SANGAMO

Lincoln Thermal Meters

SANGAMO ELECTRIC COMPANY, SPRINGFIELD, ILLINOIS, U. S. A.

Bulletin 490 — Issue 3 1951 *Supersedes Bulletin 490 — Issue 2*

1. MAXIMUM DEMAND METERS

A. Installation

General

Lincoln thermal demand meters are shipped completely assembled, adjusted and tested, ready for service. Meters should be installed in a place easily accessible for reading and where there is not excessive vibration.

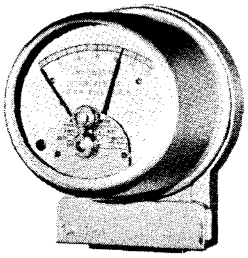


Fig. 1—Type WDA

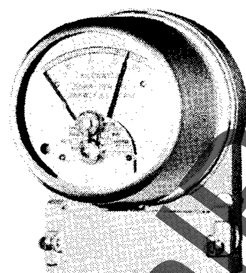


Fig. 2—Type WDP

WDA and WDP Meters

In WDA (Figure 1) and WDP (Figure 2) meters the terminal chambers, terminal blocks and all mounting dimensions are identical with corresponding watthour meters of any manufacture and therefore installation can be made with standard boxes or trims, identical with those used for the watthour meters with which the demand meters are installed.

WDS Meters

In the WDS (Figure 3) meters, the diameter of the base plates and the terminal arrangements are the same as in singlephase or polyphase "S" watthour meters of any manufacture and, therefore, permit the use of identical sockets for both watthour and demand meters.

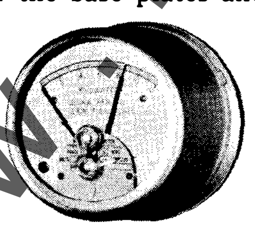


Fig. 3—Type WDS

Graphic Meters

Graphic type thermal meters are considerably larger than service type watthour meters and require more space for mounting. Terminal chambers, however, are such that standard watthour meter trims, boxes or test blocks can be used with Lincoln graphic meters.

Connections

Lincoln ampere demand meters are connected in service by connecting their current coils in series with the current coils of other instruments in the circuit.

Lincoln watt demand meters are installed with their current coils in series with the corresponding current coils of the watthour meters and their corresponding potential coils in parallel.

In all cases except in the case of 5 ampere meters, the Lincoln watt demand meters may be connected either on the *line* or the *load* side of the watthour meter, as the watts loss in the potential coils of any Lincoln demand meter is less than the watts required to start a watthour meter of over 5 ampere capacity. All 5 ampere Lincoln watt demand meters are for use with transformers and are equipped with separate potential terminals. Because the potentials of these meters can be carried to a point ahead of the watthour meter, the demand meter can be mounted on the load side of the watthour meter if desirable. Generally speaking, it is good practice to connect the Lincoln meters or their potentials ahead of the watthour meters, so that the watts loss in the potential coils will not be recorded on the customer's bill, even though the amount is slight. All meters can be supplied with independent potentials if so specified.

B. Testing and Adjusting

General

Because approximately 45 minutes is required for Lincoln meters to reach full indication of a steady load, it naturally follows that the most economical method of testing is to test a group of meters in series. The larger the group the lower will be the cost per meter. It is, therefore, recommended that thermal demand meters be gang-tested in the testing room, instead of individually tested in service.

When testing thermal demand meters, it is essential that the covers be kept on the meters, except during the actual operation of adjusting. When adjustments are to be made, remove the cover from only one meter at a time, replacing the cover as soon as the adjustment is accomplished.

Adjustments

Three adjustments are provided in indicating meters: the zero adjustment, the maximum pointer friction adjustment and the deflection, or full load, adjustment. In graphic meters and in meters equipped with grease-damped pointers there are but two adjustments, as no maximum pointer is involved.

Load checks need be made at only one point, preferably between ¾ full scale and full scale, and if any calibration is required, it should be made at this point. The individual points on the scale are not subject to adjustment. However, at the factory all meters are checked at several scale points to insure that all meters will have the proper inherent scale characteristics.

