IB-26-720-3B-5

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

RESISTANCE WELDING CONTROL

WESTINGHOUSE ELECTRIC CORPORATION
BUFFALO WORKS • RESISTANCE WELDING SECTION • BUFFALO 5, N. Y.

NEW INFORMATION

Westinghouse

ELECTRO-THERMOSTATIC FLOW SWITCH

INSTRUCTIONS

General

Westinghouse has recently developed a new means called an Electro-Thermostatic Flow Switch for detecting the lack of proper cooling water required for adequate cooling of the Ignitron Tubes used in resistance welding or other services. This switch is built primarily for use in Weld-O-Trols and Ignitron Welding Timers. It may also be used for detecting the lack of proper cooling water to any other device having water requirements within the range of the switches listed below.

Theory of Operation

The Electro-Thermostatic Flow Switch consists of a 100 watt transformer having a heavy one-turn secondary short circuited through a piece of high resistance cupro-nickel tubing through which is flowing the water from the Ignitron tubes. A demountable thermo-static switch element makes direct metallic contact with the cupro-nickel tubing. Because of the I^2R loss in the cupro-nickel tubing, the temperature of any given area, A, on this tubing tends to rise to a very high degree but the cooling water flowing through this tubing will keep the temperature at A to some low value.

This heating-cooling combination will cause the temperature at area A to reach some stable equilibrium level, depending upon the watts input to the transformer, the resistance of the cupro-nickel tubing, the inlet water temperature and the rate of inlet water flow to the cupro-nickel tubing. Two of these variables are definitely fixed—, i.e.—watts input to the transformer and resistance of the current path through the cupro-nickel tubing. Then the other two variables will determine the temperature at area A on the cupro-nickel tubing.

For example, suppose water at 30° C. is flowing through the cupro-nickel tubing at a rate of 1½ gallons per minute. Assume that the temperature at area A is stabilized at 40° C. and that a thermostat in contact with this area is calibrated to trip at 46° C. Now suppose that the water flow drops to ¾ gallon per minute. The temperature at area A will rise to say 50° C., and in a short time this higher temperature will trip the thermostat which opens up the control circuit of the Ignitron Tubes, thereby preventing further operation of these tubes until proper water flow has been reestablished.

It is readily seen that if the inlet water to the cupro-nickel tubing is less than 30° C., a lower rate of water flow can be permitted before reaching the tripping temperature level of the thermostat. No mechanical switch has ever made this automatic compensation for water temperature.

Descriptive Information

The Electro-Thermostatic Flow Switch transformer is designed for use in single phase alternating current circuits of voltage and frequencies as given in Table 1. The minimum inlet water flow in gallons per minute, and the maximum inlet water temperature are also given in this table.

When ordering Electro-Thermostatic Flow Switches, order by style number. If it is desired that the separately mounted flow switch be protected from mechanical injury or from unauthorised tampering, order the style number with enclosure. The space required for mounting the electro-thermostatic flow switch is approximately 7″ wide by 9″ high by 7″ deep, for 60 cycle switch plus additional space for rubber hose connections. The rubber hose should have an ID of ⅜″ and preferably an OD of ⅝″.

Physical dimensions of new Electro-Thermostatic Flow Switches are greater than the more commonly used mechanical design switches.

The new switch transformer has two windings, each for 220 volts. Connect in series for 440, or in parallel for 220. See Figure 1 and Figure 2. For other line voltages an autotransformer is required. Refer to the nearest Westinghouse District Office.

The demountable thermostatic switch element is included in the style number flow switches given in Table 1. Replacement thermostatic switch element for these style switches is S#1264242. To prevent excessive tightening of the moulded switch element to its position on the transformer the spring-mounting furnished with the thermostat **must** be used.

The normally closed 2-pole thermostatic switch element is rated 530 volts, 3 amperes. One set of contacts in the thermostat is connected directly in the ignitor circuit of the ignitron tubes, or in the control circuit to these tubes. The other set of contacts is in series with the primary winding of the Electro-Thermostatic Flow Switch Transformer to open this circuit and thus prevent excessive heating of this transformer during water failure. See Figure 1 and Figure 2. This thermostat will open and close cyclically about every 5 minutes as long as power is on the transformer and the water supply has stopped. Therefore, it is recommended that the power circuit breaker be opened before turning off the water supply to the tubes. Figure 4 shows the spring mounting for the thermostatic switch element.

Figure 3 shows a top view of Electro-Thermostatic Flow Switch. This facilitates customer connections.

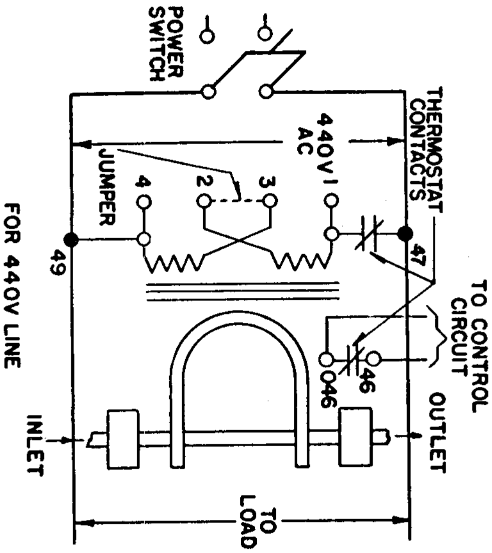
TABLE 1

STYLE NO.	WITH OR WITHOUT ENCLOSURE	FREQ. CY. PER SECOND	VOLTAGE	MAX. WATTS INPUT	CALIBRATED AT: MIN. GAL. MIN. FLOW	MAXIMUM WATER TEMP. OF °C.	°F.
1428199	without	50/60	220/440	110	1½	30	86
1429230	with	50/60	220/440	110	1½	30	86
1449101	without	25	220/440	110	1½	30	86
1449102	with	25	220/440	110	1½	30	86

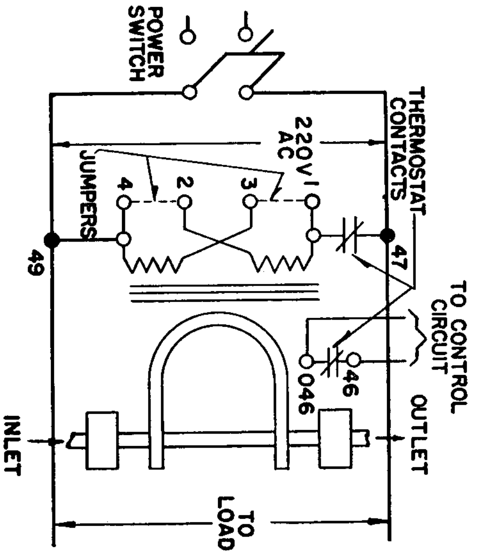
Replacement Thermostat for Any of Above—S#1 234 242.

(Over)

FLOW SWITCH OUTLINES



FOR 440V LINE
Fig. 1



FOR 220V LINE
Fig. 2

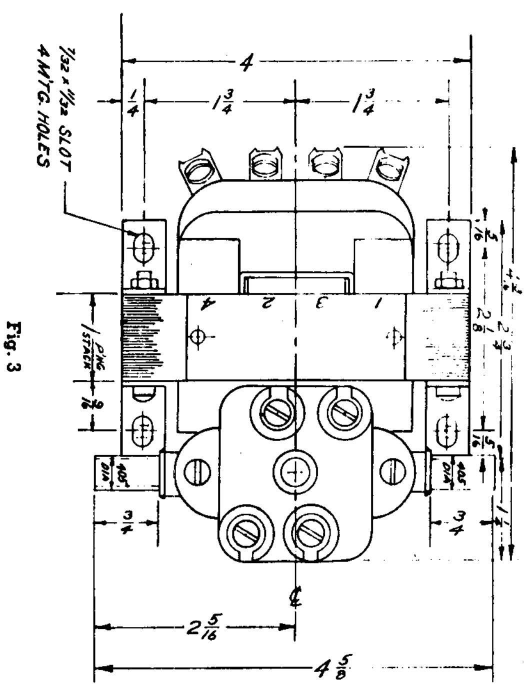


Fig. 3

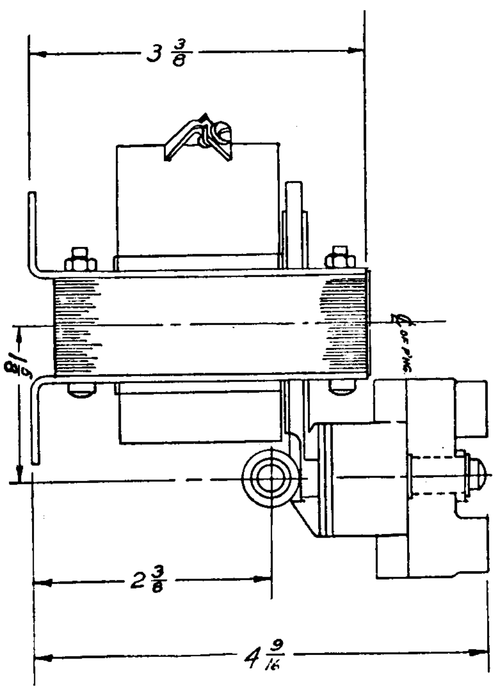


Fig. 4

Westinghouse Electric Corporation
Buffalo, New York

Printed in U. S. A. (12-46)

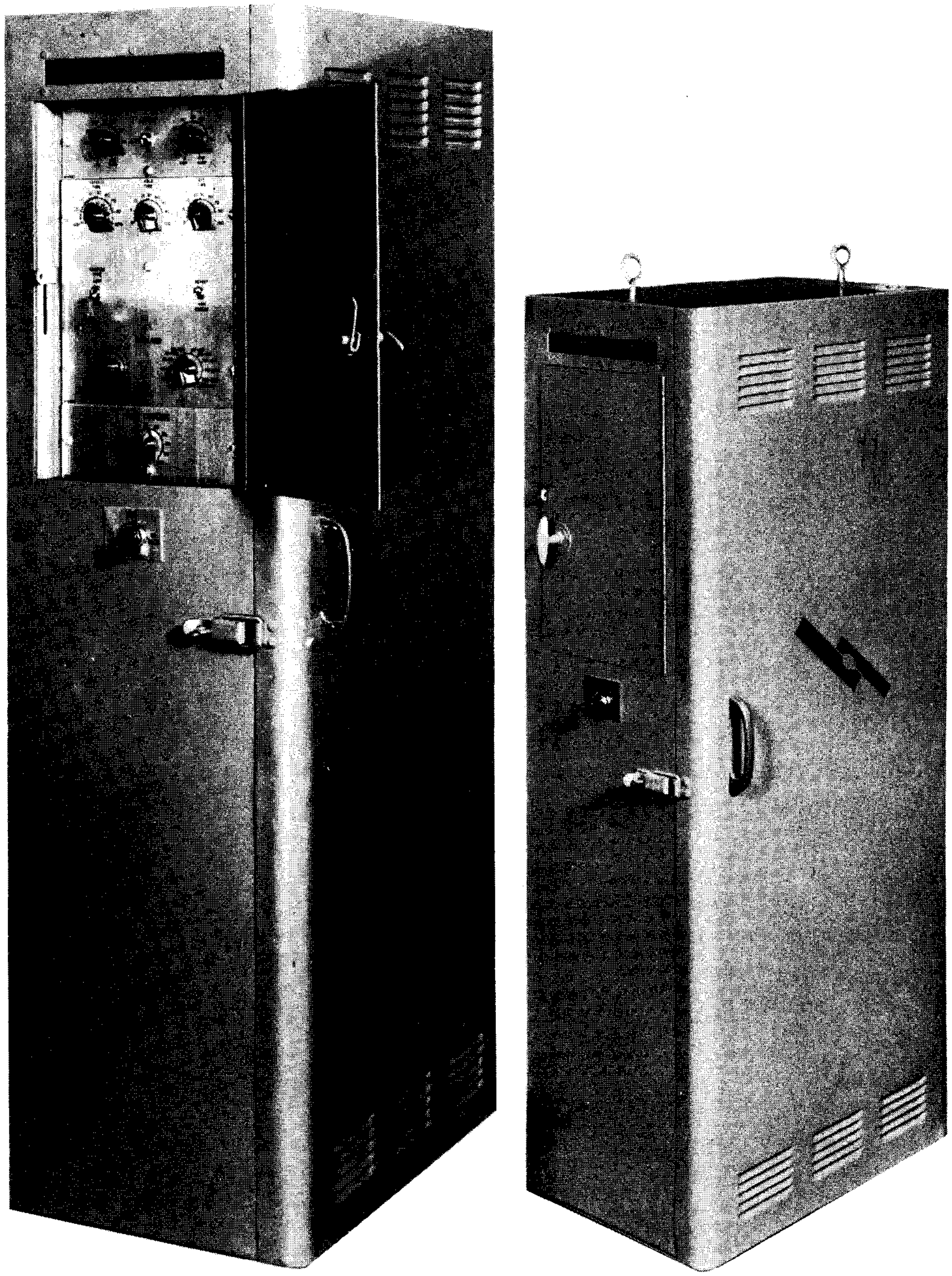


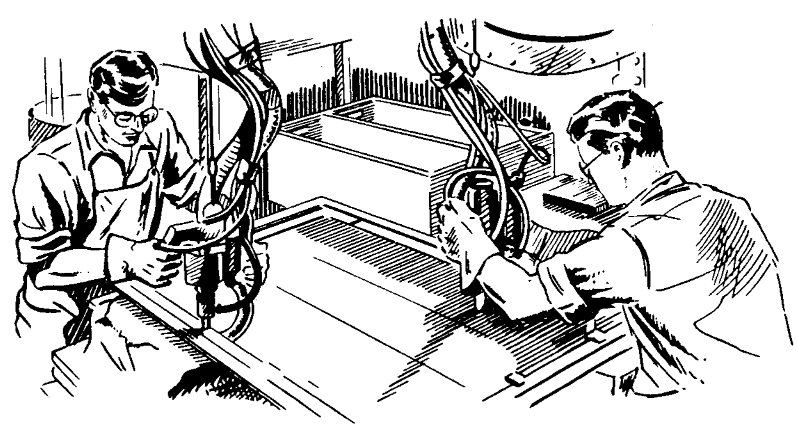
Figure 1 Standard Combination Control.

