FORM 23673 C

INSTRUCTIONS

STATIC RAMP GENERATOR

I.L. 9321-1

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WESTINGHOUSE ELECTRIC CORPORATION

MOTOR & CONTROL DIVISION - BUFFALO 5, NEW YORK

STATIC RAMP GENERATOR

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STATIC RAMP GENERATOR

A. DESCRIPTION

The static ramp generator provides the equivalent functions obtained from the conventional motor operated rheostat and UV relay preset speed scheme. A preset rheostat may be used on the operator station for speed reference. When this preset rheostat is set for 100% and the section run push button is operated, the ramp generator will change from zero to its maximum output of 100 volts with the rate of the ramp determined by the setting within the ramp generator. The voltage output will change in such a manner as to provide essentially constant rate acceleration or deceleration.

One big advantage of this ramp generator is that four separate input reference signals may be used. With the main reference connected to follow the center section of the line, an independent amount of overspeed may be easily obtained by adding fixed excitation to one of the separate input windings. This system permits much simpler control for obtaining overspeed.

When the loop between sections is considered as a storage loop (loop tower or loop car), the loop position feedback signal may be fed into the section ramp generator instead of the individual generator regulator. This offers the advantage of reducing a step voltage into a ramp and, therefore, allows the motors to change speed with a minimum of load disturbance.

The regulator used to generate the ramp function is shown schematically on diagram SK-RFG. The connections to the reference windings and the resistor and potentiometer values shown on this diagram are typical. For connections to the specific ramp generator, refer to the reduced size schematics included in another section of this instruction book. The regulator consists of two stages of Magamps. The first stage is a 400 cycle Westinghouse preamplifier internally connected in push pull and operated at a reduced 30/36 volts input for 50/60 cycle operation. The second stage is a size 1 standard Magamp. A Sola transformer provides a regulated AC supply voltage for the Magamps, to prevent a change in the rate of acceleration during line voltage variations.

Reset relay RS is used to provide intelligence that the ramp generator output is at a low value.

B. OPERATION OF THE SYSTEM

1. Preamplifier Operation

During the generation of the ramp, the preamplifier behaves as a bi-stable amplifier. This means that one side of the preamplifier is at saturation and the other side at cut-off. When the ramp has been completed, the preamplifier works on its linear range. The saturated voltage of the amplifier is approximately 15 V. About 0.15 AT are required for saturation.

2. Power Amplifier Operation

The differentiator or rate circuit shown on the schematic diagram causes the time delay of this amplifier to be extremely high. When this long delay in the amplifier is achieved, a proper selection of the positive feedback will make the amplifier behave as an integrator.

C. OVERALL SYSTEM OPERATION

When the reference is set to obtain maximum output voltage, an input of 10 AT is applied to the preamplifier, this signal will saturate amplifier No. 1 and will cut off amplifier No. 2. Amplifier No. 1 will apply a fixed AT input into the second stage. This AT input will only depend on the setting of the adjustable resistance 1P. The second stage will start integrating this input; consequently, the output voltage will increase at a rate that will depend on the magnitude of this input. The integration will stop when the AT of the feedback circuit matches the reference AT. At this moment, the output voltage will become regulated.

If the reference is turned down to zero, the ampere turns of the feedback loop will saturate amplifier No. 2 and cut off amplifier No. 1. When this occurs, a fixed AT signal which depends only on the setting of 2P will be applied to the second stage in the reverse direction. The second stage will start integrating and the voltage will fall at a rate depending on the magnitude of this new input.

The output voltage will only depend on the amount of reference input AT. This means that the output can be set at any level by varying the reference.

Acceleration and deceleration only depend on the setting of 1P and 2P and can be adjusted independently. When the output voltage levels off, the amplifier that was saturated during acceleration (Amplifier No. 1) will come out of saturation and its operating point will fall on the linear portion of its transfer curve. The amplifier that was at cut-off (Amplifier No. 2) will also maintain an operating point on its linear part of its transfer curve. The setting of these operating points will depend upon the relative values of 1P and 2P because the net AT into the second stage should be approximately equal to zero. This occurs because we have an integrator, and the net AT input to the second stage must be zero when the integration stops.

D. EXPERIMENTAL VERIFICATIONS

Figure 2 shows a curve of milliampere input to the second stage vs. time of integration. This is a hyperbola asymtotic to the X and Y axis. The product of time X input remains reasonably constant, which is an indication of good integration characteristics.

Figures 3, 4, 5, and 6 show the performance of the regulator.

In Figures 3 and 5, the acceleration and deceleration times were adjusted to be fairly similar.

In Figure 4, acceleration and deceleration times were different and the regulator was brought to several regulated output levels.

In Figure 6, the acceleration and deceleration times were adjusted to obtain approximately a 10/1 ratio.

E. RATING

1. Input

Four separate input reference

windings can be used. The rating of each winding is listed on page 20. Ten ampere turns input produces 100% (100 volts) output. The AC supply to the Sola transformer should be between 210-240 volts, 60 cycles.

2. Output

The 100% output is 100 volts DC at a maximum load current of one ampere. The rate of ramp for acceleration and deceleration can be independently adjusted from 50 volts per second to 4 volts per second (2-25 seconds).

F. ADJUSTMENT AND TEST

Each ramp generator is tested and adjusted at the factory for the designed acceleration and deceleration rate for line on which it is to be used.

The potentiometer settings made on the test floor are recorded on the schematic diagram for the specific ramp generator included in another section of this book.

This acceleration and deceleration rate should be checked using a Brush amplifier and oscillograph before the ramp generator is put into service. A filter consisting of a 500 ohm resistor in series with a 100 mfd capacitor should be connected to the input of the amplifier.

If trouble is suspected or if some of the major components have been replaced, the following procedure can be used to check or set up the ramp generator:

1. <u>Voltage Readings</u>

   1.1 Disconnect the AC supply from preamplifier and power amplifier.

   1.2 Read the output of the Sola transformer, which should be 230V.

   1.3 Read the output of the 230/36 transformer, which should be 36V.

2. <u>Pot Settings</u> (These are typical values. The factory settings made on the test floor will be shown on the schematic diagram for

the specific regulator)

2.1 Set 1P and 2P for maximum resistance (1000 ohms).

2.2 Set 5P at 70 ohms (from + to center arm).

2.3 Set 4P at 2200 ohms.

2.4 Set 3P at 1.25 ohms.

2.5 Set 12P at 20 ohms.

2.6 Set 11P at 100 ohms.

2.7 Set arm of 10P at half-travel.

2.8 Set 6P at 1000 ohms.

2.9 Set 8P at 170 ohms.

3. <u>Adjustment and Test of Magnetic Amplifiers</u>

3.01 Disconnect AC supply from second stage Magamp.

3.02 Open leads that go to terminals 3 and 6 on the power amplifier.

3.03 Connect the 36V AC supply to pre-amplifier, and adjust the output voltage of each individual amplifier to 6 V. Readings should be taken [illegible] To adjust these voltages, vary bias potentiometer 1P until approximately 6 volts are obtained between B1-B2. Once this is done, balance both outputs by means of potentiometer 10P. Recheck balance by reading zero volts between B1-B3.

3.04 Take a transfer curve of each individual amplifier of the preamplifier using winding A3-A4. Check the combined transfer characteristic. The gain between +10V and -10V should be around 100 V/AT.

3.05 Reconnect leads that go to terminals 3 and 6 of the 2nd stage Magamp.

3.06 Saturate the preamplifier in each direction and adjust 1P and 2P so that the current in the 2nd stage Magamp pattern winding is 16 ma in both directions of saturation.

3.07 Open the AC supply to preamplifier.

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3.08 Disconnect all control windings except the bias in the power amplifier. Set the bias to obtain cut-off output voltage, and run a transfer curve using the 100 turn winding (3-4).

3.09 If the transfer curve is satisfactory according to magnetic amplifier test specification, connect all control windings as shown on the diagrams. Reset the bias for cut-off on the power amplifier.

4. Regulator Operation

4.01 Disconnect the AC supply.

4.02 Turn the reference on and set the reference rheostat for maximum voltage. Adjust 7P to obtain 100 ma (10 AT) in the pattern winding.

4.03 Turn reference rheostat to zero.

4.04 Reconnect the AC supply to preamplifier and turn on AC power.

4.05 Turn reference rheostat to maximum.

4.06 Observe output voltage; it should raise in a ramp form.

4.07 Reset 8P so 100 ma flows in the voltage feedback circuit when output voltage is 100 V.

4.08 Turn the reference rheostat to obtain 50 V output. When regulator is at this level, open the AC supply of preamplifiers. Check variation of output voltage. If the output varies more than ±5 V in 20 seconds, readjust the self energizing pot 4P. If the voltage decreases, increase self energizing and vice-versa. Reconnect the AC supply on the preamplifier.

4.09 Turn the reference rheostat to minimum to decrease the output voltage.

4.10 Connect a 10-0-10 milliammeter in place of the 50-0-50 milliammeter in the rate circuit of the power amplifier.

4.11 Repeat 4.05 and observe the current in the rate circuit during acceleration. This current should remain steady over a range of 5 percent to 95 percent output. If the current in this circuit is not steady, change 5P until optimum conditions are obtained. If after the rate damping circuit has been optimized a small deviation; eg. 0.2 ma, is still observed, optimize this by means of the positive feedback pot 4P. If the current remains steady during acceleration and deceleration but its magnitude is different, adjust for equality by means of the bias potentiometer 6P.

4.12 Connect the Brush amplifier across the output, using a filter consisting of 3000 ohm resistor in series with a 20 mfd capacitor, and record output voltage from zero up to 100 V and down to zero.

4.13 Disconnect the IR compensator circuit.

4.14 Connect a 100 ohm, 200 W resistance across output and repeat 4.12.

4.15 Compare results of 4.12 with 4.14.

4.16 The time of acceleration on the record obtained in 4.14 should be longer than the acceleration time of 4.12. Deceleration time of 4.14 should be shorter than that of 4.12.

4.17 Connect the IR compensator circuit and optimize the regulator so the time of acceleration and deceleration are the same as the values obtained in 4.12. The optimization is done by adjusting pot 4P.

4.18 Reconnect the 50-0-50 milliammeter in rate circuit.

4.19 If overshoot is observed when output voltage levels off, optimize this by means of pot 12P in the interstage damping circuit.

4.20 Take a Brush recording for 4 different rates of acceleration and deceleration. Set 1P and 2P to obtain the ma indicated in table below. For each of these settings record total time of acceleration from 0 to 100% output and deceleration and percentage setting of 1P and 2P. Fill in table below.

Percentage Pot		Acceleration	Time		Deceleration	Time	
1P	2P	Ma in pattern	No load	1 Amp	Ma in pattern	No load	1 Amp
		16			16		
		25			25		
		40			40		
		80			80		

Compare these results with graph in figure 1.

5. Typical Values

5.1 Preamplifier bias - 2.5 ma.

5.2 Second stage bias - 128 ma.

5.3 Self energizing - 29 ma at 100 V.

5.4 IR compensator - 20 ma at 100 V and 1 amp load. Depends on load.

5.5 The rate current for 16 ma in second stage pattern is 3.5 ma during acceleration and deceleration with no load on the output.

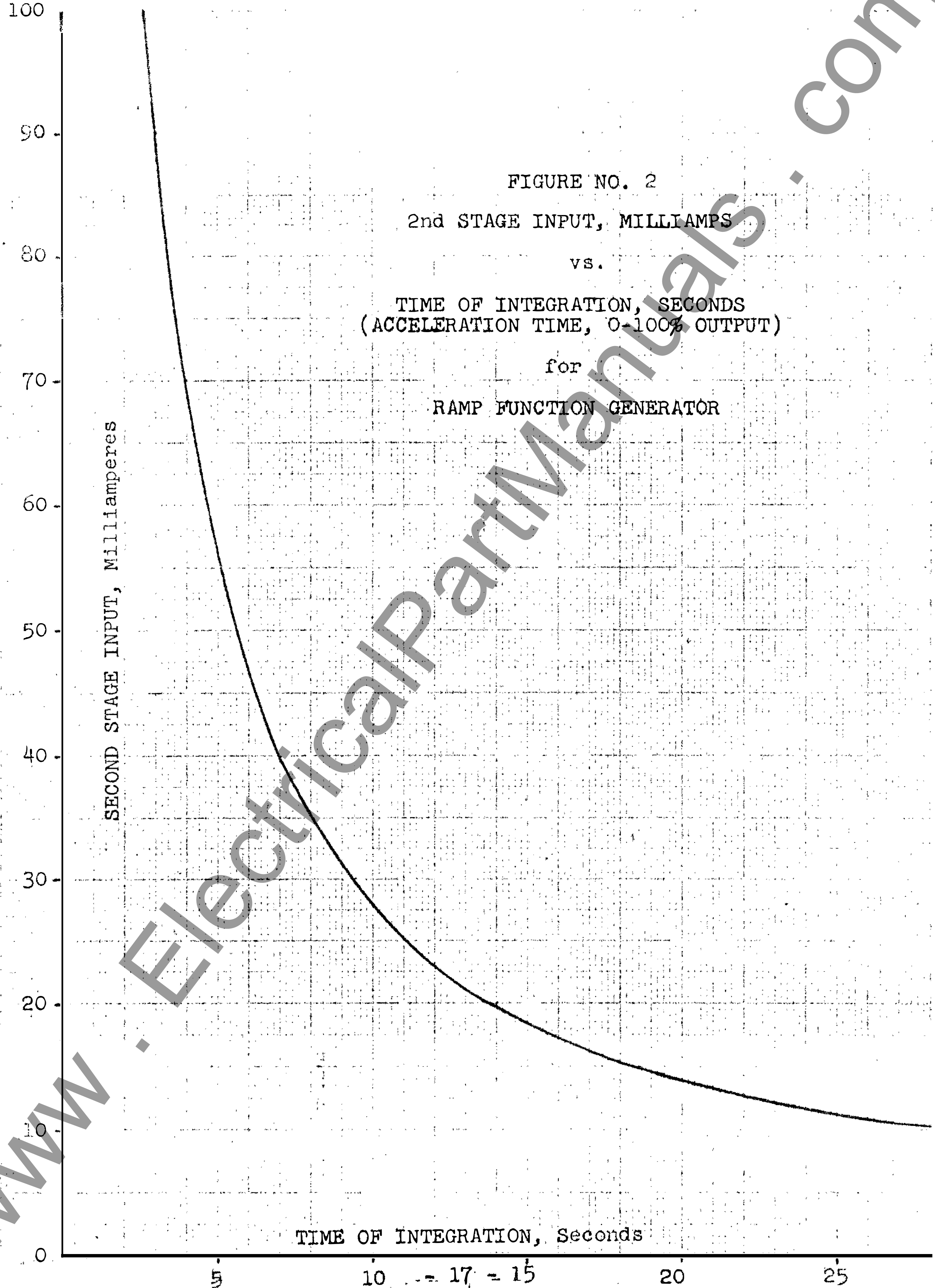
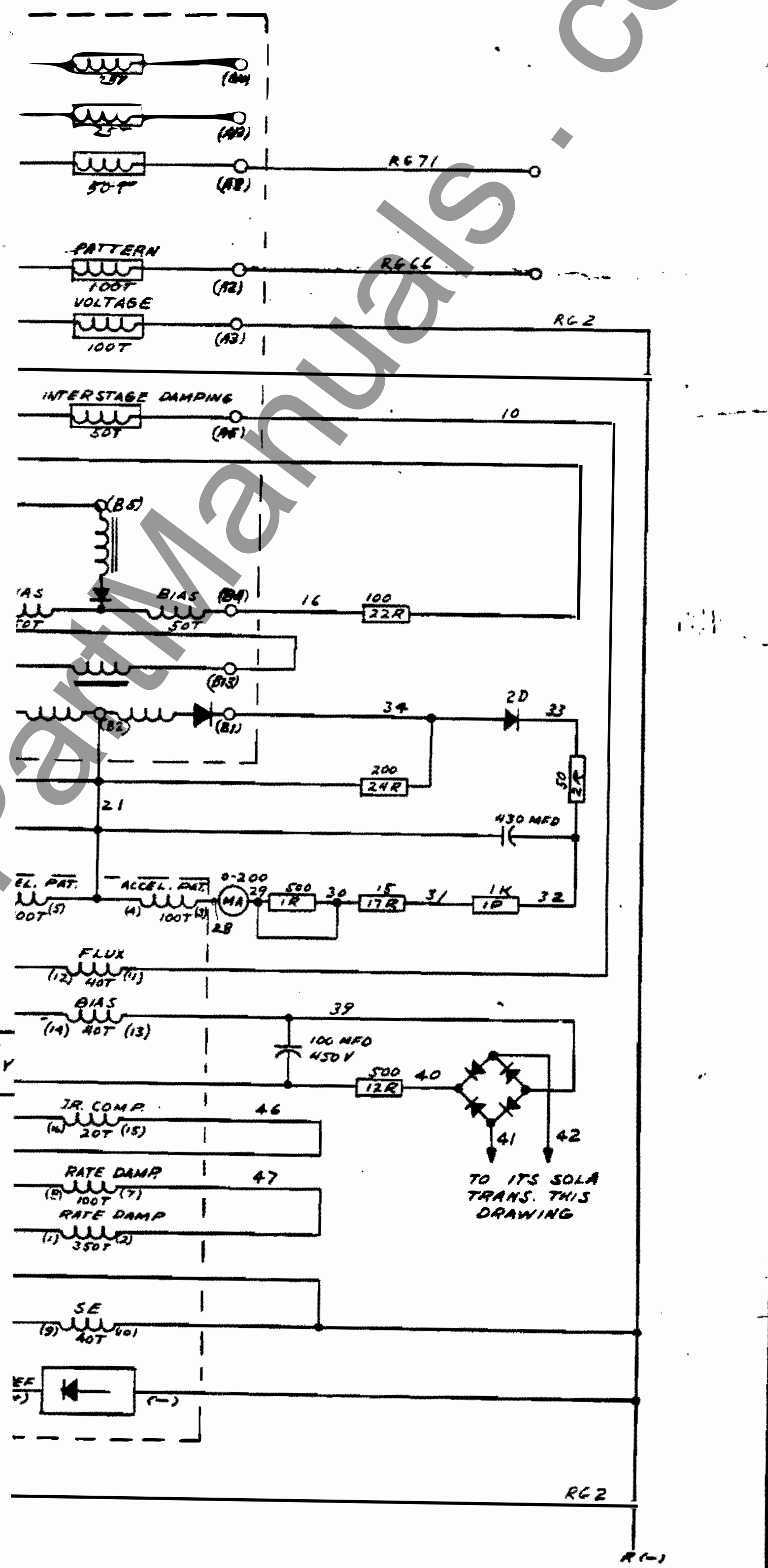