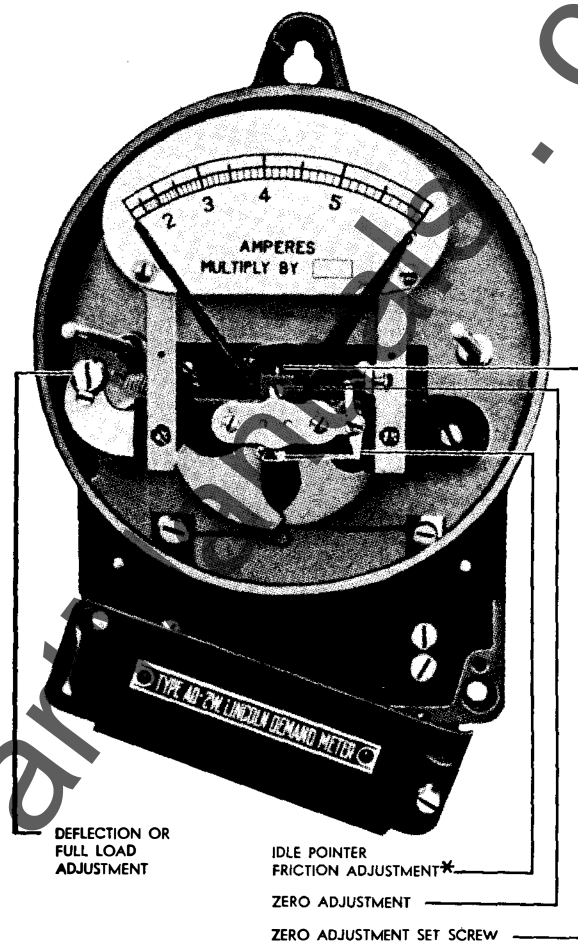


Fig. 5—Lincoln Ampere Demand Meter

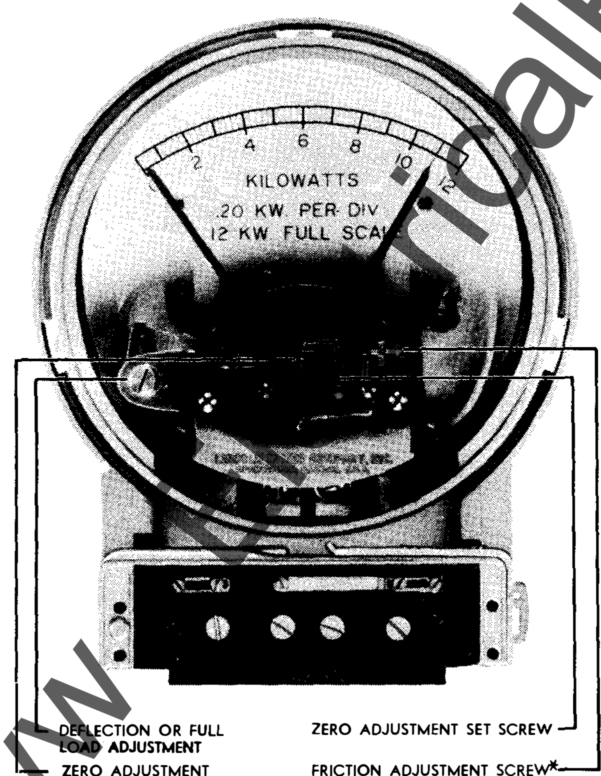


Fig. 4—Phantom View of Type WDA Meter

No provision is made for adjusting balance between elements in three-wire and four-wire meters. All meters are carefully checked for balance at the factory, and the design is such that the balance is not subject to change.

The inherent power-factor characteristics of Lincoln demand meters are such that no provision need be made to adjust the meters for accuracy or inductive loads.

Sequence of Testing Operations:

1. Check zero position of red or pusher pointer.
2. Check friction on maximum pointer.
3. Check meter under load.

* Not present when grease-damped pointer is used.

The Zero Check and Adjustment

Zero should be checked only when the meters have been warmed on potential for approximately 5 hours, and before any load has been applied. Under this condition the reading of the red or pusher pointer, when not in contact with the maximum or idle pointer, should be on the zero line of the meter scale. If any adjustment of the zero position of the pusher pointer is required, it is accomplished through the screw-headed pinion shown in Figures 4 and 5 under the designation "Zero Adjustment," and in the case of graphics by means of the gear wheel shown in Figure 6. The zero adjustment setscrew should be loosened slightly and the zero adjustment then rotated with a small screwdriver. Turning the adjustment clockwise moves the pointer down scale and vice versa.

Friction Type Maximum Pointer

For many years, the maximum pointers on all Lincoln indicating demand meters were equipped with a friction device to prevent shifting of the pointer under vibration. This friction device consisted of a silk thread bearing on a polished aluminum pulley attached to the pointer. On meters equipped with this friction device, all load tests should be conducted with the idle or maximum pointer in contact with the red or pusher pointer. Therefore, before load checks are made, the friction of the maximum pointer should be checked. This can be done in either of two ways. If a friction gauge as shown in Figure 7 is not available, the friction can be determined by depressing the maximum pointer until the red pointer is pushed down scale and then allowing the pointers to come back up scale slowly, till movement stops. The reading thus obtained should be lower than the reading of the pusher pointer alone, by an amount equal to approximately 2-½% of full scale, or by a distance of about 3/32 of an inch.

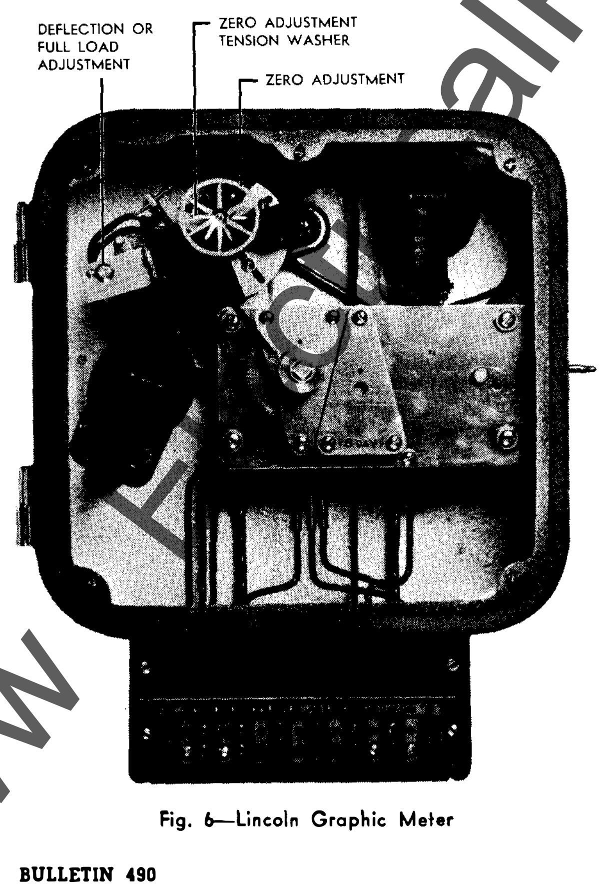


Fig. 6—Lincoln Graphic Meter

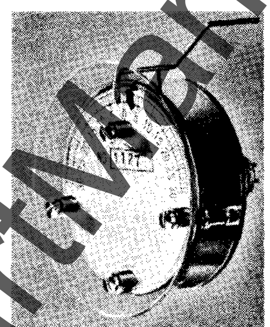


Fig. 7—Friction Gauge

A friction gauge such as shown in Figure 7 is not only a method of determining the friction, but also serves to indicate whether the friction is constant throughout the entire scale range of the meter. To use the gauge, insert the small pins in the rear plug of the gauge into the holes provided in front of the axis of the maximum pointer. Gauges require two plugs, one for AD meters and old style WD meters, and one for WDA, WDP and WDS meters where the holes for the plug are in the number plate. If the number plates of the WDA, WDP and WDS meters are removed, then one length plug suffices for all meters. After setting the gauge in position on the meter, hold it in place by a slight pressure of the thumb of the left hand at the center of the gauge. The projecting finger of the gauge should be behind the maximum pointer. The gauge should then be rotated clockwise slowly and at a steady rate forcing the maximum pointer up scale. The gauge is scaled in millimeter grams and when the friction is correct the gauge pointer should read between 12 and 17 millimeter grams. The gauge pointer should stay within these limits all along the full travel of the maximum pointer.

Adjustment of the friction applied to the maximum pointer is accomplished through the adjustment designated "Friction Adjustment," Figures 4 and 5. To use the adjustment, loosen the setscrew and then turn the adjustment screw to the right to increase the friction. To decrease the friction, back off the adjustment screw slightly and then press the upper end of the adjustment arm over to the right against the adjustment screw.

