Westinghouse

TYPE TA INDUSTRIAL ANALYZER

INSTRUCTIONS

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The Westinghouse type "TA" industrial analyzer is designed to test alternating current circuits. The analyzer may be used on single phase, two phase, and three phase circuits, as shown in the connection diagrams, and is self-contained for current ranges of 5, 25, and 125 amperes, and 115, 230, and 575 volt circuits. External voltage transformers must always be used on two-phase, four-wire circuits. Current and voltage ranges beyond the self-contained ranges mentioned can be tested by using external instrument transformers, as shown in the diagrams.

The analyzer is, in reality, a miniature switchboard mounted in a carrying case complete with instruments, transformers, and switches. A Minatrol three phase ammeter switch is provided to switch the ammeter to any phase of a three phase circuit for checking load balance and the voltmeter may be switched across any two lines of a three phase circuit for checking voltage balance. A switch is provided for changing the voltage range of the set to accommodate the circuit being tested. All switches, except the voltage terminal switch, may be operated under load. The various current ranges are taken care of by taps on the current transformers. These taps are brought out to terminals, it being necessary to change only two leads on the load side to change the range on three phase circuits.

The power factor meter, being of the polyphase type, indicates correctly only on balanced three phase circuits. The power factor of single phase and two phase circuits may be readily calculated from the readings of the ammeter, voltmeter, and wattmeter.

PHASE SEQUENCE

The analyzer is connected internally and terminals marked for phase sequence A B C. In case the phase sequence is not known, a trial connection should be made with phase rotation assumed. An incorrect connection will manifest itself by the pointer of the power factor meter swinging against one of the stops. The correct connection can be made by reversing two of the line leads The corresponding load leads should also be reversed to prevent reversal of rotation of polyphase motors. When using separate voltage terminals with external transformers, it is also important that voltage connections be properly made and transposed at the same time current leads are reversed.

PRINCIPLE OF OPERATION

The analyzer being self-contained up to 125 amperes, the total load current flows through the analyzer. The arrangement of the current circuit is shown in Figure #1. Current transformers are connected in lines A and C so that current entering line terminal A and C leaves at load terminals A and C, respectively. Taps for 25 and 5 amperes are provided on the transformer primaries and connected to separate terminals. The secondary is wound for 5 amperes, which is the full load rating of the instrument current coils. A Minatrol three phase ammeter switch is provided, which connects the ammeter to the secondary of the transformers in line A or C to indicate current in line A or C, respectively. To indicate the current in line B, the Minatrol switch connects the secondaries of the transformers to the ammeter in such a manner as to read the reversed vector sum of currents A and C, which is equal to the current in line B.

The current circuit of the analyzer has ample overload capacity to withstand any normal starting current surges. The current coils of the instruments have a full scale rating of five amperes. However, the instruments will withstand without damage an overload of 150 amperes for one second, 100 amperes for two seconds,or 25 amperes for one minute. Even if the ratio of the current transformers were maintained constant for higher currents, the instruments will safely withstand any usual starting current. This applies to safe heating limit as well as mechanical shock due to overloads.

The ammeter pointer is provided with an adjustable back-up hand for use in measuring the in-rush or starting current of motors. Since the duration of this surge current is only a fraction of a second, the inertia of the moving element of conventional ammeters pre-

Fig. 1

vents the pointer from reaching the true value of the starting current. By mechanically setting the pointer to near the final value of current, the moving element travel need be comparatively small, and it will then be possible for it to reach the true position in the short time. The starting current is determined by taking a trial reading of the starting current to determine its approximate value. The pointer back-up hand should then be set to hold the pointer slightly below the estimated value and the motor again started and pointer travel and peak indication noted. Two or three trials are usually sufficient to make a setting at which the pointer barely leaves the back-up hand, which is the true peak value of starting current.

The starting current, as determined by this method, is usually different than the locked rotor current as the latter depends upon the manner in which the teeth line up so that the locked rotor current may be greater or less than the value as determined by the back-up hand under actual starting conditions.