RESISTANCE WELDING CONTROL

Specialized electronic controls for resistance welding have provided a degree of accuracy and timing which was previously impossible to achieve. New materials can now be welded, and the process improved on others such as steel by producing welds of uniform strength and soundness.

The standard controls for resistance welding covered by this instruction book have been designed as elements of uniform appearance which fit into a standard framework. With the Weld-O-Trol as the base or power unit, assemblies of the various controls are built into a cabinet which can be either mounted on the side of the welder or placed nearby on the floor or wall. The control dials are all located on the front of the units.

A variety of auxiliary controls is available. By adding these to the standard combinations, controls for special welding problems are easily obtained. Factory wiring and testing reduce the installation cost, while the floor space occupied by the cabinet is about one-half that required for unmatched units.



DESCRIPTION

Resistance welding controls are electronic devices designed to sequence and time the pressure and weld functions and/or control the magnitude of the welding current of a resistance welding machine.

The controls are divided into three basic functional components:

1. The electronic contactor, or Weld-O-Trol, is a single-pole electronic switch in series with the primary of the welding transformer. Its sole function is to start and stop the welding current at the desired times. Capable of extremely rapid action, this contactor has no moving parts and requires little attention.

2. The sequence weld timer controls the sequence and timing of the mechanical actions of the resistance welding machine as well as the timing of the welding current.

3. The heat control gives stepless adjustment of the welding current. It contains gas-filled electronic tubes which delay the closure of the electronic contactor a pre-set time each half-cycle. The greater the delay, the lower the effective value of the welding current. The heat control and the sequence weld timer together control the pilot circuit of the electronic contactor.

In certain types of welding, where the precise control furnished by the heat control is not necessary, only an electronic contactor and a sequence weld timer are required. The magnitude of the welding current is adjusted by tap switches on the welding transformer.

Where the sequence and timing of the mechanical actions and timing of the welding current is accomplished by means of motor-driven cams, sequence weld timers are not needed.

Combinations of these three basic units are available in a considerable variety as shown in the table at the bottom of the page.

These combination controls are designed for mounting either on the side of the welder on the floor, or on the wall. The adjustment panels may be removed for remote mounting.

POWER SUPPLY VOLTAGE AND FREQUENCY

Standard controls are built for operation on 230/460 volts. The frequency for which the control is designed is stamped on the nameplate. Since some line voltages differ from the nominal 230 or 460 volts, voltage taps are provided on the control circuit transformer to permit adjustment for any power supply voltage which is within the range of plus or minus 10 percent from the nominal value. The control is designed to operate on voltages which do not at any time vary more than plus or minus 10 percent from the value for which the control is adjusted.

STANDARD COMBINATIONS — 600 VOLTS OR LESS

Control Type	WELDING CONTACTOR		TIMER		REGULATORS		
	Electronic	Magnetic	Sequence Weld 3-B	Sequence Weld 5-B	Heat Control	Voltage	Current
N1H	X				X		
N1C	X				X		X
N1V	X				X	X	
N2	*	*	X				
N2H	X		X		X		
N3	*	*		X			
N3H	X			X	X		

*Either, not both

Syn. Precision Control Type	TIMERS: Electronic Contactor	TIMERS: Synchronous Weld	TIMERS: Seam Weld	TIMERS: Pulsation Weld	TIMERS: 7-B Sequence	TIMERS: 9-B Sequence	REGULATORS: Heat Control	REGULATORS: Voltage	REGULATORS: Current
S1H	X	X					X		
S2H	X	X			X		X		
S2C	X	X			X		X		X
S2V	X	X			X		X	X	
S3H	X	X				X	X		
S3C	X	X				X	X		X
S3V	X	X				X	X	X	
S4H	X		*	*	X		X		
S4C	X		*	*	X		X		X
S4V	X		*	*	X		X	X	
S5H	X		X				X		
S5C	X		X				X		X
S5V	X		X				X	X	

*Includes selector switch to change from seam to multi-impulse welding.

STANDARD COMBINATIONS — SYNCHRONOUS PRECISION CONTROLS 2300 VOLTS

Syn. Precision Control Type	TIMERS: Electronic Contactor	TIMERS: Synchronous Weld	TIMERS: Seam Weld	TIMERS: Pulsation Weld	TIMERS: 7-B Sequence	TIMERS: 9-B Sequence	REGULATORS: Heat Control	REGULATORS: Voltage	REGULATORS: Current
HS1H	X	X					X		
HS2H	X	X			X		X		
HS2C	X	X			X		X		X
HS2V	X	X			X		X	X	
HS3H	X	X				X	X		
HS3C	X	X				X	X		X
HS3V	X	X				X	X	X	
HS4H	X		*	*	X		X		
HS4C	X		*	*	X		X		X
HS4V	X		*	*	X		X	X	
HS5H	X		X				X		
HS5C	X		X				X		X
HS5V	X		X				X	X	

*Includes selector switch to change from seam to multi-impulse welding.

INSTALLATION

RECEIVING

Care in uncrating is necessary in order not to damage the unit.

Inspect the controls for any damage in shipment and report it within 10 days to the transportation company for adjustment.

To remove the shipping hardware, open the main door and remove three shipping bolts, one located at the top left side and two at the bottom of the panel frame. The three shipping bolts are tagged for easy location. Rotating the handle at the bottom frame 90° will then allow panel frame to be swung outward for access to the connection panel.

To remove the panel frame from the cabinet; remove the plugs from the connection block, remove the cable clamps from the back wall of the cabinet, swing the panel frame outward 90°; grasp the panel frame firmly top and bottom, lift upward and pull outward on the bottom of the frame. When the panel frame is free from the lower pivot, lower the frame slightly to clear the top pivot. To insert, reverse the procedure.

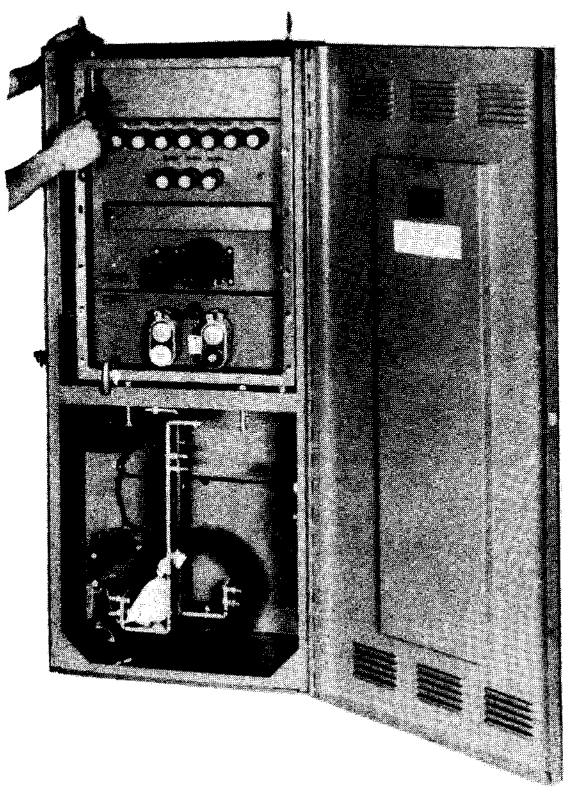


Figure 3 Removal of Shipping Bolts.

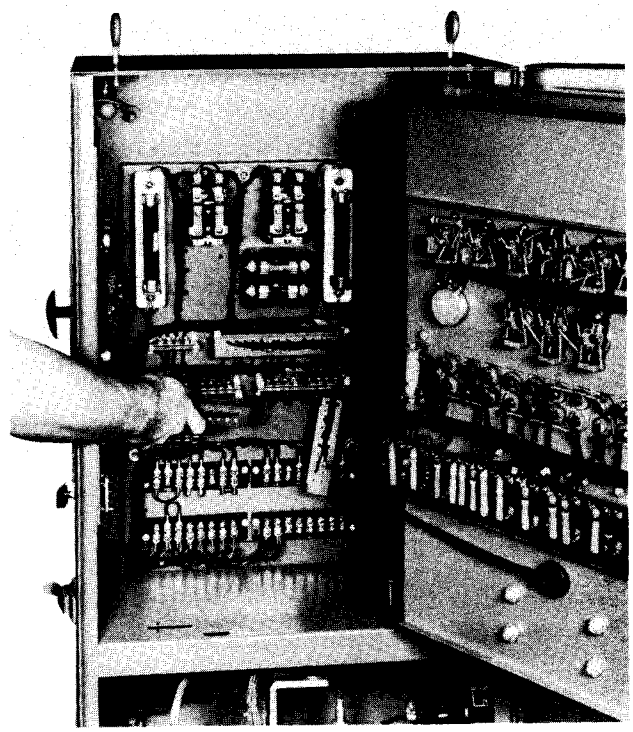


Figure 4 Removal of Connection Plugs.

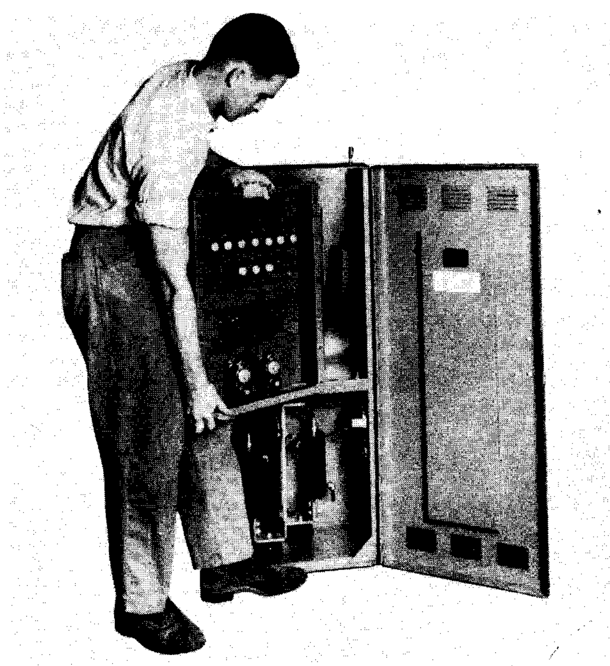


Figure 5 Removal of Panel Frame from Cabinet

THYRATRONS

If heat control is used, the large thyratrons are shipped in separate cartons in the bottom of the cabinet. Care should be exercised in unpacking and installing them in the sockets. Do not attemp to twist the glass envelope when inserting in or removing from the socket.

MOUNTING THE CONTROL

The control is desgined for mounting either on the right side of the welder, on the wall or on the floor. Preliminary consideration is necessary to provide the correct water connections and installation of control and power leads. Read the sections on these items before beginning to install the control.

A drill template can be made from the outline drawing supplied with the unit. Place the front of the control as close to the front of the welder as practical. If the welder housing is not long enough to accomodate both of the mounting holes, extension brackets must be provided by the customer.

IMPORTANT: If vibration is present in the mounting, See I.L. 4993 in back of book.

POWER CONTROL LEADS AND BREAKERS

Bring the power leads into the cabinet through the three-inch knock-outs on the side, at the rear or at the top of the control. If the control is side mounted, clearance holes in the side of the welder must be provided in each case as shown in the drilling plan.

Control leads should be No. 14 stranded wire with 600 volt insulation.

Select size of power leads from tables in the supplementary data of this book.

A separate breaker in the control supply line is not recommended. However, if one is required, Westinghouse breaker S #1040456 with S #966480 heater is recommended.

CAUTION: If a switch or breaker in the control supply is used, the cabinet bus and wiring will still be energized after this line is opened if the main power supply is not disconnected.

A breaker or fused disconnect switch of the correct rating is essential in the power supply circuit of every welding machine for proper protection of the ignitron tubes. The correct breaker or fuse can be chosen from charts in the supplementary data of this book.

FOOT SWITCH CONNECTIONS

The standard control is provided with connections for single position low voltage foot switch. To install the two position low voltage foot switch remove jumper FS1 - FS3 and make connections as shown on the connection diagram to the proper foot switch.

FORGE TIMER PANELS

For applications such as welding aluminum, special alloys and some projection welding, it is desirable or necessary to forge the weld in the welding machine. An a-c forge timer or precision d-c forge timer is available for such applications.

The forge timer provides a contact to energize the forge solenoid of the welding machine at a preset time after the start of the weld. The range in the forge timer is sufficiently great to allow. forging during either the weld or hold periods.

The a-c forge timer may be mounted in the place of the blank panel provided in the standard type of control. The d-c forge panel requires a cabinet greater in height.

TEMPER SEQUENCE WELD TIMER

When it is desired to weld at one value of current and time, then afterward heat treat the weld at another value of current and time, a built-in tempering sequence weld timer can be supplied to do this automatically. Such tempering is frequently required when welding NAX steel, high carbon steels and special alloy steels. This attachment may also be used when functions of pre-heat and weld at different currents and times are desired. The use of pre-heat is frequently desirable in welding special alloy steels and/or scaly mild steel.

SLOPE CONTROL

Electrode life when welding either aluminum or scaly or dirty steel can be materially increased by the use of a slope control. This control starts the welding current at a low value allowing it to increase until it reaches the desired welding current in a pre-set time. Starting with a low value of current allows the electrodes to attain more intimate contact with the work piece so that spitting and tip pickup will not result when the full welding current is applied. This panel may be mounted in the blank panel space of the standard controls.