Grease-Damped Maximum Pointer

Lincoln indicating demand meters in current production are equipped with grease-damped maximum pointers, which do not depend upon friction to prevent shifting of the pointer under shock or vibration. The bridge plate or upper bearing plate for the maximum pointer includes a grooved clutch plate into which a cup-shaped disk on the maximum pointer fits, forming a grease type clutch. A special silicone grease coats all adjacent surfaces of these two members. The nature of this special silicone is such that it resists quick relative movements of the surfaces of the clutch, but conforms readily and smoothly to relative motion of the surfaces when motion is produced slowly. Thus the pointer is protected from shifting under vibration or sudden shock, but moves up scale with negligible friction when driven by a light but steady pressure. The silicone grease changes very little in viscosity over wide ranges of temperature and has extremely low evaporation characteristics under temperatures far in excess of those experienced in meter service. It should, therefore, last for many years without replacement.

If necessary, after long service, to change or replenish the silicone the following procedure should be employed. Clean the surfaces of the clutch, then apply sufficient grease to the working surfaces, so that when the pointer disk is placed into the clutch plate and rotated, some excess will appear around the edges. Wipe away the excess grease and, without separating the pointer and bridge plate, place them on the meter as a unit. No adjusting of the clutch is provided or required. *The maximum pointer should not be bent out of shape as distortion of the balance of the pointer will lower the effectiveness of the clutch.* To check for proper action of the clutch and freedom from friction in the maximum pointer, step the pointer along the entire scale by tapping the lower end of the pointer at the right hand edge with the forefinger with just sufficient force to move the pointer about 1/4 inch at a time. The pointer should show a backlash of .03 to .05 inch from the highest point of each step. The backlash will indicate two things: first, that the clutch is performing its function of resisting quick movements and, secondly, that the pointer has no undue friction. If friction is present the pointer will remain at its maximum point of each step and no backlash will be apparent.

Deflection Adjustment

The adjustment designated "Deflection or Full Load Adjustment" consists of a drum and chain connected to a helical spring which in turn exerts a pull or retarding effect on the red or pusher pointer. By turning the slotted drum head with a screwdriver, the spring's pull on the pusher pointer can be either increased or decreased. If the reading of the meter is low, decrease the tension on the spring and if the reading is high, increase the tension.

On indicating meters, all scale readings must be taken with the pusher pointer pushing the maximum pointer. This is especially necessary on meters equipped with silk thread and friction pulley maximum pointer stabilizing feature. It is a good plan when taking a reading after an adjustment has been made to depress both pointers, and then allow them to return to rest slowly and gently, so that the black pointer indicates the point on the scale to which the pusher pointer will carry it.

On graphic meters since there is no idle pointer involved, the "Deflection Adjustment" is merely employed to bring the pen to the proper scale point on the chart.

With a bit of practice the adjustment of Lincoln demand meters becomes quite a simple process. The main thing in economical testing is to test meters in groups so that the time required to respond to the full value of the load may be divided between a number of meters. The actual calibration of the meters requires little time.

Group Testing

A test rack should be used which provides for the convenient connection of a group of current coils in series and potential coils in parallel. The circuit diagram for a relatively inexpensive and very convenient form of such a test rack is shown in Figure 8. It permits group testing of quantities of meters from 2 or 3 up to as many as 50 meters in series, and can be adjusted to the required meter capacity. When such various loading is imposed on a loading transformer, the phase angle of the loading transformer is seriously affected. Furthermore, if the load is controlled by resistance, great variation in the resistance and losses of the test circuit occurs for widely different quantities and capacities of meters under test.

The arrangement shown in the diagram, Figure 8, permits ready adjustment of load with small losses and also permits elimination of the phase angle between the loading transformer secondary current and the potential applied to the meters.

In the diagram, potential to the meter is taken from phase AB. The primary of the loading transformer is connected to a variac. Moving of the variable tap of this variac changes the magnitude of the voltage applied

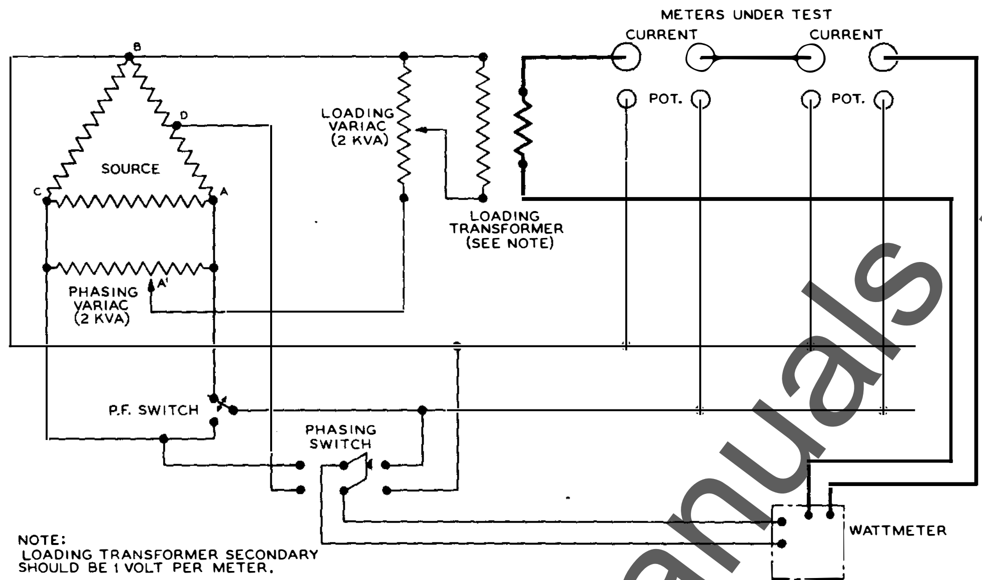


Fig. 8—Circuit Diagram of Lincoln Thermal Meter Test Rack

to the primary, providing a complete range of adjustment of load.

The loading transformer should be so designed that the secondary supplies 1 volt per meter for the maximum number of meters that will be connected in series at any one time. This voltage is sufficient for either singlephase or polyphase meters. The transformer should, of course, be of sufficient capacity to handle the maximum ampere load of the largest capacity meters that are to be tested.