The arrangement of the voltage circuit of the analyzer is shown in the wiring diagram, Figure #2. The analyzer is self-contained up to 575 volts, taps being provided in the resistors of the instrument for ranges of 115 and 230 volts. When used on circuits below 575 volts, the voltage terminal switch is set to the COM position, which connects the voltage terminals to the regular line terminals making separate external voltage leads unnecessary. For voltages above 575 volts, external voltage transformers must be used, as shown in the external connection diagrams. Since such transformers usually have 115 volts normal secondary rating, the voltage range changing switch should be set at the 115 volt point and voltage leads connected to the voltage terminals, as shown in the connection diagrams, and the voltage terminal switch set to the SEP position. For single phase testing, it is unnecessary to use the separate voltage terminals when external transformers are used. A study of the wiring diagram will make the reason for this clear as the necessity for separate voltage terminals arises only when all three line terminals are used and a short circuit would exist across lines A and C when transformers with grounded secondaries are used. This is standard practice so that it is necessary to isolate the voltage terminals for such conditions.

A separate switch is connected in the voltmeter circuit to switch the voltmeter across any two lines of the circuit making it possible to check voltage balance conditions.

Motor circuits may usually be checked by removing the fuses in the supply line and connecting the necessary leads from the lines to the analyzer terminals, as shown in the external connection diagrams. It is of course

