Westinghouse

Type XT Automatic Synchronizer

(Thermionic Type)

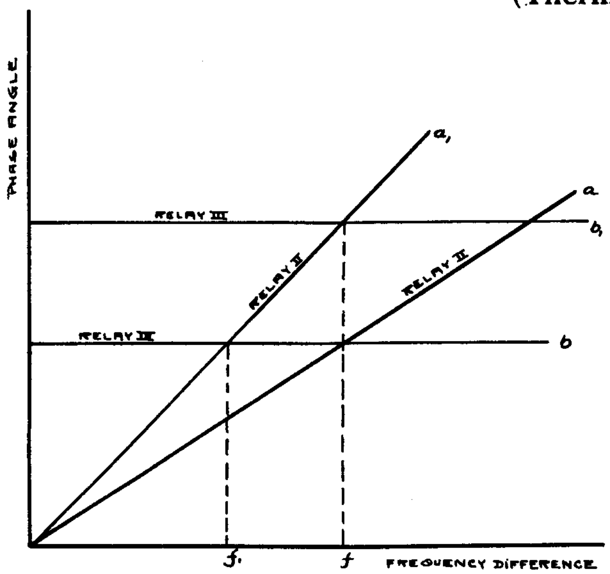


Fig. 3 - Closing Characteristics of Relays II and III of Type XT Automatic Synchronizer

Introduction

(1)

Several years ago Westinghouse introduced a new type of automatic synchronizer, the type XY, having the desirable and exclusive characteristic of energizing the breaker closing coil at a point in advance of synchronism proportional to the frequency difference, so that, taking the breaker closing time into account, the breaker main contacts would always engage at the exact point of zero phase-angle displacement between the voltages of the two systems to be paralleled. Numerous installations of the Type XY-11 and XY-12 automatic synchronizers during the past years have proved that the proportional-advance feature insures exceptionally smooth synchronizing, thus greatly reducing the possibility of system disturbances during the paralleling operation. Due to the relatively large volt-ampere burden of the Type XY automatic synchronizer, these devices, as well as other synchronizing devices on the market, cannot be operated from standard condenser bushing potential devices because these devices do not have sufficient volt-ampere capacity. With the increasing popularity of condenser bushing potential devices, a definite need arose for an automatic synchronizer with a volt-ampere burden well within the output capacity of the potential device. To meet this demand, the type XT thermionic automatic synchronizer has been developed. This synchronizer has the desirable "proportional-advance" feature, as well as a "lock-out" frequency characteristic which permits synchronizing at the first possible chance, even in installations having very erratic machines driven by propeller-type water wheels, and imposes a burden of only 5 volt-amperes on the potential device.

Design

(2)

The type XT synchronizer is mounted on an ebony asbestos base 3/4" x 7-11/16"x 13-11/16" with connecting studs protruding from the rear of the base. The device extends 9 inches from the switchboard panel, and the design is so arranged that the bracket supporting the potentiometers, relays, and tubes may be swung open to make the interior wiring easily accessible. The performance of the device depends upon the constant electrical characteristics of the two vacuum tubes, and various resistors and condensers. There are no springs and sensitively balanced moving parts which require skilled inspection and maintenance; when once calibrated, the synchronizer will remain in perfect calibration indefinitely.

Principle of Operation

(3)

The ideal synchronizer should comply with the following requirements:

1. The synchronizer should operate to energize the circuit-breaker closing coil only if the instantaneous frequency difference is less than the selected lock-out frequency difference. The lock-out frequency difference should be subject to easy adjustment.

2. The breaker closing coil should be energized at an advanced phase angle proportional to the instantaneous frequency difference. The amount of advance should be adjustable, in order to adapt the synchronizer to the closing time of different types of breakers.

These requirements can be met by properly interlocking two relays having closing characteristics as shown in Figure 3. Relay III will operate and close its contacts at a fixed point in advance of synchronism, the closing characteristic being independent of the frequency difference as illustrated by line (b), while relay II will close its contacts at a point in advance of synchronism proportional to the frequency difference according to line (a) of Figure 3. If an interlock between relays II and III is arranged so that a third relay, which is energizing the breaker closing coil, is closed only if relay III is operated before relay II is closed then the relay combination will have the characteristic required of the ideal synchronizer with (f) in Figure 3 being the selected lock-out frequency difference as given by the intersection of lines (a) and (b). If the slope of line (a) is changed to the position of line (a_1,) the device would operate at an increased advance corresponding to a breaker with a longer time element, and the lock-out frequency difference would be reduced from (f) to (f_1). In order to bring the lock-out frequency difference back to (f),line (b) must be moved into position (b_1).The problem of designing an automatic synchronizer is consequently simplified to provide two relays having closing characteristics as shown in Figure 3, and to interlock the relays to give the proper selective closing sequence.

From the wiring diagram, Fig. 2, it may be seen that the automatic synchronizer is connected to the potential transformers of the two systems which are to be paralleled by means of two transformers whose secondaries are connected to give a dark lamp beat voltage across the two Rectox banks connected between leads 13-23 and 12-22, the A-C. components of the rectified voltage being smoothed out by means of condensers

D-G and H-F. The Rectox output voltage is therefore essentially a pulsating D-C. voltage varying according to a sine wave between zero and maximum once per second for each cycle frequency difference between the two systems to be paralleled.