When the loading variac is connected directly across phase AB, the phase angle between the load applied to the meters and the applied potential will vary with the quantity and capacity of the meters under test. Therefore, another variac indicated as the "phasing variac" is connected across phase AC. One end of the loading variac is connected to the moving contact of the phasing variac, this moving contact being designated as A′. The loading transformer primary is A′B and the potentials to the meters AB. By moving A′, the secondary loading current can be brought into phase with the meter potential, regardless of the impedance in the load circuit.

The switch "P.F." is unnecessary for testing thermal meters since the meters are inherently within good accuracy limits and no adjustment for power factor is provided. The switch, however, permits selecting potential BC which is 60° displaced from the load current for 50% power factor loading.

The double-pole, double-throw phasing switch is very convenient in determining unity power factor in the test circuit. The current through the wattmeter is connected in series with the meters under test. The potential for the wattmeter can be transferred to potential CD which is 90° displaced with respect to phase AB. Therefore, when point A′ is moved along the variac across phase AC, until the wattmeter reads zero when its potential is across CD, it is known that the load is exactly 90° out of phase with CD and, therefore, in phase with the potential AB applied to the meters under test. When this power factor condition has been established the switch is then thrown over to connect the wattmeter to the same potential that is applied to the meters under test, and the wattmeter then serves as the indicator for the load applied to the meters. The loading variac can be used to vary the load over wide ranges without disturbing the established phase angle of the test circuit.

In one method of testing, an indicating wattmeter is used to indicate the load on the demand meters. In this case, means must be provided for holding the load steady. A given load, preferably not less than ¾ full scale value of the meters under test, should be applied for not less than 45 minutes, at which time the indication of the demand meters should agree with the standard meter. If the load does not vary too greatly, say, not over 10% plus or minus, it is not necessary to control the load during the first 30 minutes, but the load should be controlled carefully for a final period of not less than 15 minutes. Because the Lincoln meters will indicate 90% of any change in load in 15 minutes, it can readily be seen that an approximate load, except during the final 15 minutes, will suffice to give a sufficiently accurate indication.

Another method of testing consists of connecting a Lincoln graphic meter in the line with the meters under test. The meters may then be loaded to an approximate value for a period of time not less than one hour. The indication of the black, or maximum, pointers of the several meters under test should all agree with the maximum point recorded by the graphic meter.

Tests in Service

When it is necessary to test an occasional thermal demand meter in service the following methods are suggested.

A specially-calibrated Lincoln demand meter of the same capacity as the meter to be tested may be placed in series with the service meter and allowed to remain long enough to get a comparison of the maximum demand readings of the two meters.

Test may be made with an indicating wattmeter and controlled phantom load or resistance load, holding the load carefully during the last 15 minutes of a 45 minute period.

Test may also be made with a rotating standard and phantom load, by timing the speed of the rotating standard with a stop watch. By checking the speed of the test meter at frequent intervals the average load can be ascertained, which should correspond with the indication of the demand meter at the end of the test interval of 45 minutes.

2. MINIMAX MINIMUM-MAXIMUM VOLTMETERS

A. Adjustments

General

The Type V-2 indicating minimax voltmeters have been supplied in both the friction pulley and grease-damped pointer construction. Where friction pulley type minimum and maximum pointers are employed, three adjustments are provided, namely the "Zero Adjustment", "Deflection Adjustment", and "Friction Adjustment". Where the grease-damped pointers are employed, no "Friction Adjustment" is required and hence only two adjustments, the "Zero Adjustment" and the "Deflection Adjustment" are present.

Zero Adjustment

The Type V-2 minimax voltmeters have suppressed zeros and should be set by means of the "Zero Adjustment" to the lowest mark on the scale, after the potential represented by the lowest scale marking has been applied to the meters for at least 30 minutes. The "Zero Adjustment" is made by means of rotating the convolutions of the hairspring attached to the center shaft of the actuating element. The "Zero Adjustment" screw is located just above the front bearing of the center shaft, as shown in Figures 4 and 5. The same procedure for using the "Zero Adjustment" is employed in the case of the Type CCV graphic voltmeters to set the pen to the lowest voltage value on the chart. (See Figure 6.)

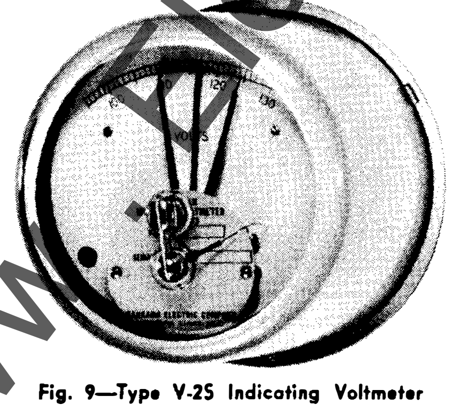


Fig. 9—Type V-2S Indicating Voltmeter

Deflection Adjustment

The second adjustment to be made on the indicating type minimum-maximum voltmeter is the adjustment of the reading of the red or pusher pointer. The red pointer responds to changes in voltage at a rate of 90% of the change in 10 minutes, but it will require 30 minutes for 99.9% of the change. Therefore, in adjusting the position of the pusher pointer, normal voltage should be applied and maintained constant for 30 minutes. The voltage may be approximate for the first 15 minutes but should be held definitely constant during the final 15 minutes. The "Deflection Adjustment" should then be made until the red or pusher pointer reads the correct voltage. The same procedure for setting the "Deflection Adjustment" should be followed in the case of Type CCV graphic voltmeters.

Friction Adjustment

Only the early production used the friction pulley type method of stabilizing the minimum and maximum pointers against shifting under vibration. In these meters it will be noted that the pointers are not stacked one above the other when closed in against the red pusher pointer. Both the minimum and maximum pointers depart from the reading of the pusher pointer by the amount that they retard the pusher pointer when it is driving either of them.