DUAL WELD TIME AND/OR DUAL HEAT ADJUSTMENT

Welded assemblies are frequently encountered having more than 1 combination of thicknesses necessitating the change of welding time during the welding of the assembly. To avoid the time consuming process of the operator making these settings for each assembly, the dual weld time attachment may be supplied. With this attachment it is possible to present two weld times either of which may be selected at will be the operator. This can be accomplished either by a selector switch or two operating switches available to the operator. In many welding operations dual heat as well as dual weld time is frequently needed. Two values of heat may be preset and selected in the same manner as the dual weld time. These are separate attachments which may be mounted at any spot convenient to the operator.

TI-MATIC PANEL

The Ti-Matic panel makes it possible for three weld times to be preset and automatically selected by the thickness of the joint. This frees the operator from the necessity of operating a transfer switch, making it only necessary for him to position the work and operate the pilot switch. The Ti-Matic panel may be installed in a standard type cabinet.

METER PANELS

A built-in panel containing a pointer stop ammeter, and a range selector switch can be provided to enable the customer to see the value of the current each time a weld is made. A current transformer to be mounted by the customer is provided with this panel. This panel may be installed in the blank panel space in a standard type cabinet.

CURRENT REGULATOR

If the welding current varies due to changing conditions such as insertion of magnetic material into the throat of the welding machine, a built-in regulator can be supplied to keep the current essentially constant. Heat control is required. The addition of the current regulator requires a cabinet greater in height than a standard type cabinet.

VOLTAGE COMPENSATOR

If the welding current varies due to line voltage variation, a built-in voltage compensator can be provided to keep the current essentially constant. Heat control is required. The voltage compensator can be added in the 4½ inch blank panel space in the standard cabinet.

HEAT CONTROL

Heat control can be added to any standard non-synchronous timer by simply removing the panel containing the rector rectifiers, replacing with a heat control panel and installing the heat adjustment panel in place of a blank name plate. No other change is necessary.

IGNITRONS

Mount ignitrons, which are shipped separately, to the bus with the hardward provided. Make certain that the tubes are absolutely vertical and that the bolts are pulled up tightly.

IMPORTANT: Handle the ignitrons carefully as violent motion of the mercury in the tube may damage the ignitor, making the tube worthless.

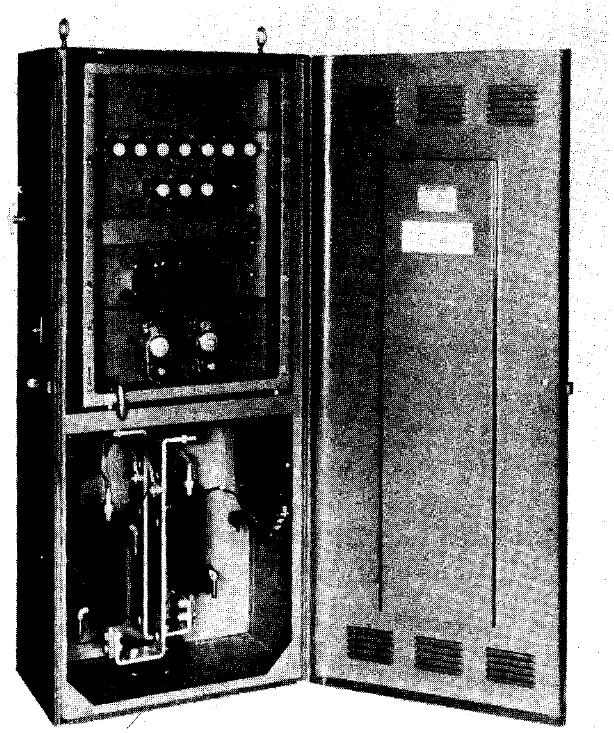


Figure 6 Mounting of Ignitrons.

WATER CONNECTIONS

Water connections for the ignitron tubes are brought in through the left side, the rear or the bottom of the lower cabinet. Use one-half inch pipe. Two feed through water coupling are provided and are shipped in the electronic contactor cabinet with the necessary hose connections. After the desired water coupling knock-outs are selected, the couplings are installed in these holes.

If the control is side-mounted and the water connections made on the left side, a clearance hole must be cut in the side of the welder as shown on the outline drawing furnished with the unit. These connections must be made exactly as shown. The direction of flow is shown on the connection diagram.

The temperature of the outlet cooling water must not exceed 40°C. The rate of flow of cooling water for the various size ignitrons is shown below. This rate of flow must be maintained whether the tube is used at full or part load.

Size A — 1½ gal/min.
Size B — 1½ gal/min.
Size C — 1½ gal/min.
Size D — 3 gal/min.

In some localities where the water is soft, the city water supply may be used. If the water contains more than 250 parts of solids by weight per million of water, it should be softened or a heat exchanger system provided with some visual means of checking water flow. If this is not done, the ignitron cooling jacket must be cleaned frequently.

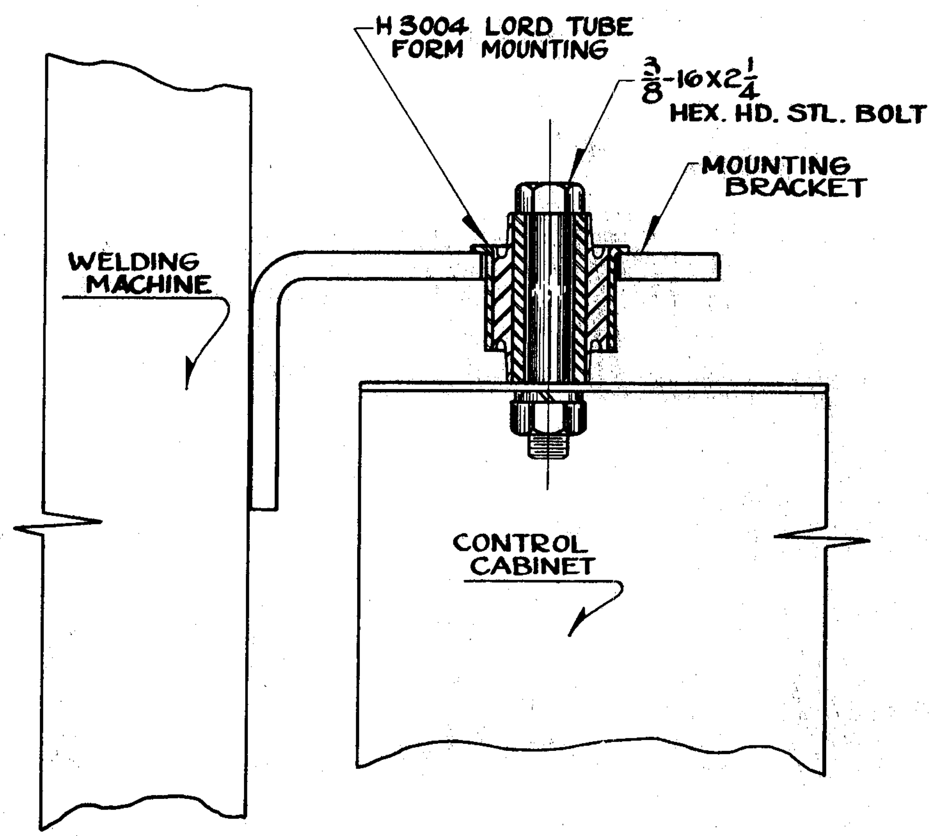
VIBRATION

The control cabinet has been designed for great rigidity and the industrial components in this control have been chosen to withstand severe vibration. However, in some cases severe vibration and impact may cause maloperation of the ignitron or relay. It may also drastically shorten control tube life.

To correct this difficulty, consult the welding machine manufacturer for elimination of the vibration. This can frequently be done by adjusting the air-speed control' valve, or adjusting the cushioning valve of the main cylinder.

In case the vibration cannot be eliminated, it is recommended that the user shock mount the control by the method shown below. At least three points of support should be provided.

The rubber mounting may be obtained from the Lord Manufacturing Company, Erie, Pennsylvania.

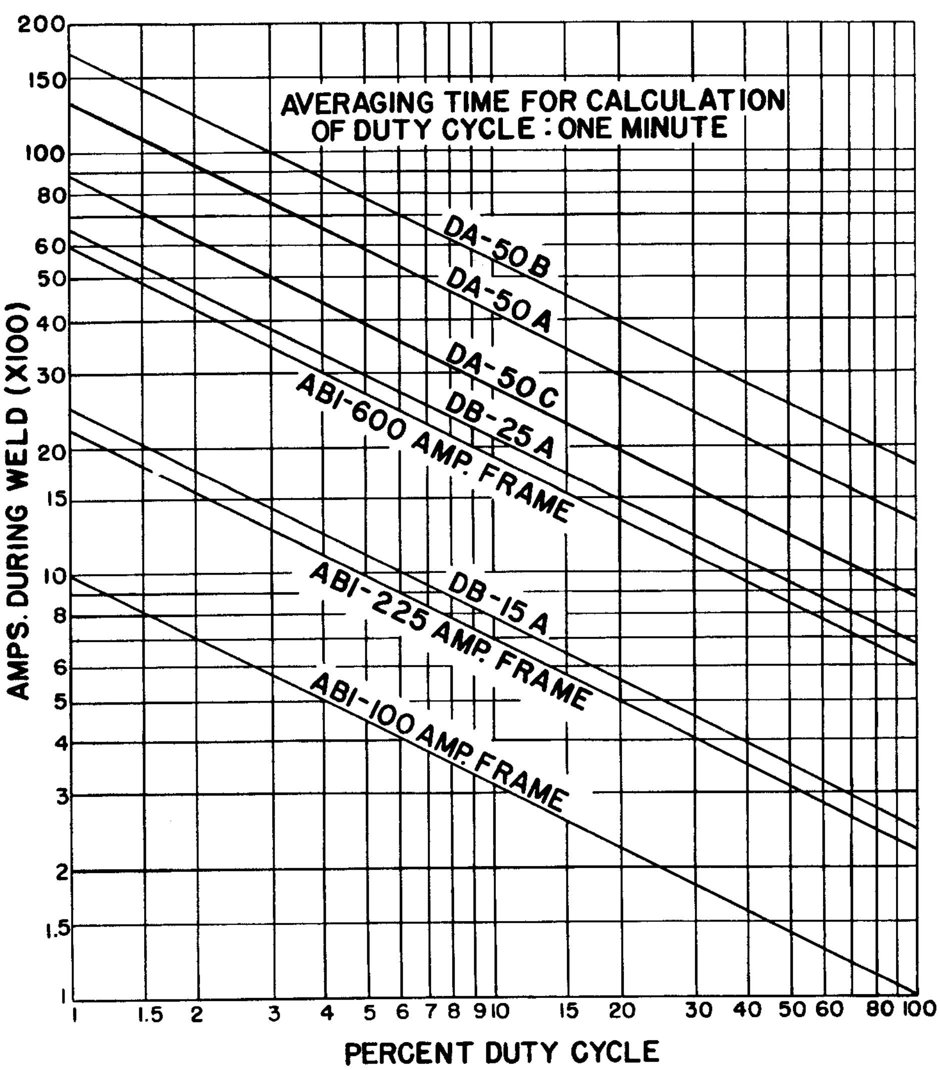


CONTROL CABINET WITH LORD SHOCK MOUNTING

BREAKER TABULATIONS

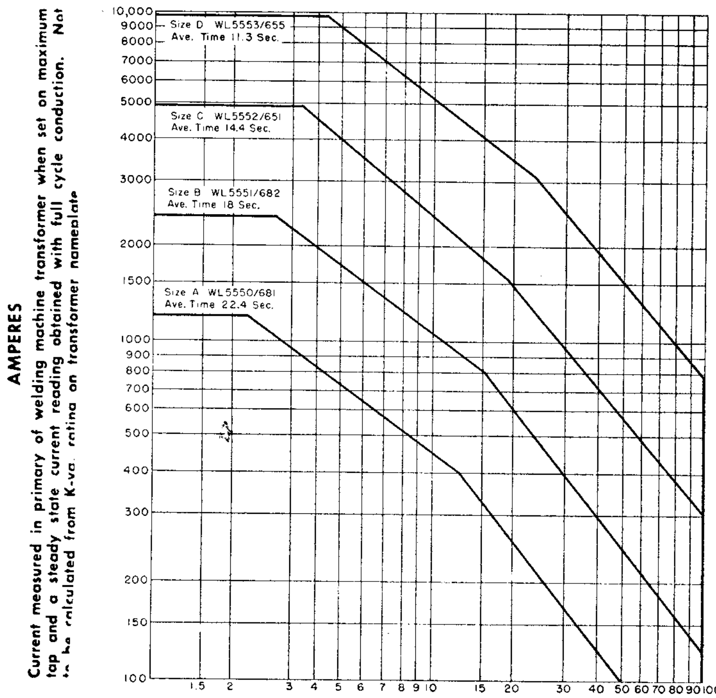
Type of Breaker	Interrupting Rating	Trip Calibration Range	Name Plate Cont. Rating Amps	Volts
DB-15A	15,000	900-3400	225	600
DB-25A	25,000	2500-9000	600	600
DA-50-C	50,000	4000-12000	800	600
DA-50-A	50,000	6000-18000	1200	600
DA-50-B	50,000	8000-24000	1600	600
ABI-100	15,000	450-1500	100	600
ABI-225	15,000	900-3400	225	600
ABI-600	25,000	6000	600	600
ABI-600	25,000	9000	600	600

BREAKER THERMAL RATING CURVES



IGNITRON TUBE PERFORMANCE DATA SHEET

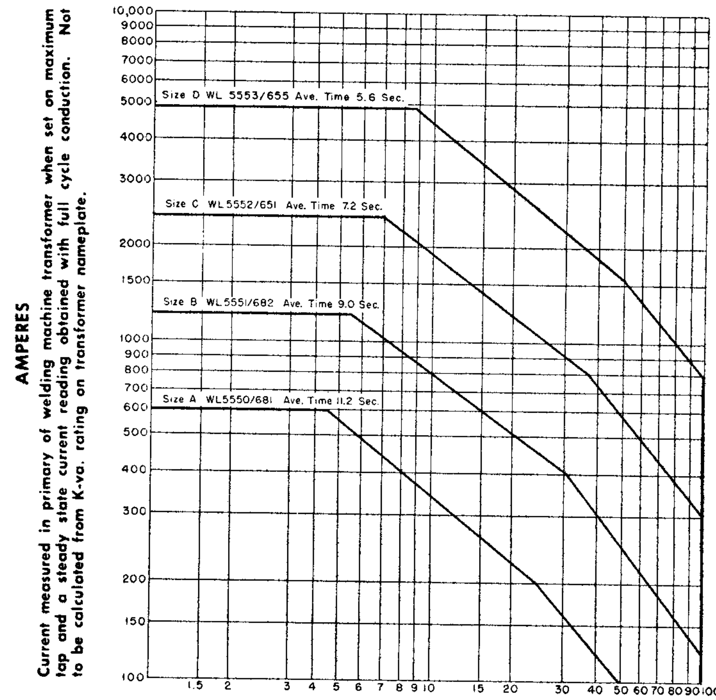
IGNITRON TUBE RATINGS FOR TWO TUBES
200-250 VOLTS • 25 TO 60 CYCLES



IGNITRON TUBE DUTY CYCLE — PERCENT
The maximum duty cycle permissible within the averaging time given for each tube.