FIGURE NO. 2
2nd STAGE INPUT, MILLIAMPS
vs.
TIME OF INTEGRATION, SECONDS
(ACCELERATION TIME, 0-100% OUTPUT)
for
RAMP FUNCTION GENERATOR
SECOND STAGE INPUT, Milliamperes
TIME OF INTEGRATION, Seconds
100
90
80
70
60
50
40
30
20
10
0
5
10
15
20
25
17

DWG 821D063 SUB X 2



VOLTAGE CHART

FREQ. C/S	AC SUPPLY VOLTS	1TS VOLTS	2TS VOLTS	R+-R- VOLTS
50	190/380	190	30	100
60	220/440	220	36	100

CHANGE: 50.675-665 TEST ELEC CHG. R.D. BETTI

WESTINGHOUSE ELECTRIC CORPORATION

TITLE SCHEMATIC DIAGRAM

DC VV CONTROL

STANDARD STATIC RAMP FUNCTION GENERATOR

DFTM. G KELLY

DIV. & PLANT LOCATION SYS CONT

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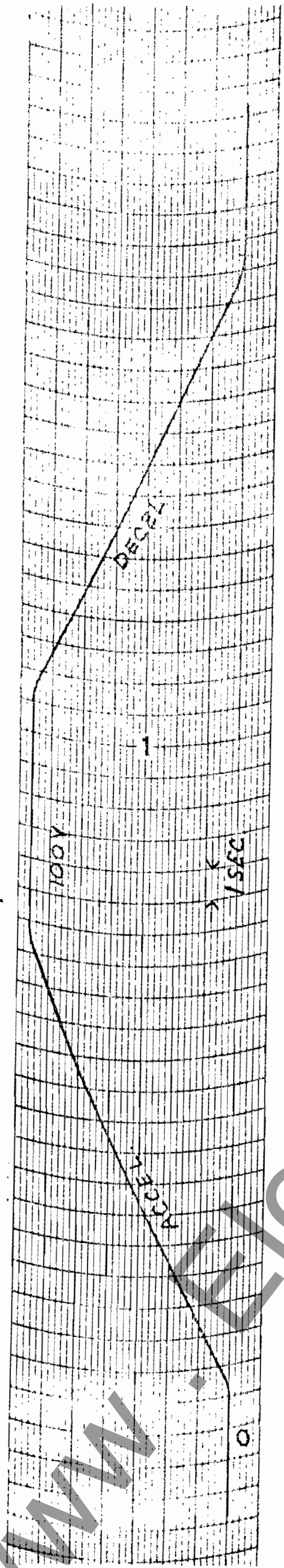


FIG-3

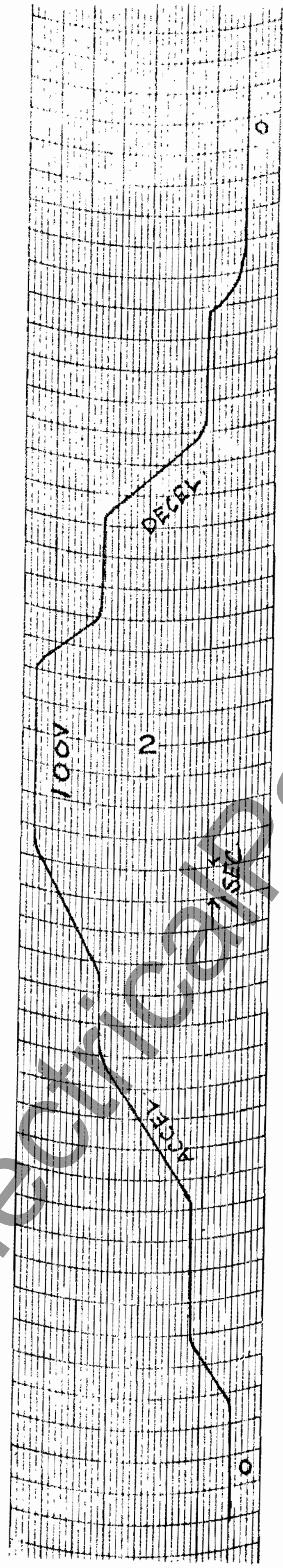


FIG-4

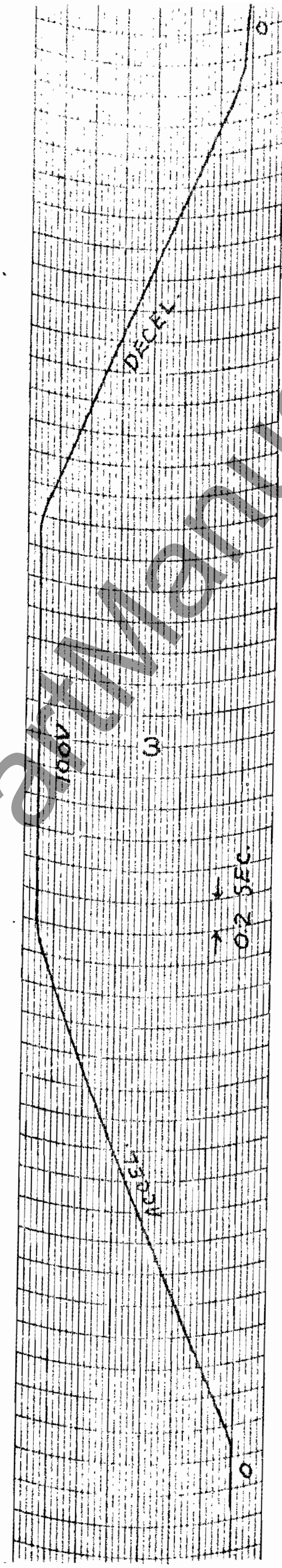


FIG-5

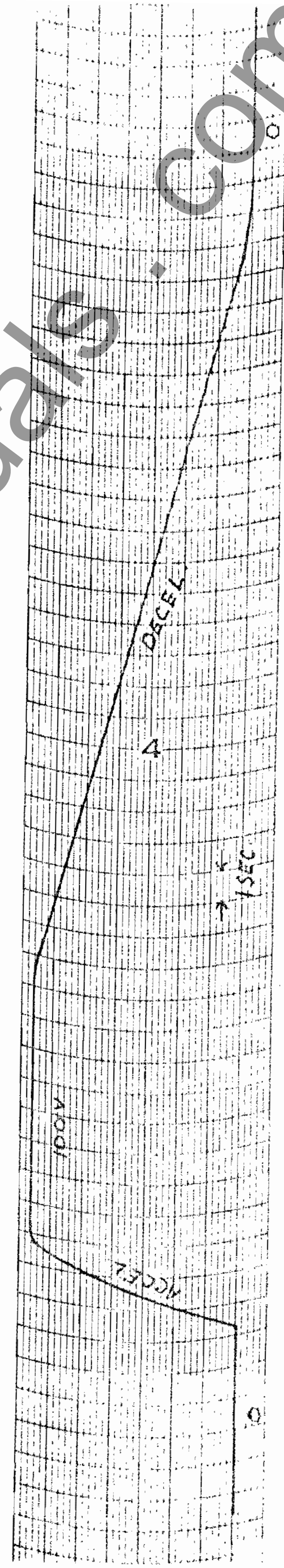


FIG-6

PUSH-PULL MAGAMP PREAMPLIFIER

NOMINAL A.C. RATING - 240 VOLTS - 400 CYCLES - 0.23 AMPS

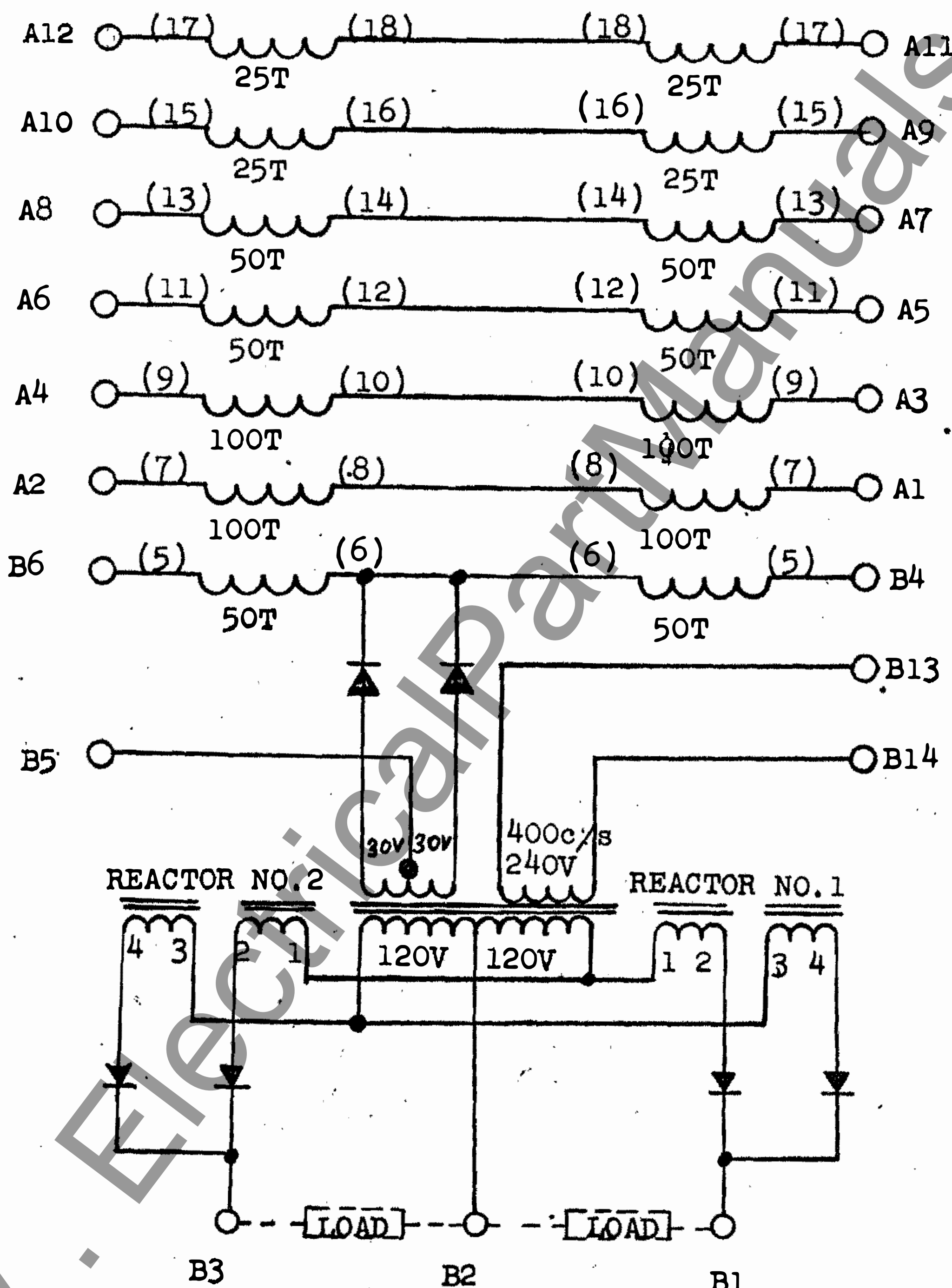
D.C. OUTPUT - 90 VOLTS - 200 MA

REACTOR STYLE NUMBER - 427A322G02

WINDING	TURNS	FUNCTION	RATING	OHMS
A1-A2	100	CONTROL	200 MA	4.0
A3-A4	100	CONTROL	200 MA	4.0
A5-A6	50	CONTROL	200 MA	2.0
A7-A8	50	CONTROL	200 MA	2.0
A9-A10	25	CONTROL	200 MA	1.0
A11-A12	25	CONTROL	200 MA	1.0
B4-B5-B6	50	BIAS	200 MA	2.0
B16-B17	---	AC SUPPLY	------	
B1-B2-B3	---	OUTPUT	200 MA	

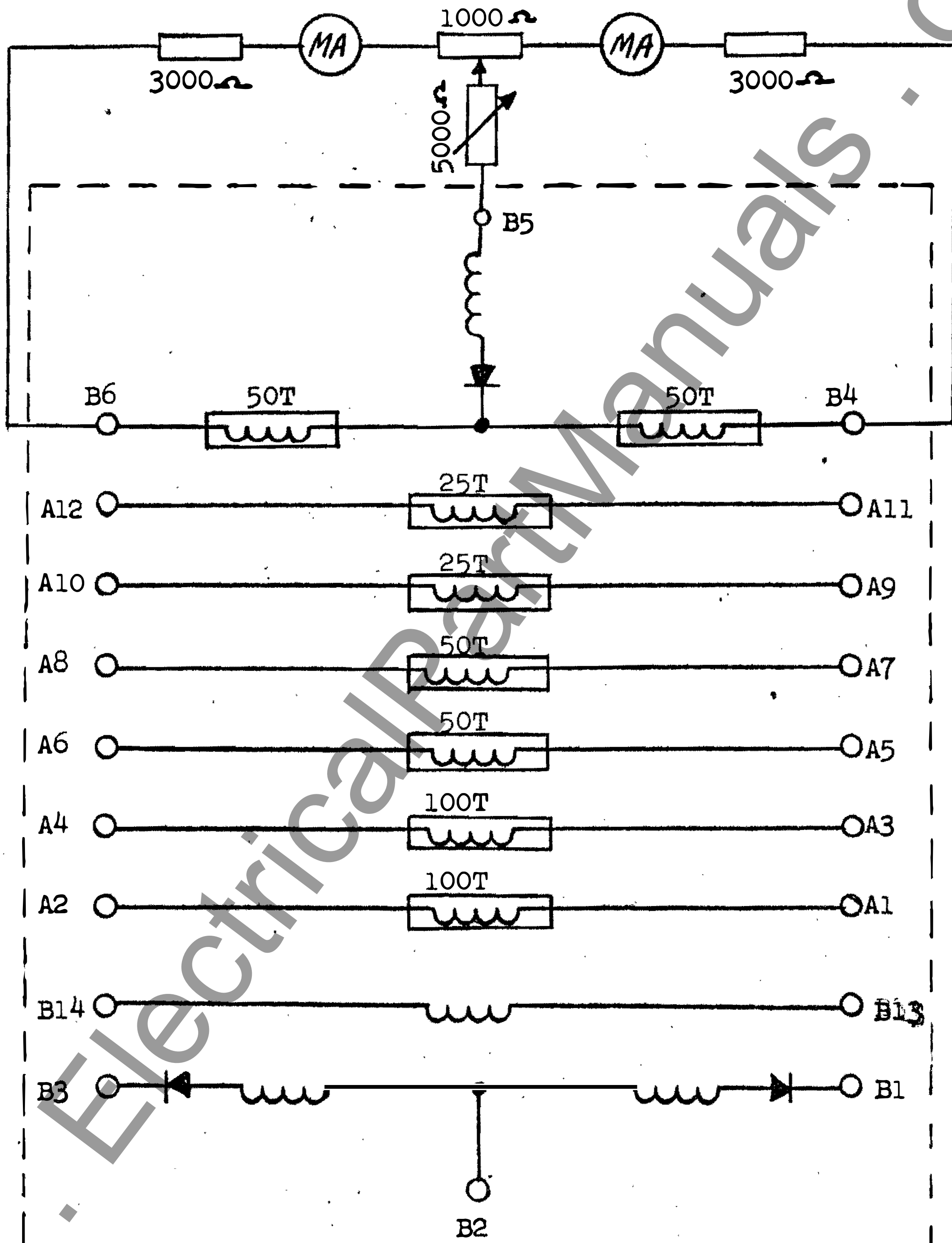
PUSH-PULL MAGAMP PREAMPLIFIER

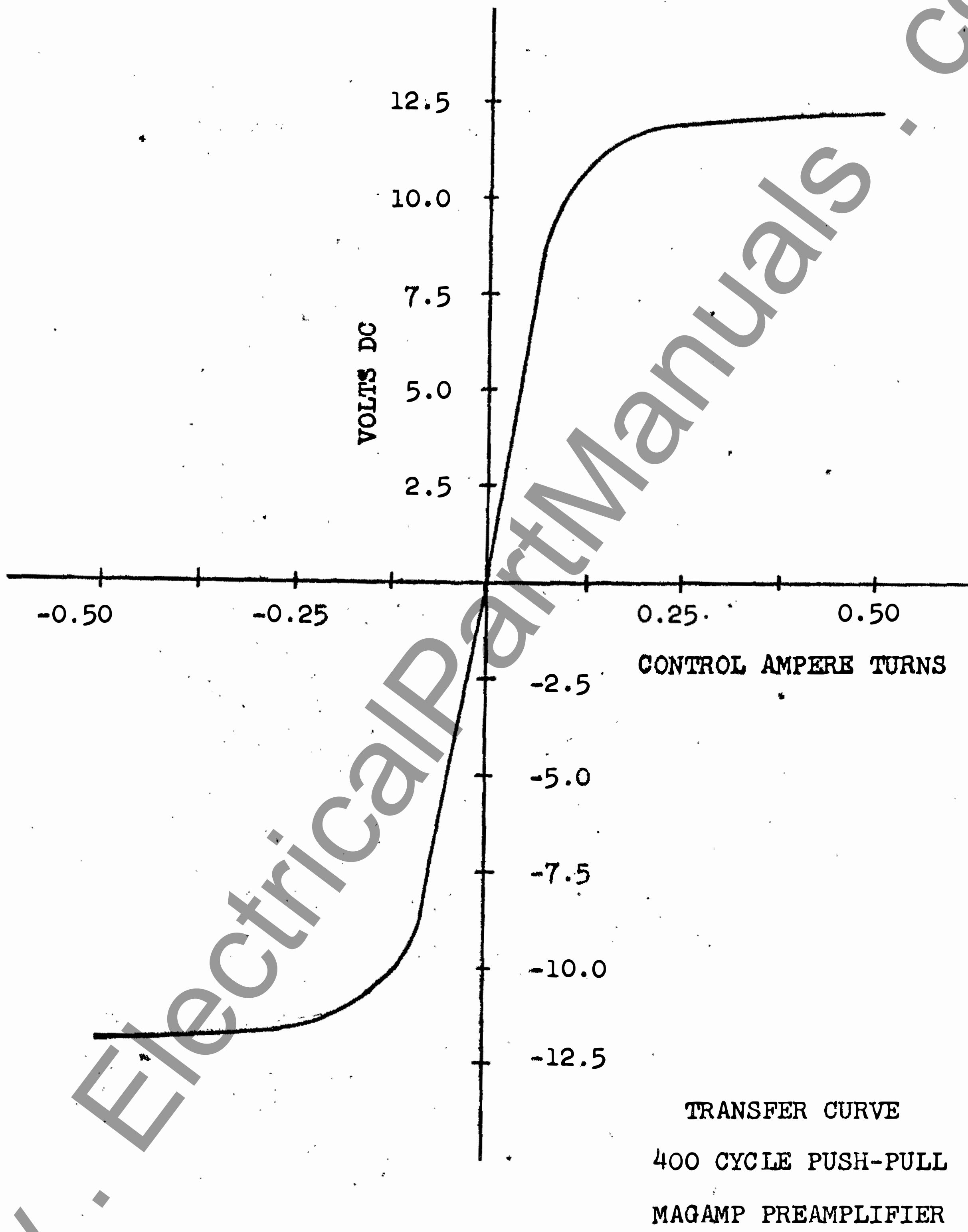
INTERNAL WIRING DIAGRAM



PUSH-PULL MAGAMP PREAMPLIFIER

SCHEMATIC DIAGRAM





TRANSFER CURVE
400 CYCLE PUSH-PULL
MAGAMP PREAMPLIFIER
STYLE NO. 427A322G02
OPERATING ON 36 VOLT 60 CYCLES
200 OHM LOAD EACH