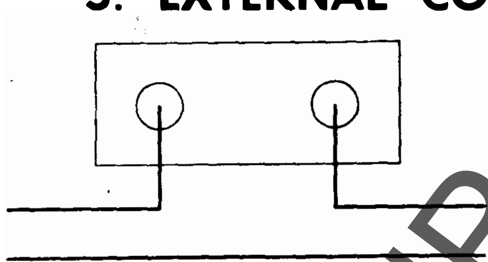
To determine the proper amount of friction for the minimum pointer the voltage applied to the meter should be dropped by 5 to 10 volts without the minimum pointer being in contact with the red pointer. The minimum pointer should then be pressed against the pusher pointer sufficient to move it back up scale by 2 or 3 volts, and then the two pointers in contact should be allowed to slowly come to their point of rest. The minimum pointer should now read the correct voltage. If the voltage reads too low, there is not enough friction on the minimum pointer. If the minimum pointer reads too high it means that too much friction is applied, as evidenced by the fact that the red pointer was unable to bring it to the correct reading. Adjustment of the friction is accomplished in the same manner as that described for indicating demand meters in a previous part of this Instruction Manual.

To check the friction on the maximum pointer, the voltage should be raised by 5 or 10 volts above normal, and maintained sufficiently long that the red pointer is stabilized in its reading, and then the same procedure followed as in the case of the minimum pointer.

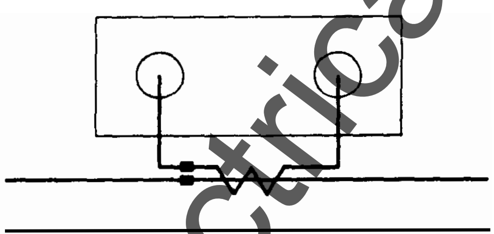
Grease-Damped Pointer

The grease-damped pointers do not retard the reading of the red or pusher pointer appreciably. In this type all 3 pointers will fall one directly above the other when the minimum-maximum pointers are closed in against the pusher pointer. If it is desired to see whether or not the grease-damped pointers are operating satisfactorily, the procedure described under grease-damped pointers in a previous section of this bulletin should be followed.

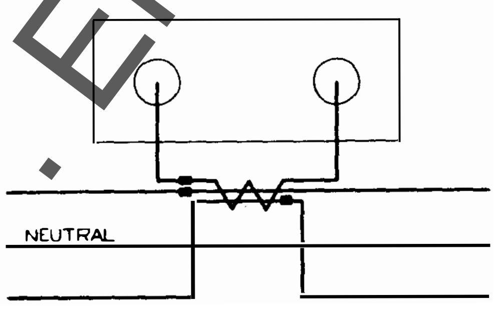
3. EXTERNAL CONNECTION DIAGRAMS



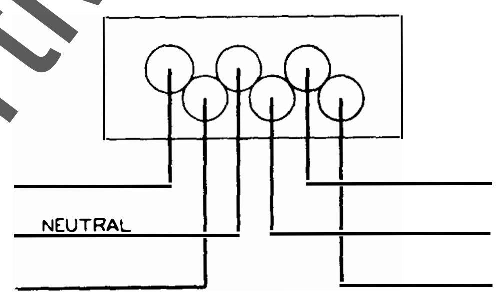
1. AD 2-Wire Meter Self Contained



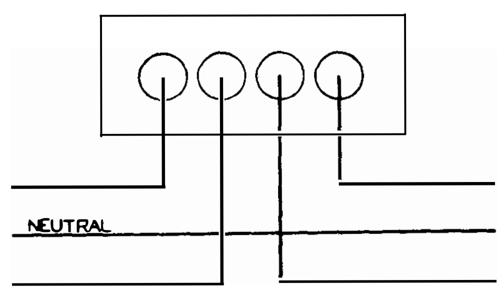
2. AD 2-Wire Meter with 2-Wire Current Transformer



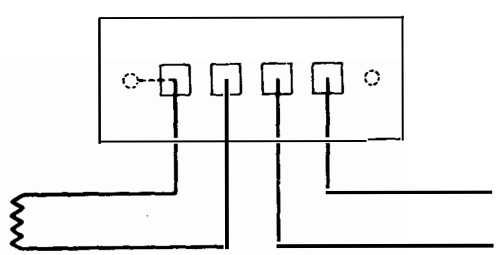
3. AD 2-Wire Meter with One 3-Wire Current Transformer



4. AD 3-Wire Meter Self Contained For Direct Current

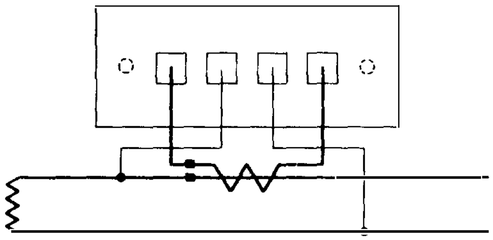


5. ADT Singlephase 3-Wire Meter Self Contained

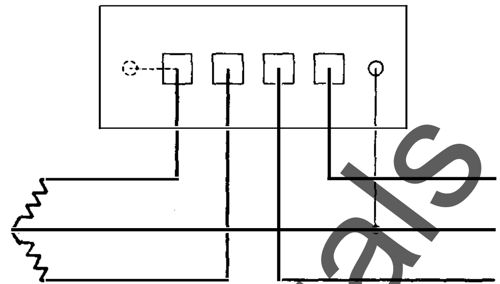


6. WDA Singlephase 2-Wire Self Contained

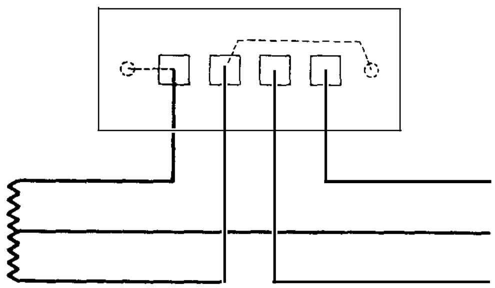
3. EXTERNAL CONNECTION DIAGRAMS



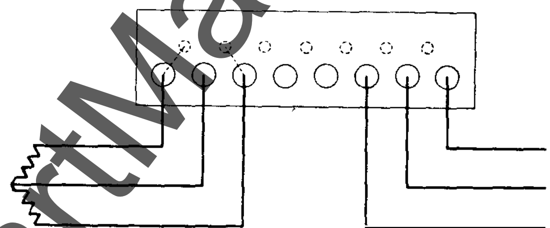
7. WDA Singlephase 2-Wire with One 2-Wire Current Transformer



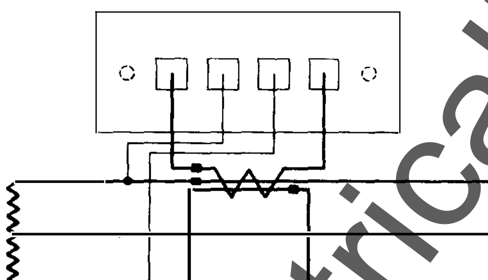
11. WDA 2-Element 3-Wire Self Contained on Network 3-Wire Service