Figure 1.

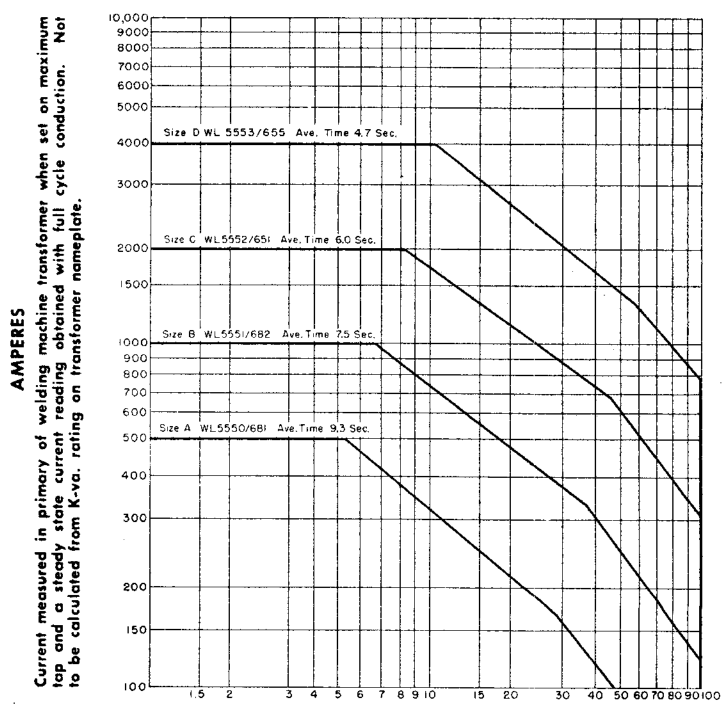
IGNITRON TUBE RATINGS FOR TWO TUBES
400-500 VOLTS • 25 TO 60 CYCLES



IGNITRON TUBE DUTY CYCLE — PERCENT
The maximum duty cycle permissible within the averaging time given for each tube.

Figure 2.

IGNITRON TUBE RATINGS FOR TWO TUBES
501-600 VOLTS • 25 TO 60 CYCLES



IGNITRON TUBE DUTY CYCLE — PERCENT
The maximum duty cycle permissible within the averaging time given for each tube.

Figure 3.

III

SELECTING CORRECT TUBE SIZE

The performance data curve sheets Fig. 1 to 6, pages 5 and 6 show the tube characteristic for the various size ignitron tubes. Information required for using these curves is as follows.

* 1. During Weld K.V.A., or During Weld Current in Amperes.
2. Welder Supply voltage.
* 3. Per Cent Duty Cycle.

Sample calculations:

Example 1.

During Weld Current = 1200 amperes

Weld time = 30 cycles

Total off time = 30 cycles

Welder supply voltage 460 volts

$$\text{Per cent Duty Cycle} = \frac{30 \times 100}{30 + 30} = 50\%$$

Refer to performance data sheet for 400-500 volts. The point at 50% duty cycle and 1200 amperes falls within the range of the size D tube #5553.

The total time for one complete welding operation (60 cycles) is well within the 5.6 sec. averaging time for this tube; therefore, the size D tube is the correct size for this installation.

* See qualification of curve sheets and terms on page 1-IL. 5007.

USE OF RESISTANCE WELDING FUSE RATING GRAPH

To determine the proper fuse rating, the demand current and duty cycle at which operation is desired should be known.

The duty cycle may be obtained by calculating the ratio of total welding current conducting time to the weld period. If the weld period is more than 10 seconds, the duty cycle is the ratio of the total welding current conducting time to 10 seconds.*

The Demand current is actual measured transformer primary current at 100% heat setting for full sine wave conduction.

Sample calculations:

Example 1 — Demand current = 1000 amps.
Duty Cycle = 20%

$$\text{Ratio } \frac{\text{I at .1 sec.}}{\text{I at 1 sec.}} = 2.8$$

Enter the curve sheet at 1000 amps and 20% duty cycle. The curve sheet shows that a 400 ampere fuse is the closest fuse rating for this application.

Example 2 — Demand current = 750 amps.
Weld time = 7 seconds
Off time = 5 seconds

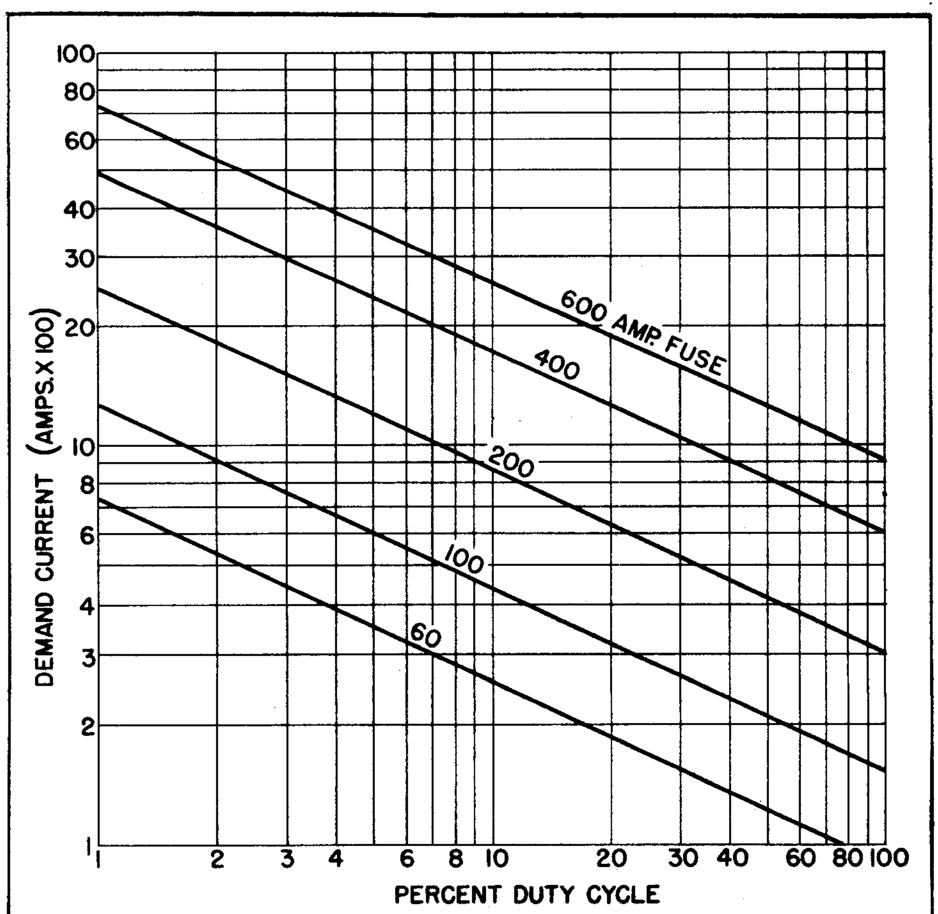
$$\text{*Ratio } = \frac{\text{I at 1 sec.}}{\text{I at .1 sec.}} \quad 3.0$$

On time plus off time here exceeds the averaging time of 10 seconds so,

$$\text{D.C.} = \frac{\text{on time}}{10} = \frac{7}{10} = .7$$

Entering the curve sheet at 750 amps and .7 duty cycle, we find that a 600 amp fuse is needed for this application; however, the 400 amp fuse comes close to meeting the requirement. The ratio of I to blow in .1 sec. to I to blow in 1 sec. is greater than 2.8 for the fuse being used. Under these conditions a fuse of slightly lower rating than that indicated by the curves could be used and the 400 amp fuse would probably fulfill the requirements.

*For discussion of averaging times and duty cycles and current ratios, see page 1, I.L. 5007.



SELECTION OF POWER SUPPLY LEADS FOR WELDING MACHINES

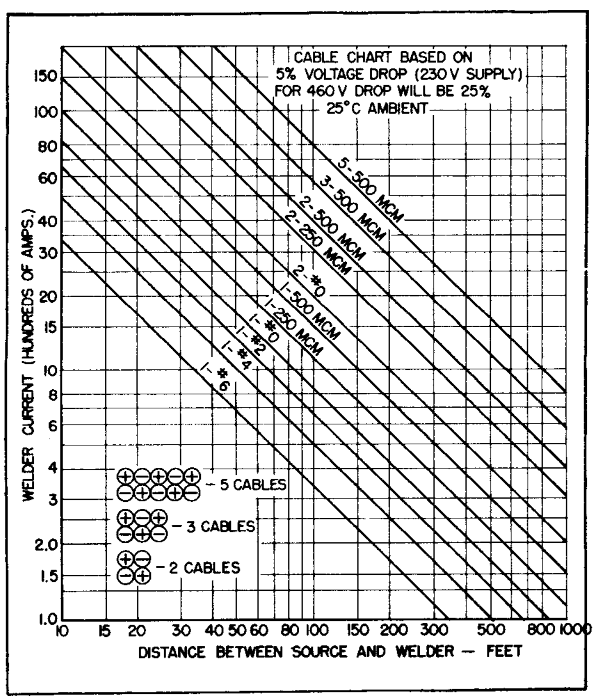
The accompanying charts will serve as a guide in selecting the proper number and size of power supply cables for welding machines.

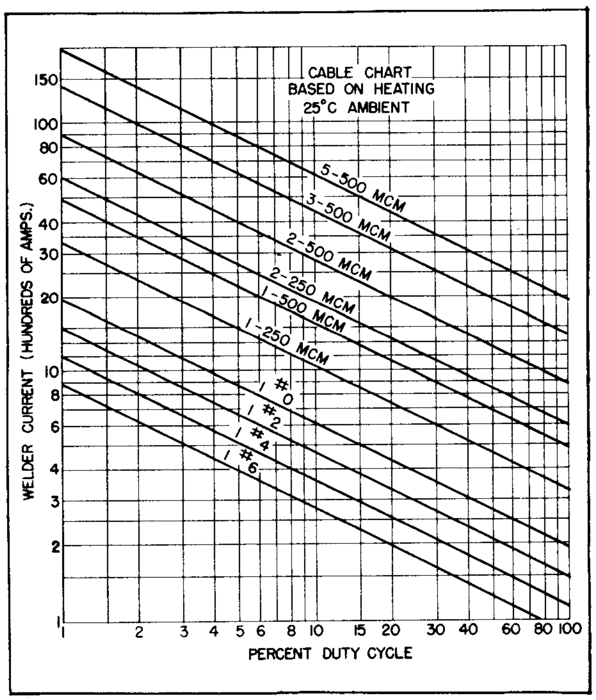
In order to use these charts, the demand current, duty cycle and the distance in feet from the power source to the welder must be known. Cable size must be checked in two ways. Using welder demand current and the distance between source and welder, a cable size can be determined from figure 1. Using welder demand current and percent duty cycle, a cable size can be determined from figure 2. The larger of these two cables should be used.

Figure 1 is based on a 5 percent regulation for a 230 volt supply and a 2.5 per cent regulation for a 460 volt supply. If it is desired to select leads to give a different percent regulation, this may be done by proportioning the percent regulation and welder current, i.e., to select conductors for a 5 per cent drop on 460 volt supply, choose conductors based on one half the welder current. Selection from figure 2 must still be based on the full welder current.

CAUTION: These charts include only the regulation of the supply leads. The overall regulation must include the regulation of the power source.

These charts are tentative and are subject to change to conform with standards now pending.





SELECTION OF POWER SUPPLY LEADS, FUSES, CIRCUIT BREAKERS AND ELECTRONIC TUBES FOR RESISTANCE WELDING APPLICATIONS.

This section groups together the information data and curve sheets required in making calculations for a Resistance welding installation.

QUALIFICATION OF CURVE SHEETS AND TERMS USED THROUGHOUT THE SECTION

Per cent Duty Cycle is defined as the ratio of the "weld time" to the sum of the weld time off time. "Off time" here is the total time between welds, that weld current is not flowing.

$$\frac{\text{Weld time} \times 100}{\text{Weld time} + \text{off time}} = \%\,\text{D.C.}$$

where the weld time + off time must not exceed the averaging time for the tube or fuse.

Averaging Time is a function of the thermal capacity of a body. Obviously the thermal capacity for fuses and tubes will differ through wide limits; therefore, their averaging time will also differ. The curve sheet for fuses was constructed on the basis of a 10 second averaging time.