SIZE 1 SINGLE CHANNEL MAGAMP

NOMINAL AC RATING - 230 VOLTS - 60 CYCLES - 1.75 AMPS

D.C. OUTPUT - 170 VOLTS - 1.25 AMPS (FORM FACTOR 1.37)

REACTOR STYLE NUMBER - 614C521G01

SILICON DIODE STYLE NUMBER - 432A921H01

WINDING	TURNS	FUNCTION	RATING	OHMS
1-2	350	CONTROL	200 MA	19.5
3-4	100	CONTROL	200 MA	5.5
5-6	100	CONTROL	200 MA	5.5
7-8	100	CONTROL	200 MA	5.5
9-10	40	CONTROL	200 MA	2.3
11-12	40	CONTROL	200 MA	2.3
13-14	40	CONTROL	200 MA	2.3
15-16	20	CONTROL	1A	.20

TYPICAL TRANSFER CURVE 65 VOLTS PER AMPERE TURN WITH 100 OHM LOAD.

CONTINUOUS LOOP REGULATOR

The Solid State Continuous Loop Regulator provides a means to control the free hanging loop of a continuous processing line.

The continuous loop regulator employes all solid state devices such as transistors and magnetic amplifiers. Physically, it consists of three major components:

1. Light source, compensator, and receiver.
2. Loop position detector amplifier.
3. Loop regulator panel.

The loop position detector panel consists of a photoelectric detector and a Sola power supply.

The loop regulator panel consists of two 60 c/s magnetic preamplifiers. The first stage preamplifier is used as a proportional integrator, and is effective in performing the regulation without a steady state error. The second stage preamplifier is used as an amplifier with adjustable gain. All necessary potentiometers, meters, and other accessories are assembled in one magamp panel.

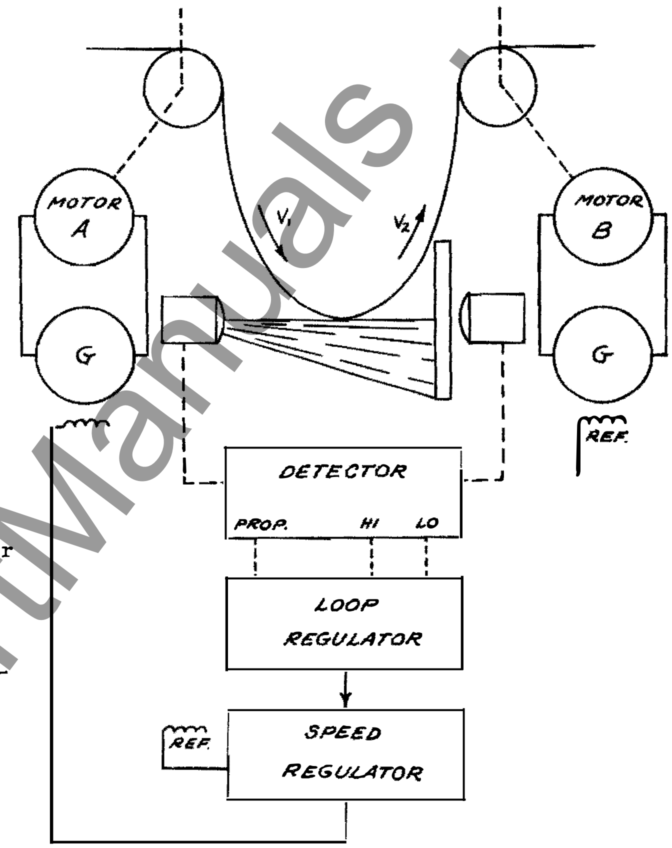


Fig. 1 - Continuous Loop Regulator Application to Variable Voltage Drive System

SYSTEM OPERATION

The loop regulator is designed to work in conjunction with a speed or voltage regulator, usually acting on the drive system ahead of the loop. The speed of this drive is changed by the signal applied by the loop regulator, in such a manner as to match the line speed at the entry and exit ends of the loop, and consequently keep the loop in the regulating zone.

The output of the detector varies from 0 to 10 MA as the light to the receiver is cut off by the loop. The reference AT applied to the loop regulator determines the zero regulating level. When the loop is at this level, the net AT input to the regulator is zero.

If the drive ahead of the loop runs slower, the loop pulls up and more light is received by the receiver. The detector output decreases and the net ampere turns acting on the loop regulator are in the same direction as the reference ampere turns. The loop regulator applies a signal to the drive regulator to increase motor speed and bring the loop back into zero regulating level.

If the drive ahead of the loop runs faster the reverse action takes place to decrease the motor speed and bring the loop back into zero reference level.

The Proportional Integrator:

The proportional integrator output consists of a step with a superimposed ramp. Both the magnitude of the step and the slope of the ramp are dependent upon gain and the magnitude of the input signal. The step component is effective in transmitting the error without a time delay and thus tends to improve system stability, whereas the ramp component is effective in eliminating the steady state position error. When an input is applied to the proportional integrator the output rises in the form of a step to a predetermined value, and integrates up in the form of a ramp until the input is removed. At this time the output drops immediately and remains constant thereafter.

To obtain an output it is only necessary to apply an error signal to the proportional integrator and remove it when the output has integrated up the desired value. If the input is not removed, the output keeps on building up until limited by saturation. Obviously a steady state position error does not exist. This explains why the regulator regulates for zero position error.

When the loop is completely out of range, the proportional integrator output consists of a large step and a short ramp to saturation. The corrective ampere turns applied to the speed regulator may be as high as 20-30% in the form of a step depending upon system parameters.

To prevent undesirable large step speed changes such as may occur when starting a processing line with the loop completely out of the regulated zone, an auxiliary signal is generated by the photo-switch detector unit when more than 90% or less than 10% light is received. This indicates complete position error and the signal is used to cut down the error ampere turn input to the proportional integrator. By adjusting the resistance in the low and high loop limit windings it is possible to limit the speed step to any desired value.

The loop can be manually controlled by applying a signal to the second stage preamplifier directly. In this case the loop regulator output consists of a step without a ramp.

Note should be made of certain terminology so as to not confuse the detail of operation. The Photoswitch loop position detector unit has maximum current output at minimum light condition. For a free hanging loop, this corresponds to the loop being lower than normal. If the loop completely blocks off all light to the receiver (low loop position), the high limit auxiliary signal is triggered on. The Photoswitch unit is labeled "high limit" because it corresponds to the high output current end of its range. This signal is used in the "low loop position" winding in the regulator because the condition occurs when a free hanging loop is too low. This explanation should be noted to avoid confusion between "high output limit" and "low loop position". An opposite effect occurs on extreme high loop.

Loop Position Detector:

The Loop Position Detector consists of a Photoswitch compensated photoelectric detector, and a Sola power supply. The detector works in conjunction with a single 36" fluorescent lamp, one compensating cell located next to the light source and a receiver on the opposite side of the loop mounted so that it is facing directly in center of light source. The difference between the outputs of the compensating cell and receiver is proportional to the loop position, and is not affected by changes in temperature, light intensity, dirt, dust, etc. within practical limits. This difference is amplified by the detector and applied to the pattern field of the loop regulator.

COMPONENT IDENTIFICATION	
LOOP POSITION DETECTOR APPARATUS*	PROPORTIONAL INTEGATOR*
Photoswitch loop displacement detector type 28MF3 - Model 1000	Westinghouse style 427A324G01 60 c/s magnetic preamplifier
Receiver type 41NW4 - Model 1002 is for total span (light source to receiver) of 6 - 40 feet 36" - 30 W Fluorescent light source light compensator type 47BW4	PREAMPLIFIER* Westinghouse style 427A324G01 60 c/s magnetic preamplifier
* Three independently adjustable, electrically interconnected devices.	

Figure 2

INSTALLATION

The approved standard calibration tests recommended for the Continuous Loop Regulator detection apparatus and Magamp regulator are outlined in this leaflet. They are based on certain typical conditions relating to looping pit dimensions. Since these conditions vary in actual application, the following should be performed at installation:

1. Recalibrate the detection apparatus (receiver and light compensator) for the specific span between the receiver unit and the fluorescent light source, as installed. The procedure for this is outlined under "Tests".

   Each receiver unit is supplied with two 33% transparent filters. If the receiver cell resistance is greater than 28,000 OHMS when exposed to the full light from the light source, the filters should be removed and stored in a pocket provided for this purpose, on the side of the housing. This will reduce the resistance to 1/3.

   At 15 feet or less, at least one filter (and possibly two) will be required; beyond 15 feet usually no filter (but possibly one) is required. For distances of 25 feet and greater no filter will be needed. A removable aperture in front of the inner lens holder should be removed for distances less than 15 feet.

2. Check the performance of the Solid State Position Loop Regulator under normal load conditions. If the output voltage and response are not satisfactory, a calibration test should be performed on the Solid State Magamp Regulator individually in the same manner as outlined under "Tests".

TESTS

A. Detection Apparatus

General Information

The Continuous Loop Regulator Detection apparatus is manufactured by the Photoswitch Division-Electronics Corporation of America. It is designed to provide an electric signal which is linearly proportional to the amount of transmitted light. This ultimately provides position feedback control. The apparatus also provides two triggered output signals to indicate that the received light is less than 10% from either end of its regulating range. These signals recalibrate the integrating section of the loop regulator, (supplied by Westinghouse) to provide a different action when the loop is completely out of regulating range. The Photoswitch unit includes a light compensator which monitors the basic fluorescent light intensity and provides compensation in the amplifier circuit to maintain the same output curve over a 50% range of light source intensity. The position scanner covers a total light-to-scanner span of 6 to 40 feet. Figure 3 shows the output current proportional to received light and compensated for light source change.

The purchased items - amplifier, compensator, and scanner - are designed for specific use with a complete loop regulating magnetic amplifier system.

Power Supply: 115 V. 50/60 cycle (regulator), Power Consumption 10 VA nominal
Outputs: (A) Proportional signal, linear, 0mA at full light, 10 mA at no light
(B) Triggered signal, adjustable from 0 to 20% from end points, 2.5 mA.
Ambient Temperature: 35 to 130°F.
Response: 50 milliseconds

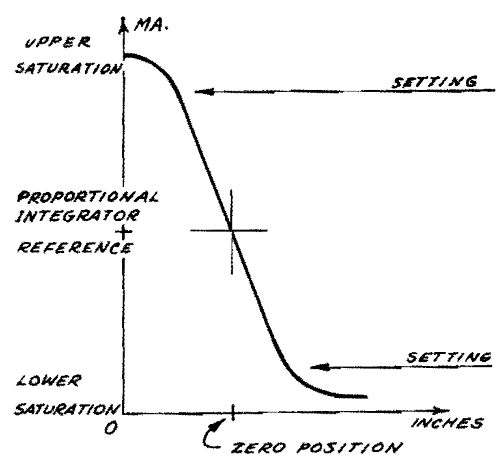
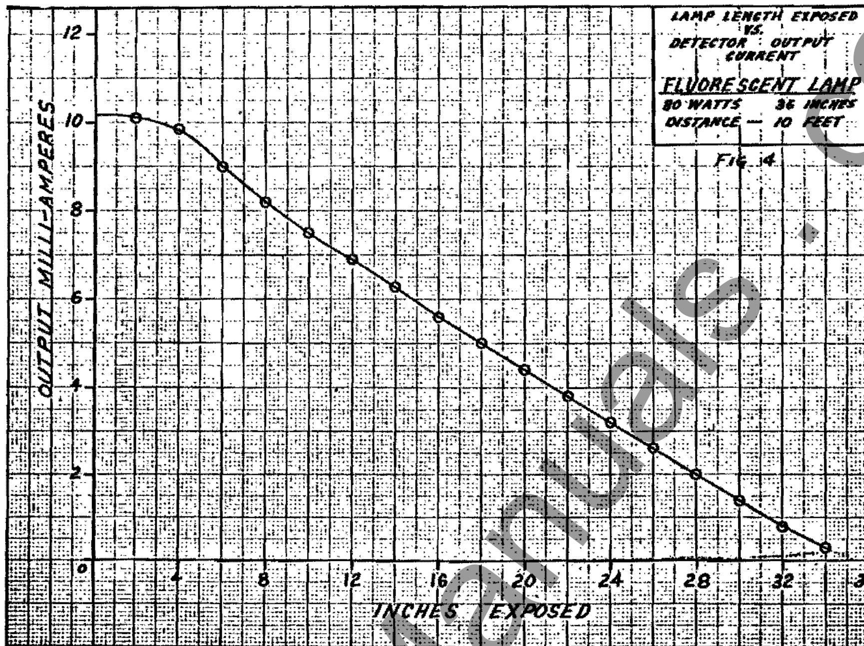


Fig. 3 - Photocell Characteristic

Calibration (Loop Detector, Receiver & Light Source Compensator)



1. Mount the 36", 30 watt fluorescent light source vertically and at a distance from the Receiver, as specified in Item 3 below.

2. Mount the Receiver such that the center line of the lens lines up with the midpoint of the light source.

3. Place the receiver unit at a distance of 10 feet from the fluorescent light source without removing either filter or the aperture from the receiver.

4. Mount the compensating cell, type 47BW4, on the side of the housing of the fluorescent tube, such that it will receive light from the tube through the opening cutout in the side of the housing. It should be located so that the end of the sight tube is spaced about 5 inches from the fluorescent tube and at least 12 inches away from an end. It must be securely mounted, so as not to block off any light to the main Receiver.

5. Wires from the loop regulator detector to the light compensator and to the Receiver should be shielded or at least enclosed in conduit. Polarity is not important.

6. Apply about 115 volts A.C. 50-60 cps. to terminals 1 and 2. The voltage between terminals 9 and 12 should be checked and should be approximately 50 volts. If it is higher than 53 volts, the chassis should be dismounted and a connection changed to a terminal strip underneath the transformer. The red wire which goes to the left-hand outside terminal should be moved and connected to the center terminal. This will place the system on a lower secondary voltage. When this voltage checks out, the remaining wiring should be installed. Shorts between certain terminals could cause damage to transistors.

7. Calibration Test
   After the system is electrically operable, a final calibration test should be made.

   Connect a 0-10 MA meter between terminals 3 and 4.

   Turn power on to light source and detector unit. Cover the main Receiver lens completely and note the output current. It should be very close to 10 MA. It may be adjusted to exactly 10 MA, by means of the scale range potentiometer located just above these terminals.

   When a full scale reading has been established, the receiver should be uncovered and the fluorescent lamp fully exposed. The current should drop to approximately 20% of full scale.

   The fluorescent lamp should now be obscured for exactly half its length and the extension tube of the compensator unlocked and rotated until a reading of exactly 5.0 MA is obtained. This method gives the greatest accuracy in the central region.

   Lock the compensating cell extension tube and read the current when the fluorescent tube is fully exposed. The reading should be approximately zero.

Take a transfer curve by obscuring the light source in steps of 2" starting with the light source fully exposed until it is fully obscured, and noting each time the detector output current. Figure 4 is a typical curve taken for a span of 10 feet and using the Photoswitch loop displacement detector type 28MF3, Receiver type 41NW4 Model 1002, 36" fluorescent lamp 30 watt tube, and Light compensator type 47BW4.