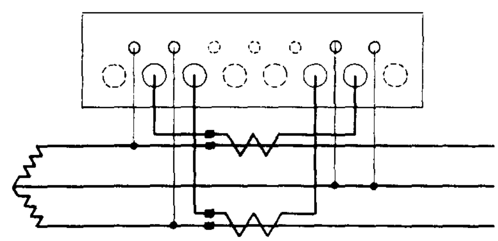
8. WDA Singlephase 3-Wire Self Contained



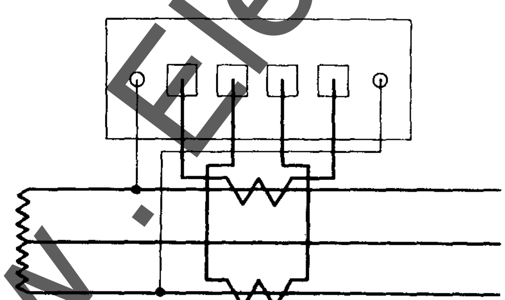
12. WDP and WD 3-Phase 3-Wire Self Contained on Network 3-Wire Service



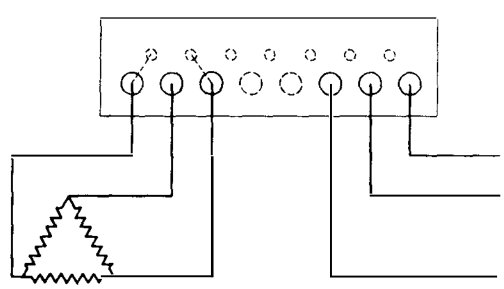
9. WDA Singlephase 2-Wire with One 3-Wire Current Transformer



13. WDP and WD 3-Phase 3-Wire with Current Transformers on Network Service

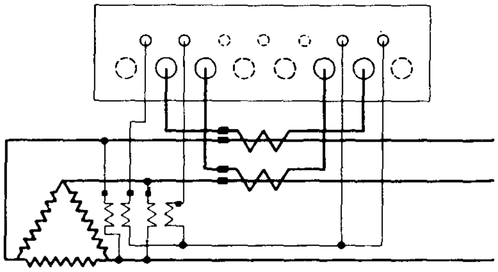


10. WDA Singlephase 3-Wire Meter with Two 2-Wire Transformers

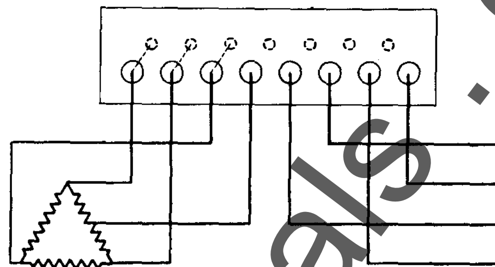


14. WDP and WD 3-Phase 3-Wire Self Contained

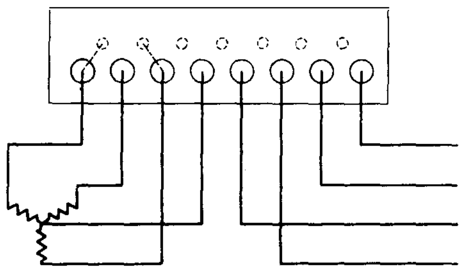
3. EXTERNAL CONNECTION DIAGRAMS



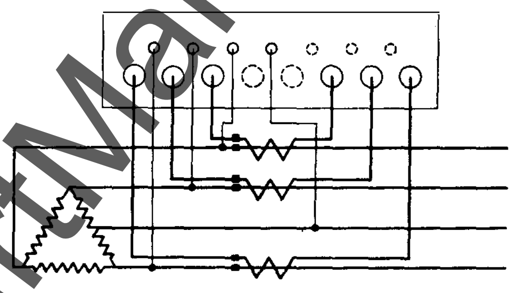
15. WDP and WD 3-Phase 3-Wire with Current and Potential Transformers



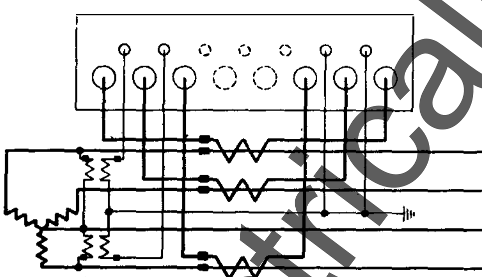
18. WDP 2-Element and WD 2- & 3-Element 3-Phase 4-Wire Delta Self Contained



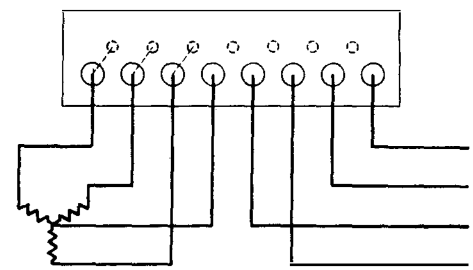
16. WDP and WD 3-Phase 4-Wire 2-Element Wye Self Contained



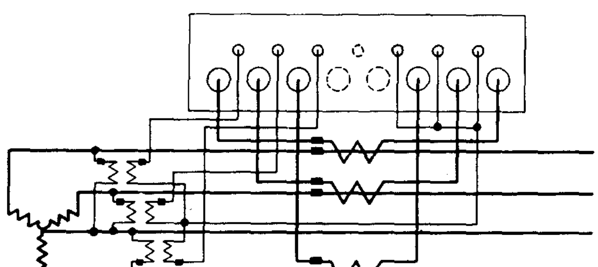
19. WDP 2-Element and WD 2- & 3-Element 3-Phase 4-Wire Delta with Current Transformers