(4) Lock-Out Relay III

An electronic tube type UX-112-A is connected in series with the coil of relay III across a 250 volt D-C. supply circuit; the D-C. voltage being obtained from the station bus or from the "B" eliminator. By means of the potentiometer 8-37 the grid is supplied with a constant negative bias which may be varied by changing the potentiometer setting. In addition to this bias, a negative bias equal to one-half of the voltage across Rectox terminals 8-15 is applied to the grid. This bias is a maximum when the phase angle displacement between the system voltages is 180 degrees. When the phase angle is reduced the negative bias on grid 17 is reduced until a point is reached where the total negative bias on grid 17 is low enough to allow relay III to operate and close its contacts. By adjusting the potentiometer the operating characteristic for relay III can be located at any phase angle position between zero and 40 degrees.

(5) Advance Feature

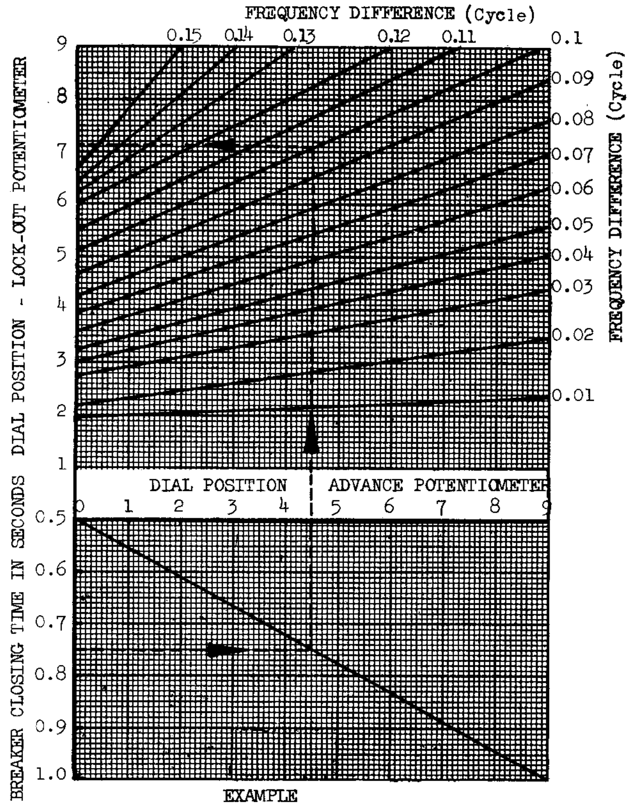
The proportional advance characteristic of relay II is obtained through the combined action of condenser A-C. resistor 26-15 and the Rectox voltage across terminals 24-25. As previously stated the D-C. output voltage of the Rectox will be pulsating at a rate proportional to the frequency difference between the two systems to be paralleled. The voltage across the condenser A-C. when the frequency difference is zero is equal to the output voltage of the Rectox. If there is a definite frequency difference between the two systems and the phase angle displacement is changing from 180 degrees towards zero, then the voltage across the terminals of the Rectox and the voltage across condenser A-C. will be decreasing, but the voltage across the condenser will be higher than the Rectox voltage by an amount dependent upon the frequency difference. The discharge current from the condenser will produce a voltage drop across resistor 26-15, the magnitude of this voltage drop being proportional to the frequency difference.

As shown in Diagram, Fig. 2, the voltage drop across resistor 26-15 is connected to give a positive bias to the grid of the UX-112-A type tube 2. A constant negative bias is applied to the grid of this tube by means of the potentiometer 8-36 and a varying negative bias is obtained from Rectox No. 1. Potentiometer 8-36 is so adjusted that the negative grid bias obtained from the potentiometer is just low enough to operate relay II at zero phase angle displacement when the frequency difference is zero. For any definite frequency difference the grid of tube No. 2 will have a definite positive bias which will reduce the total negative bias on the grid, and relay II will therefore operate at an advanced phase angle position, the amount of advance being proportional to the instantaneous frequency difference.

Operation

(6)

The schematic diagram of the automatic synchronizer shows in addition to relays II and III and breaker closing relay IV, also an intermediate relay I. The function of this relay is to interpose a time delay corresponding to one phase rotation when the device is first given control, and thus prevent synchronizing until



DOTTED LINES SHOW ADJUSTMENT FOR 0.75 SEC. BREAKER; - LOCK-OUT FREQUENCY DIFFERENCE 0.1 CYCLE

USE [ADVANCE POTENTIOMETER POSITION 4.5
LOCK-OUT POTENTIOMETER POSITION 7.15

IMPORTANT: BEFORE USING THIS CHART ADJUST SYNCHRONIZING ZONE POTENTIOMETER AS OUTLINED IN INSTRUCTIONS.

Fig. 4 - Calibration Characteristic Curves for Type XT Automatic Synchronizer

condenser A-C. has assumed the charge corresponding to the instantaneous phase angle displacement and frequency difference. The sequence of relay operation when the synchronizer is given control by means of the master relay of the automatic station is as follows: The first time the phase angle displacement is zero, relay II operates, and "make" contacts of relay II energize relay I which operates and seals itself in. If the frequency difference when the phase angle during the next beat is decreasing from 180 towards zero, is higher than the selected lock-out frequency difference relay II will operate at a point in advance of synchronism and close its contacts before relay III is closed, and since the "break" contacts of relay II are connected in series with the coil of relay III the latter will not operate until relay II drops open at zero phase angle displacement, and synchronizing consequently will not take place. If the frequency difference is less than the selected lock-out frequency difference relay III will operate ahead of relay II, and when relay II finally operates at the proper phase advance relay III will, due to condenser 28-33 remain closed for a time interval long enough to pick up relay IV which seals itself in, energizes the breaker closing relay and thereby completes the paralleling operation. When the circuit-breaker is closed the automatic synchronizer is disconnected from the control circuits by means of an auxiliary relay which is operated by