Note that the calibration is linear to about 10% of the ends of the scale. Slight non-linearity may occur closer to the ends due to circuit non-linearities as well as non-uniformity of the lamp. The sensitivity is about 0.3 MA/inch, but this can vary from 0.23 to 0.7 MA/inch for different span lengths.

In addition to the main output, static (transistor) switches are provided to cut in near each end of the scale. These switches provide outputs of 2.5 MA in series with 4700 ohms which are reduced to about 1.0 MA by having the high loop limit and low loop limit windings of the continuous loop regulator, connected to terminals 5, 6 and 7, 8 of the loop detector unit, respectively. Current is switched on abruptly when the preselected limit is reached. The switches are designed to switch current on as either end of the scale is approached, both switches being off in the central operating region.

The switches may be adjusted to switch on at any point within about 20% of the end of the scale, and are factory adjusted to switch at approximately 10%. To prevent unstable operation at the critical operating point, the switches are provided with a differential of one to two percent of full scale current, so that if, for example, they switch on at 10%, they will switch off at 11 to 12%. Adjustment of the limits is accomplished by means of two slotted shafts located just above the terminal board. Clockwise rotation increases the scale current at which switching takes place.

B. <u>Continuous Loop Regulator - Magamp Type</u>

General Information

The loop regulator provides a means to control the position of a loop and automatically adjust it to a value specified by a reference signal. Basically, the loop regulator consists of two independently adjusted but electrically interconnected devices. The proportional integrator combines positive feedback and derivative lag networks to provide proportional plus integral characteristics. The push-pull preamplifier feeds its output into the main regulator which can be a speed or voltage regulator dependings on the application.

Figure 5 shows a typical family of step and ramp output curves depending on the value of error between the proportional position signal and normal loop position reference signal.

Loop Detector Calibration

a. Disconnect the following wires: From No. B13, No. B14 terminals on Preamplifier; From No. B13, No. B14 terminals on Proportional Integrator.

b. Install 4 temporary wires from the loop detector to the loop regulator, and make the following connections:

Loop Regulator	Loop Detector
Output of sola transformer 118V AC X1	1
Output of sola transformer 118V AC X2	2
Terminal A10 of PATT Field preamp through milammeter	3
Terminal A9 of PATT Field Preamp	4

c. Turn power to the loop regulator on and measure 118 V AC across 1, 2 on the loop detector.

2. <u>Proportional Integrator Calibration</u>

a. Connect wires to terminals B13 and B14 on proportional integrator.

b. Disconnect all control wires except bias in the proportional integrator.

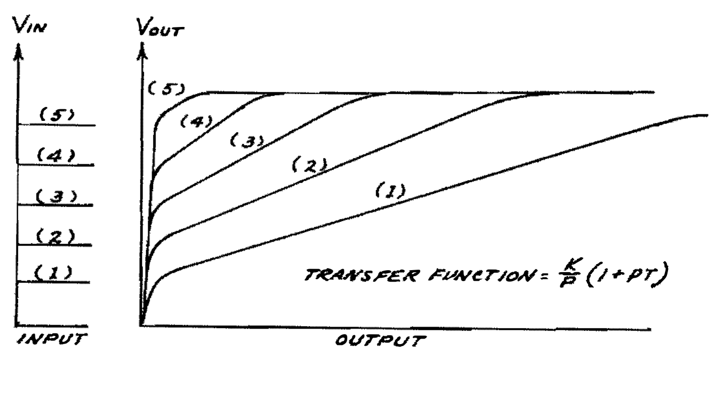


Fig. 5 - Proportional Integrator

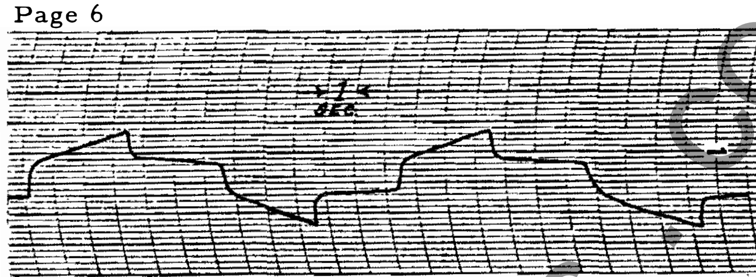


Fig. 6 - 10 V Step Error; Proportional Integrator

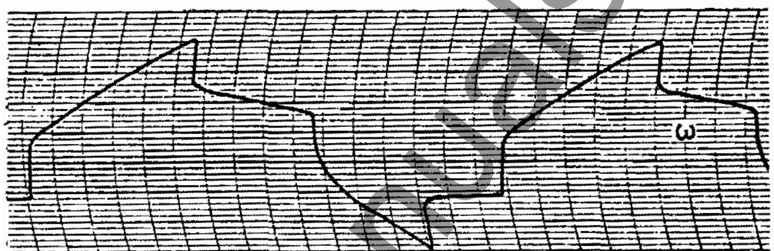


Fig. 7 - 18 V Step Error; Proportional Integrator

c. Turn AC power on, adjust bias to obtain 55V in each channel. (Voltage across B1-B2, B2-B3. Obtain zero volts across B1-B3).

d. Take a combined transfer curve of proportional integrator by applying an external DC supply on winding A11-A12. (Control current from - 10 to 0 to 10 ma)
The combined transfer curve should be linear between -60 to 60V with a gain of 150 to 200 V/AT. (170 V/AT)

e. Turn the a-c power off. Connect windings A5-A6 A8-A7. Set Pots. 9P, 15P, 10P to values specified in the diagram. Turn the power on and reset the bias to get 55V across terminals B1-B2, B2-B3, if a change in the output is observed.

f. Connect a brush recording instrument to the output of the proportional integrator, put an R-C filter in combination with the brush recorder consisting of 20 MFD 3000 ohms. Apply a 0.5 mA step input to winding A11-A12 and record the output of proportional integrator. The output should be a step of 10V and a ramp of 3V/sec approximately. If the brush recording does not satisfy the above condition, optimize the circuit by readjusting pots 10P and 15P.

3. Preamplifier Calibration

a. Turn AC off, disconnect all control windings of the preamplifier except the bias, and the AC input. (Terminals B13, B14, B4, B5, B6).

b. Turn AC on and adjust bias to obtain 55V in each channel (between terminals B1-B2; B2-B3) and zero volts between B1-B3.

c. Repeat item 2-d and obtain a transfer characteristic of the preamplifier.

d. Connect winding A1-A2 and adjust gain of preamplifier to 55 V/AT with 12P.

e. Turn AC off. Connect wires to B13 and B14 in proportional integrator and wires to A7 and A8 in preamplifier

4. Combination Test

a. Connect brush recording instrument to output of the preamplifier (terminals B1, B3) and connect the same filter used in item 2-f.

b. Apply a step of 0.5 mA to windings A11-A12 of proportional integrator. The output of the preamplifier should consist of an 18.3 V step and a 7V/sec. ramp.

c. If the brush recordings are off more than 10 percent of the above figures, turn the a-c power off. Disconnect wires from terminals A6 and A7 of the proportional integrator and take a combined transfer curve. The system gain should be 1.83 times the proportional integrator gain.

e. Note Fig. 8 below is a typical performance recording of the continuous loop position regulator.

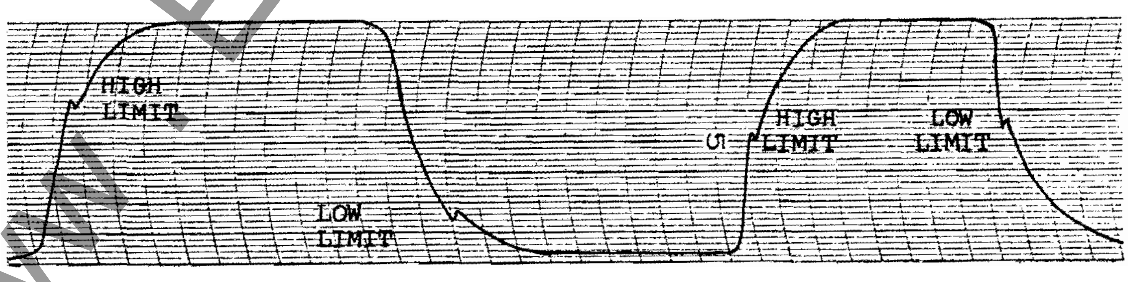
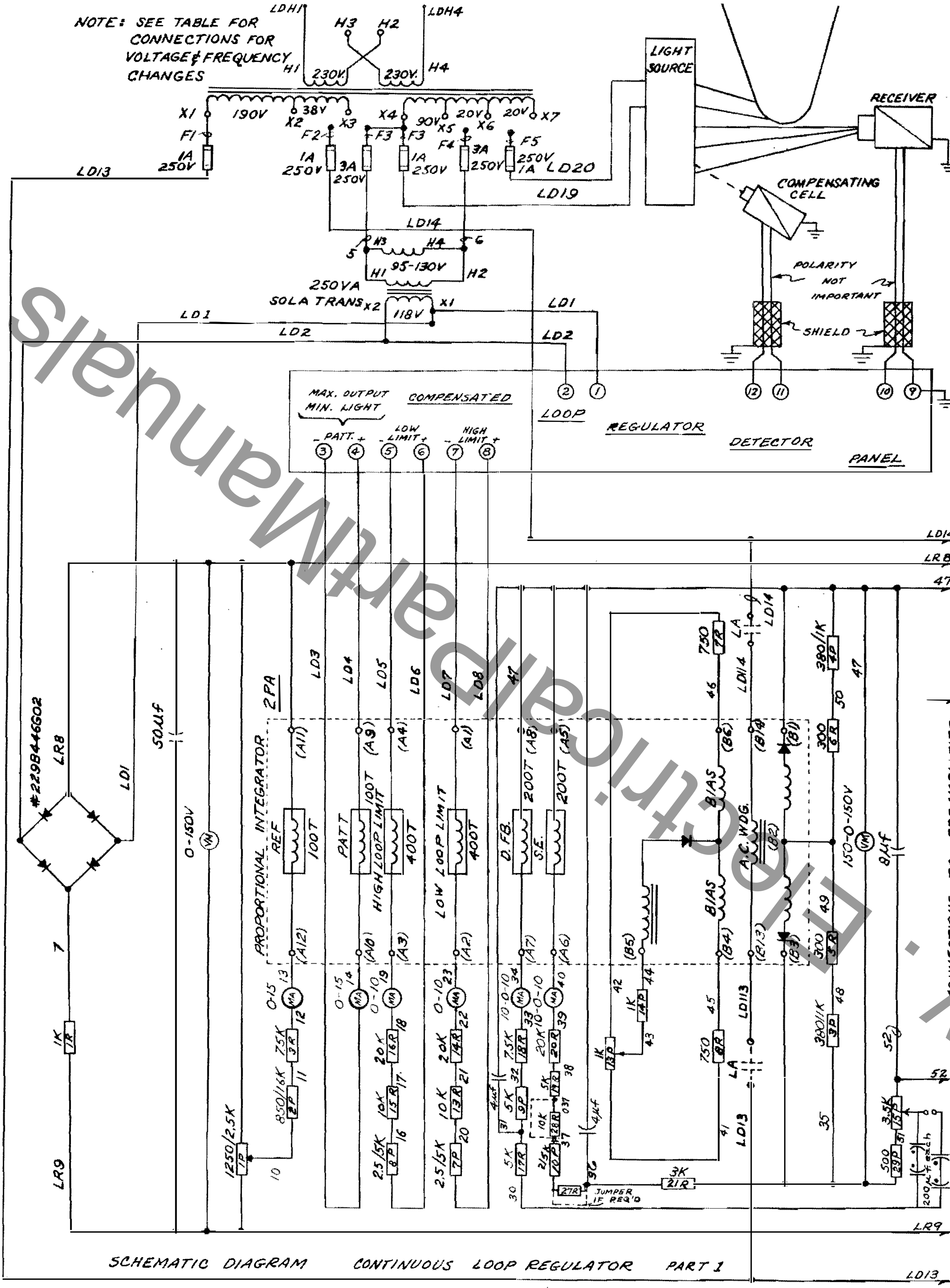
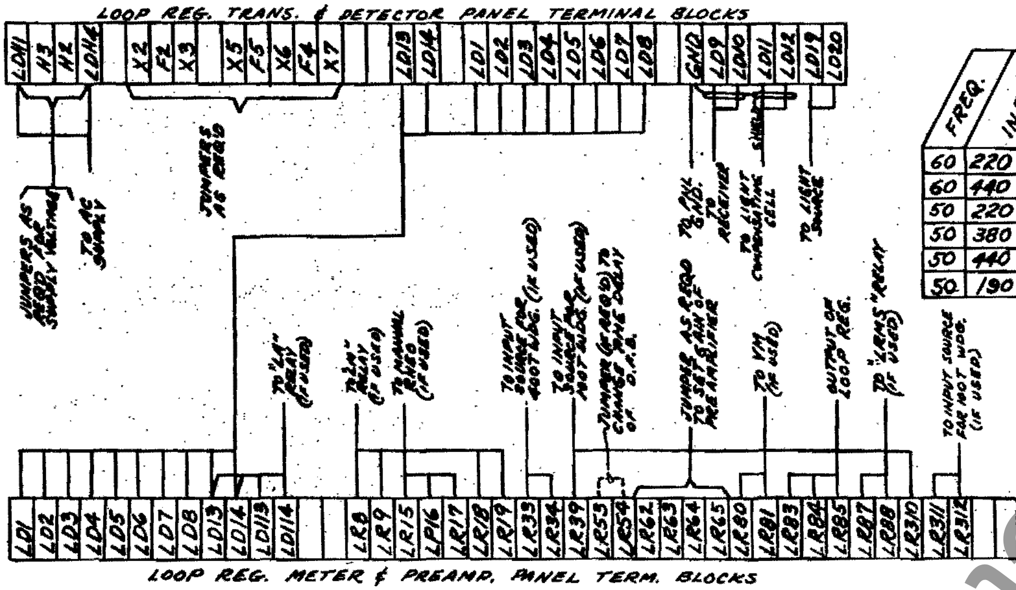


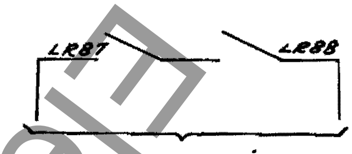
Fig. 8 - Typical Performance of the Continuous Loop Position Regulator Showing the Effect of High and Low Limit Signal at 10 Sec. and 4 Sec. Travels With Large Step Error



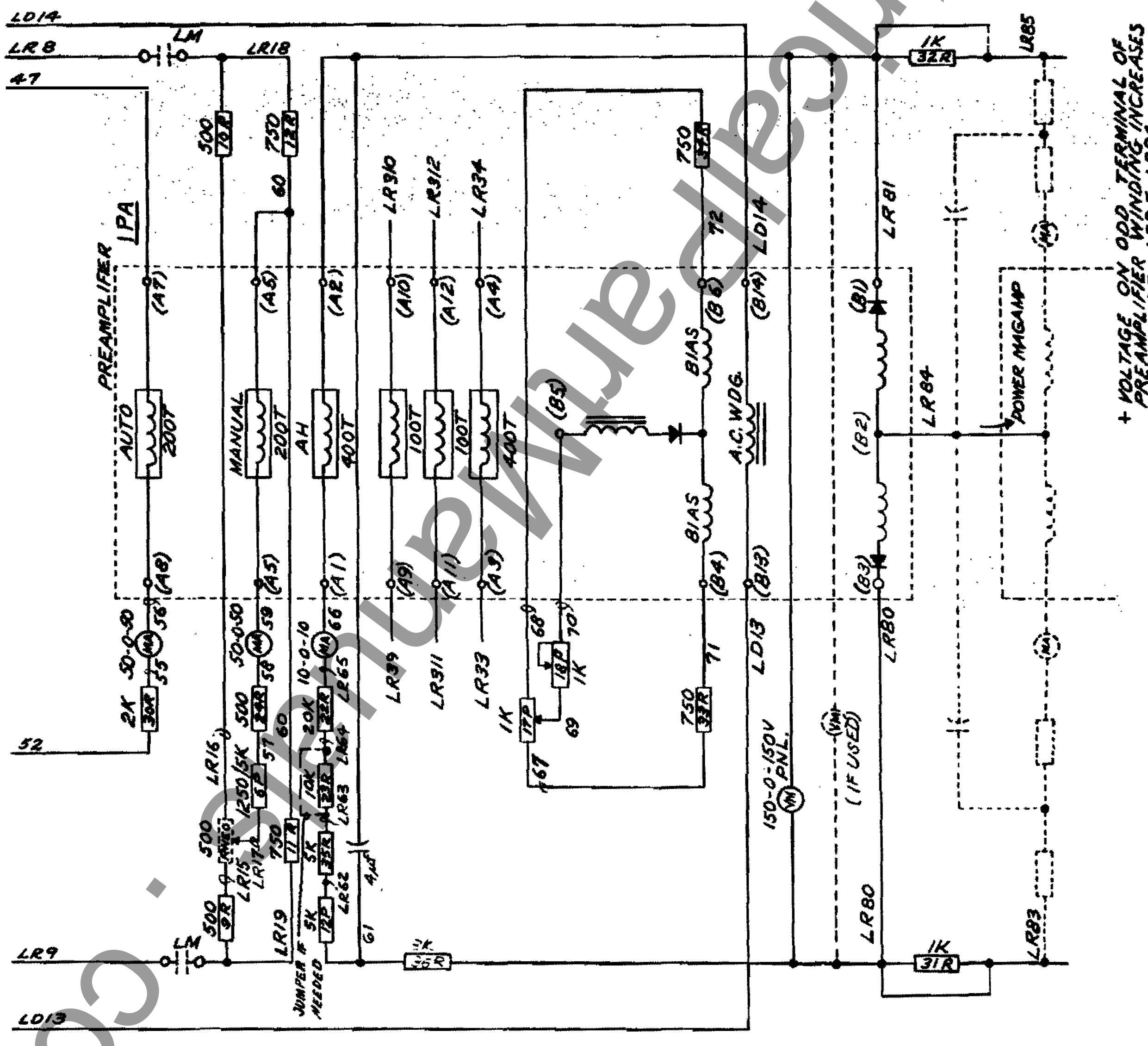
SCHEMATIC DIAGRAM CONTINUOUS LOOP REGULATOR PART 1



		PRIMARY		SECONDARY		
FREQ.	INPUT VOLTAGE	CONNECT H2 TO	CONNECT H3 TO	CONNECT F2 TO	CONNECT F4 TO	CONNECT F5 TO
60	220 V	LDH4	LDH1	X3	X6	X6
60	440 V	H3	H2	X3	X6	X6
50	220 V	LDH4	LDH1	X2	X6	X6
50	380 V	H3	H2	X3	X7	X7
50	440 V	H3	H2	X2	X6	X6
50	190 V	LDH4	LDH1	X3	X7	X7



LOOP REQ'D A.C. SUPPLY RELAY IF USED



SCHEMATIC DIAGRAM CONTINUOUS LOOP REGULATOR PART 2

WESTINGHOUSE ELECTRIC CORPORATION
BUFFALO DIVISION BUFFALO 5, N.Y.