17. WDP and WD 3-Phase 4-Wire 2-Element Wye with Current and Potential Transformers

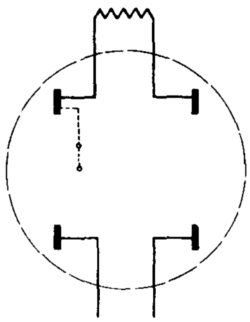


20. WD 3-Phase 4-Wire 3-Element Wye Self Contained

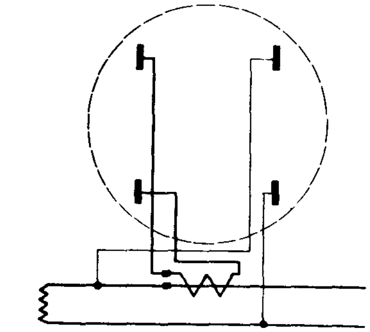


21. WD 3-Phase 4-Wire 3-Element Wye with Current and Potential Transformers

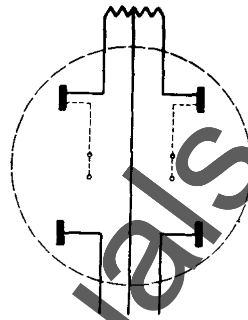
3. EXTERNAL CONNECTION DIAGRAMS



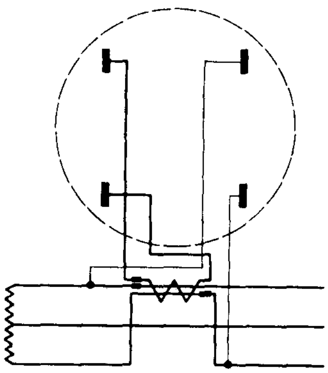
22. WDS Singlephase 2-Wire Self Contained



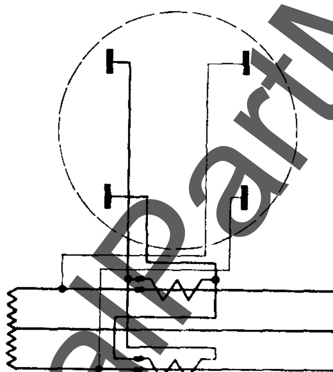
23. WDS Singlephase 2-Wire Meter with Current Transformer



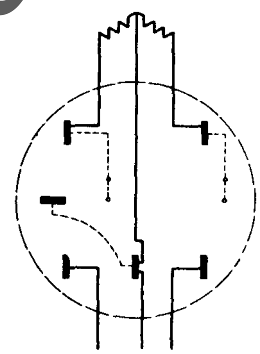
24. WDS Singlephase 3-Wire Self Contained



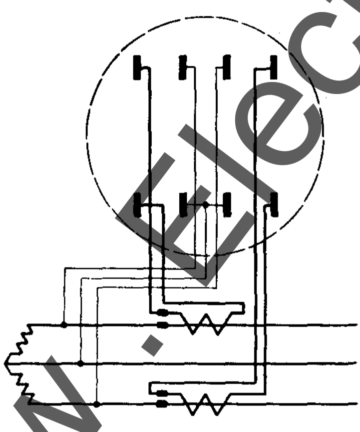
25. WDS Singlephase 2-Wire Meter Used on 3-Wire Circuit with 3-Wire Current Transformer



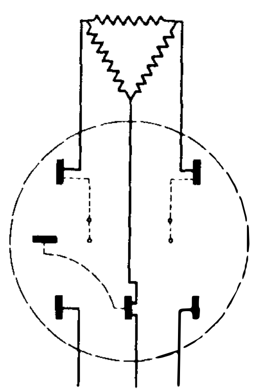
26. WDS Singlephase 2-Wire Meter Used on 3-Wire Circuit with Two 2-Wire Transformers



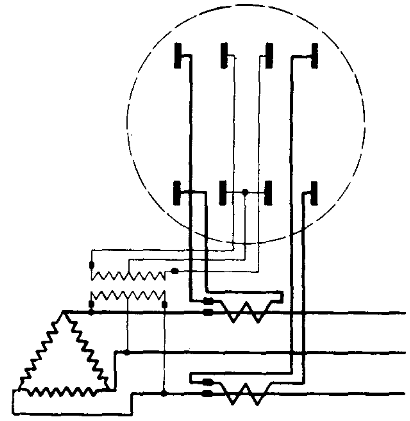
27. WDS 3-Phase 3-Wire Self Contained on Network Service



28. WDS 3-Phase 3-Wire with Current Transformers on Network Service

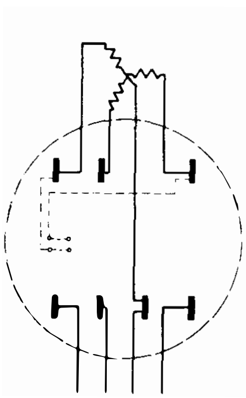


29. WDS 3-Phase 3-Wire Self Contained

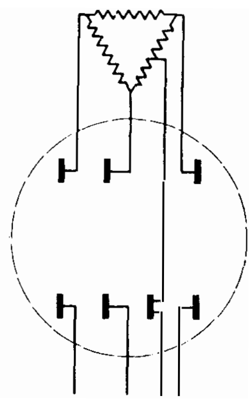


30. WDS 3-Phase 3-Wire with Current and Potential Transformers

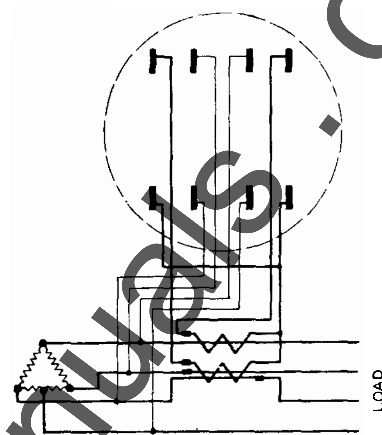
3. EXTERNAL CONNECTION DIAGRAMS



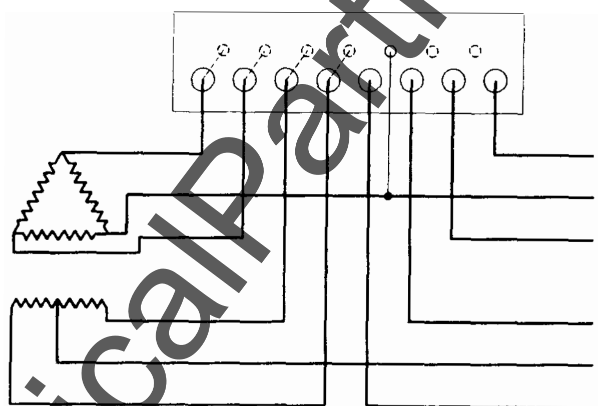
31. WDS 3-Phase 4-Wire
2-Element Wye
Self Contained



