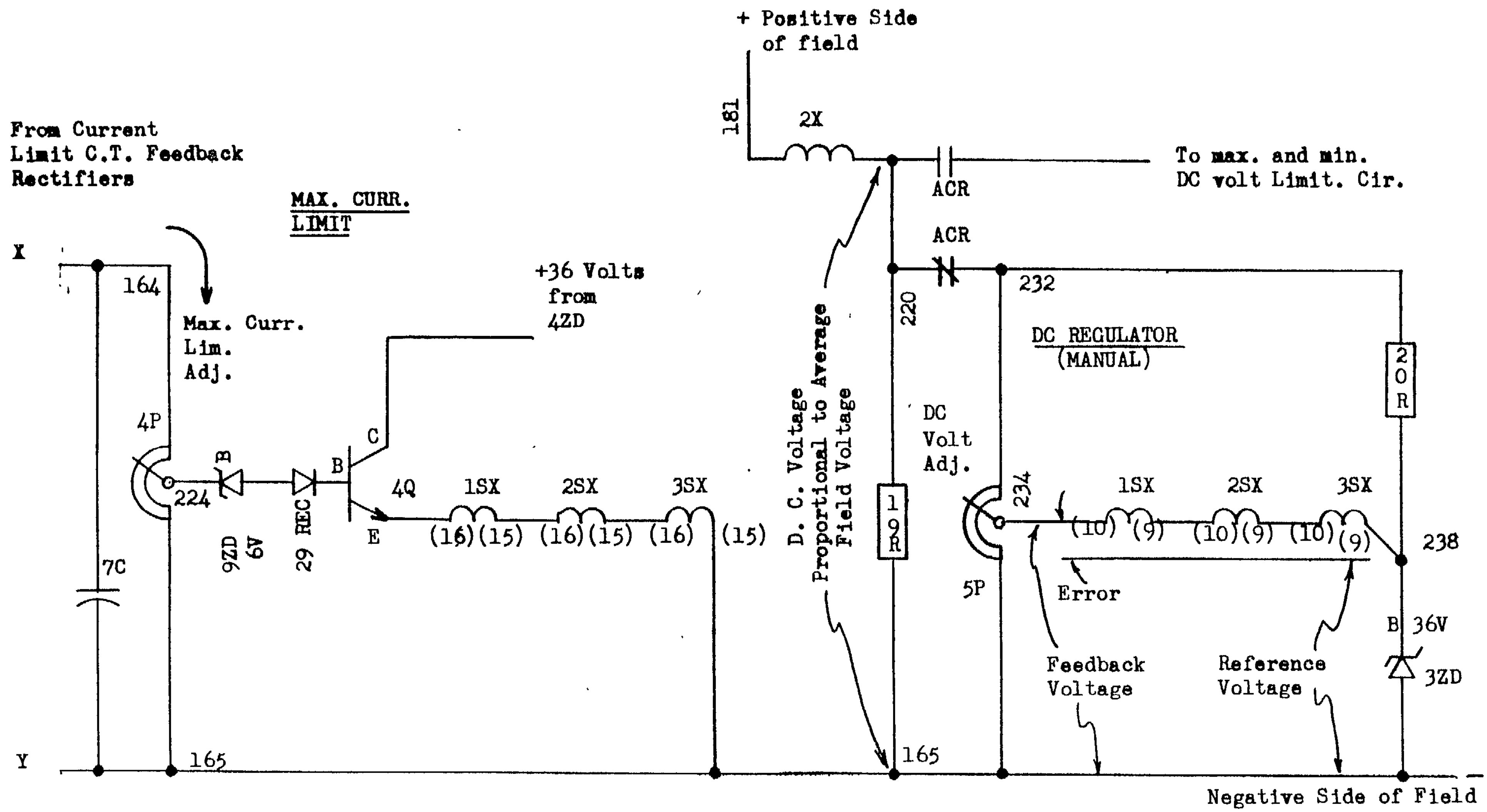


Figure 7 DC Regulator and Max. Current Limit

limit circuits when operating on the AC (automatic) voltage regulator.