Variable Voltage
SCREWDOWN CONTROLLER

This leaflet describes the basic controller for a variable voltage screwdown system with automatic gauge control (AGC), manual override of AGC, and a Trinistor controlled rectifier regulator amplifier. The screw motors are in a sandwich series circuit and are clutch coupled. They have no brakes. A single operator's station provides for manual control. Single speed control is available for raising or lowering both screws simultaneously, or one screw at a time. Variations of this basic controller consist of multi-speed manual operation, multiple operator's stations, differential leveling, and the addition of brakes. See the reference list at the end of this leaflet for the I. L. designations covering these variations.

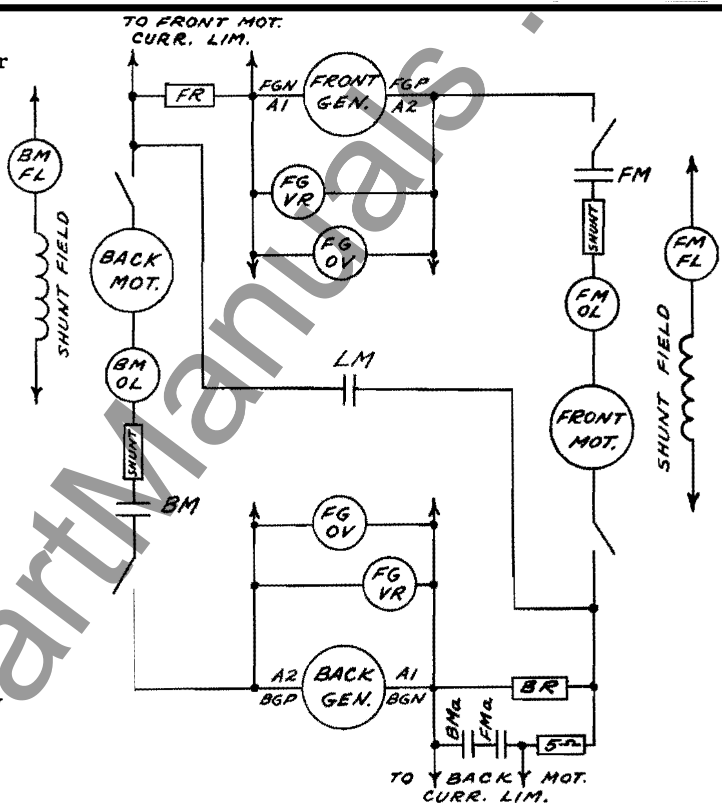


FIG. 1 - BASIC SANDWICH SERIES CIRCUIT

MACHINE CIRCUIT

Figure 1 shows the basic sandwich-series arrangement. Each generator is shunted by a voltage relay set to pick up at approximately 10% of rated voltage, and an overvoltage relay. Each motor circuit contains an overload relay and a set of knife switches for isolation. Each motor field circuit includes a relay for field loss detection.

For "both screw" operation, both the BM and FM contacts are closed, and LM is open. For back screw operation, only BM and LM are closed; for front screw operation, only FM and LM are closed. Across resistors FR and BR, a small voltage is developed proportional to armature current. Each voltage operates its corresponding regulator current limit circuit. The signal from BR is shorted out during "both screw" operation to prevent two limit signals from appearing at the regulator at the same time. The fields of both generators are controlled by the regulator described later in this leaflet.

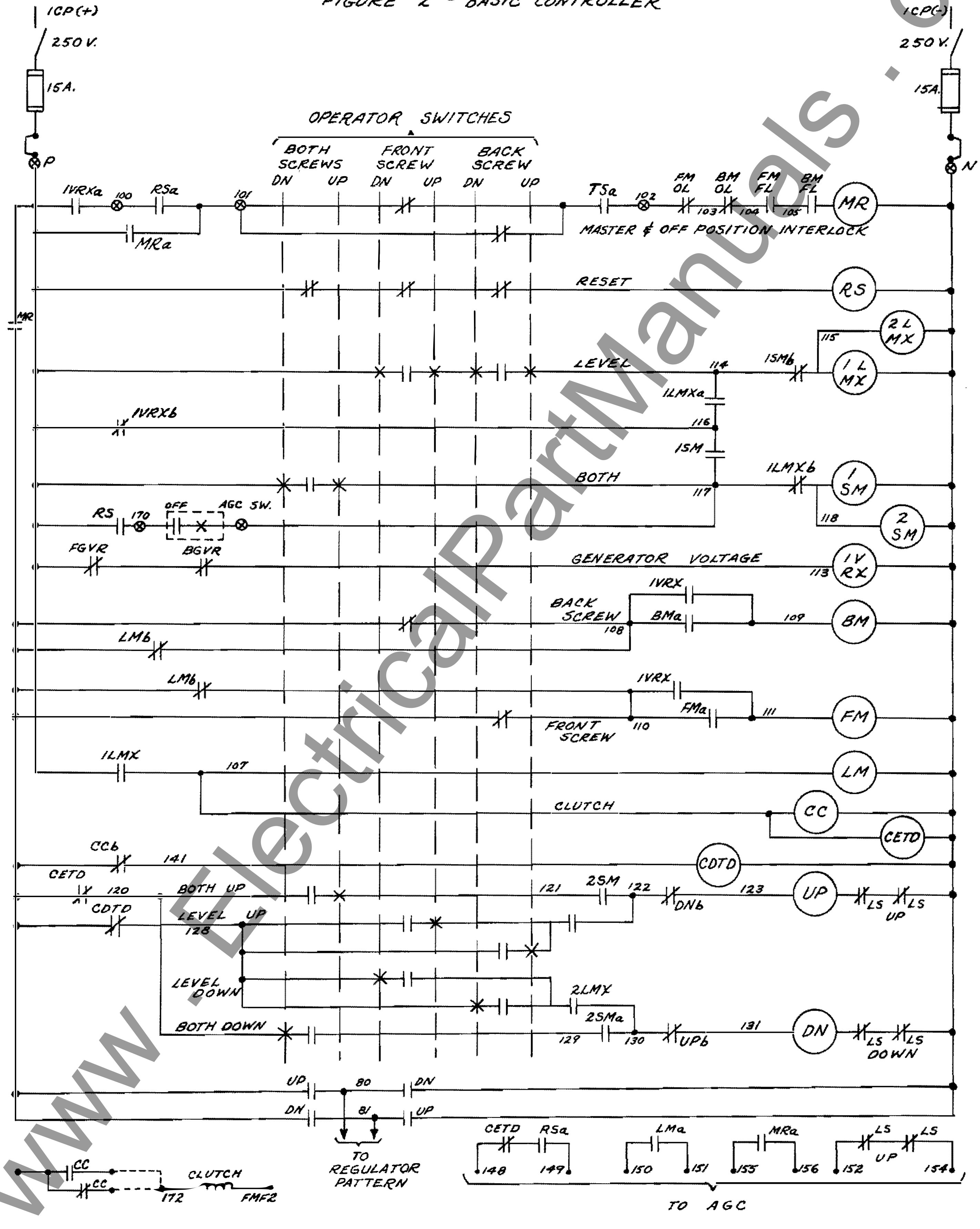
CONTROLLER

Figure 2 shows the basic controller including the operator's switch. The operation of the controller circuit is as follows:

1. Reset - Reset relay RS is energized when all operator switches are in the off position. An RS contact in the master circuit energizes MR (if other contacts in this circuit are also closed). A second RS contact, in series with a CETD contact, provides information to the AGC circuit that all operator's switches are off. This condition calls for AGC control of the regulator.

2. Generator Voltage - Voltage relay contacts FGVR and BGVR energize relay 1VRX only if both generator voltages are below a set value (generally 50V). Contacts of 1VRX interlock other controller circuits to prevent closing or opening of the main armature contactors if generator voltage is high.

FIGURE 2 - BASIC CONTROLLER



3. Master and Off Position Interlock - Master switch contacts provide interlocking between front screw and back screw switches, de-energizing MR if both are operated at the same time. Interlocking between both screw and single screw operation is provided by a first come first serve relay circuit within the controller. Contact TSa is an interlock from the AC contactor supplying the Trinistor Amplifier, and de-energizes MR if the amplifier is not operating. Armature overload and motor field loss relay contacts also interlock MR, de-energizing MR in case of overload or loss of field. Contact 1VRXa prevents initial pick-up of MR if the generator voltage is high.

One MR contact allows power to be applied to armature contactors BM and FM, clutch timer CDTD, and the pattern circuit of the amplifier. Thus, when MR is de-energized, the motor armature circuit is opened and the amplifier pattern signal is removed. Contact MRa informs the AGC circuit of the state of MR, thus providing for removal of AGC signals from the amplifier.

4. Level - Both - A signal is placed on lead 114 if the "front screw" or "back screw" switches are operated, and a signal is placed on lead 117 if the "both screws" switch is operated. Relays 1LMX and 1SM, together with their respective contacts 1LMXb and 1SMb, form a first come first serve interlock circuit which prevents both relays from being energized at the same time. Two relays are used for each function in order to obtain the required number of contacts. Contacts 1LMXa and 1SM, together with 1VRXb (lead 116), form seal-in circuits for their respective relays at high generator voltages (contact 1VRXb is closed at high generator voltages). Thus, when the operator switches are returned to off (or switched to some other condition) the LMX or SM relays will remain energized until the generator voltages return to a low value. Also, when the AGC switch is on and the operator's controls are in the off position, relay 1SM is kept energized thru the RS contact and the AGC switch (leads 170 and 117).

Therefore, regardless of the command given by the operator, the controller will not switch from one state (AGC, Level, Both) to any other state until the motors have nearly stopped.

Clutch - Contact 1LMX (lead 107) closes for leveling operations. This energizes clutch contactor CC, clutch engage time delay CETD, and armature contactor LM. Contactor CC contains a transfer contact (lead 172) which can be connected with a jumper so that either a magnet closed or a spring closed clutch may be disengaged when CC is energized.

Contact CCb(lead 141) de-energizes the clutch disengage timer CDTD. This relay provides a time delay (set equal to the time required to disengage fully the clutch) before closing a contact (lead 128) in the level up/level down circuits. A pattern signal cannot be applied to the regulator until this contact closes.

A contact on LM (LMa, leads 150, 151) indicates to the AGC circuit that a leveling operation is being performed.

When the operator's switch is turned from leveling to off (AGC), or to "both screws", 1LMX (lead 107) will open (after the generator voltage has dropped to a low value) de-energizing CC and the clutch engage timer CETD. This relay provides a time delay to allow the clutch to engage fully. Then, it closes a contact in the both up - both down circuit (lead 120) and a contact in the AGC interlock circuit (lead 148 - 149). Thus, neither AGC signals nor a manual pattern signal can appear at the regulator until the clutch has engaged fully.

Back Screw - Front Screw - The back screw motor contactor, BM, is de-energized when the front screw switch is operated, provided that LM is energized. Since LM is controlled by 1LMX, and 1LMX is operated through 1VRXb and the first come first serve circuit with 1SM, BM cannot be de-energized until the motors have nearly stopped. When the front screw switch is returned to zero, BM cannot be energized until the generator voltage is low and contact 1VRX has closed. The front screw circuit operates in a similar manner.

Level Up - Level Down - Relays UP or DN are energized through the up or down contacts on the front screw or back screw switches. The circuit must be pre-set by the energization of 2LMX and the de-energization of CDTD. Relay CDTD provides a time delay to allow disengagement of the clutch before UP or DN can be operated. The up and down limit switches prevent overtravel in either direction.

Both Up - Both Down - Relays UP or DN are energized through the up or down contacts on the "both screw" switch. The circuit must be pre-set by energizing 2SM and by de-energizing CETD. Relay CETD provides a time delay when switching from "level" to "both screws" operation to allow engagement of the clutch before UP or DN can be operated.

Pattern - Contacts UP and DN (leads 80, 81) apply a pattern voltage of the proper polarity to the regulator.

REGULATOR

Figure 3 shows the block diagram of the regulator circuit. Both generator fields are energized by a reversing "Trinistor" power amplifier (dual converter) which utilizes silicon controlled rectifiers as its active components. The complete regulator consists of the power amplifier, pre-amplifier, A. C. control and bias circuits, calibration and damping circuits, meters, and protective devices. Detailed information on operation and adjustment is provided in the regulator drawings. Maintenance and operating instructions for the power amplifier are provided in I. L. 16-800-19.

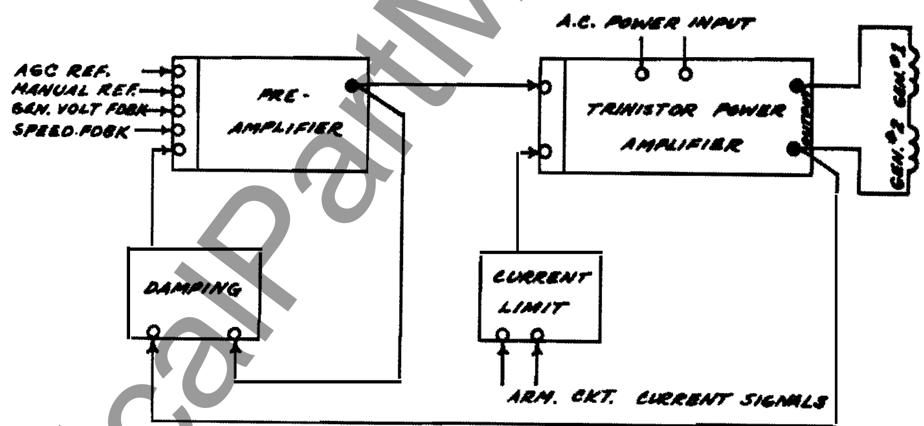


FIGURE 3 - REGULATOR BLOCK DIAGRAM

VARIATIONS

The frequently used variations of this basic controller are described in the following supplementary leaflets:

I. L. 9321-4 - Multiple Operator's Stations
I. L. 9321-5 - Multi-Speed Manual Operation
I. L. 9321-6 - Differential Leveling
I. L. 9321-7 - Controller with Brakes

Westinghouse

An Introduction to THE M-2 TRINISTOR REGULATORS

The type M-2 line of Westinghouse standard regulators represents a new concept in applying power and regulating systems to all types of mills and processing lines. This conecept evolved from a strong determination to provide reliable, high-performance systems with enough flexibility to meet the production facility requirements of a wide variety of the industries we serve. Drawing from extensive experience in satisfying individual customer requirements, we have merged the latest developments in control components with the reliability of standardized, regulator packages. Each package is pre-wired and pre-tested to insure adherence to rigid performance specifications. The customer advantages of this approach are obvious. Each package maximizes the benefits of individual component development. Each package represents a functional unit of known capability. Each package serves as a large building block for complete control system application.

ADVANTAGES

of M-2 Trinistor Regulators . . . . .

1. Regulators are completely static.
2. Standardized high gain-fast response Trinistor silicon - controlled rectifiers are used.
3. Power amplifier- power ratings up to 25KW are provided by 3 amplifier designs, using only 2 Trinistor device ratings.
4. Power amplifiers are fully self-protecting.
5. Packaged pulse position modulator (PPM) Trinistor firing circuits have electrically isolated control inputs.
6. Power circuits are electrically isolated by input transformers in each regulator.
7. Converter type power amplifiers provide reverse voltage forcing in unidirectional designs to provide fast response for decreasing output as well as increasing output.
8. Dual converter type power amplifiers provide full reversing output with a single machine field.
9. The new, fast response, 1600 cycle magnetic preamplifier operates on 24 V DC.
10. Standard power amplifiers are combined with a line of standard calibration panels to form regulators for a large variety of uses.
11. Standard designs permit interchangeability of many parts; and facilitate adjustment and maintenance.
12. The inherent high performance of these regulators plus the wide range of adjustment provides unusual ease of adjustment to obtain excellent performance.
13. Each regulator includes excited machine meters as well as signal meters to allow easy observation of performance.

In all industries, increasing production costs and more insistent demands for better product quality make optimum system performance essential in all production applications. The M-2 modular concept was designed to meet this need. Recent applications, especially in the metal working industries for such systems have substantiated these customer advantages.

FLEXIBILITY

In order to achieve the flexibility required to satisfy the multitude of diverse applications of our many customers, a unique method of standardizing on functional modules was adopted. Each regulator is made-up of two or more standard sections which together, perform a pre-selected regulating function. The function determining sections are named calibration panels. Table 1 shows these panels. For special features, auxiliary panels are added to the primary calibration panel. These are shown in Table 2. From these listings it is apparant that all regulating functions are satisfied; 90% by pre-tested standard units.

The other main section of the regulator is the Trinistor Power Amplifier. The Trinistor Power Amplifier (T.P.A.) possesses realistic advantages in power gain, better linearity and faster response over existing commercial amplifiers bases on different means of amplification. It forms an ideal partner for the function determining calibration panel. The TPA capability provides a definite size advantage when compared with other static apparatus required to accomplish the same function. For example, since the TPA is operable with 60 cycle supply at all ratings, often this means complete elimination of the 400 cycle equipment installation requirement for higher capacity regulating systems.