The averaging times for electronic tubes vary from type to type and for different operating conditions on a given type. The Averaging time for an electronic tube is given on its respective performance data sheet.

THE "DURING WELD" K.V.A. OR "DURING WELD" CURRENT

These quantities can not be determined from the welding machine or welding transformer name plate data. They should be either measured on the welding set-up or obtained from the welding machine manufacturer.

FUSE CURVE SHEET

Because of the wide range of characteristics of fuses as supplied by different manufacturers it is impossible to plot a single curve sheet to give accurate data for all makes of fuses. The curve sheet in this section was constructed to give accurate results for fuses having characteristics most representative of all available fuses.

For greatest accuracy in selecting fuses from this curve sheet, a type fuse having the following current-time relationship should be used:

$$\frac{\text{Current required to blow fuse in .1 sec.}}{\text{Current required to blow fuse in 1.0 sec.}} = 2.8$$

The two terms in the above equation can be obtained from the current time curves for the fuse being used or it can be supplied by the fuse manufacturer.

When a fuse having a ratio other than the 2.8 ratio shown above is used, the value obtained from the curve should be adjusted accordingly. Fuses having a ratio greater than 2.8 should have a slightly lower rating than that specified by the curve sheet. When the ratio is less than 2.8, it should be higher than the value specified by the curve sheet.

c. Blocking 1TU de-energizes 1CR and thereby solenoid valve.
d. Blocking 2TU allows 3TU and 4TU to fire.
e. Firing 4TU charges 19C, blocking 5TU.
f. Blocking 5TU allows voltage on 20c to decay, 7TU fires.
g. Firing of 7TU charges 21C, locking off 6TU, and charges 23C, blocking 9TU.
h. Blocking 9TU allows voltage on 22C to decay, firing 10TU.
i. Firing 10TU charges 24C, blocking 11TU.
j. Blocking 11TU allows hold time circuit to start timing.

6. At end of hold time, 1TU and 2TU fire, repeating sequence.

IF CONTROL IS SET FOR NON-REPEAT:

b. Charging 11C blocks 1TU.
c. Blocking 1TU de-energizes 1CR, and thereby solenoid valve.
d. Control is then locked in this condition until foot switch is released.
e. Releasing foot switch applies bias from 18C to 2TU, blocking 2TU.
f. Blocking 2TU allows 3TU and 4TU to fire.
g. Firing 4TU charges 19C, blocking 5TU.
h. Blocking 5TU allows voltage on 20C to decay, 7TU fires.
i. Firing of 7TU charges 21C, locking off 6TU, and charges 23C, blocking 9TU.
j. Blocking 9TU allows voltage on 22C to decay, firing 10TU.
k. Firing of 10TU charges 24C, blocking 11TU.
l. Blocking of 11TU allows voltage on 18C to decay. Circuit is now re-set.

Two Position Foot Switch Operation:

As shown in Figure (5), provision is made for either single or two position low voltage foot switch operation.

When a single position switch is used, its closure results in bias being removed from the shield grids of both 1TU and 2TU. This fires both tubes simultaneously causing squeeze timing to begin at the same time the welding heat begins to lower.

When a two position switch is used, closure of the first position removes the bias from the shield grid of 1TU only. 1TU fires energizing the solenoid valve relay and the welding head lowers and builds up pressure. Closure of the second position; removes the bias from the shield grid of 2TU causing to fire and initiate squeeze timing.

Tip Dress Operation:

When the control is set for tip dress operation; the welding electrodes are brought together under full operating pressure when the foot switch is closed and are released when the foot switch is opened.

SPOT WELDING SEQUENCE CONTROL

Basic Operation of Timing Circuits

All timing functions in this control are based upon the exponential discharge of an initially charged capacitor through a resistor. Basically, each timing function is performed by two thyratrons, a capacitor, and a variable resistor.

The first thyratron is initially firing, maintaining the timing capacitor at full charge. The grid of the second thyratron is connected across this capacitor, and is therefore neagative, preventing firing. At the start of timing, the first thyratron is cut off, and the capacitor begins discharge through a variable resistor in shunt with it. When the capacitor voltage reaches some low value, the second thyratron fires. Time is controlled by varying the resistor. Calibration of the circuit is accomplished by placing small capacitors in parallel with the main one until actual time agrees with dial setting.

Operation of Spot Sequence Control

Refer to the schematic diagram:

1. Operating switch is closed.
2. 1TU and 2TU fire due to removal of bias from shield grids.
   a. 1CR relay is energized by firing of 1TU.
   b. 1CR contacts energize solenoid valve.
   c. Firing of 2TU charges 16C, blocking 3TU and 4TU.
   d. Blocking 3TU allows bias on 25C to decay, locking 1TU and 2TU in the "on" condition.
   e. Blocking of 4TU starts squeeze time circuit timing.
3. 5TU fires at end of squeeze time.
   a. Firing of 5TU charges 20C, blocking 7TU.
   b. Blocking 7TU allows 21C to discharge rapidly, firing 6TU.
   c. Firing 6TU energizes 2CR relay.
   d. 2CR contacts close ignitron circuit of ignitrons, initiating weld.
   NOTE: If heat control is employed, 2CR is eliminated;
   6TU fires through RC circuit in heat control panel to initiate weld.
   e. Blocking 7TU starts weld time circuit timing.
   f. 8TU isolates the two outputs of 7TU from each other.
4. 9TU fires at end of weld time.
   a. Firing of 9TU blocks 6TU, stopping weld current.
   b. Firing of 9TU blocks 10TU.
   c. Blocking of 10TU starts hold time circuit timing.
5. At end of hold time 11TU fires.
   a. Firing of 11TU charges 18C.

IF CONTROL IS SET FOR REPEAT:

b. Charging 11C blocks 1TU and 2TU.

TESTING COMPONENT PARTS

TEST INSTRUMENTS AND THEIR USE

Listed below is a group of instruments which will be useful for installing and maintaining electronic welding controls. If the user has several controls, and a service staff adequately trained in electronics, he will find use for all of the items. If the user has only a few controls, it is recommended that a Westinghouse Service Engineer be called on those jobs which require extensive equipment.

Every user should have items 1, 2, and 3 on the list, and item 4 if possible. Listed in the approximate order of their importance the items are:

1. Volt-ohm-milliammeter
2. Line voltmeter—a-c
3. Miscellaneous materials
   a. Voltmeter calibrating transformer TI Style #1405468.
   b. Current calibrating transformer T4 Style #1405465
   c. One-ohm 100-watt resistor Style #281212
   d. One pair 10 ft. twisted oscilloscope leads
   e. Four 10 ft. insulated clip leads
   f. Six 3 ft. insulated clip leads
   g. Voltage dividing resistor for oscilloscope
   h. One 115-volt, 10-watt test lamp
   i. Two 500-ohm-watt resistors Style #281402
   j. Glow lamp voltage tester
   k. One 400-watt, 115-volt lamp bank.
4. Cathode-ray oscilloscope
5. Current transformer
6. A-c ammeter
7. Variable ratio autotransformer
8. Capacitor tester
9. Ignitron and thyratron gas tester (Alternate: Neon sign or oil burner ignitron transformer and glow lamp.)
10. A-c ammeter—Tong type
11. Direct-writing cycle recorder
12. Weld-o-trol firing rectifier test panel, see parts list on page 9, Fig. 15.

Specification and Use of Volt-Ohm Milliammeter

D-C Volts—0 to 1,000 in at least 5 ranges and not less than 5,000 ohms per volts.

A-C Volts—0 to 1,000 in at least 5 ranges and not less than 1,000 ohms per volt.

D-C Ma.—0 to 500 in at least 3 ranges.

OHMS—0 to 3 Meg. in at least 3 ranges.

This instrument is used in general testing on the control. Although these testers are very convenient they are not, in general, precision instruments, and for this reason they should be frequently calibrated. However, they are sufficiently accurate, without calibration, for at least 90 percent of the tests. The largest errors generally occur on the low a-c scales. The volt-ohm-milliammeter should not be used to measure non-sinusoidal a-c voltages since its readings are almost meaningless for this condition.

Specification and Use of the Oscilloscope

Supply—115 volts, 50/60 cycles.

Frequency Response—Essentially flat from 60 to 6,000 cycles.

Input Impedance—Not less than 0.25 megohms.

Input Voltage Rating—Not less than 230 volts RMS alternating current.

Tube Size—3 or 5 inch.

The oscilloscope enables the user to "see" the voltage in any part of the control circuit.

When using the oscilloscope, it should be connected to the equipment under test with long, flexible, well-insulated and tightly twisted leads. It is necessary that long leads be used so that the oscilloscope may be placed at a considerable distance from the welder to avoid distortion of the pattern by the strong magnetic fields produced by the welder.

Caution: One of the input terminals of the oscilloscope is connected directly to the case. Therefore, the oscilloscope should be mounted on an insulated platform and handled with care when adjustments are made. Do not allow measured voltage to exceed rated input voltage of the oscilloscope.

care when adjustments are made. Do not allow measured voltage to exceed rated input voltage of the oscilloscope.

Specification and Use of the A-C Line Voltmeter.

Iron vane repulsion or dynamometer type

Range—0-150-300-600 volts

Not less than 200 ohms per volt

Style #936242

The line voltmeter is used when adjusting the taps on the control transformers.

Specification and Use of the Current Transformer and the A-C Ammeter.

Current Transformer:

Accuracy—1%

Capacity—25 volt-amperes

Type—Portable or Split Core

Range—1,000 amperes in at least 4 ranges

A-C Ammeter with Pointer-Stop

Accuracy—1%

Iron vane repulsion or dynamometer type

Ranges—0/2.5/5/0/10.0 amperes

The current transformer and the ammeter are used together to measure the current in the primary of the resistance welding transformer. They may be used to measure any other current within their range. If available, the Tong Type ammeter is much more convenient to use than the current transformer and ammeter although its readings are in general not as accurate. The Tong Type ammeters which have a rectifier movement are subject to wave form errors when used on non-sinusoidal waves and should be used only when the control is set for 100 percent current.

Important: When using a current transformer, always keep the secondary shorted or loaded with a low resistor.

Specification and Use of the Variable Ratio Auto-Transformer.

Input—115 volts, 60 cycles

Output—0 to 130 volts, 5 amperes

The variable ratio autotransformer is used in calibration of the oscilloscope and the a-c ammeter. A full description of the calibration procedure will be given later.

Specification and Use of the Direct-Writing Cycle Recorder.

Rated Input Voltage—115 or 230 volts a-c, 60 cycles.

Type—Electromagnetic or Crystal Driven Type.

Record—It must clearly record each cycle of an applied 60-cycle voltage.

The cycle recorder is used in the calibration of the weld time and in checking erratic operation. The input to the recorder is connected across the primary of the welding transformer through an isolating stepdown transformer, and a weld made. The number of cycles recorded on the chart of the recorder is then compared with the setting on the timer. Transformer T12 listed in the miscellaneous materials can be used as the step-down transformer.

Since the recorder is connected across the welding transformer primary there is a chance for confusion in the record due to the fact that the welding timer controls the duration of welding current, and the recorder records voltage across the transformer primary. When the welder is set for 100 percent current and has a low power factor, the recorder trace will be as shown in Fig. 1. The reverse voltage pip shown at "a" in Fig. 1 should not be considered as an extra half-cycle of current flow, as it is the voltage induced in the transformer due to the highly lagging current.

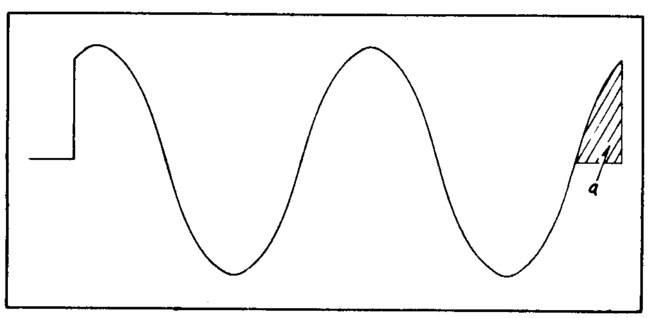


FIG. 1. Voltage Wave Form as Seen on Direct-Writing Cycle Recorder.

Specification and Use of the Capacitor Tester. The capacitor tester may be either the bridge type or the direct reading "ohmmeter" type. Since great accuracy is seldom needed, any of the commercially available types will be satisfactory.

The capacitor tester is used to locate defective capacitors and is more convenient than most other methods.

Specification and Use of the Gas Tester. Westinghouse manufactures an ignitron and thyratron gas tester. See your local Westinghouse office for information.

Alternate Tester: A neon sign transformer or an oil burner ignition transformer with an open circuit secondary voltage of 10 to 15 kv., a primary voltage of 115 volts, 60 cycles, and a secondary short circuit current of 20 to 60 milliamperes can be used.

Complete instructions are given with the Westinghouse tester. For instructions on the alternate tester refer to next section on test procedure.

Specification and Use of Miscellaneous Materials. The only necessary specifications for these materials are given with the list. Their use is explained in this section, or in the section on testing of component parts.

Oscilloscope Calibration. The oscilloscope may be calibrated to read either RMS or peak voltages. To calibrate for RMS voltages, a voltage of approximately the same magnitude as the one to be measured is applied to the input terminals of the oscilloscope, and the sweep is adjusted to one or two cycles and synchronized with the line.

The various taps on transformer T12 offer a wide range of voltages with which to calibrate the oscilloscope.

Fo example, assume the voltage to be tested is around 100 volts RMS. Connect the oscilloscope input to terminals G and H of transformer T12 which is known to be 120 volts. The 230 volts is applied to A and C. The pattern on the oscilloscope screen is adjusted as in Fig. 2A.