The maximum current limit provides a ceiling or top limit on the DC current that can be applied to the motor field, and also protects the static exciter power rectifier circuits by limiting the peak current that can be supplied by any phase of any of the three rectifier bridge circuits.

A current transformer in each AC line to each rectifier bridge circuit provides a voltage proportional to current due to its fixed load resistor. The voltage from each 3 phase group is rectified and applied to circuits 164 and 165 (X and Y). Capacitor 7C holds the voltage across X and Y to near peak voltage of the highest single phase input. The voltage across 7C is then proportional to the highest AC phase current into any power rectifier bridge circuit.

A portion of this dc voltage (current signal) is applied across 4P so the voltage at 224 is proportional to current. If this voltage exceeds the 6 volt level of 9ZD, current will flow from base-to-emitter through 4Q. This causes a larger current flow from collector-to-emitter through 4Q. This emitter follower action of 4Q applies reset voltage to the firing reactor control windings to decrease excitation; thereby, reducing the overcurrent. Using 4Q and the 36 volt supply from 4ZD allows 4P resistance to be high enough not to add extra burden on the CT's.

The Maximum DC Voltage Limit circuit provides a ceiling or top limit on the DC field voltage. See Figure 8. It is energized only when operating the AC regulator. The max. DC voltage limit is similar to the DC voltage regulator, except that 22 Rec allows current flow through the firing reactor control windings only in the "turn-off" direction. The max. DC voltage limit circuit will thus provide only a "turn-off" function when circuit 251 is more positive than circuit 257. Reactor 5X prevents interaction between the three firing reactors since this circuit and the AC regulator or is energized simultaneously. Transient forcing is possible even when using the max DC voltage limit, because the L/R circuit (2X and 19R) that filters field voltage provides approximately a .1 second lag (time delay).

The Minimum DC Voltage Limit circuit provides a bottom or minimum DC limit on DC field voltage. It is also energized only when operating the AC regulator. The min. DC voltage limit is similar to the DC voltage regulator, except 30 REC allows current flow through the firing reactor control windings only in the "turn-on" direction if the DC field voltage drops below a preset value. This "turn-on" function occurs when circuit 240 is more negative than circuit 248. Reactor 4X prevents interaction between the three firing reactors since this circuit and the AC regulator is energized simultaneously. The DC field voltage may go to zero transiently, even with the min. DC voltage limit set, because the L/R circuit (2X and 19R) provides approximately a .1 second time delay in feedback. The reference voltage across 4ZD is taken from a power source other than the field voltage because there would be no reference if field voltage dropped to zero.