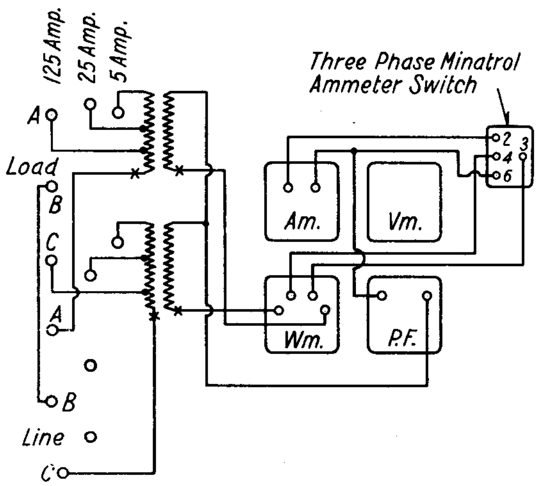


Fig. 1 Type TA Industrial Analyzer Current Circuit
Front View

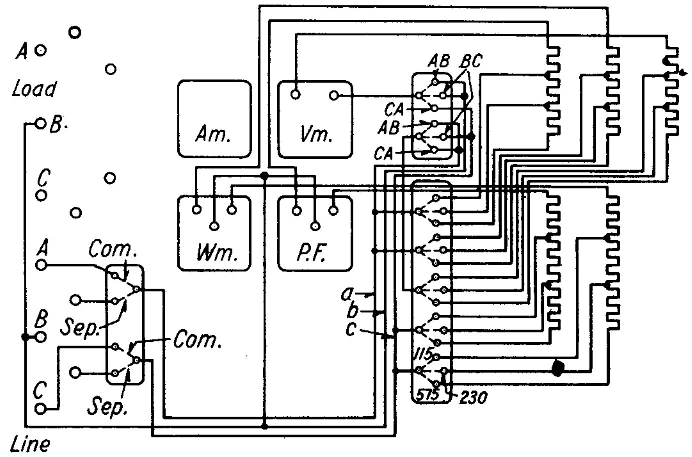


Fig. 2 Type TA Industrial Analyzer Voltage Circuit
Front View

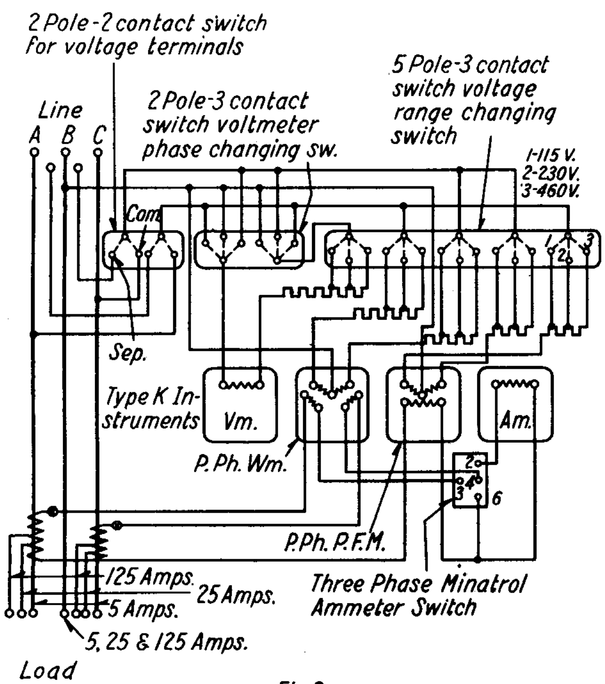


Fig. 3

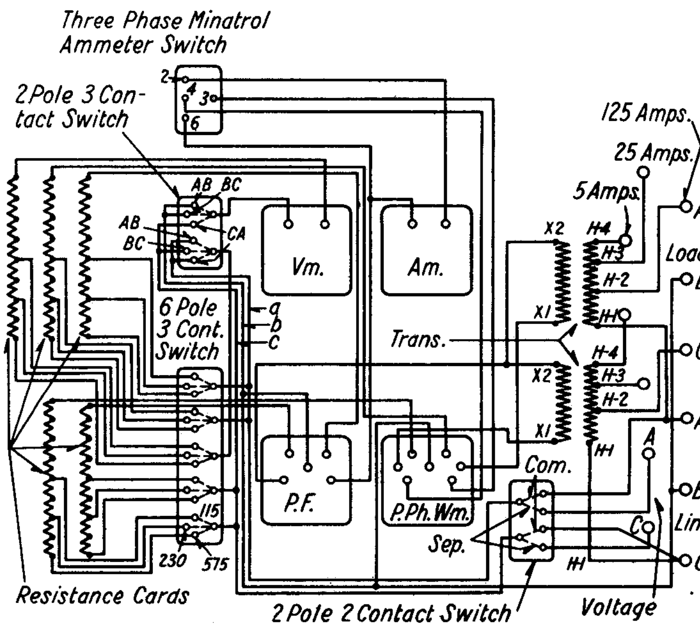


Fig. 4 Rear View

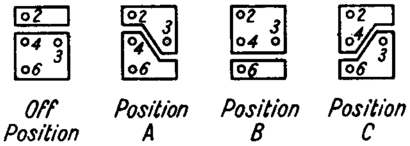


Fig. 5 Drum Development of Three Phase
Minatrol Ammeter Switch

necessary to have back-up protection in the circuit, such as, circuit breakers or other fuses, so that in case of trouble, the removal of the fuses for inserting the analyzer will not cause any damage.

The ammeter and voltmeter read directly on single phase the same as on three phase. The wattmeter being of the conventional two element polyphase type indicates directly on single phase or polyphase. The power factor meter being of the polyphase type indicates correctly only on balanced three phase, three wire circuits. For single phase and two phase circuits, the power factor may be readily calculated by dividing the wattmeter reading by the product of the readings of the ammeter and voltmeter.

TWO PHASE CIRCUITS

Two phase, three wire circuits may be tested by connecting the common wire to terminal B and outside wires to terminals A and C. Ammeter readings give phase currents when set to A or C. Phase voltages may be read by setting the voltage switch to AB or BC.

Four phase, five wire circuits (or 2 phase, 5 wire) may be considered as 2 two phase, three wire circuits. If the two circuits are balanced, readings may be obtained by connecting to one of the two phase, three wire circuits and multiplying the readings by 2.

Two phase, four wire circuits may be tested similar to three phase, three wire circuits using external transformers. The non-polarity sides of the voltage transformer secondaries must be connected together; this permits three voltage leads being brought to the analyzer.