Leaving the vertical gain control set in exactly this position, connect the terminals of the oscilloscope to the test voltage. The calibration is now 10 volts RMS per division (+ and —) deflection. Thus an applied voltage which gives a pattern as shown in Fig. 2B is 50 volts RMS.

The sweep frequency and the horizontal amplitude may be changed without effect on the vertical calibration.

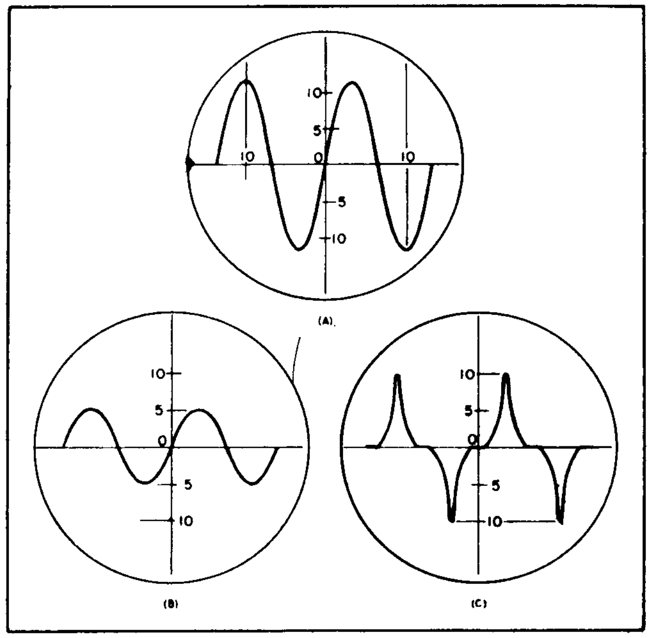


FIG. 2. Calibration of an Oscilloscope.

It is frequently desirable to be able to read instantaneous values of voltage on the oscilloscope. To make such readings follow a procedure similar to the RMS calibration, except use peak values on the applied voltage. The peak value of a sine wave is 1.41 times the RMS value.

For example, apply 115 volts RMS; the peak value of 115 volts will be 115 x 1.41 =162 volts. The image on the screen of the oscilloscope is then adjusted to plus and minus 16.2 divisions, and the screen is direct reading in instantaneous values. If the output voltage of a peaking transformer is now applied to the oscilloscope, and the image obtained is as shown in Fig. 2C, the peak value of the transformer is 100 volts.

Since the maximum rated input voltage for many oscilloscopes is 250 volts or less, some type of voltage divider is required for the higher voltages. The diagram of an appropriate divider is shown in Fig. 3.

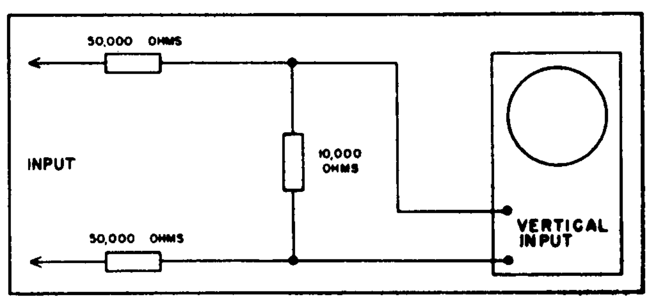


FIG. 3. Voltage Divider for Oscilloscope.

Tubes.

1. Small control tubes.

A. Types WL-2050 and 6X5 may be tested with a commercial tube tester.

B. If no tester is available, try a new tube.

C. If a tube fails frequently—

(1) The load is shorted.

(2) The grid resistor is shorted.

(3) The grid is shorted to other element at the tube socket.

(4) The filament voltage is high or low.

D. Rated filament voltage (6.3 volts a-c ±5% for WL-2050 and 6X5) should be measured at tube socket.

2. Voltage regulator tubes type VR-105-30.

A. If tube glows when voltage is applied to control, it is usually good.

B. Calibrate oscilloscope as previously explained and connect as shown in Fig. 8A. Wave form on oscilloscope should be as shown in Fig. 8B.

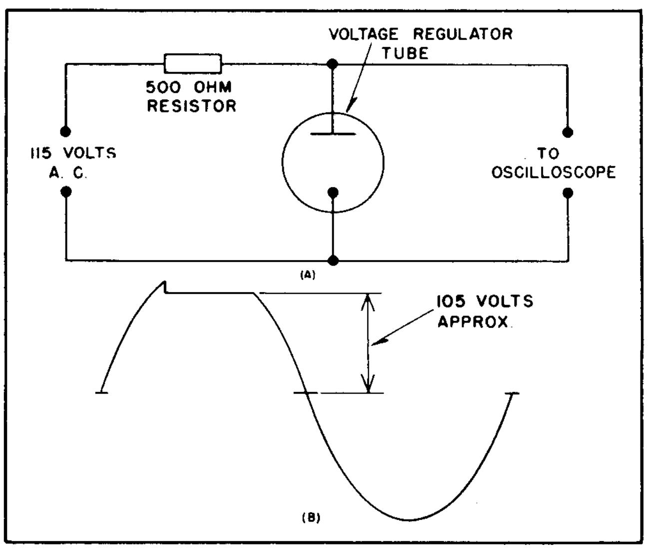


FIG. 8. Test of Voltage Regulator Tube.

C. If no oscilloscope is available, connect as shown in Fig. 9.

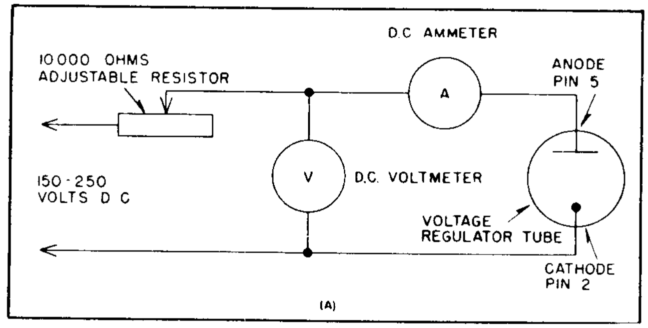


FIG. 9. Test of Voltage Regulator Tube.

(1) Adjust resistor for ammeter A to a reading of 0.030 amperes direct current.

(2) If voltmeter V does not read between 101 and 109 volts d-c, tube is defective.

Important: Voltmeter V must have an accuracy of ±1%.

3. Large thyratrons.

A. Gassy tubes.

(1) Remove tube from control and allow to cool for at least 30 minutes.

(2) Test tube in Westinghouse tube tester for gas.

(3) If tester is not available, mount vertically with anode up and connect as shown in Fig. 10.

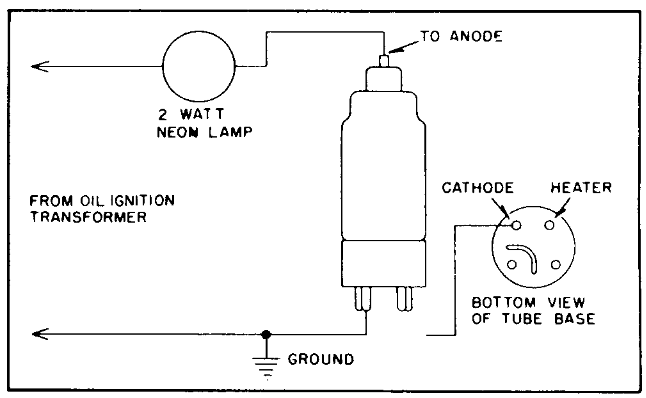


FIG. 10. Gas Test for Thyratron Tube.

Important: Filament must not be heated during this test.

If lamp glows, tube is gassy.

B. Try a new tube.

C. If tube fails frequently—

(1) The grid resistor is shorted.

(2) The grid is shorted to other elements at the tube socket.

(3) The filament voltage is too high or low. Rated filament voltage (5.0 volts ± 5% for WL-672) should be measured at tube socket.

4. Ignitrons

A. Try a new tube.

B. Gassy tube.

(1) Remove tube from control and test tube in Westinghouse tube tester.

(2) If no tester is available, mount vertically with anode lead up and connect as shown in Fig. 11.

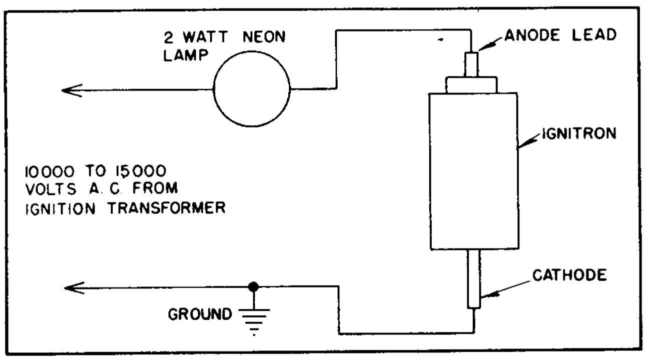


FIG. 11. Gas Test for Ignitron Tube.

(3) If neon bulb glows, tube is gassy.

Important: The ignitron must have been inoperative for at least four hours before test.

C. Defective ignitor.

(1) Remove power from ignitrons.

(2) Remove ignitor lead and measure resistance between ignitor and cathode of tube with an ohmmeter. If resistance is less than 5 ohms or greater than 100 ohms, tube is defective.

Rectox Rectifiers.

1. Connect Rectox as shown in Fig. 12A.

A. If Rectox unit has 3 terminals, connect as shown in Fig. 12B.

Check each section of three-terminal Rectox by moving input lead from one end of Rectox to other after one section has been checked.

Wave form should be shown as in Fig. 13A.

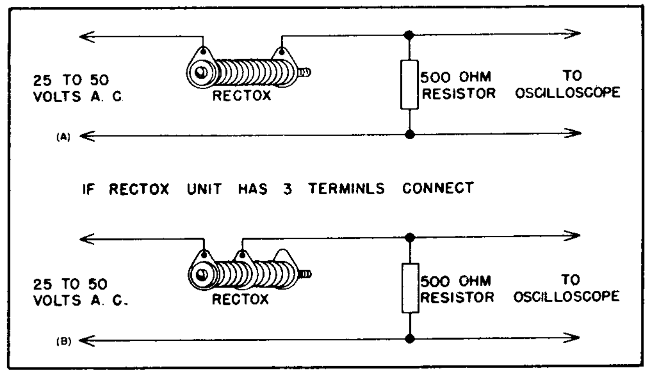


FIG. 12. Test of Rectox.

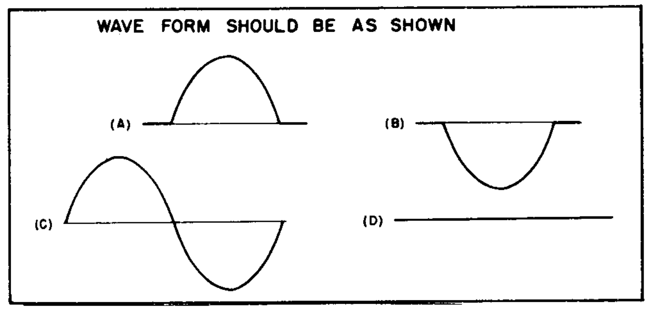


FIG. 13. Test of Rectox.

If it is as shown in Figure 18C or 18D, unit is defective.

2. If oscilloscope is not available.

A. Connect as shown in Fig. 14.

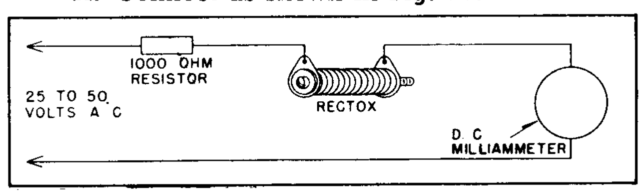


FIG. 14. Ground Test of Rectox.

B. If ammeter A does not read at least 0.010 amperes, Rectox is defective.

C. Three-terminal Rectox unit may be checked in similar manner.

Caution: Rectox must be, removed from circuit before test is made.

3. Ground test.

A. Connect as shown in Fig. 15.

B. If bulb lights, unit is defective.

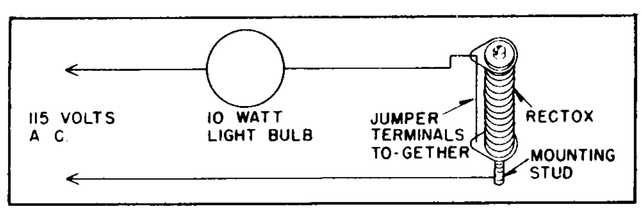


FIG. 15. Ground Test of Rectox.

Procedure for Checking the Merits of the Ignitron Firing Rectifiers

Ignitron tubes may be controlled by Thyratron firing tubes or by metalic rectifiers. When a tube is suspected of being defective it may easily be checked by inserting a spare. This same procedure may be used to check a firing rectifier, but frequently no spare is available and it is desirable to check the unit in question.

Figures 1 and 2 show a simple but reliable testing procedure which may be used. For the manufacturer using Westinghouse Weld-O-Trols in quantities it may be desirable to establish a small test circuit to expedite Weld-O-Trol rectifier testing. To this end, a complete list of component parts and specifications follow on Fig. 16.

Refer to Fig. 16 and proceed as follows:

A. Test for proper Back resistance and shorted cells.

1. With IP set at maximum resistance, insert the rectifier to be tested as shown in Figure 15A and apply the power.

   Decrease IP to 0 Resistance slowly, watching meter "MA" to see that the meter does not read off scale. If the meter reading exceeds the value shown in the tabulation "Test #1" the back resistance is low and the component defective.

2. If "Test #1" is satisfactory short out the small section of the rectifier with a jumper.

   The current through MA should rise to minimum figure indicated on the tabulation as "Test 2".

3. Repeat 2 except short out the large section of the rectifier and refer to tabulation "Test 3" for the minimum increase in current.