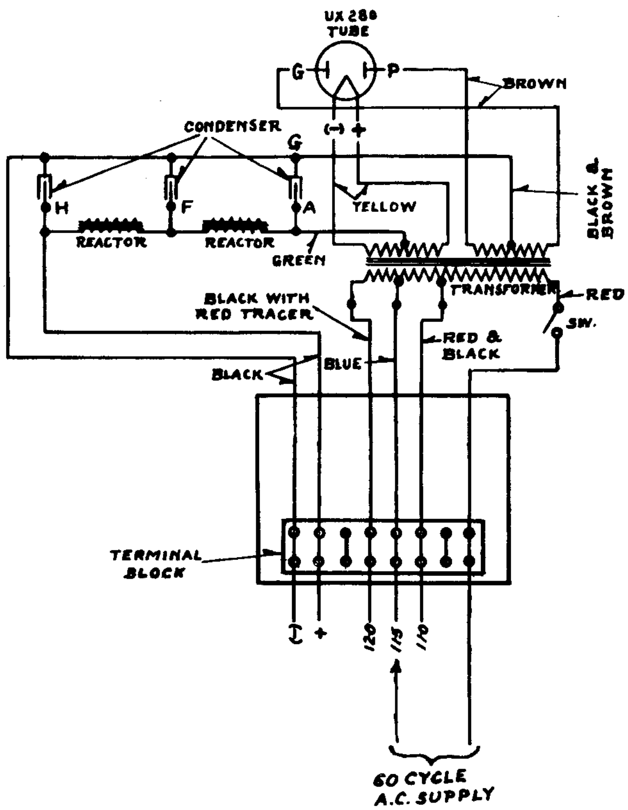


Fig. 5 - Wiring Diagram for "B" Eliminator Used with Type XT Automatic Synchronizer

auxiliary contacts on the breaker. Since relay IV can operate and close the circuit-breaker only if both relays II and III are closed it is apparent that the device is made inoperative by failure of either of the electronic tubes. Faulty synchronizing due to tube failure is therefore prevented.

(7)

When the synchronizer is applied to close a breaker which may at times be the last tie in a loop system there will be no phase rotation between the voltages on the two sides of the breaker although a phase angle displacement may be present. Under these conditions relay I and II would close;but relay III would not close because the "break" contacts of relay II are connected in series with the coil of relay III. To obtain breaker closure a type CV time delay relay V is connected in bright lamp beat voltage circuit to operate within a phase angle of $\pm$ 30 degrees, and the make contacts of this relay are connected to shunt the break contacts of relay II. The time delay of relay V is adjusted so that the relay contacts will not close if the frequency difference exceeds 0.005 cycle;under ordinary operating conditions relay V therefore does not have any effect.

General Application

(8)

Automatic synchronizer applications can properly be classified in two main groups:

1. Where synchronizing breaker is always the first tie between the two sources to be connected.

Applications included in this group are:

(a) Synchronizing a generator to another generator.

(b) Synchronizing a generator to a system.

(c) Synchronizing two separate systems.

2. Where the synchronizing breaker may not always be the first tie between the two sources to be connected.

Applications of this type are:

(a) Synchronizing two lines of the same system.

(b) Synchronizing two systems already connected at some other point.

(9)

When the synchronizer is applied to close a breaker which may at times be the last tie in a loop system, there will be no phase rotation between the voltages on the two sides of the breaker, although a phase-angle displacement may be present. Under these conditions, Relays I and II would close; but Relay III would not close because the "break" contacts of Relay II are connected in series with the coil of Relay III. To obtain breaker closure, a type CV time-delay relay is connected in the bright-lamp beat voltage circuit to operate within a phase angle of $\pm$ 30 degrees, and the make contacts of this relay are connected to shunt the break contacts of Relay II. The time delay of the CV relay is adjusted so that the relay contacts will not close if the frequency difference exceeds 0.005 cycle; under ordinary operating conditions the CV relay, therefore, does not have any effect. A CV relay Style No. 506272 is recommended for this use.

(10)

The type XT automatic synchronizer is designed to energize the closing relay of a breaker paralleling two systems whenever the frequency difference between the two systems,and the phase-angle displacement between the system potentials, are within predetermined limits. The synchronizer will energize the breaker closing relay at a point in advance of synchronism. The amount of advance, measured in degrees,is proportional to the frequency difference,and consequently, if the advance is adjusted to suit the time element of the breaker, the breaker contacts will always be closed right on synchronism, independent of the frequency difference. The maximum advance obtainable is 30 degrees. The maximum frequency difference for which the synchronizer should be adjusted will, therefore, be that frequency difference at which the phase-angle vector travels through a 30-degree angle, within a time interval equal to the closing time of the breaker In most applications it will be found that for practical reasons it is desirable to limit the maximum frequency difference to a value well below the calculated maximum value.

(11)

It should be noted that, when the synchronizer is given control, the voltage vector will have to make at least one full revolution (360 degrees) before synchronizing can take place.

(12)

The synchronizer will operate and close the breaker if the frequency difference, at a point 30 degrees ahead of synchronism, is less than the selected lock-out frequency difference. Suppose that the frequency conditions are such that the frequency difference is too high when the phase-angle displacement is 30 degrees, but an instant later is correct, so that the phase-angle displacement remains constant at approximately zero. Under these conditions synchronizing would not take place unless the phase-angle displacement is increased to a value larger than ± 5 degrees, and then again reduced to zero. In other words, when the lock-out has once operated, it is necessary to increase the phase-angle displacement to a value outside the ± 5 degrees range in order to reset the device.