TABLE 1

TYPE M-2 REGULATORS

Since the calibration panel determines the characteristic of the regulator of which it is a part, the regulator model designation is identical with the calibration panel designation. Typical applications of some of the models are given in the following tabulation.

MODEL	NAME	TYPICAL APPLICATIONS
1100	General Purpose Voltage Regulator	Process Line Voltage Regulators Reference Exciter Voltage Regulator Continuous Hot Mill common Bus Generators Voltage Regulators
1200	V.V. Auxiliary Voltage Regulator	V.V. Auxiliary Drives
1300	Reversing Mill Voltage Regulator	Main drive reversing hot mills voltage regulator
1500	High Gain Voltage Regulator	Tandem Cold Mill Voltage Regulator
2100	General Purpose Speed Regulator	Process Line Speed Regulator; Single Stand Cold Mill Speed Regulator
2200	V.V. Auxiliary Speed Regulator	V.V. Auxiliary Drives
2400	High Performance Rectifier Speed Regulator	Continuous Hot Mills with Each Stand powered by an individual Ignitron Rectifier
2500	High Performance Generator Speed Regulator	Continuous Hot Mills with each stand powered by an individual generator
2700	High Performance Motor Field Speed Regulator	Continuous Hot Mills with stand motors supplied by common bus.
3500	Generator Current Regulator	Tension Reels and Bridles that are current regulated by generator or booster voltage control.
3700	Motor Field Armature Current Regulator	Tension Reels and Coilers that are current regulated by motor field control.
4600	General Purpose Motor Field Flux Regulator	To excite and control field of main drive stand and reel motors
4300	Reversing Mill Motor Field Flux Regulator	Main drive reversing hot mill motor Field Regulator
5000	M.O.R. CEMF Regulator	CEMF Regulation of Reel motor by control of reel motor operated rheostat. Rheostat or Flux Regulator must excite motor field.
5600	General Purpose Motor Field CEMF Regulator	Controls Reel Motor CEMF by direct excitation of motor fields.
5700	High Performance Motor Field CEMF Regulator	CEMF regulation of continuous Hot Mill Stand Motor controlled by speed Regulators 2400 and 2500.

TABLE 2

Auxiliary calibration panels are used in conjunction with a primary calibration panel to provide special features for the regulator. They are listed in the following tabulation, to show their application and the primary calibration panel with which each is used. The P model series contains a pre-amplifier; the C model designates auxiliary circuits only, without preamp.

MODEL	NAME	USED WITH PRIMARY CAL. PNL.	APPLICATION
P221	Speed Limit Preamp	3500	Provides thread speed and speed limit for generator current regulated reel drive.
P321	Current Limit Preamp	1200-2200	Provides shaped current limit for V.V. Auxiliary Drives.
P322	Current Limit Preamp	4300	Provides Current Limit for Reversing Hot Mill drives by means of motor field control.
P211	Speed Compensation Preamp	2400-2500-2700	Provides droop, tail end compensation, No-Load overspeed and auxiliary reference windings for loopers, AGC, etc., for speed regulated hot mills.
P311	IR Preamp	1500	Provides IR compensation, Jog and Auxiliary Reference Windings for Tensiometers, AGC, etc., for Tandem Cold Mill Voltage Regulators.
P551	CEMF Preamp	4600	Provides CEMF regulation for generator speed regulated drive thru a motor field flux regulator.- Single Stand Cold Mills.
C311	IR Compensation	1100	Provides IR Compensation for General Purpose generator voltage regulators.
C321	Current Limit	1200-2200	
C322	Current Limit	1200-2200	
C323	Current Limit	1200-2200	
C324	Current Limit	1200-2200	

Special regulator features such as load balance, inertia compensation, speed unbalance, etc. which are not available on standard primary or auxiliary calibration panels, may be added by individual design of a special auxiliary calibration panel to provide the features desired.

Screwdown Controller
MULTIPLE OPERATOR'S STATIONS
(first come, first serve)

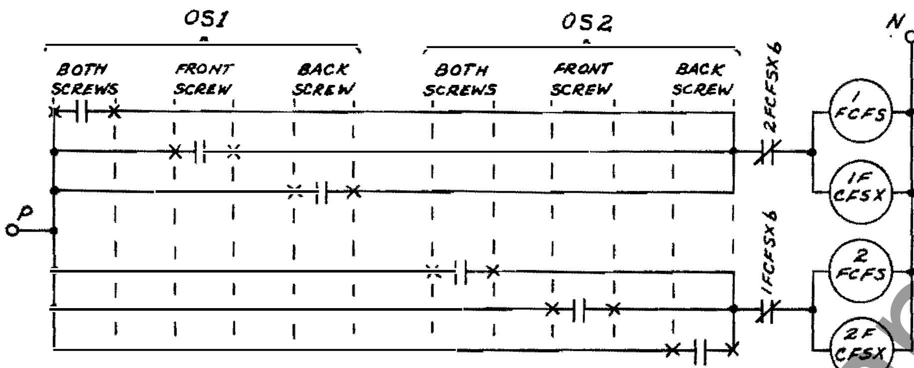


FIGURE 1 - BASIC INTERLOCK CIRCUIT

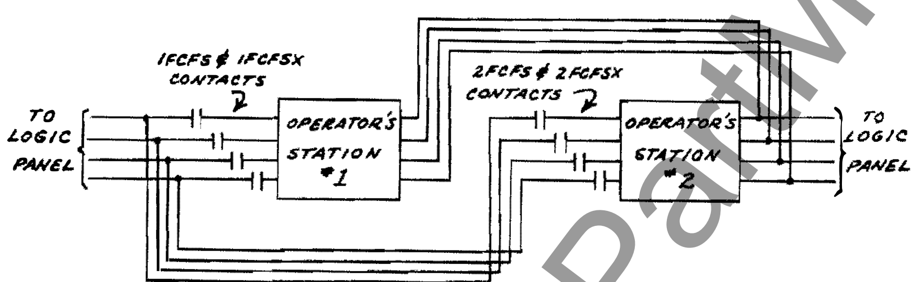


FIGURE 2 - STATION CONTROL ARRANGEMENT

This leaflet describes the first come, first serve interlocking used when two or more operator's stations are used to govern the same screw down controller. The basic controller is described in I. L. 9321-3.

Under the dual station system described here, operation of the switches at one operator's station will disconnect the circuits to the other station, and hold them disconnected until all the first station switches have been returned to OFF. Figure 1 shows the basic interlock circuit.

Circuit Details

Operation of any switch at any one operator's station will pick up the relays associated with that station. An interlocking contact of one of the relays opens in the relay circuitry of the other station. Normally open contacts of the relays are located in series with the switch circuits to each operator's station (#1 relay contacts to OS1 and #2 relay contacts to OS2). Thus, circuits thru switch contacts of either station remain open until the appropriate relays are energized. This is shown in Figure 2.

Circuits are identical (only 4 shown here) with those shown in Figure 2 of I. L. 9321-3 except that the single operator's station is replaced by 2 operator's stations controlled by FCFS and FCFSX contacts of the station selector circuit.

WESTINGHOUSE ELECTRIC CORPORATION
BUFFALO DIVISION BUFFALO 5, N. Y.

NEW INFORMATION MAY 1962

TIN REFLOW PHOTOELECTRIC SCANNER

SYSTEM CONCEPT

The Westinghouse scanner unit is a photoelectric device used for sensing the flow line location on electrolytically tinned steel strip. It is used to provide a corrective signal to the Reflow regulators in the event the flow line shifts position.

After the strip leaves the plating zone of an electrolytic tinning line, it has a dull, porous matte surface. In order to provide a shiny, non-porous smooth surface, which is required for many applications, the tin coating must be heated until it melts. The tin coating is reflowed or fused by induction power from high (radio) frequency, power oscillators feeding into induction coils through which the strip passes. The strip is heated by eddy currents induced in it by the changing electro-magnetic field of the coil. Normally, the strip passes through several induction heating coils, each of which is fed by a separate oscillator controlled by a separate regulator. The first coils serve to pre-heat the strip, while the last coil or "lead coil" raises the surface temperature to the melting point of tin. The tin coating usually melts at a point approximately two-thirds of the way through the last coil. Reflectivity of the tinned surface changes at this point, creating a flow line which appears to remain stationary as the strip passes through the coil. The flow line, or "melt line" as it is sometimes called, is defined as the point at which the tin changes from a matte to a shiny finish.

SCANNER

The scanner is a photoelectric device containing four light sources, two photo-sensitive pickup tubes, and an amplifier.

Figure 1 shows the relationship between the scanner and the strip flow line. The four light sources project four separate, oval shaped light spots onto the strip. These appear in a vertical row in the center of the strip with two spots above and two spots below the flow line. The scanner, working on the principle of scattered light reflected from the unreflowed portion of the strip, produces greater output. Since most of the light projected to the reflowed surface is reflected away from the scanner pickup unit, the amount of light picked up from the reflowed portion is less than that of the unreflowed surface.

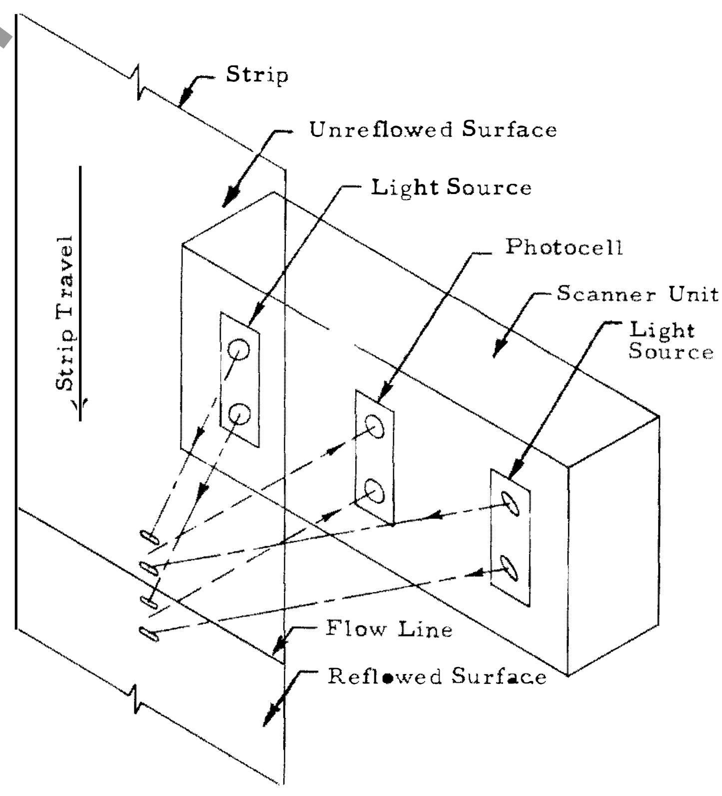


Figure 1 - Tin Reflow Scanner

The scanner output is approximately proportional to the flow line position. Thus, if the flow line position changes, the scanner output changes correspondingly. For typical applications, the scanner output is fed to the reflow regulator system, and the oscillator output is changed to bring the flow line back to its proper position.

The scanner circuit is presented schematically in Figure 2. When the light reaches the cathode of either phototube 14TU or 15TU, a small current flows through resistor 1R, producing a positive voltage on the grid of tube 16TU. The amount of current flowing through 1R is proportional to the amount of light reaching the cathodes of 14TU and 15TU.

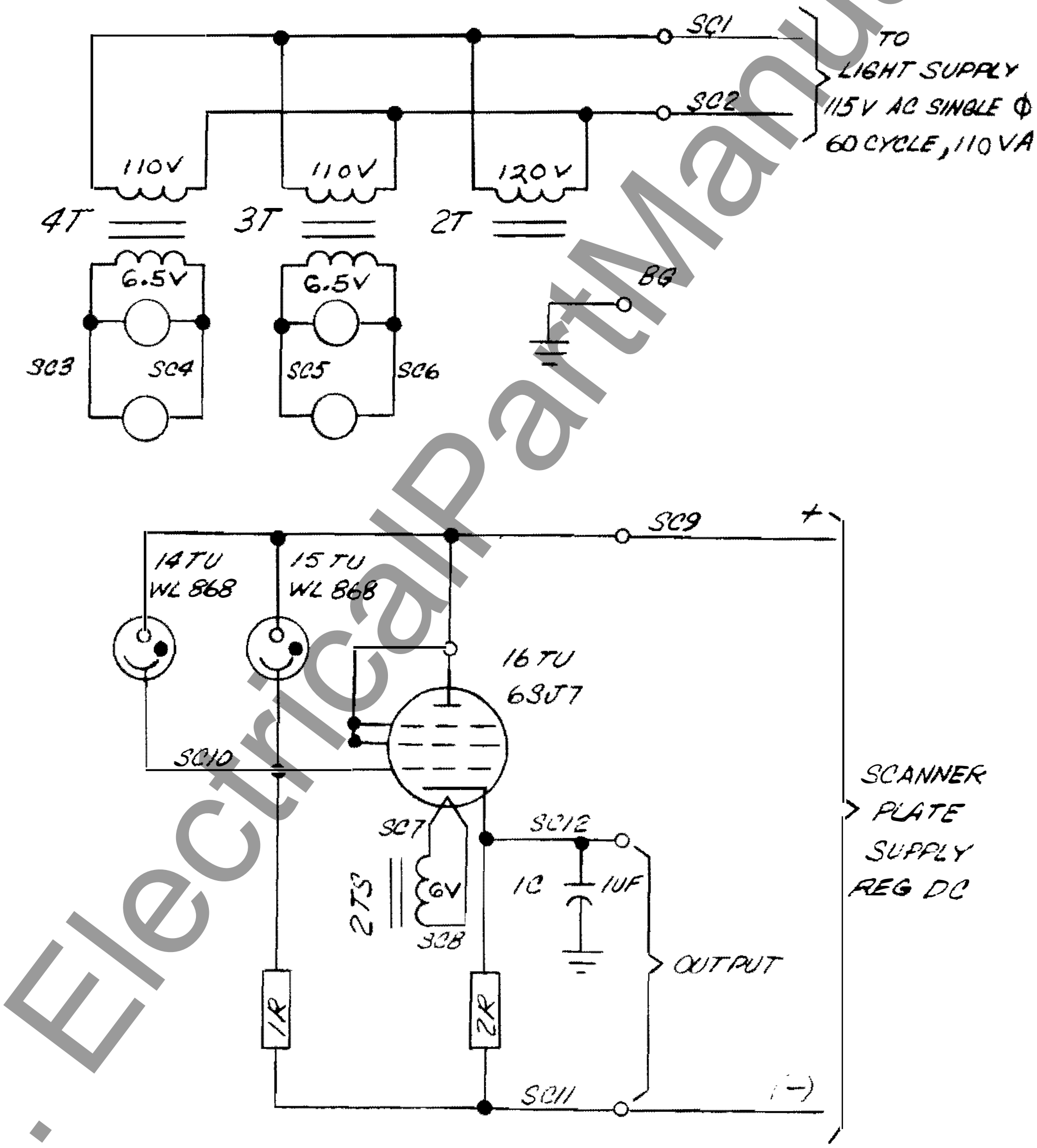


Figure 2 - Tin Reflow Scanner Schematic

Tube 16TU is connected as a cathode follower in order to get a low impedance output. The output signal across leads SC11 (negative) and SC12 (positive) ranges from approximately 5 to 15 volts. When the scanner is properly adjusted, the output voltage should be approximately in the middle of this range.

POWER SUPPLY

A regulated, ungrounded power supply should be used to supply approximately 85 volts to the scanner plate circuit. The positive lead should be connected to SC9, and the negative lead to SC11.

The light source requires a 115 volt, single phase, 50/60 cycle supply voltage applied across SC1 and SC2.

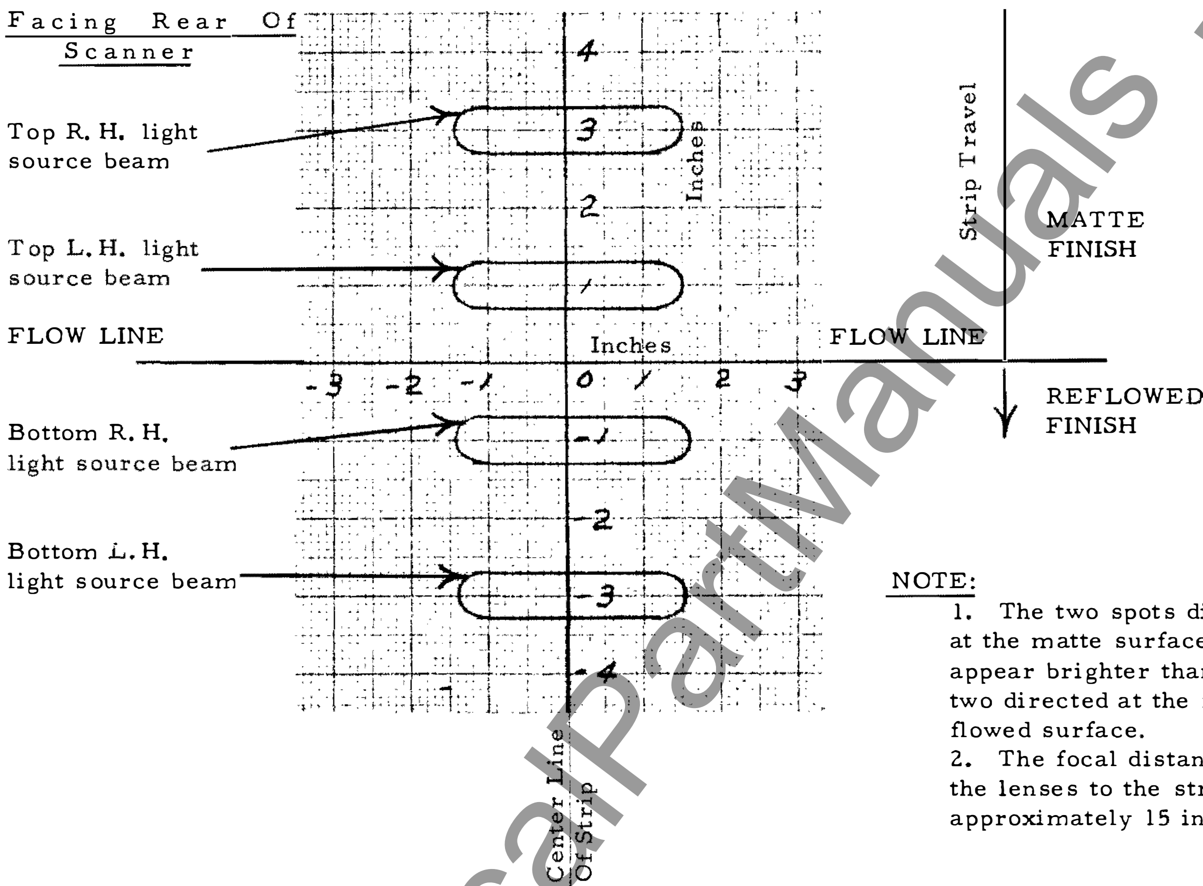
CALIBRATION PROCEDURE

The scanner should be adjusted properly before putting the system into operation. It should always be located so that the flow line is opposite the horizontal center line of the scanner unit and the phototube lenses are directed approximately at the middle of the strip at a focal distance of approximately 15 inches. Initially, the scanner unit should be at the level of the fourth turn of the work coil. This positioning can be accomplished by cranking the jack screw assembly. A clockwise rotation of the handwheel lowers the unit, while a counter-clockwise rotation raises it. However, before attempting to operate the jack screw assembly, make sure it is unlocked. A counter-clockwise rotation of the position clamp will unlock the screw assembly.