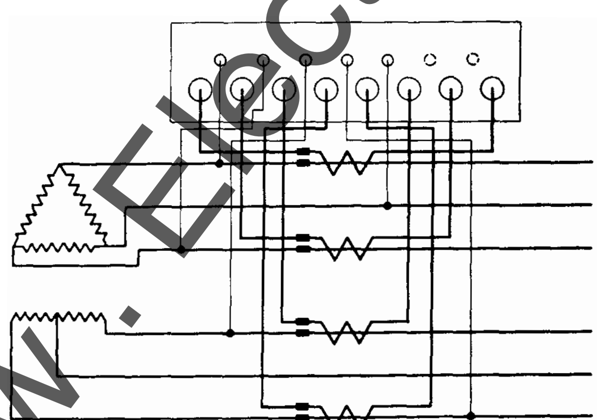
32. WDS 3-Phase 4-Wire
2-Element Delta
Self Contained



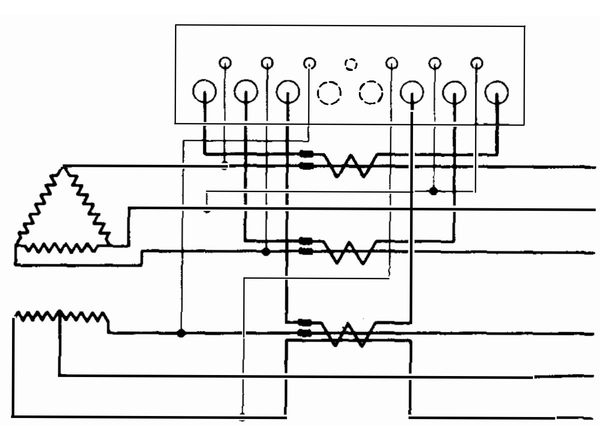
33. WDS 3-Wire 3-Phase Meter Used with One 2-Wire and One 3-Wire Current Transformer for 4-Wire 3-Phase Delta Service



34. WD Multicircuit 3-Phase 3-Wire and Singlephase 3-Wire Self Contained

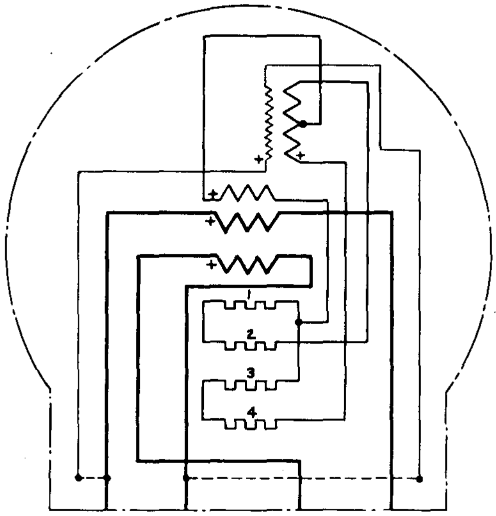


35. WD Multicircuit 3-Phase 3-Wire and Singlephase 3-Wire Using Four 2-Wire Current Transformers

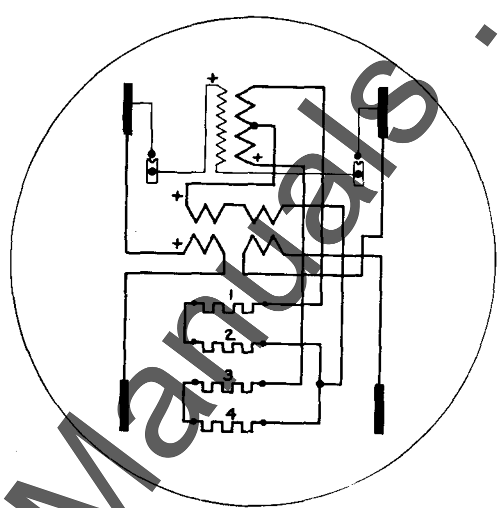


36. WD Multicircuit 3-Phase 3-Wire and Singlephase 3-Wire Using 3-Wire Current Transformer in Singlephase Circuit

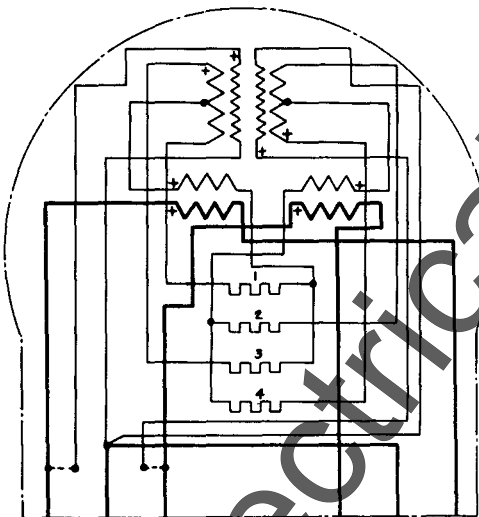
4. REPRESENTATIVE INTERNAL CONNECTION DIAGRAMS



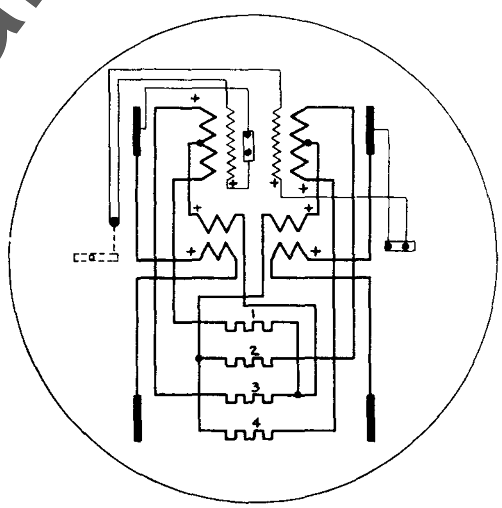
1A. Singlephase 3-Wire Bottom Connected



2A. Singlephase 3-Wire Socket Type



3A. 3-Phase 3-Wire Bottom Connected



4A. 3-Phase 3-Wire Socket Type

SANGAMO ELECTRIC COMPANY

Springfield, Illinois, U. S. A.

Sangamo Company Limited
Leaside, Ontario
Montreal, *Tramways Building*
3M—4-51

Sangamo Weston Limited
Enfield, *Middlesex*
England
Printed in U.S.A.