(13)

The automatic synchronizer operates from 115-volt potential transformers and requires 5 volt-amperes per transformer. At the present time the apparatus is available only for 50/60 cycle operation. A 250-volt d-c. source is required to operate the tubes. The load on the d-c. source is 0.1 ampere. When 250 volts from a battery is not available in the station, a "B" eliminator Style No. 799762 should be applied. This device is arranged for mounting on the rear of the switchboard, as outlined later in these instructions.

(14)

The synchronizing contacts will carry a maximum current of 1/2 ampere. An auxiliary relay must, therefore, be applied to energize the breaker closing coil. This auxiliary relay should have an instantaneous closing characteristic and should be connected to seal itself in. A type MC relay, or a faster relay, should be used. The "make" contacts of any convenient relay, which is energized when the breaker is open, should be connected in series with the d-c. control circuit to the synchronizer <u>so that the d-c. circuit is de-energized whenever the breaker is closed.</u> This is necessary because the telephone relays of the synchronizer, and the breaker closing relay, seal themselves in, and therefore will remain closed, after the synchronizing has been completed unless the d-c. control circuit energizing the relays is opened. Special care should be taken to see that this requirement is met when several generators are synchronized by the same synchronizer. The d-c. circuit must then be opened following each connection of a generator to the bus.

(15)

In case of fuse failure the automatic synchronizer will be made inoperative. If for some reason, however, the voltage of one potential transformer should become zero and later return to its full value, improper synchronizing may take place. For this reason, the connections should be arranged so that the master relay will be de-energized if the voltage of either of the potential transformers drops below 70 per cent of the normal value. <u>When the "B" Eliminator is applied to supply the d-c. control power it is essential to arrange the connections so that the "B" Eliminator is connected to the a-c. supply source at least 5 seconds before the time of closure of the master relay.</u>

Voltage Error

(16)

For line voltage differences within 15 per cent of normal voltage the synchronizer operates practically without error so long as a definite frequency difference exists between the two sources to be connected. One reason for this is, that the beat voltage at 30 degrees phase angle displacement between the system voltages does not change appreciably, and the grid bias voltages of tubes No. 1 and No. 2 therefore, will remain practically unchanged. Furthermore a 15 per cent change in filament voltage does not affect the tube operation since the plate current is considerably below the maximum filament emission at rated voltage. When a voltage difference is present, there will be an equalizing current flowing between the two systems even if the breaker is closed at exactly zero phase angle displacement. This equalizing current will be proportional to the voltage difference at zero phase angle displacement, and will be proportional to the beat voltage at any other phase angle displacement. Since the beat voltage at 5-degree phase angle displacement is only 12 per cent higher than the beat voltage at zero phase angle displacement if a 15 per cent voltage difference is present, it will be realized that a few degrees error in synchronizer performance will have a negligible effect on the paralleling operation.

(17)

In generating stations, synchronizing is usually accomplished at a frequency difference exceeding 1/10 cycle, and the phase angle error due to a 15 per cent voltage difference will under these conditions not exceed 4 degrees, which of course is quite satisfactory.

(18)

When the synchronizer is applied to connect two systems the frequency difference will usually be below 1/10 cycle, and if the two systems are already tied together at some other point the frequency difference will be zero. To obtain breaker closure if a voltage difference is present under above conditions, it is necessary to widen the synchronizing zone. Recalibrated in this manner the synchronizer will perform perfectly at the maximum voltage difference for which the device was recalibrated; but will close too early if the voltage difference is zero. The amount of early closure measured in degrees will be equal to one-half of the maximum voltage difference in volts, referring to 110 volts as normal voltage.

Tube Life

(19)

The operating life of the electronic tubes is in excess of 3,000 hours. Assuming that the synchronizer is in service during 1 hour each day, the useful life of the tubes would be approximately 8 years. It is apparent from Figure 3 that in order to obtain breaker closure both relays II and III must operate. No faulty synchronizing can, therefore, take place due to tube failure.

"B" Eliminator—Style No. 799762

(20)

This device is designed to operate on 110/115/120 volts, 50 to 60 cycles, and to give a maximum direct-current output of 100 milliamperes at 250 volts. The "B" Eliminator is assembled in a sheet metal box 7" x 7-3/4" x 10" high. The "B" Eliminator may be mounted on the rear of the switchboard, and should be mounted so that the cover may be swung open. It is recommended to mount the "B" eliminator so that the UX-280 tube is in a vertical position with the top of the tube upwards. The internal connections are shown in Figure 5.

Preliminary Adjustments

(21)

Before proceeding to place the synchronizer into service, open the line switch between breaker and bus so that the breaker can be closed without paralleling the two sources. Connect a quick-acting relay or lamp with small time lag in series with one pair of the main contacts of the breaker, across a suitable voltage source, to give an indication of when the breaker is closed. If the relay or the lamp cannot be connected to the breaker main contacts, auxiliary breaker contacts can be used.