When this initial positioning of the scanner unit is completed, the position of the projected light spots should be adjusted. It will be noted that there are four light sources, each of which must be adjusted to provide a light spot of the proper size, and properly positioned on the strip. Figure 3 shows how these spots should be positioned and their recommended size. It is recommended that the light sources on one side of the scanner be adjusted with the light from the other side blocked off. In this way, only two light spots need be contended with at a time, one above the flow line and one below it.

Since the four light sources are identical units, the instructions given for focusing one will apply to the other three. However, please note that the bottom units are turned 180° which makes the knurled knobs on the opposite side of the unit shown in Figure 4.

There are three adjustments necessary to produce a light spot as indicated in Figure 3.



NOTE:
1. The two spots directed at the matte surface will appear brighter than the two directed at the reflowed surface.
2. The focal distance from the lenses to the strip is approximately 15 inches.

Figure 3 - Light Spot Focusing and Positioning

Refer to Figure 4 for the location of the adjustments discussed below:

1. Adjust the size of the light spot.

   a) Loosen the projector lamp mounting assembly by rotating knurled knob "A" counterclockwise.

   b) Move the mounting plate until the light beam is focused to produce a spot on the strip which is approximately 1 inch high and 2-1/2 inches long. Moving the assembly forward decreases the size of the spot, while moving it backward increases the size. The light beam should fall between the work coils.

   c) Tighten the knurled knob "A" by turning it clockwise.

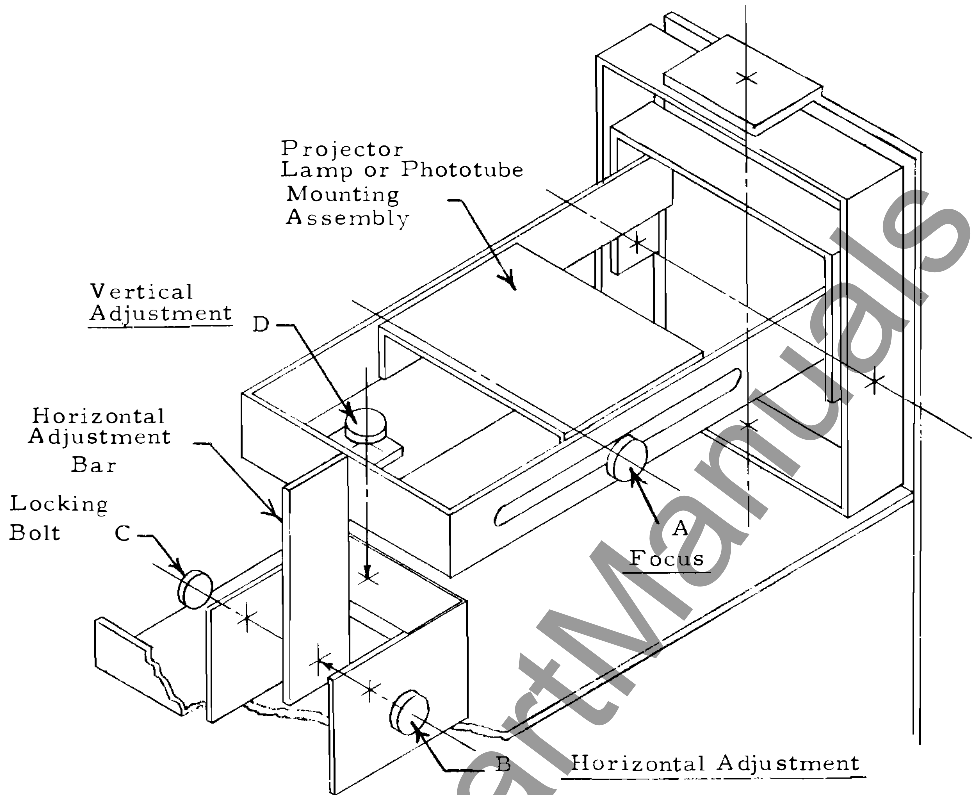


Figure 4 - Light Source or Phototube Assembly

2. Horizontal adjustment of the light spot.

   a) Loosen the horizontal adjustment assembly by rotating locking bolt "C" counterclockwise until there is sufficient space for moving the horizontal adjustment bar.

   b) Rotate knurled knob "B" until the light spot is directed at center of the strip, as indicated in Figure 3. A clockwise rotation moves the spot to the right, and a counterclockwise rotation moves it to the left.

   c) Tighten locking bolt "C" against the horizontal adjustment bar by rotating it clockwise.

3. Vertical adjustment of the light spot.

   a) Loosen the locking nut on the vertical adjustment bolt "D".

   b) Adjust the vertical position of the light spot to correspond to that indicated in Figure 3. A clockwise rotation of knurled knob "D" moves the spot down, and a counterclockwise rotation moves it up.

   NOTE: The light spots must NOT strike the heating coils. The entire scanner unit should be moved up or down in order to make the spots clear the coil and strike the strip directly.

c) Tighten locking nut.

The scanner light sensing units must be adjusted after the light sources have been properly adjusted. There are two sensing units each consisting of a lens, a phototube and mounting assembly which is similar to the light source mounting assembly.

Each phototube must be positioned so that the light entering the lens strikes the phototube cathode. While observing the light from the lens striking the cathode, adjust the phototube position horizontally and vertically until all the light entering strikes the cathode. The horizontal and vertical adjustments are made in the same manner as described in steps 2 and 3 for the light source.

CAUTION: Make sure that light reflected from the strip does not strike the phototube window directly. This can be checked by visual inspection.

When this step is completed, loosen the phototube mounting plate as described in step 1 for the light source. Move the plate forward and backward until the point of maximum output is found. Now, tighten the plate into position.

MAINTENANCE

1. The scanner lenses should be cleaned periodically in such a manner that they are free of dust and film. Mill conditions will determine the time interval between cleanings. However, under no circumstances should this interval be longer than two weeks.

2. Replace projector lamps at least every two weeks.

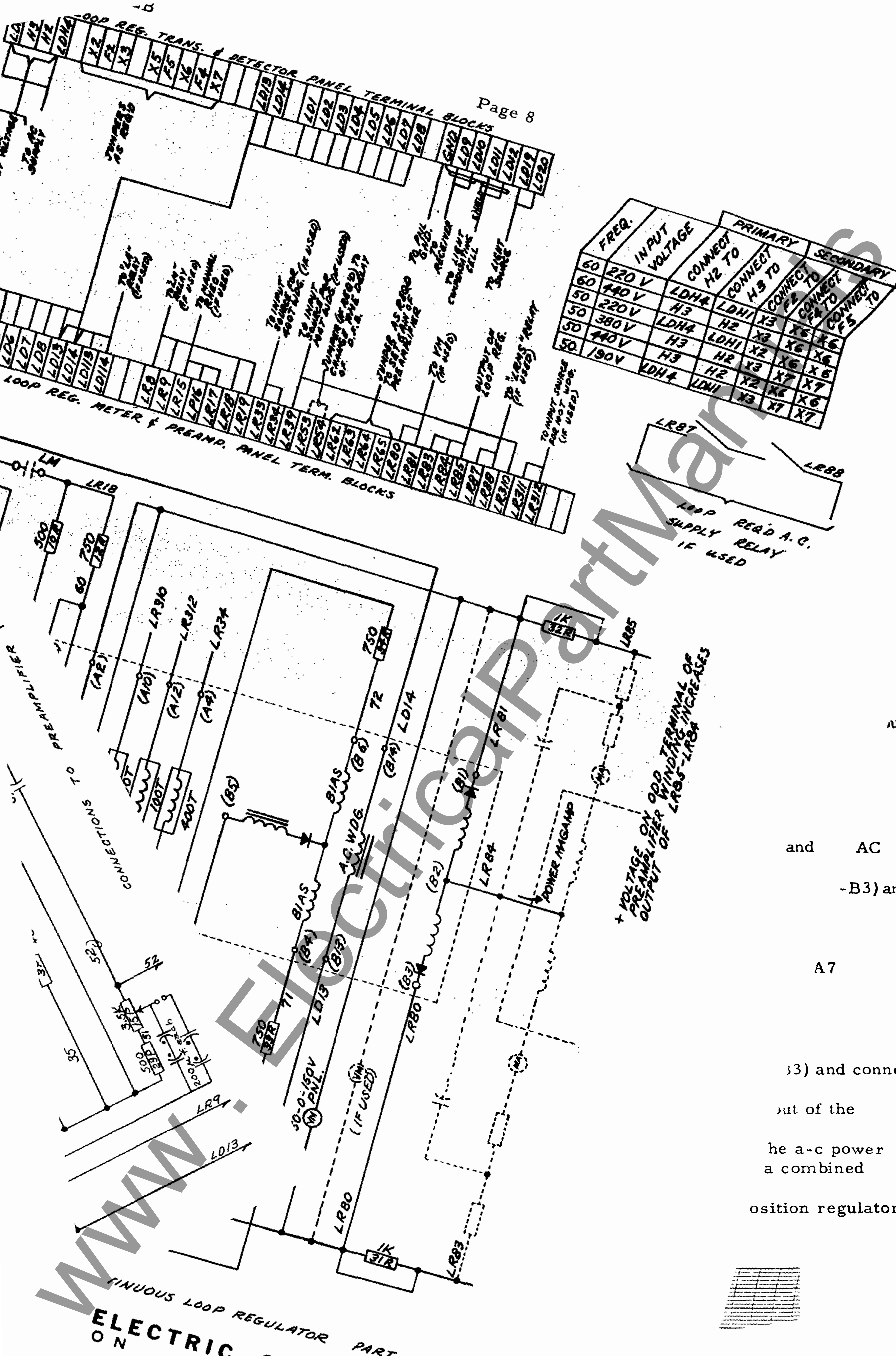
3. Replace the phototubes at least every two weeks.

PARTS LIST

Light Source Lamp - 32W., 8.5V., 4A., single contact, type T-8 bayonet base (W) S# 1014663 or equivalent.

Phototube (14TU and 15TU) - WL 868 or equivalent.

Amplifier Tube (16TU) - 6SJ7 or equivalent.



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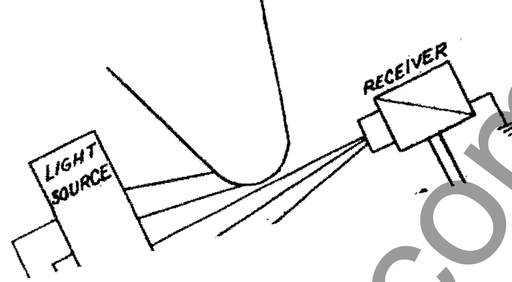

Page 7

I. L. 9321-2B

CONTINUOUS LOOP REGULATOR

The Solid State Continuous Loop Regulator provides a means to control the free hanging loop of a continuous processing line.

The continuous loop regulator employes all solid state devices such as transistors and magnetic amplifiers. Physically, it consists of three major components:

1. Light source, compensator, and receiver.
2. Loop position detector amplifier.
3. Loop regulator panel.

The loop position detector panel consists of a photoelectric detector and a Sola power supply.

The loop regulator panel consists of two 60 c/s magnetic preamplifiers. The first stage preamplifier is used as a proportional integrator, and is effective in performing the regulation without a steady state error. The second stage preamplifier is used as an amplifier with adjustable gain. All necessary potentiometers, meters, and other accessories are assembled in one magamp panel.

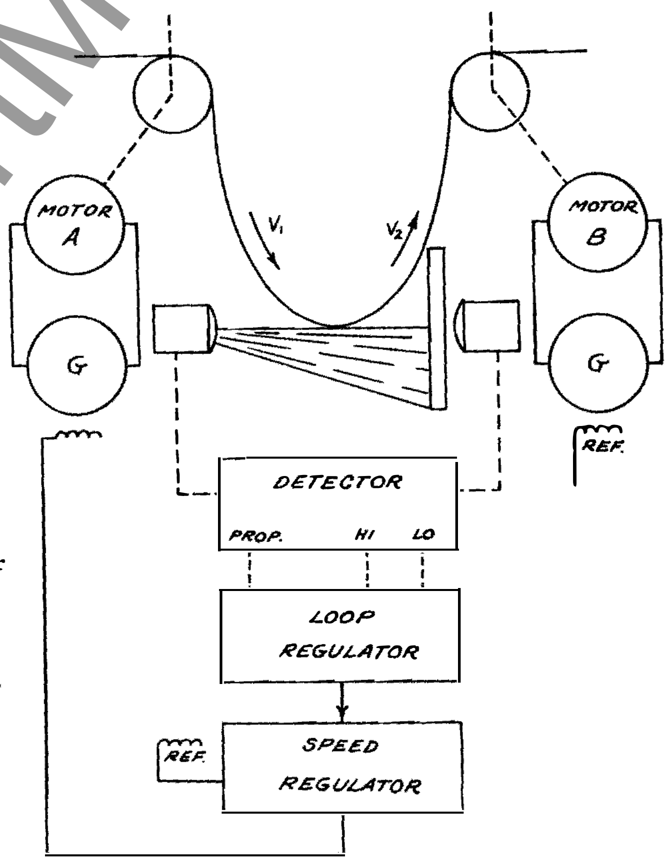

Fig. 1 - Continuous Loop Regulator Application to Variable Voltage Drive System

SYSTEM OPERATION

The loop regulator is designed to work in conjunction with a speed or voltage regulator, usually acting on the drive system ahead of the loop. The speed of this drive is changed by the signal applied by the loop regulator, in such a manner as to match the line speed at the entry and exit ends of the loop, and consequently keep the loop in the regulating zone.

The output of the detector varies from 0 to 10 MA as the light to the receiver is cut off by the loop. The reference AT applied to the loop regulator determines the zero regulating level. When the loop is at this level, the net AT input to the regulator is zero.

If the drive ahead of the loop runs slower, the loop pulls up and more light is received by the receiver. The detector output decreases and the net ampere turns acting on the loop regulator are in the same direction as the reference ampere turns. The loop regulator applies a signal to the dri[...] regulator to increase motor speed and bring the loop bac[...]

Westinghouse

Screwdown Controller
MULTIPLE OPERATOR'S STATIONS
(first come, first serve)

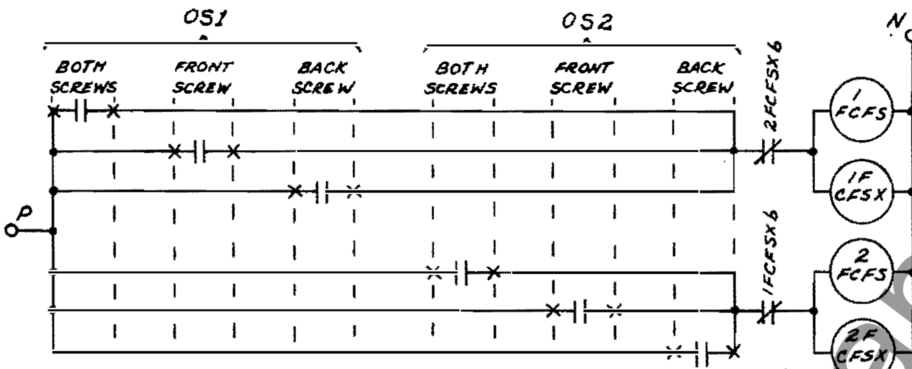

FIGURE 1 - BASIC INTERLOCK CIRCUIT

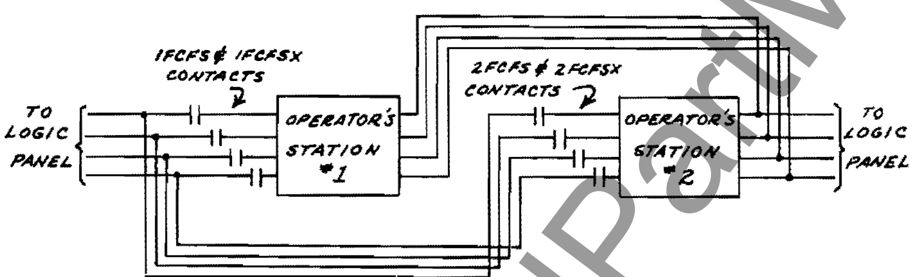

FIGURE 2 - STATION CONTROL ARRANGEMENT

This leaflet describes the first come, first serve interlocking used when two or more operator's stations are used to govern the same screw down controller. The basic controller is described in I. L. 9321-3.