B. Test for forward resistance.

4. Connect the rectifier as shown in figure 2. With R1 at maximum resistance apply power. Now decrease IP slowly to minimum resistance observing the Voltmeter to see that the reading does not go off scale. The meter reading should not exceed the minimum figure shown as "Test 4" on the tabulations.

C. If all tests from 1 through 4 are satisfactory the rectifier is good.

   If any one test fails the rectifier is defective and there is no point in continuing the test procedure.

Current and Voltage Tabulations.

Test No.	Reading	
1	Back Resistance Current Maximum	3.0 ma Max.
2	Short Cell test (Small section) Minimum increase in test 1 current.	.5 ma
3	Short Cell test (large section) Minimum increase in test 1 current.	1.85 ma
4	Forward Voltage Minimum	1.8 Volts

FIG. 16A

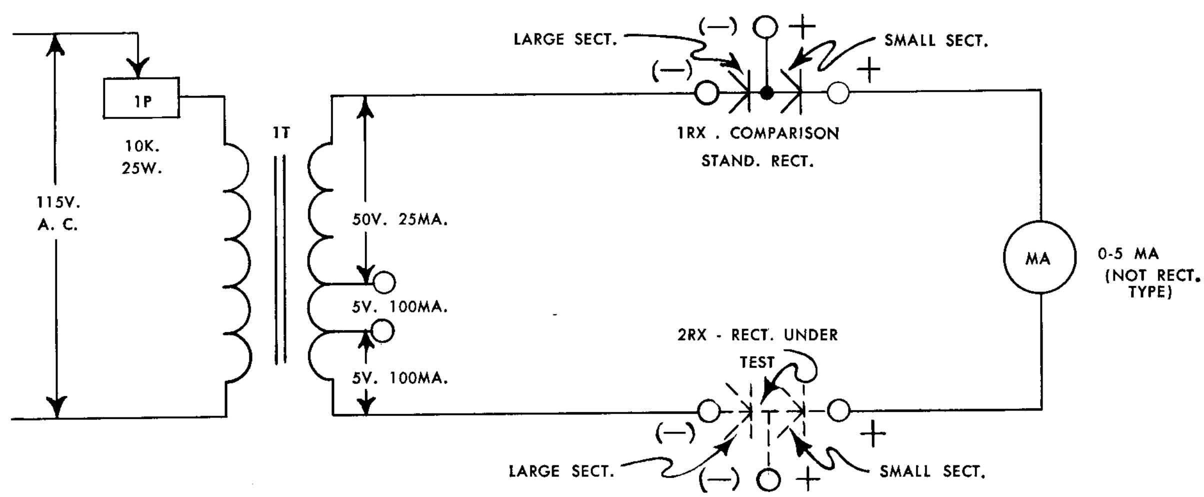
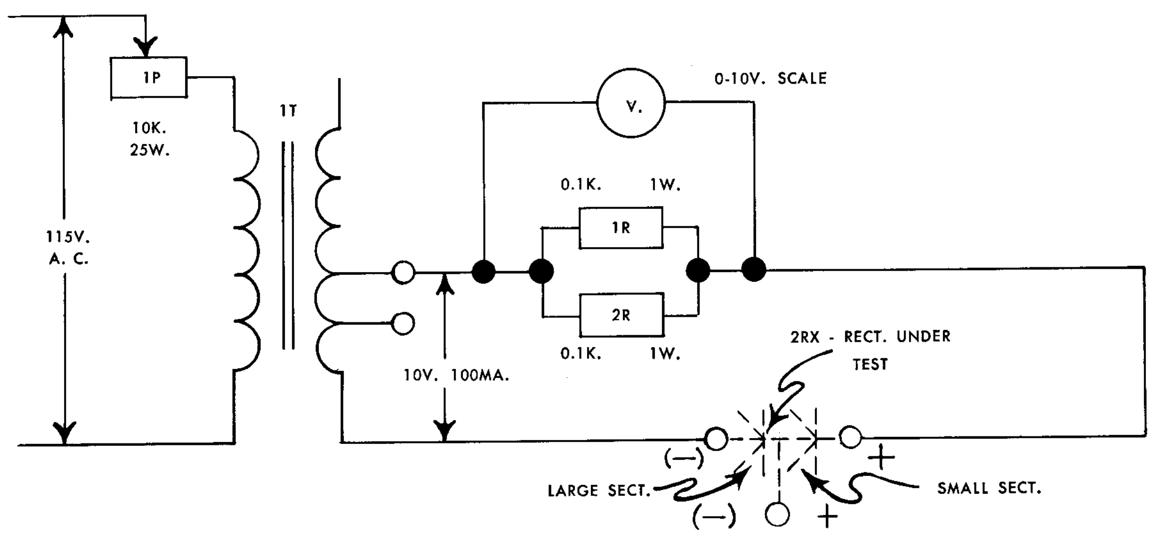


FIG. 16B



LEGEND

NO.	STYLE	NO.	STYLE
1T	849095	1R	1496894
1P	(10K-25W.)	2R	1496894

1RX—Rect. S#1186297 (This should be a new Rect. which is known to be good since it functions as a comparison standard.)

2RX—Rect. under test.

MA.—0-5 MA. Meter (Must be dynamometer type. Rectifier type commonly used in multi-test meters will not work.) 1RX—DC

V. —O-10V. meter with 1000 Ohms per volt movement or higher.

FIG. 16. Bias Supply Circuit.

MAINTENANCE

A regular inspection and maintenance procedure minimizes "down" time by detecting potential troubles before they occur.

Examine capacitors and replace any found to be leaking. They can seldom be satisfactorily repaired in the field.

Periodically examine contacts of the solenoid and ignitor relays. These contacts are silver and require no dressing. If they become badly pitted or burned they should be replaced.

Remove dust from all parts of the control with a soft brush or an air hose. If an air hose is used, the supply must be free from dirt and water.

Flush the ignitron tubes with a cleaning solution approximately every six months, depending on the local water conditions. No specific solution can be recommended because the proper one will vary with the local water. The purpose of the flushing is to remove the precipitate which accumulates in the tubes and flow switch due to the heating of these parts.

Any cleaning compound which will remove this precipitate and not damage the stainless steel ignitron tubes or the rubber hoses may be used. Mix about two gallons of the cleaning solution, remove the hose connections at the water inlet and outlet and drain the excess water out of the system. Place a funnel in the inlet hose and a receptacle at the outlet. Flush the cleaning solution through the tubes several times, then plug the outlet and fill the system with the solution. Let stand for several hours and drain. Reconnect hoses and flush out with clean water.

Use fuses of the same size as originally furnished. The purpose of a fuse is to protect the control from overload. When fuses blow, it is an indication of trouble in the control and not that the fuse is too small.

A great deal of information on the condition and loading of a thyratron tube may be gained from its appearance during operation. No hard and fast rules can be given, but in general, in an overloaded or worn-out thyratron, the glow will increase in intensity and change in color from that of normal operation. It is best to study the control when it is new and operating normally. Then this inspection may be used as a guide in the location of the trouble.

Examine resistor for signs of overheating. A cracked or discolored resistor should be replaced by a new one of the same value.

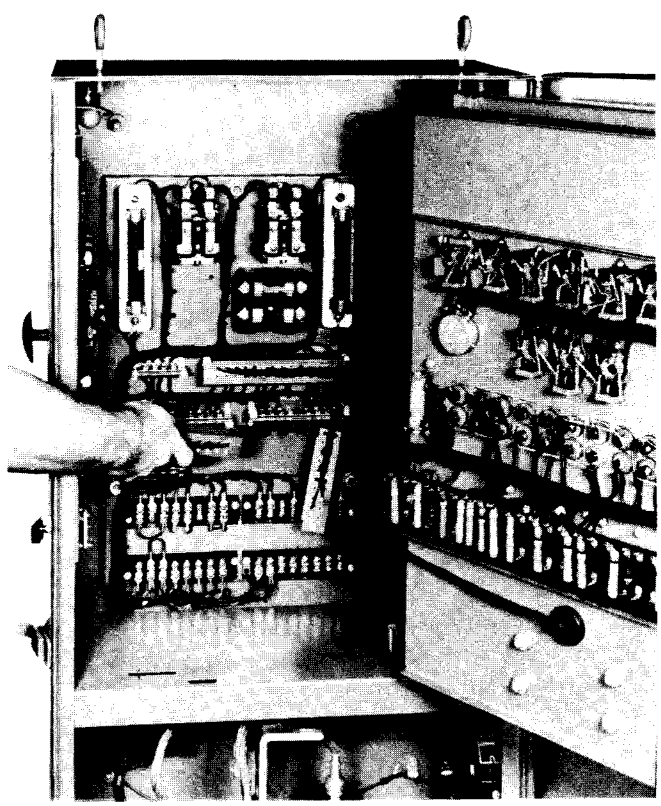


Figure 6. Disconnecting Cable Plugs.

PANEL REMOVAL

REMOVING COMPLETE PANEL FRAME

1. Disconnect the cable plugs.
2. Swing the panel frame outward 90 , grasp the frame firmly top and bottom, lift upward and pull outward on the bottom of the frame. When the panel frame is free from the lower pivot, lower the frame slightly to clear the top pivot. To insert, reverse the procedure.

REMOVAL OF INDIVIDUAL PANELS

Remove the four nuts on the front of the panel frame to remove an individual panel.

1. Disconnect the cable plugs.
2. Remove the two or four binding head screws on front of adjustment panel.
3. Remove panel.

To replace, reverse procedure.

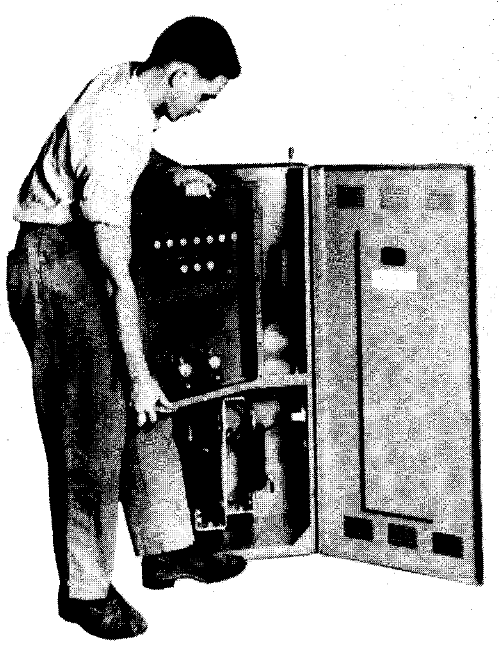


Figure 7. Removal of panel frame from cabinets.

REMOVAL OF ADJUSTMENT PANEL

1. Disconnect the cable plugs.
2. Remove the two or four binding head screws on front of adjustment panel.
3. Remove panel.

To replace, reverse procedure.

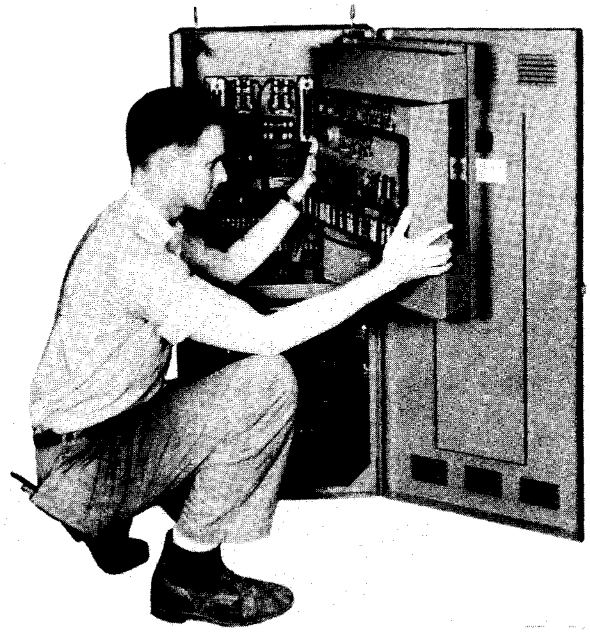


Figure 8. Removal of individual panel.

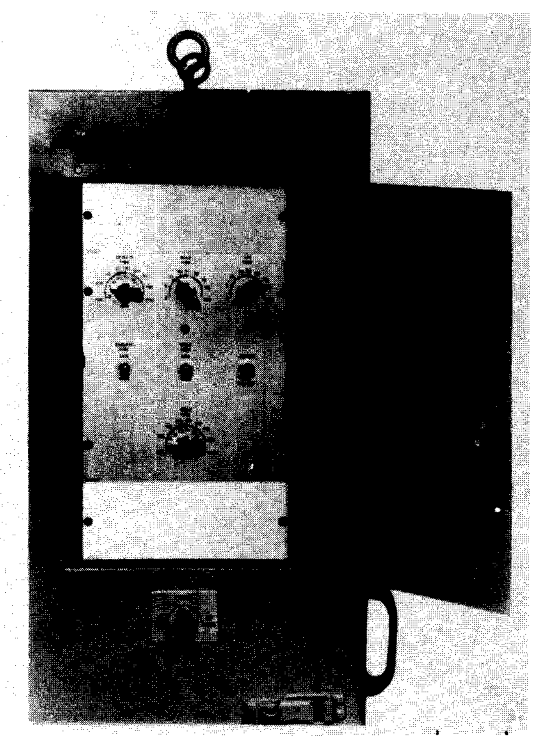


Figure 9. Removal of adjustment panel.