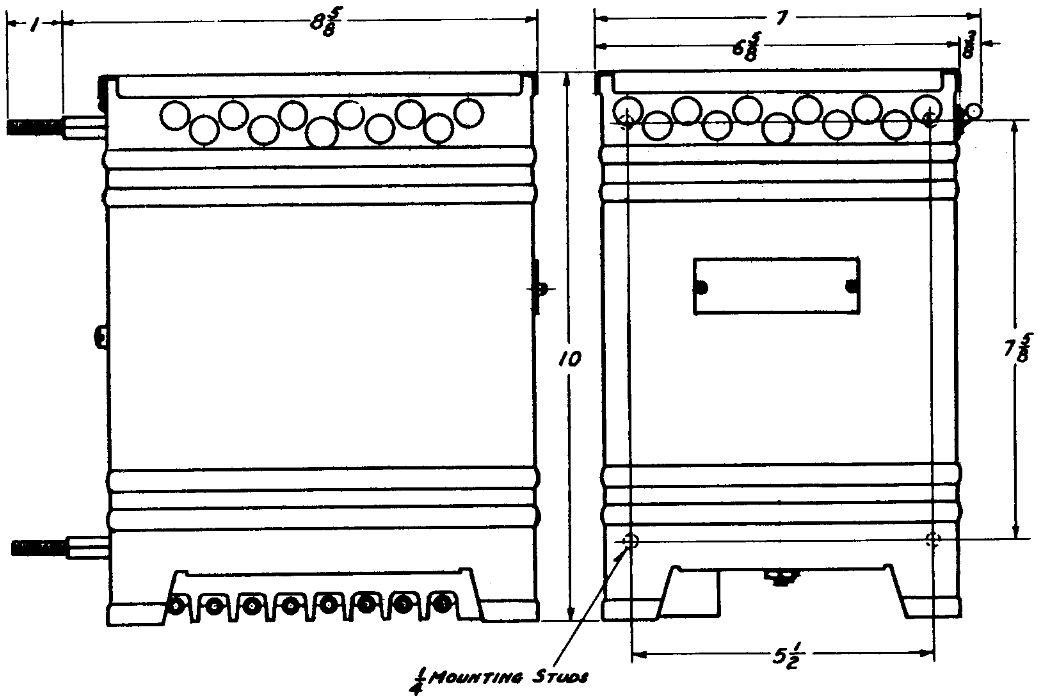


Fig. 6 - Outline Drawing for "B" Eliminator Used with Type XT Automatic Synchronizer

(22)

Read paragraphs 8 to 15 of these Instructions to make sure that the equipment is properly applied. Check connections per diagram, Fig. 3, to see that terminals 1 and 2 are connected to the machine potential transformer, and that terminals 3 and 4 are connected to the line potential transformer. If the synchronizer is applied to "line-synchronizing" it is recommended to connect terminals 1 and 2 to that line which has the more constant average voltage.

"B" Eliminator Connections

(23)

If a "B" eliminator is used, connect the "B" eliminator to an a-c. source with fairly constant voltage so that the "B" eliminator supply voltage does not vary more than + 5 per cent from normal. Check the primary connections to the "B" eliminator per Figure 5 and connect to the 110, 115 or 120 volts terminal to suit the average a-c. supply voltage. Energize the "B" eliminator primary and inspect the UX-280 tube to see that both filament loops are glowing with a dull red glow.

(24)

If the d-c. voltage across a synchronizer terminals 7 and 8 is supplied from an auxiliary d-c. source, measure the d-c. voltage across terminals 7 and 8. This voltage should be between 240 volts and 260 volts.

(25)

Open the line disconnect switch. Close switch D on the synchronizer panel, while switches L and M remain open. Close relay IV by hand and observe that the breaker closing relay and the circuit-breaker is closed. As soon as the breaker is closed, the auxiliary relay should be brought to a position so that the d-c. voltage across terminals 7 and 8 is disconnected.

Preliminary Synchronizing Zone Adjustment

(26)

Open switch D and trip the circuit-breaker. Close the line switches and synchronize manually. With the breaker closed, if possible, adjust the a-c. voltage to normal. Plug the auxiliary relay and the master relay so that the a-c. and the d-c. circuits to the synchronizer are energized. Measure the voltage across terminals 1 - 2 and 3 - 4. This voltage should be between 110 volts and 120 volts. Close switch M on the synchronizer panel. The filament of the left hand UX-112-A tube should now glow with a dull red glow. Close switch L. The filament of the right hand UX-112-A tube should now glow with a dull red glow. Close switch D. Turn the knob of the left hand "Synchronizing Zone" potentiometer all out counterclockwise. If necessary adjust the potentiometer knob to indicate zero in this position. Turn the potentiometer clockwise until relay No. II is closed. The knob should now be between dial position 2 and 4. This adjustment will give zero synchronizing zone. By turning the potentiometer further clockwise, the synchronizing zone will be proportionally widened until at dial position 9 the synchronizing zone will be approximately 19 degrees. It is recommended to use a potentiometer adjustment corresponding to the zero synchronizing zone adjustment, in all installations, except in line to line synchronizing applications where the breaker is the last tie in a loop system. In that case the synchronizing zone potentiometer should first be adjusted for the zero synchronizing zone position and then turned a definite amount clockwise, equal to 2/10 dial division for each one per cent maximum voltage difference between the two sides of the circuit-breaker. If it is not possible to close relay II even if the synchronizing potentiometer is turned all in clockwise to the 9 position, leads (a) and (b) connecting to terminals 1 and 2 should be reversed, and the adjustments previously outlined should be made.