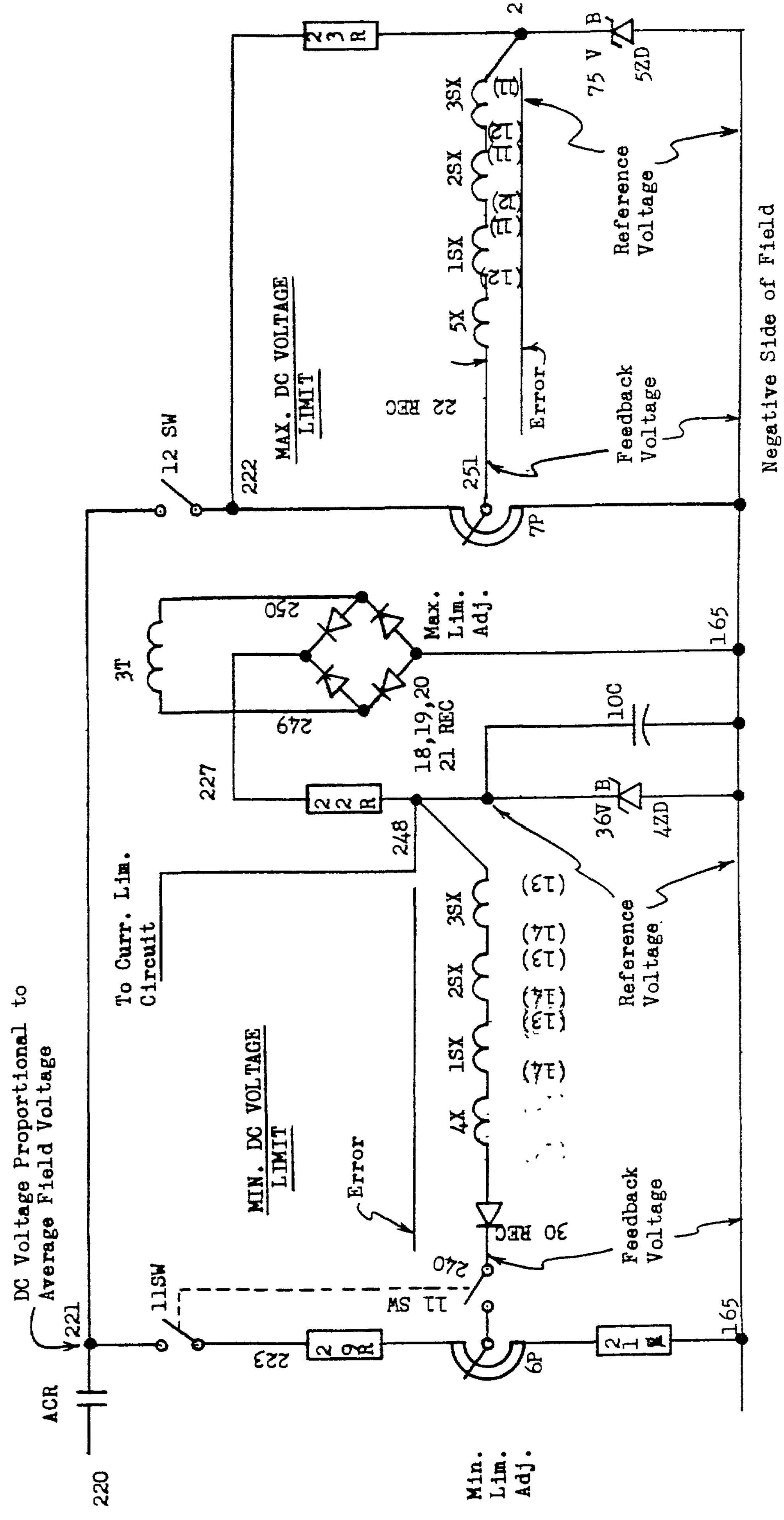


Figure 8 Minimum and Maximum DC Voltage Limit

Relaying and Control Circuits

The control circuit relays may be powered by an AC or DC source depending on application. These consist of the following:

A manual interlock relay (MCR) that prevents closing the main breaker to start motor unless the exciter (1SS) is on "Manual Control".

An operate relay (OCR) energizes the firing circuit to provide excitation when in "Manual", "Test", or "Automatic" operation as selected by 1SS. The operate relay (OCR) will drop out to deenergize exciter if the field overcurrent relay (FOC) picks up, or if 20CR picks up due to extreme over-temperature.

An input circuit relay (ICR) to connect the input to the sensing circuit when in "Test" or "Auto" operation.

An Auto relay (ACR) to connect the AC voltage regulator and limit circuits when in "Auto" operation. Interlocking relay contacts (93-1 & 93-2) prevents "Auto" operation until the motor starting circuits have completed their sequence. A contact of ICR will drop ACR, returning control to "Manual", should ICR drop out for any reason.

Relays 11CR, 12CR, or 13CR pickup to turn on indicator lights 11I, 12I, or 13I and also operate annunciator circuits should air flow through a forced air convector cease for any reason.

Relay 10GR operates in moderate over-temperature to turn on 14I and operate annunciator circuit. Relay 20CR operates in extreme over-temperature to turn on 15I and turn-off exciter (OCR).

Each of the six fan motors has thermal overload protection and a light to indicate its being energized. All 107I and 108I indicators should be on during operation.

Control relaying and protective relaying shown in Figure 9 are only typical. Relaying and Instrumentation may vary with application.

MAINTENANCE

Since there are no moving parts in this exciter regulator,little maintenance should be required. Periodic checks should consist of checking the power factor or reactive volt-ampere adjustment, regulation, and peformance as required for the particular application. The regulator should be cleaned with a blower as required to prevent an accumulation of dust and dirt.