A special portable transformer for two phase, four wire circuits, S#876141, is available for this application. Rated primary voltages are 115, 230 and 460-575 volts and secondary voltage is 115 volts.

CALIBRATION OF INSTRUMENTS

Adjustments and repairs should be made only by skilled meter men familiar with the instrument.

Calibration may be readily checked by connecting suitable standard calibrating instruments in the circuit. The current transformers have a ratio characteristic with an error of less than 1/2% over the greater part of the range and a phase angle error of less than thirty minutes on 60 cycles.

Pointers may be reset on zero by removing the front covers of the instruments and turning the zero adjuster button on the sub-cover. The front cover is held in position by a snap button arrangement, and may be removed by prying under the upper edge carefully with a fine bit screw driver.

The ammeter and voltmeter are of the repulsion iron vane type. Calibration adjustments are made by shifting the outer end of the spring in its holder after loosening the small clamping screw with a jewelers' fine screw driver. The zero adjuster would be left in mid-position, the pointer being set to zero by shifting the small tail piece of the inner spring adjuster located beneath the spring, using a small bore aliminum tube as a wrench. The outer spring clamping screw must be tightened before shifting the inner spring adjuster.

The wattmeter is of the two element electrodynamometer type. Calibration may be checked by testing each element separately. Calibration adjustments are made by changing the resistance of the potential circuits.

The power factor meter is of the crossed coil, electrodynamometer type. Highest accuracy is obtained when current in the current coils is from 40% to full load and voltage on the potential circuit from 75 to 125 per cent of normal. Voltage and current taps should be set accordingly. Calibration may be checked with a standard power factor meter or with the voltmeter, wattmeter, and ammeter. Adjustments are made by changing the value of resistance in the potential circuits.

Do not disturb the balance adjustments of the moving elements. Balance adjustments should be made only by skilled repair men.

GENERAL

Use reasonable care in operating, handling, and transporting the analyzer. Do not jar or strike the instrument to free the moving elements in case they become stuck, as a cracked jewel or ruined pivot may result. Sticking is a sign that friction or misalignment is present and to prevent further trouble, this must be corrected properly.

Do not overload the elements--switch to the next higher range. It is safer to start with the highest range and work down.

When transporting the analyzer in an automobile or trolley car, please place it on a seat cushion to prevent road shocks from damaging the pivots and jewels.

ALTERNATING CURRENT DATA

I = Current (ampere per phase)
E = Terminal voltage
P.F. = Power factor (decimal terms)
W = Watts

Single phase $I = \frac{W}{E \times P.F.}$ $\qquad W = E \times I \times P.F.$

Three phase $I = \frac{W}{1.732\ E \times P.F.} \qquad \frac{.578\ W}{E \times P.F.}$

$W = 1.732\ E \times I \times P.F.$

Approximate Amperes per Terminal for Three Phase Squirrel Cage Induction Motor

Hp. of Motor	220 Volts 2 Ph.	220 Volts 3 Ph.	Hp. of Motor	220 Volts 2 Ph.	220 Volts 3 Ph.
.5	1.7	2.0	50.	108.	125.
1.	3.0	3.5	60.	130.	150.
2.	5.5	6.4	75.	160.	185.
3.	8.0	9.2	100.	215.	250.
5.	13.	15.	125.	260.	300.
7.5	19.	22.	150.	320.	370.
10.	24.	28.	175.	360.	420.
15.	35.	40.	200.	415.	480.
20.	45.	52.	225.	460.	530.
25.	56.	65.	250.	520.	600.
30.	66.	76.	275.	570.	660.
40.	87.	100.	300.	620.	720.

For 110 volts, double these values; for 440 volts, use 1/2; for 550 volts, use 2/5; for 1100 volts, use 1/5; and for 2200 volts, use 1/10 the above values. For single phase motors use twice the value of two phase motors.