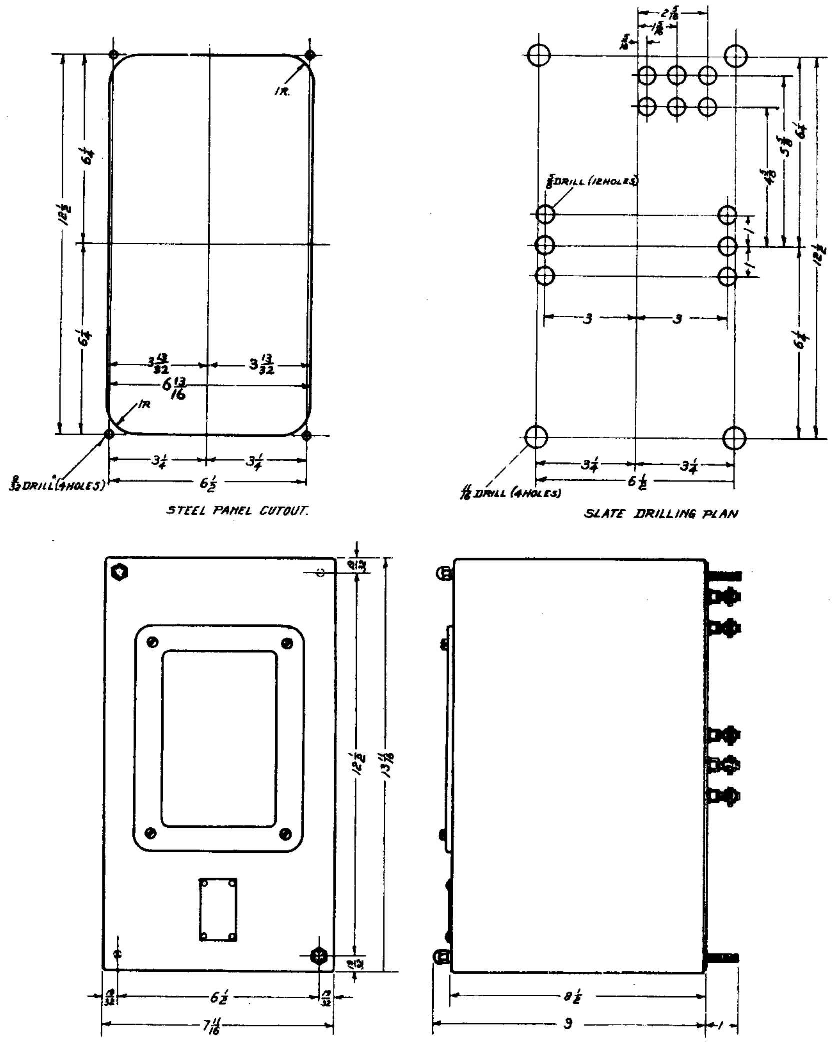


Fig. 7 - Outline Drawing and Drilling Plan for Type XT Automatic Synchronizer

(27) Relay Test

Observe that relay I closes, and remains closed when relay II is energized. To de-energize relays I and II open switch D.

(28) Lock-Out Potentiometer

Close Relay I. Turn the knob of the synchronizing zone potentiometer counterclockwise so that relay II is open. Turn the lock-out potentiometer to the all out counterclockwise position, and, if necessary, adjust the knob to the zero dial position. Relay III should now be de-energized. Turn the potentiometer clockwise towards the 9 position. Relay III should close when the dial indicates between position 4 and 2, provided relay I is closed and relay II is open. Turn the synchronizing zone potentiometer clockwise until relay II is energized. This should cause relay IV to close. Open switch D. Turn the lockout potentiometer to position 0. Close switch D. Relays I and II should now be closed. Turn the lock-out potentiometer to the 9 position. Relay III should now not be energized. Turn the synchronizing zone potentiometer to the zero position. Relay I should now be de-energized and Relay III should be energized; but relay IV should remain de-energized. If a CV relay is applied check that relay III will close if relay II is energized, provided the CV relay contacts are closed. Relay IV should be energized when relay III is closed.

(29) Final Synchronizing Zone Adjustment:

Repeat tests as described under Preliminary Synchronizing Zone Adjustment, paragraph 26.

Placing Synchronizer in Service

(30)

In all synchronizer applications it is desirable to know exactly the closing time of the circuit-breaker, and it is therefore recommended to measure this closing time by means of a cycle counter. The closing time of the circuit-breaker should include the time from the closure of relay IV to the closure of the main contacts of the circuit-breaker. If this closing time is known the adjustment chart as shown in illustration Fig. 4 may be used in calibrating the lock-out potentiometer and the advance potentiometer provided the synchronizing zone potentiometer has previously been adjusted as described in paragraph 26, and provided the dial of the advance potentiometer is on zero when the advance potentiometer is ~~turned~~ all out counter-