TROUBLESHOOTING

The best aid for troubleshooting is a thorough study of the particular circuit in the "Principles of Operation". By operating in "Test" position the AC voltage regulator can be monitored by observing voltage across circuits 51 to 48.

RENEWAL PARTS

Should a component fail, a replacement part can be ordered from the nearest sales office of the General Electric Company. When ordering renewal parts, specify the quantity required, give the catalog number and describe the required parts in detail. In addition, give the 3S model number and complete nameplate rating of the equipment. Principal Renewal Parts Lists are furnished with each particular model.

GENERAL ELECTRIC COMPANY ● DRIVE SYSTEMS PRODUCT DEPARTMENT
CONTROL DEVICES OPERATION ● WAYNESBORO, VIRGINIA 22980

GENERAL ELECTRIC

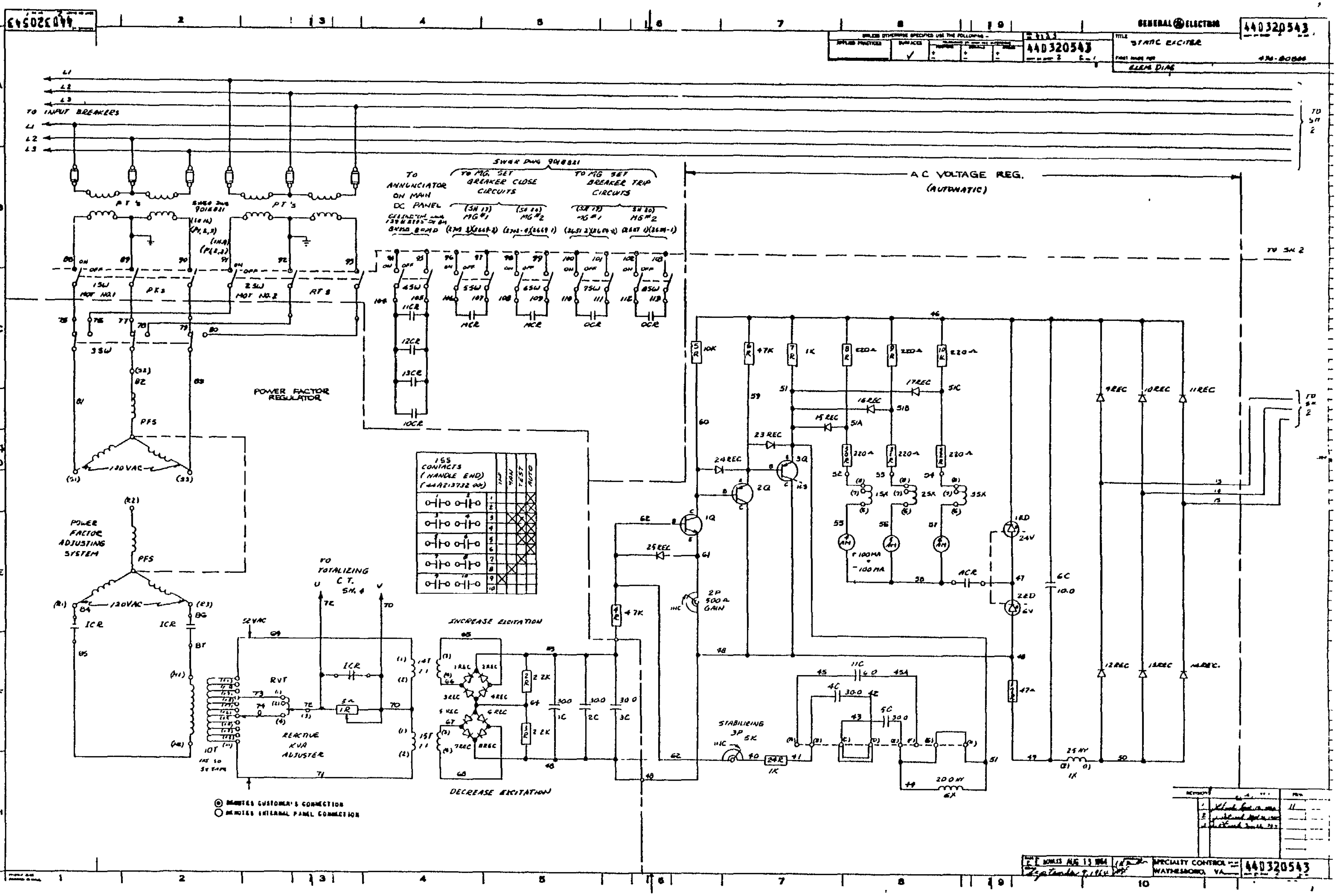


Figure 9. Typical Elementary Diagram (44D320543) (4 Sheets)