Under the dual station system described here, operation of the switches at one operator's station will disconnect the circuits to the other station, and hold them disconnected until all the first station switches have been returned to OFF. Figure 1 shows the basic interlock circuit.

Circuit Details

Operation of any switch at any one operator's station will pick up the relays associated with that station. An interlocking contact of one of the relays opens in the relay circuitry of the other station. Normally open contacts of the relays are located in series with the switch circuits to each operator's station (#1 relay contacts to OS1 and #2 relay contacts to OS2). Thus, circuits thru switch contacts of either station remain open until the appropriate relays are energized. This is shown in Figure 2.

Circuits are identical (only 4 shown here) with those shown in Figure 2 of I.L. 9321-3 except that the single operator's station is replaced by 2 operator's stations controlled by FCFS and FCFSX contacts of the station selector circuit.

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BUFFALO DIVISION BUFFALO 5, N.Y.

NEW INFORMATION MAY 1962

Level Up - Level Down - Relays UP or DN are energized through the up or down contacts on the front screw or back screw switches. The circuit must be pre-set by the energization of 2LMX and the de-energization of CDTD. Relay CDTD provides a time delay to allow disengagement of the clutch before UP or DN can be operated. The up and down limit switches prevent overtravel in either direction.

Both Up - Both Down - Relays UP or DN are energized through the up or down contacts on the "both screw" switch. The circuit must be pre-set by energizing 2SM and by de-energizing CETD. Relay CETD provides a time delay when switching from "level" to "both screws" operation to allow engagement of the clutch before UP or DN can be operated.

REGULATOR

Pattern - Contacts UP and DN (leads 80, 81) apply a pattern voltage of the proper polarity to the regulator.

Figure 3 shows the block diagram of the regulator circuit. Both generator fields are energized ...y a reversing "Trinistor" power amplifier (dual converter) which utilizes silicon controlled rectifiers ...its active components. The complete regulator consists of the power amplifier, pre-amplifier, ...7. control and bias circuits, calibration and damping circuits, meters, and protective devices. ...led information on ...ion and adjustment ...ded in the regulator ...'. Maintenance ...ting instructions ...er amplifier ... in I.L. 16-800-19.

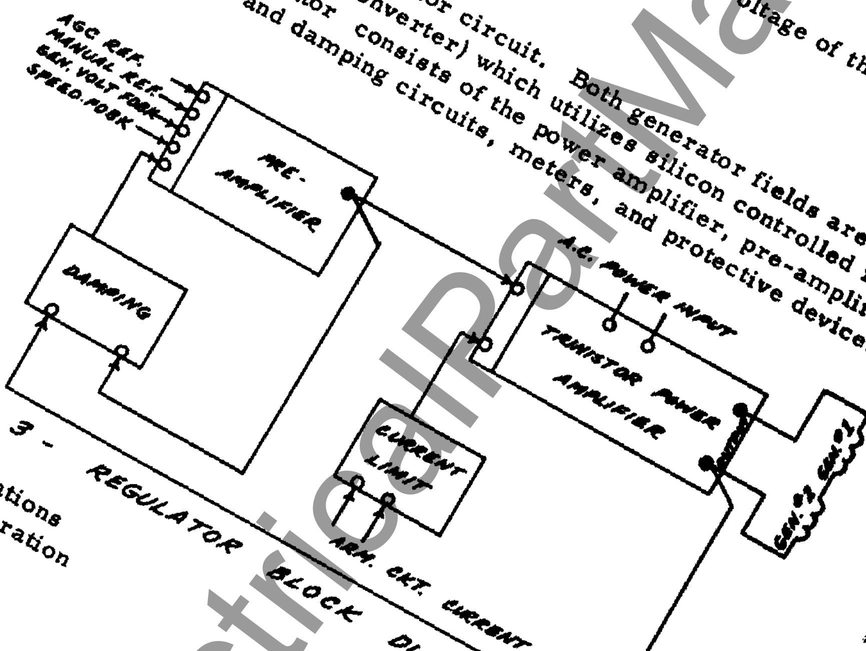

FIGURE 3 - REGULATOR BLOCK DIAGRAM

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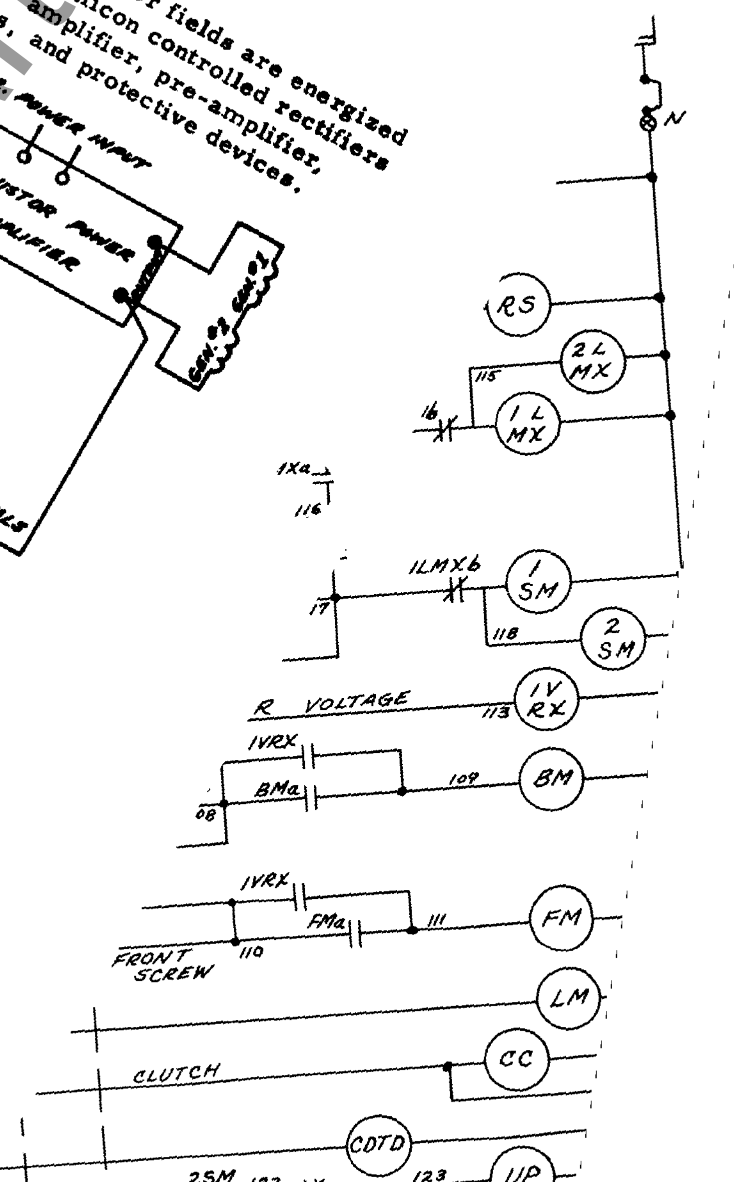

and Off Position Interlock - Master switch contacts provide interlocking
front screw and back screw switches, de-energizing MR if both are operated
time. Interlocking between both screw and single screw operation is
st come first serve relay circuit within the controller. Contact TSa is
e AC contactor supplying the Trinistor Amplifier, and de-energizes
ot operating. Armature overload and motor field loss relay
de-energizing MR in case of overload or loss of field.
l pick-up of MR if the generator voltage is high.

pplied to armature contactors BM and FM, clutch
the amplifier. Thus, when MR is de-energized,
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the "both screws" switch is
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Westinghouse

Variable Voltage
SCREWDOWN CONTROLLER

This leaflet describes the basic controller for a variable voltage screwdown system with automatic gauge control (AGC), manual override of AGC, and a Trinistor controlled rectifier regulator amplifier. The screw motors are in a sandwich series circuit and are clutch coupled. They have no brakes. A single operator's station provides for manual control. Single speed control is available for raising or lowering both screws simultaneously, or one screw at a time. Variations of this basic controller consist of multi-speed manual operation, multiple operator's stations, differential leveling, and the addition of brakes. See the reference list at the end of this leaflet for the I. L. designations covering these variations.

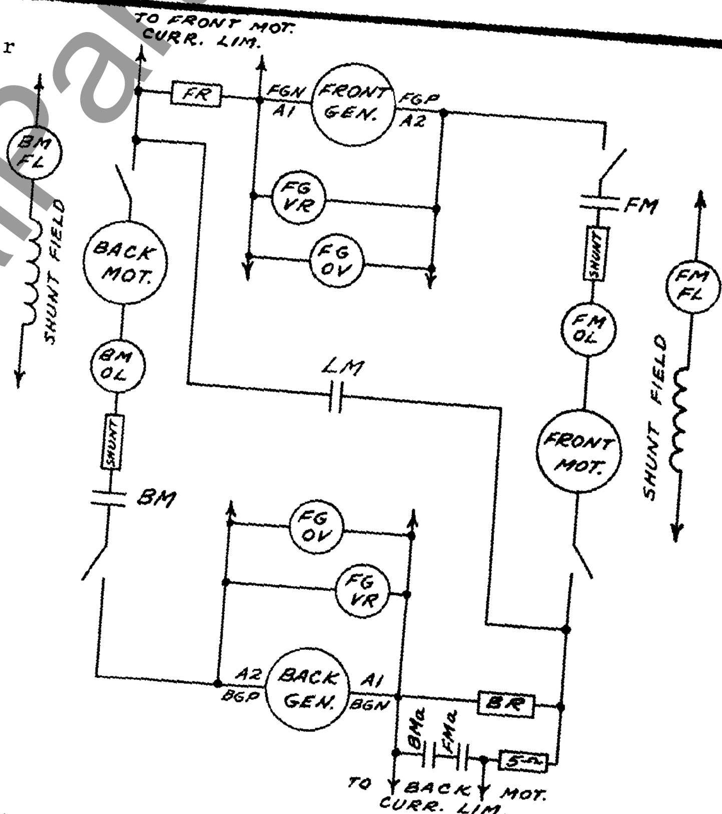

FIG. 1 - BASIC SANDWICH SERIES CIRCUIT

MACHINE CIRCUIT

Figure 1 shows the basic sandwich-series arrangement. Each generator is shunted y a voltage relay set to pick up at approximately 0% of rated voltage, and an overvoltage relay. ach motor circuit contains an overload relay d a set of knife switches for isolation. Each tor field circuit includes a relay for field loss ction.

For "both screw" operation, both the BM and FM contacts are closed, and LM is open. For screw operation, only BM and LM are closed; for front screw operation, only FM and LM are l. Across resistors FR and BR, a small voltage is developed proportional to armature current. oltage operates its corresponding regulator current limit circuit. The signal from BR is shorted ing "both screw" operation to prevent two limit signals from appearing at the regulator at the me. The fields of both generators are controlled by the regulator described later in this

LLER

gure 2 shows the basic controller including the ope
circuit is as follows:

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TABLE 1

TYPE M-2 REGULATORS

Since the calibration panel determines the characteristic of the regulator of which it is a part, the regulator model designation is identical with the calibration panel designation. Typical applications of some of the models are given in the following tabulation.

MODEL	NAME	TYPICAL APPLICATIONS
1100	General purpose Voltage Regulator	Process Line Voltage Regulators Reference Exciter Voltage Regulator Continuous Hot Mill common Bus Generators Voltage Regulators
1200	V.V. Auxiliary Voltage Regulator	V.V. Auxiliary Drives
1300	Reversing Mill Voltage Regulator	Main drive reversing hot mills voltage regulator
1500	High Gain Voltage Regulator	Tandem Cold Mill Voltage Regulator
2100	General Purpose Speed Regulator	Process Line Speed Regulator; Single Stand Cold Mill Speed Regulator
2200	V.V. Auxiliary Speed Regulator	V.V. Auxiliary Drives
2400	High Performance Rectifier Speed Regulator	Continuous Hot Mills with Each Stand powered by an individual Ignitron Rectifier
2500	High Performance Generator Speed Regulator	Continuous Hot Mills with each stand powered by an individual generator
2700	High Performance Motor Field Speed Regulator	Continuous Hot Mills with stand motors supplied by common bus.
3500	Generator Current Regulator	Tension Reels and Bridles that are current regulated by generator or booster voltage control.
3700	Motor Field Armature Current Regulator	Tension Reels and Coilers that are current regulated by motor field control.
4600	General Purpose Motor Field Flux Regulator	To excite and control field of main drive stand and reel motors
4300	Reversing Mill Motor Field Flux Regulator	Main drive reversing hot mill motor Field Regulator
5000	M.O.R. CEMF Regulator	CEMF Regulation of Reel motor by control of reel motor operated rheostat. Rheostat or Flux Regulator must excite motor field.
5600	General Purpose Motor Field CEMF Regulator	Controls Reel Motor CEMF by direct excitation of motor fields.
5700	High Performance Motor Field CEMF Regulator	CEMF regulation of continuous Hot Mill Stand Motor controlled by speed Regulators 2400 and 2500.

TABLE 2

Auxiliary calibration panels are used in conjunction with a primary calibration panel to provide special features for the regulator. They are listed in the following tabulation, to show their application and the primary calibration panel with which each is used. The P model series contains a pre-amplifier; the C model designates auxiliary circuits only, without preamp.

MODEL	NAME	USED WITH PRIMARY CAL. PNL.	APPLICATION
P221	Speed Limit Preamp	3500	Provides thread speed and speed limit for generator current regulated reel drive.
P321	Current Limit Preamp	1200-2200	Provides shaped current limit for V.V. Auxiliary Drives.
P322	Current Limit Preamp	4300	Provides Current Limit for Reversing Hot Mill drives by means of motor field control.
P211	Speed Compensation Preamp	2400-2500-2700	Provides droop, tail end compensation, No-Load overspeed and auxiliary reference windings for loopers, AGC, etc., for speed regulated hot mills.
P311	IR Preamp	1500	Provides IR compensation, Jog and Auxiliary Reference Windings for Tensiometers, AGC, etc., for Tandem Cold Mill Voltage Regulators.
P551	CEMF Preamp	4600	Provides CEMF regulation for generator speed regulated drive thru a motor field flux regulator.- Single Stand Cold Mills.
C311	IR Compensation	1100	Provides IR Compensation for General Purpose generator voltage regulators.
C321	Current Limit	1200-2200	
C322	Current Limit	1200-2200	
C323	Current Limit	1200-2200	
C324	Current Limit	1200-2200	

Special regulator features such as load balance, inertia compensation, speed unbalance, etc. which are not available on standard primary or auxiliary calibration panels, may be added by individual design of a special auxiliary calibration panel to provide the features desired.

An Introduction to

THE M-2 TRINISTOR REGULATORS

The type M-2 line of Westinghouse standard regulators represents a new concept in applying power and regulating systems to all types of mills and processing lines. This conecept evolved from a strong determination to provide reliable, high-performance systems with enough flexibility to meet the production facility requirements of a wide variety of the industries we serve. Drawing from extensive experience in satisfying individual customer requirements, we have merged the latest developments in control components with the reliability of standardized, regulator packages. Each package is pre-wired and pre-tested to insure adherence to rigid performance specifications. The customer advantages of this approach are obvious. Each package maximizes the benefits of individual component development. Each package represents a functional unit of known capability. Each package serves as a large building block for complete control system application.

In all industries, increasing production costs and more insistent demands for better product quality make optimum system performance essential in all production applications. The M-2 modular concept was designed to meet this need. Recent applications, especially in the metal working industries for such systems have substantiated these customer advantages.

ADVANTAGES

of M-2 Trinistor Regulators . . . . .

1. Regulators are completely static.
2. Standardized high gain-fast response Trinistor silicon - controlled rectifiers are used.
3. Power amplifier- power ratings up to 25KW are provided by 3 amplifier designs, using only 2 Trinistor device ratings.
4. Power amplifiers are fully self-protecting.
5. Packaged pulse position modulator (PPM) Trinistor firing circuits have electrically isolated control inputs.
6. Power circuits are electrically isolated by input transformers in each regulator.
7. Converter type power amplifiers provide reverse voltage forcing in unidirectional designs to provide fast response for decreasing output as well as increasing output.
8. Dual converter type power amplifiera provide full reversing output with a single machine field.
9. The new, fast response, 1600 cycle magnetic preamplifier operates on 24 V DC.
10. Standard power amplifiers are combined with a line of standard calibration panels to form regulators for a large variety of uses.
11. Standard designs permit interchangeability of many parts; and facilitate adjustment and maintenance.
12. The inherent high performance of these regulators plus the wide range of adjustment provides unusual ease of adjustment to obtain excellent performance.
13. Each regulator includes excited machine meters as well as signal meters to allow easy observation of performance.

FLEXIBILITY

In order to achieve the flexibility required to satisfy the multitude of diverse applications of our many customers, a unique method of standardizing on functional modules was adopted. Each regulator is made-up of two or more standard sections which together, perform a pre-selected regulating function. The function determining sections are named calibration panels. Table 1 shows these panels. For special features, auxiliary panels are added to the primary calibration panel. These are shown in Table 2. From these listings it is apparant that all regulating functions are satisfied; 90% by pre-tested standard units.

The other main section of the regulator is the Trinistor Power Amplifier. The Trinistor Power Amplifier (T.P.A.) possesses realistic advantages in power gain, better linearity and faster response over existing commercial amplifiers bases on different means of amplification. It forms an ideal partner for the function determining calibration panel. The TPA capability provides a definite size advantage when compared with other static apparatus required to accomplish the same function. For example, since the TPA is operable with 60 cycle supply at all ratings, often this means complete elimination of the 400 cycle equipment installation requirement for higher capacity regulating systems.