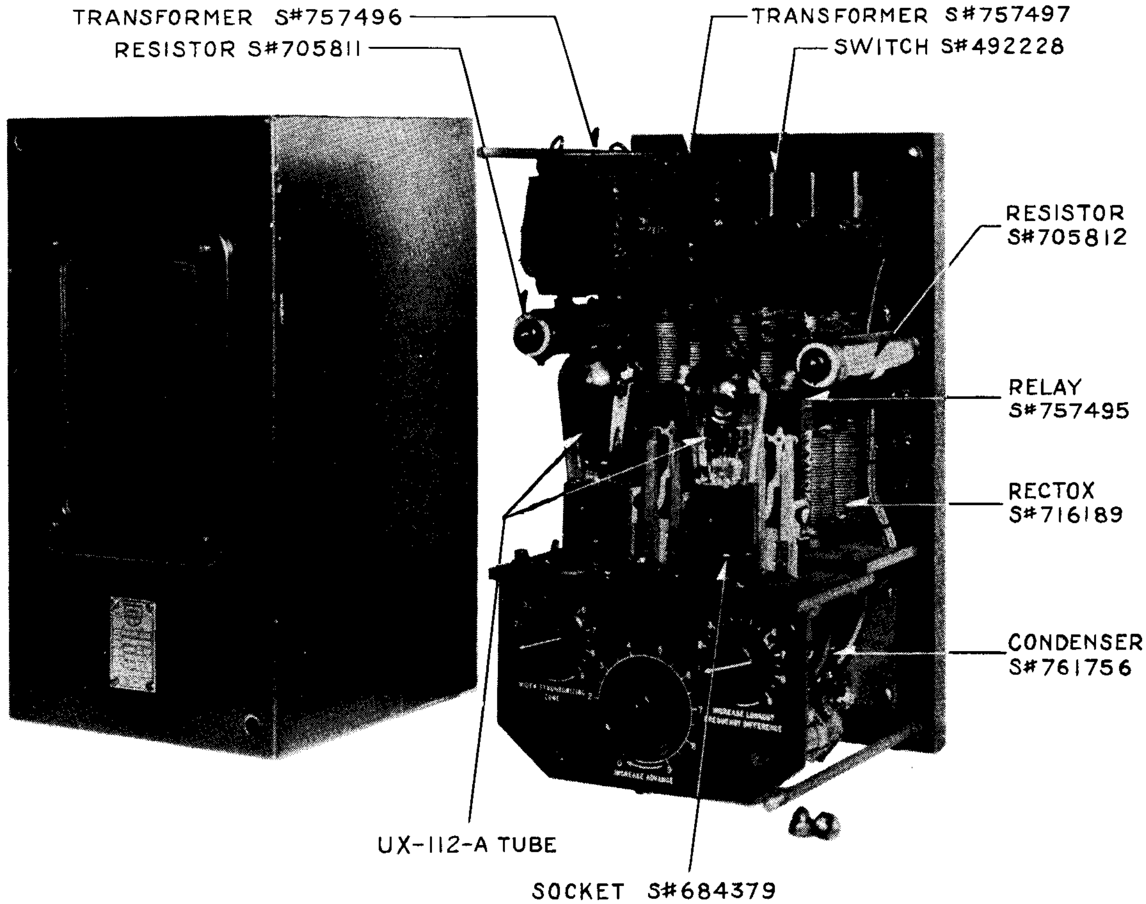


Fig. 8 - Type XT Automatic Synchronizer with Cover Removed Showing Parts

clockwise. The adjustment chart should be used in the following manner; with the closing time of the breaker known read the advance potentiometer adjustment from the lower curve. A breaker closing time of 0.75 second will for example give potentiometer position 4.5 as indicated by the dotted line in the chart. It will be apparent from this chart that for a breaker closing time less than 0.5 second, advance potentiometer position zero should always be used. The lock-out frequency difference when the advance adjustment has been made, depends only upon the position of the lock-out potentiometer. Select the desirable lock-out frequency difference, for example 0.1 cycle, and draw the vertical line from the advance potentiometer curve to the frequency curve, then draw the horizontal line to the lock-out potentiometer scale which will give the correct lock-out potentiometer position. In the example illustrated in the Chart, lock-out potentiometer position 7.2 should be used with a 0.75 second breaker in order to prevent synchronizing if the frequency difference exceeds 0.1 cycle.

(31)

When the preliminary adjustments outlined in paragraph 30 have been made, trip the breaker and open the line switches, then proceed as outlined in the following paragraphs.

AS APPLIED TO CONNECT TWO SOURCES WHEN SPEED CONTROL OF ONE OF THE SOURCES IS AVAILABLE

(32) Advance Adjustment

Adjust the speed of one source to give a frequency difference of 1/6 cycle, corresponding to a time of 6 seconds per revolution of the synchronoscope. Regulate the voltage of one source, so that the voltages of the two sources to be paralleled are equal. Close switches A and D and give the synchronizer control. Let the synchronizer close the breaker several times and note whether the main contacts of the breaker are closed right on synchronism by watching the synchronoscope and the closing indicating device. If the contacts close ahead of synchronism turn the advance potentiometer slightly towards zero. Check the closing of the breaker against the synchronoscope and adjust the potentiometer 24 until the breaker contacts close at synchronism for the average of 10 operations. If the breaker at first trial should close too late, the advance is too small and the advance potentiometer should be adjusted towards 9.

(33) Lock-out Adjustment

Adjust the lock-out potentiometer, if necessary, to prevent synchronizing if the frequency difference exceeds the selected lock-out frequency difference. Vary the speed of the machine to give practically creep beat speed. Check that the synchronizer operates satisfactorily at this small frequency difference, closing the breaker within 5 degrees of synchronism, if the synchronizing zone potentiometer is adjusted for zero synchronizing zone, or within $(5 + \frac{\Delta E}{2})$ degrees if the potentiometer has been adjusted for a maximum voltage difference ΔE as outlined in paragraph 26.

(34) CV Relay Test

Adjust the CV relay so that the relay contacts will not close if there is a frequency difference exceeding 1/100 cycle between the two sides of the circuit-breaker. It should be noted that the CV relay is connected so that the voltage across the CV relay should be maximum at synchronism. The CV relay should be adjusted to close at approximately 180 volts and the time delay of the CV relay at 220 volts across the relay terminals should be 20 seconds or longer.

(35) Synchronizing

Check the closing of the breaker against the synchronoscope for several operations with a frequency difference just below the lock-out frequency difference. When the synchronizer operates satisfactorily, the indicating device should be disconnected from the breaker contacts, the line switch can be closed, and the machine paralleled to the line.