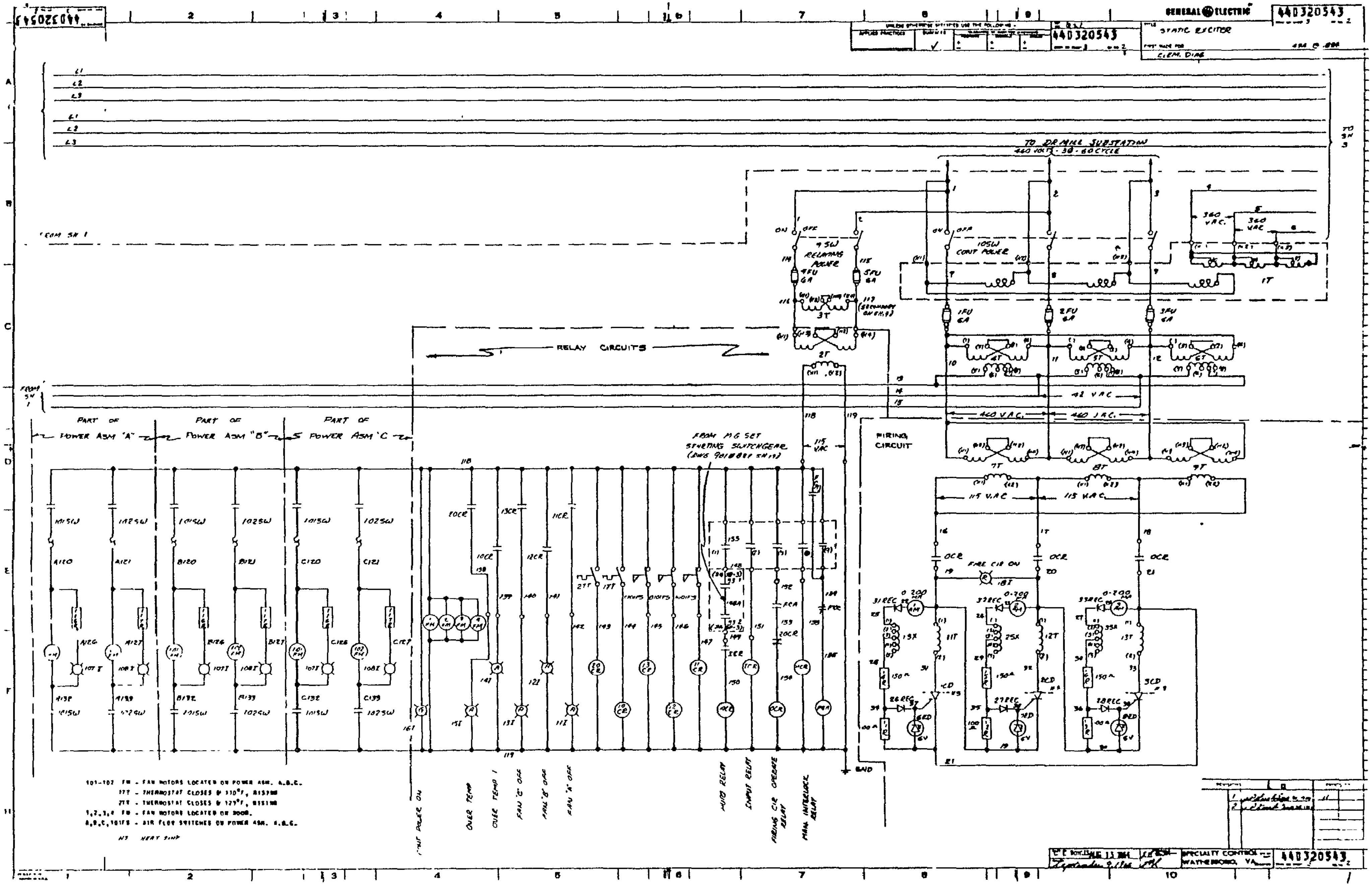


Figure 9 Typical Elementary Diagram (44D320543) (4 sheets)