SPARE PARTS LIST

	DESCRIPTION	STYLE NO.	RECOMMENDED QUANTITY	
			1 Unit	5 Units
1T	MAIN TRANSFORMER	1499751	0	1
	FLOW SWITCH	1428199	0	1
	LAMP BULB	1501115	0	1
	NO WELD SELECTOR SWITCH	1449206	0	0
1CR	RELAY	1537212	0	1
2CR	RELAY	1537212	0	0
	SOCKET (8 PRONG)	1501054	0	0
	SOCKET (16 PRONG)	1501053	0	0
	SOCKET (24 PRONG)	1501052	0	0
	FUSE 250 VOLTS 3 AMP.	37155	2	4
	FUSE 600 VOLTS 6 AMP.	37190	2	4

OPERATION

STARTING UP THE CONTROL

Measure the voltage of source to be used for the control circuit. The one point at which changes in jumpers are necessary for the various line voltages is plainly marked with a red tag. Connect the tap for the measured line voltage as shown on the customer connection diagram.

WATER

Turn on the cooling water for the ignitron tubes, the welding transformer and the welding electrodes. The recommended rate of flow for all parts must be maintained. See page 4 of IL 10205 for the rate of flow for the ignitron tubes.

POWER

With the control power on, the secondary of transformer IT voltage will be within the required $\pm$ 5% if the taps have been accurately set. Since a low range precision voltmeter for checking filament voltages is frequently not available, the voltage between leads 2 and 4 on the sequence timer may be used as a check. The taps should be so set that this voltage is as close to 115 volts as is possible.

SEQUENCE

(If control is supplied with sequence) Turn "No-Weld" switch to the No-Weld position and run the control and welding machine through its complete machanical sequence with each of the timing functions set at the center of its adjustment range. The operation will then be slow enough to observe the performance of each function. Each of the timing functions should be varied throughout its range while the others remain near the center point. This procedure gives a complete check on each circuit.

POWER FACTOR ADJUSTMENT

(If heat control is used) The power factor adjustment is set for 20% at the factory. Power factor adjustment is accomplished by setting the potentiometer on the heat control main panel. Before altering the power factor adjustment set the current dial to 100% current and set the weld time at 6 cycles. For this test the welding machine should be set on an intermediate or low tap. Place a piece of copper at least ⅛ inch thick between the welding electrodes, turn the No-Weld switch to Weld, and operate the machine with weld current flowing. **Important: Never fire the ignitrons with the welding electrodes open.** Serious damage to thyratrons, rectox or ignitrons may result. The copper bar will serve to prevent damage to the welding electrodes in case of faulty operation.

The purpose of the power factor adjustment is to bring the percent current dial into correct calibration. When the percent current dial is set for 100% the primary welder current should be a full sine wave with no zero current gaps.

Connect the oscilloscope as instructed on page 3 and observe the wave form of the primary current. With the welding machine and control operating properly set the power factor adjustment at successively higher points until a full sine wave of current at 100% setting of the percent current dial is obtained. See figure 1.

The replacement of the copper bar with the material to be welded may result in a slight change in power factor which will necessitate further adjustment of the power factor setting.

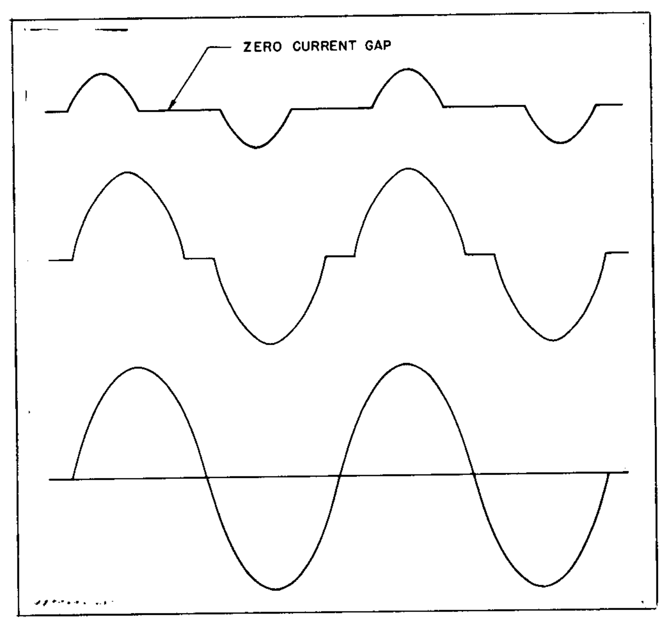


Fig. 1

Current Wave Shape as Power Factor adjustment is set progressively higher. The current dial is set at 100%.

While making the above adjustments it may be found that 100% current produces so much welding heat even on short weld time that the welding electrodes become too hot. Using the highest electrode pressure possible with the welding machine will relieve this situation.

SETTING WELD

When the power factor setting has been properly made adjust the weld time and pressure according to the material to be welded. The percent current is then adjusted so that a weld of desired strength, size and quality is obtained. **Important:** Before the machine is put into production operation, the load on the ignitron tubes must be measured so that a final check may be made to determine if the correct size of tubes have been chosen for the operation. Avoid overloading the ignitrons, since the life of the tubes will be drastically shortened.

IGNITRON RATINGS

To determine the size of ignitrons required, the primary supply voltage, maximum primary demand current, and maximum duty cycle must be known. Reference to the ignitron rating sheets in the supplementary data in this book will then give the proper tube size.

The maximum demand current must be measured with full sine wave conduction (100 percent current) even if less current is required for welding.

MAXIMUM DUTY CYCLE

To calculate the maximum duty cycle, proceed as follows:

1. Determine the weld period in seconds. The weld period is defined as the time required to go through one complete cycle of a welding operation.

2. Assume a tube size and take from the rating curves the averaging time of this tube size at the given voltage.

   Note: If the assumed tube is proved too large or too small, the duty cycle must be recalculated for another tube size.

3. Compare the weld period to the averaging time and use the formula listed below which fits the application.

Case I. If the weld period is shorter than the averaging time:

$$\text{Percent Duty Cycle} = \frac{\text{total conducting time (in sec.) during weld period} \times 100}{\text{weld period}}$$

Case II. If the weld period is longer than the averaging time:

$$\text{Percent Duty Cycle} = \frac{\text{Total conducting time (in sec.) during averaging time} \times 100}{\text{averaging time:}}$$

Example 1: Supply Voltage — 460 volts
Max. Demand Current—1000 Amp. rms

Sequence of Operation: Spot Weld

Squeeze Time	—	15 cycles
Weld Time	—	20 cycles
Hold Time	—	10 cycles
Off Time	—	9 seconds

$$\text{Weld period: } 9 + \frac{15}{60} + \frac{20}{60} + \frac{10}{60} = 9.75 \text{ sec.}$$

Assume Size C ignitrons. From the chart the averaging time of Size C tubes, at 500 volts, is 7.1 sec.

Since the weld period is longer than the averaging time, this is a Case II application.

$$\text{Percent Duty Cycle} = \frac{20/60 \times 100}{7.1} = \frac{33.3}{7.1} = 4.7\%$$

Checking the rating curve of the Size C ignitron at 500 volts, it is found that this size will carry 2300 amperes at the calculated duty cycle. Size C appears to be too large, so check must be made for Size B.

Averaging time of Size B at 500 volts, is 9 seconds.

$$\text{Percent Duty Cycle} = \frac{20/60 \times 100}{9} = 3.7\%$$

From the Size B rating curve it is seen that this tube is adequate.

Example 2: Supply Voltage — 230 volts
Max. Demand Current — 1000 Amps.

Sequence of Operation: Seam Weld

Heat Time = 9 cycles
Cool Time = 6 cycles
Duration of weld = 20 seconds

$$\text{Weld period: } \frac{9}{60} + \frac{6}{60} = 0.25 \text{ sec.}$$

Assuming Size D ignitrons, at 250 volts the averaging time is 11 seconds.

Since the weld period is shorter than the averaging time, this is a Case I application.

$$\text{Percent Duty Cycle} = \frac{9/60 \times 100}{0.25} = 60\%$$

Checking the rating curves, at this duty cycle, Size D will carry 1300 amperes, so Size D must be used.

Note: The selection of ignitrons for applications involving variable weld time and current cycles should be referred to the nearest Westinghouse representative.

MEASURING PRIMARY CURRENT OF WELDERS

There are three methods which may be used to measure the primary current of the welding transformer.

OSCILLOSCOPE MEASUREMENT

A current transformer is connected to the primary of the welding transformer. The secondary of the current transformer is loaded with a 1 ohm resistance (S #281212). The oscilloscope is connected across this shunt as shown in Fig. 2. The image on the oscilloscope is adjusted to a suitable amplitude with the current at 100 percent (full sine wave). Leaving the oscilloscope at exactly this setting, the resistor is removed from the secondary of the current transformer and is placed in series with an ammeter and a variable current source. See Fig. 3. If the current is

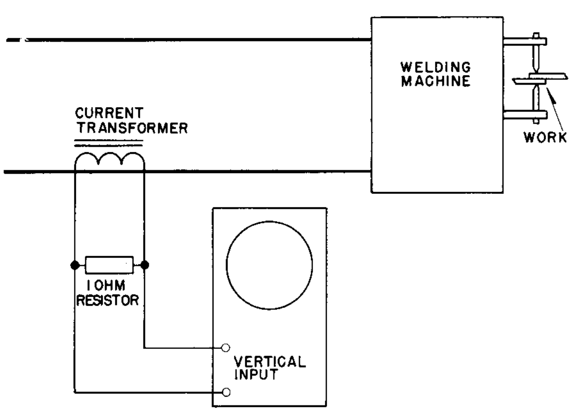


Fig. 2
Measurement of Welder Current.

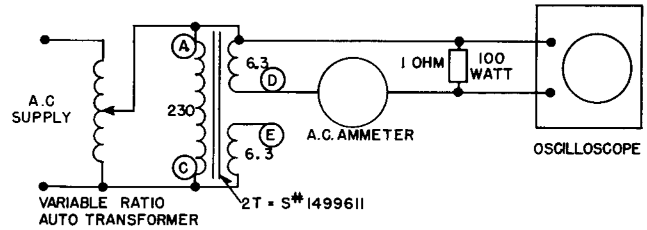


Fig. 3
Measurement of Welder Current.

then adjusted so that the image on the screen of the oscilloscope is exactly the same size as the image previously formed by the primary current, the primary current will be equal to the ammeter reading times the current transformer ratio. Do not allow the current to exceed 5 amperes and if greater than 3 amperes it should not flow longer than 1 minute. This is to protect the transformer.

The exact value of the calibration resistor is not important, and need not even be known. However, it should be as low as possible to still allow a good image to be formed on the oscilloscope screen.

POINTER-STOP AMMETER METHOD

The pointer-stop ammeter (S #1501175) and a current transformer, or a Tong Type ammeter with pointer-stop may also be used to measure primary current under certain conditions. This will depend on the design of the particular meter in question and on the recommendations made by its manufacturer.

S #1501175 has been designed specifically by Westinghouse for use in checking the primary current of welding transformers. It consists of a pointer-stop ammeter, a suitable range tap switch mounted in a portable case. This meter may be used with one of of several current transformers, the exact size depending upon the application. Refer to the nearest Westinghouse Office for information.

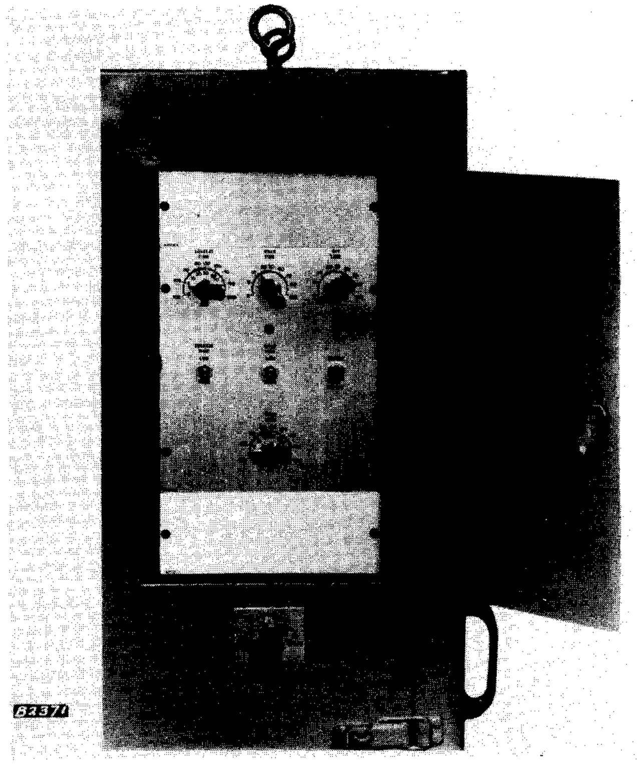
CURRENT METERING PANEL

A combination ammeter and tap switch panel, with a current transformer especially designed to measure primary welding current, can be supplied by Westinghouse. The pointer stop ammeter and tap switch are on a panel which may be mounted in the control cabinet. A current transformer should be mounted in the cabinet with the ignitron tubes or in the welding machine housing. This arrangement will meter the full range of current for which ignitron tubes are available.

ADJUSTMENT OF TIMING AND TIMING RANGES

The timing of any function of the sequence weld timer is adjusted by turning the designated knob on the adjustment panel to the desired point. The dials are all calibrated in cycles.

Standard weld timers, pulsation weld timers, sequence weld timers will perform their stated functions from the lower to the upper limits, inclusive, shown in the following table.



N2 Adjustment Panel.

TIMING RANGES

(Standard Weld Timers, Pulsation Weld Timers, Sequence Weld Timers)

		POWER CIRCUIT FREQUENCY TIMING RANGE — CYCLES		
Functions	Timer Types	60 Cycles	50 Cycles	25 Cycles
Weld	Spot Timer	1-240	1-240	1-120
Squeeze	3B, 5B	2-200	2-165	1-83
Weld	3B	2-200	2-165	1-83
Weld Interval	1B, 5B	4-400	3-330	2-165
Heat	1B, 5B	2-100	2-83	1-42
Cool	1B, 5B	2-100	2-83	1-42
Hold	3B, 5B	2-100	2-83	1-42
Off	3B, 5B	2-100	2-83	1-42