AS APPLIED TO CONNECT TWO SOURCES WHEN SPEED CONTROL OF ONE SOURCE IS NOT AVAILABLE

(36) Advance Adjustment

The adjustment of the advance potentiometer should be made at a time when the two systems are not inter-connected, so that a definite frequency difference exists between the two lines to be synchronized. The adjustment of the advance potentiometer will be similar to the adjustment outlined in paragraph 32 except that it will not always be possible to make the adjustment at exactly 1/6 cycle frequency difference since no means are available to control the frequency difference between the two systems. If 1/6 cycle frequency difference should not be obtained within a reasonable time the adjustment may be made at any other frequency difference; but it should be noted that it is easier to get an exact adjustment at the higher frequency difference of 1/6 cycle than for lower frequency differences because the error in breaker closure, which is proportional to the frequency difference, will be easier to detect when the frequency difference is higher.

(37) Lock-Out Adjustment

The lock-out potentiometer should always be adjusted when the adjustment of the advance potentiometer has been completed. If the frequency difference of the two networks to be paralleled is varying over such a wide range that the lock-out frequency is obtainable then the adjustment should be made as outlined in paragraph 33. If a frequency difference as high as the lock-out frequency difference cannot be obtained, the equipment should be adjusted as outlined in paragraph 30 and the position of the lock-out potentiometer at highest obtainable frequency difference should be checked according to the application chart for verification.

(38) Synchronizing

Synchronize as outlined in paragraph 35.

Renewal Parts

(39)

(a) Type XT Automatic Synchronizer

Description	Style	Req.	Recommended Stock For 1 Unit	Recommended Stock For 5 Units
Top Transformer	757496	1	0	0
Bottom Transformer	757497	1	0	0
Disconnect Switch	492228	1	0	0
R.C.A. UX-112-A Amplifier	Tube	2	2	2
Telephone Relay	757495	4	0	4
Rectox	716189	6	0	6
Condenser	761756	1	0	1
Resistor	705811	3	0	1
Resistor	705812	1	0	1
Socket	684379	2	0	1
Potentiometer-Yaxley Type HIMP 1000 Ohms		1	0	1
Potentiometer-General Radio Co.#371, 10000 ohms		1	0	1
Grid Resis.-0.1 Meg.	860000	2	0	1
Grid Resis.-0.3 Meg.	860877	2	0	1

(b) "B" Eliminator Style No. 799762

Description	Style	Req.	Recommended Stock For 1 Unit	Recommended Stock For 5 Units
Transformer	754986	1	0	0
Top Reactor	Dwg.7-B-82	1	0	0
Bottom Reactor	Dwg.7-B-82	1	0	0
Condenser	754947	1	0	1
UX-280 Rectifier	Tube	1	1	1
Socket	684379	1	1	1

311-000

Westinghouse

Type XT Automatic Synchronizer
(Thermionic Type)

INSTRUCTION BOOK

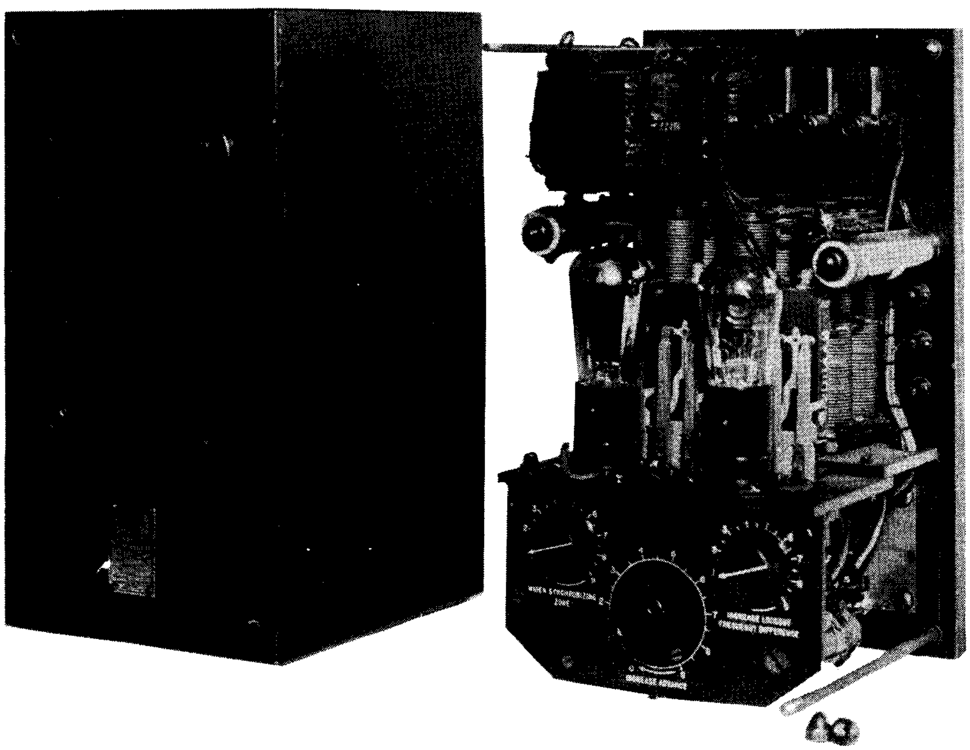


Fig. 1 - Type XT Automatic Synchronizer with Cover Removed

Westinghouse Electric & Manufacturing Company

East Pittsburgh Works, Printed in U.S.A. East Pittsburgh, Pa.

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