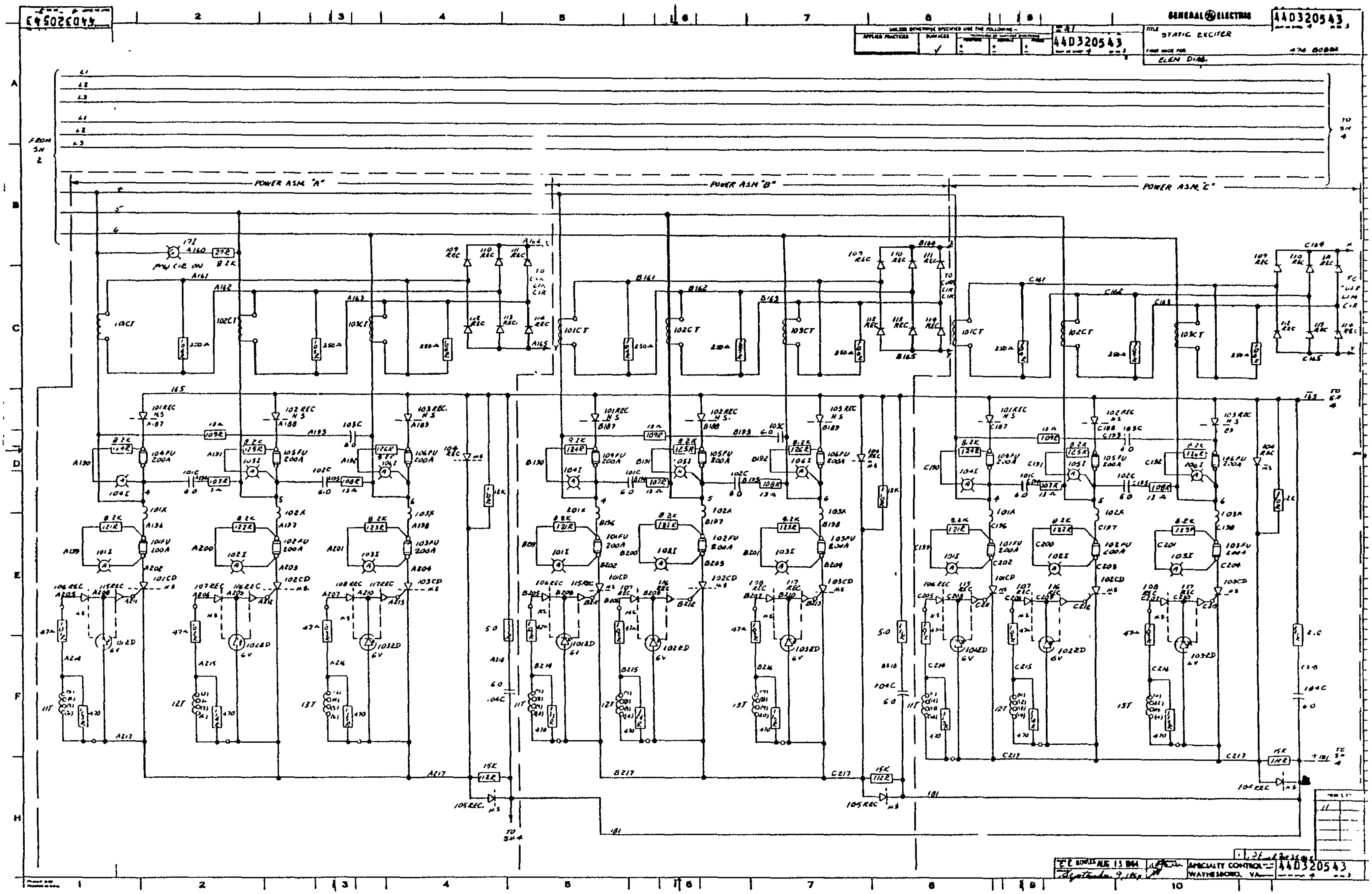
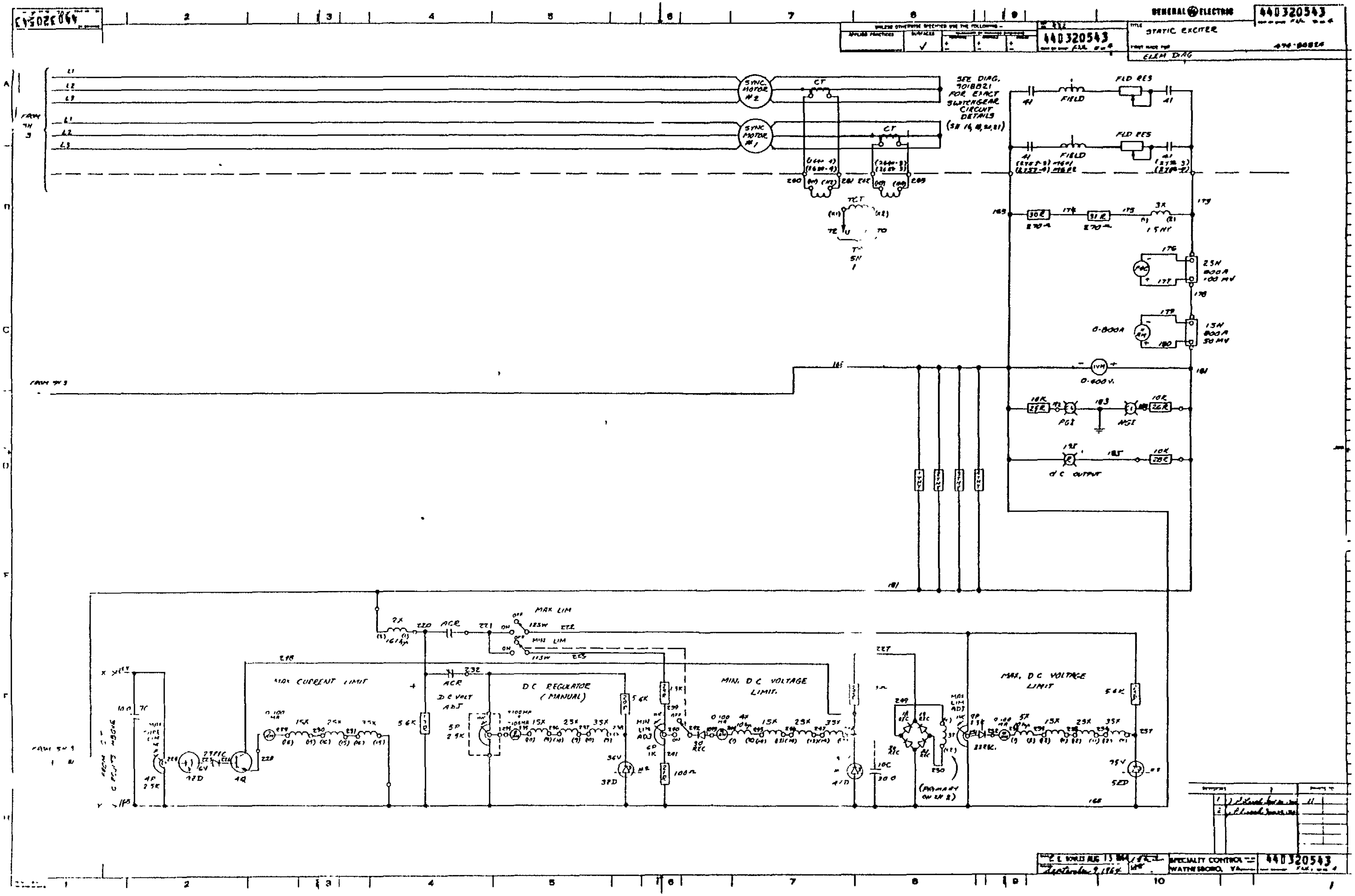


Figure 9 Typical Elementary Diagram (44D320543) (4 sheets)



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