POINTS TO BE CHECKED IN CASE OF INCORRECT INDICATIONS

Friction is the most common cause of inaccuracy. Possible points of friction in alternating-current instruments are: 1. The clearances between the aluminum vanes and the walls of the damping chamber are necessarily small and sometimes after a severe jar the vanes might rub against the walls of the damping chamber; 2. Pivots and jewels may become dirty and must be cleaned. Corn pith is often used for this purpose; 3. The control springs should be carefully inspected to see that convolutions are not touching each other or adjacent mechanical projections; 4. Lint may project from the stationary coils of a dynamometer type instrument, and rub on the moving coil; 5. The pointer or its tail-piece rubbing on adjacent parts, although a rare occurrence, it is well to watch for this condition.

Friction eliminated, there remains causes of inaccuracies, zero error, partial short-circuits, and loose connections. A partial short-circuit in the element coils of ammeters, voltmeters and wattmeters will cause a low reading while a short-circuit in the resistors of voltmeters and wattmeters will cause a high reading. A partial short-circuit in the element coils, or reactor or resistors of power factor and frequency meters will cause erratic readings Loose connections cause variable and erratic indications.

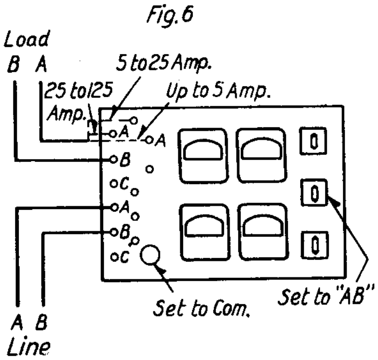
RENEWAL PARTS

When ordering renewal parts, give the name of the part wanted and the style number and serial number of the instrument, which appear on the name plate. Failure to give this information may result in delay.

REPAIRS

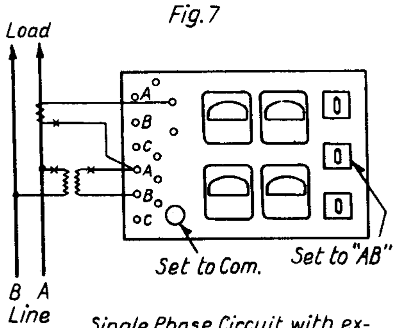
If an instrument is to be returned to the factory for repairs, write to the dealer or nearest Westinghouse Sales Office, for a return material tag, so that the apparatus will be properly identified at the factory.

Fig.6



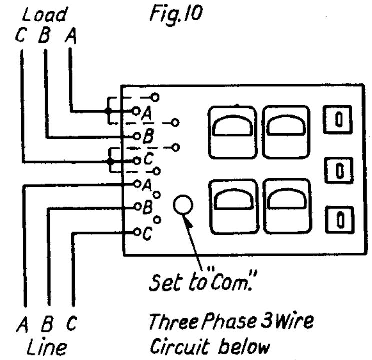
Single Phase Below 125 Amp. and 575 Volts

Fig.7



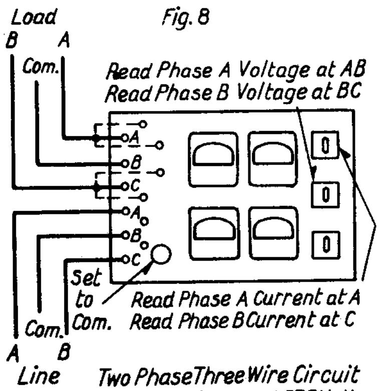
Single Phase Circuit with external current or voltage transformers (or both) for circuits above 125 Amp. and 575 Volts

Fig.10



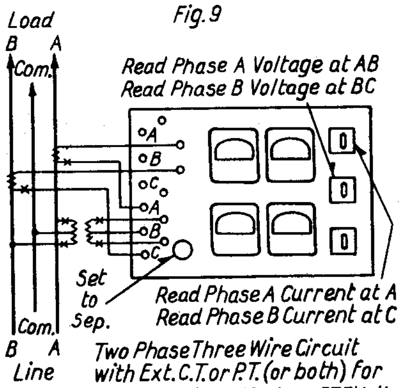
Three Phase 3 Wire Circuit below 125 Amp. 575 Volts

Fig.8



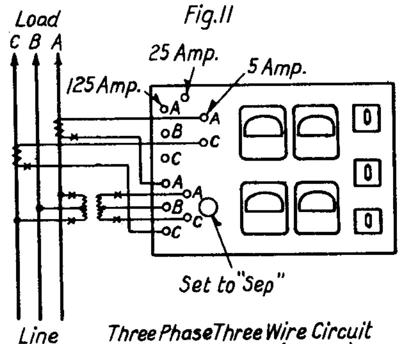
Two Phase Three Wire Circuit below 125 Amp. and 575 Volts

Fig.9



Two Phase Three Wire Circuit with Ext. C.T. or P.T. (or both) for circuits above 125 Amp. 575 Volts

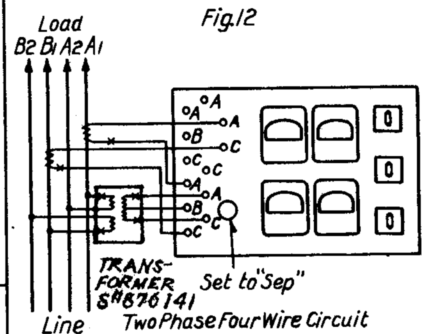
Fig.11



Three Phase Three Wire Circuit with Ext. C.T. or P.T. (or both) for circuits above 125 Amp 575 Volts

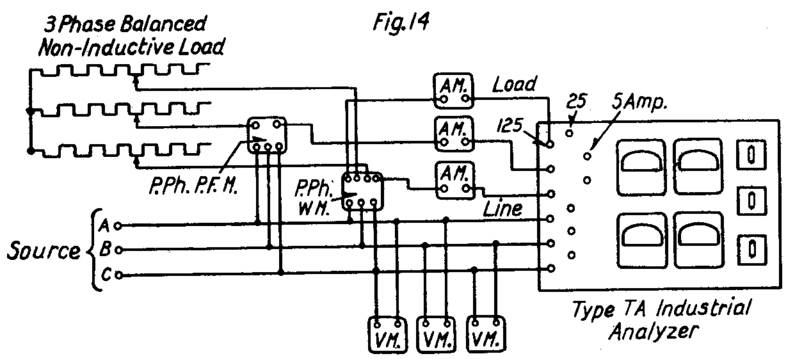
Note:
Two-Phase, Five Wire (4 Phase, 5 Wire) Balanced circuits may be considered as two 2 Phase, 3 Wire Circuits. Connect per Fig. 8 or 9 and multiply wattmeter readings by two for total circuit power. Or take readings of both halves of the five wire circuit according to Fig. 3 or 4 and add wattmeter readings for total power.

Fig.12



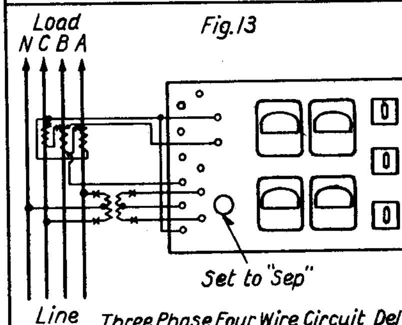
Two Phase Four Wire Circuit External Voltage Transformers must always be used

Fig.14



Connection Diagram for checking calibration of analyzer with portable standards. Connect instruments as shown so that internal losses of analyzer will not enter calibration readings.

Fig.13



Three Phase Four Wire Circuit Delta connected current transformers must always be used. Voltage Transformers must be used above 575 Volts

CIRCUIT PRECAUTIONS

Before opening the secondary circuit of a current transformer, the terminals of the secondary winding must be short-circuited to prevent damage to the transformer and personal injury.