DEPARTMENT OF TRADE AND COMMERCE

STANDARDS BRANCH

CANADA

E-42

OTTAWA November 10 19 66

NOTICE OF APPROVAL

FOR

FERRANTI TYPE "FMFR" 2-ELEMENT POLYPHASE REACTIVE ENERGY METER

Apparatus

Current Range	0.25 - 10 Amperes			
Voltage	120, 240; and 208, 416			
Elements	Two pairs			
Circuit	3-phase 3-wire and 3*-phase 4-wire Y			
Frequency	60 Hz		*	*
Disc Constant (Kh)	120 volts	240 volts	208 volts	416 volts
Polyphase varh	1.25	2.5	1.25	2.5
Single phase wh	1.0826	2.1652	2.1652	4.33
Register	4-dial clock-type with test dial			
Register ratio (Rr)	133-1/3	66-2/3	160	80
Phase rotation	ABC			

* Reactive energy meters marked with these voltages obtain the required 90° shift in voltage by connecting the potential coils "line-to-line" as indicated in the schematic on the back of this circular.

A reverse running stop prevents the disc from running backward on leading power factors, so that if these meters are to be used on circuits with leading power factors, the connections to the current coils must be reversed so that the disc will rotate in a forward direction. A Maximum Demand Indicator "D" is approved for use on these reactive energy meters. It is similar in appearance to that illustrated on the back of circular "E6" and when installed the type "FMFR" will become "FMFRD". Either the transistorized pulse generator using two photo transistors described on circular "E3" or the inductive pulse generator described on "E29" may be used with these reactive energy meters. The Kvarh per contact will be marked on the nameplate.

The printed circuit card shown on the 120 volt rating illustrated on the back of this circular is used with the transistorized pulse generator using photo transistors.

The inductive type pulse generator is shown on the top right of the type FMF2 illustrated on circular E-29.

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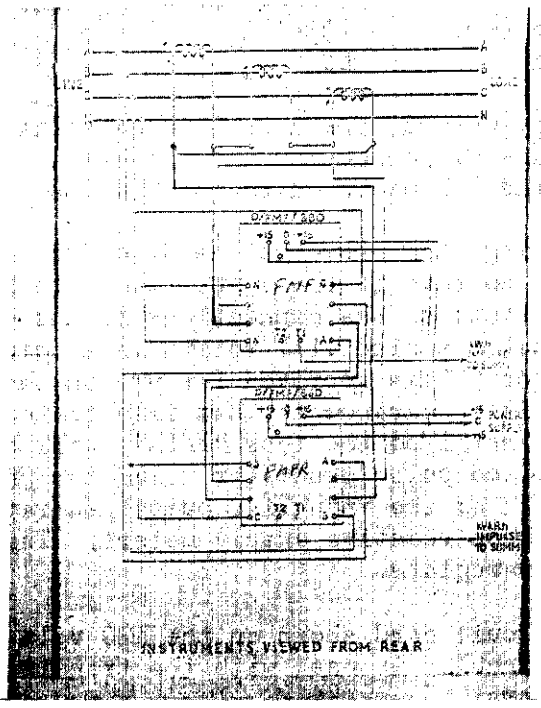
FERRANTI POLYPHASE REACTIVE ENERGY METER

3 PHASE 4 WIRE "Y"



Description

The type FMFR 2-element reactive energy meters are intended for use with instrument transformers to measure the reactive energy in a polyphase circuit.

Meters rated at 120 and 240 volts are intended for use on 3-phase 3-wire circuits and those rated at 208 and 416 volts are intended for use on 3-phase 4-wire Y circuit with delta-connected current transformers. They are not interchangeable.

In all cases there are four electromagnets acting on two discs, but the internal connections for metering a 3-phase 3-wire circuit differ from those used to meter a 3-phase 4-wire Y circuit.

3-Phase 3-Wire 120 and 240 volts

To obtain the required 90° shift in voltage for measuring varhours, the two voltage coils of the upper elements are connected to two different phases, and the two voltage coils of the lower elements are also connected to different phases. The current coils of the two top elements are connected together in series, and the two current coils of the two bottom elements are also connected in series internally. Thus each current is acted upon by two voltages, producing a torque proportional to the vector sum of these two voltages. The phases from which these voltages are taken are chosen so that the vector sum or resultant is at 90° to that of a similar element in a watthour meter. This satisfies the requirement for varhour measurement and is the basis for the polyphase varhour constant and the register ratio.

When verifying on single phase, all the voltages are in phase, so that for a given current and voltage, the disc runs faster than on polyphase by a factor of $2/\sqrt{3}$ so that the polyphase disc constant is reduced by $\sqrt{3}/2$ to change the varhour constant of 1.25 into a watthour constant of 1.0826.

When dial testing on single phase, because the register ratio is based on the varhour constant it is necessary that the single phase load produce 1000/1.25 or 800 disc revolutions for 1 revolution of the test dial. As the single phase test constant is 1.0826, the rotating standard must record for 1 revolution of the test dial 800 x 1.0826 or 866 watthours.

The successful operation of this meter is dependent upon the torque of each of the four elements being equal, so that for verification purposes it will be treated as having four elements. This can be done as the leads to the four current coils are brought out to separate studs.

As of the date of this circular, the reference low load speed is obtained with twice the minimum current flowing through all the current coils in series so that to produce the same reference speed on the separate current coils, the current to be applied would be eight (8) times the minimum.

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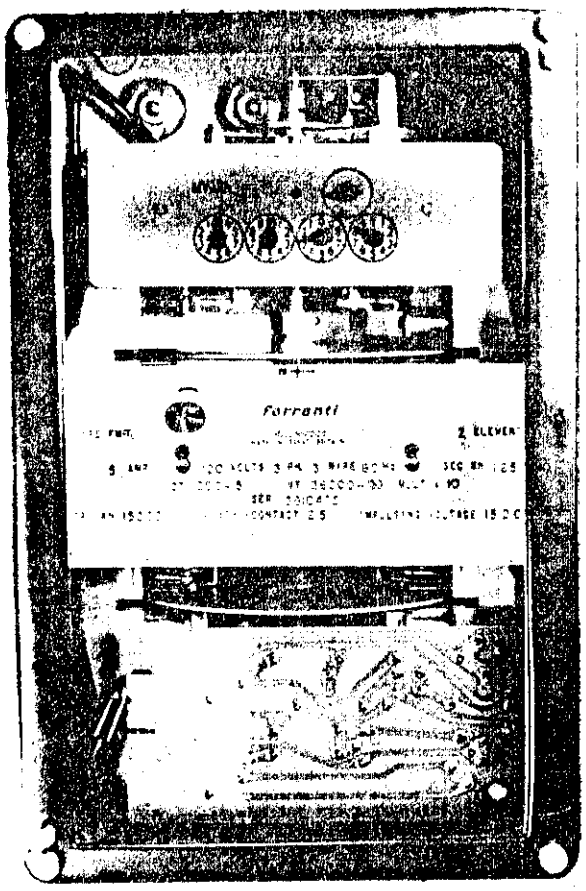
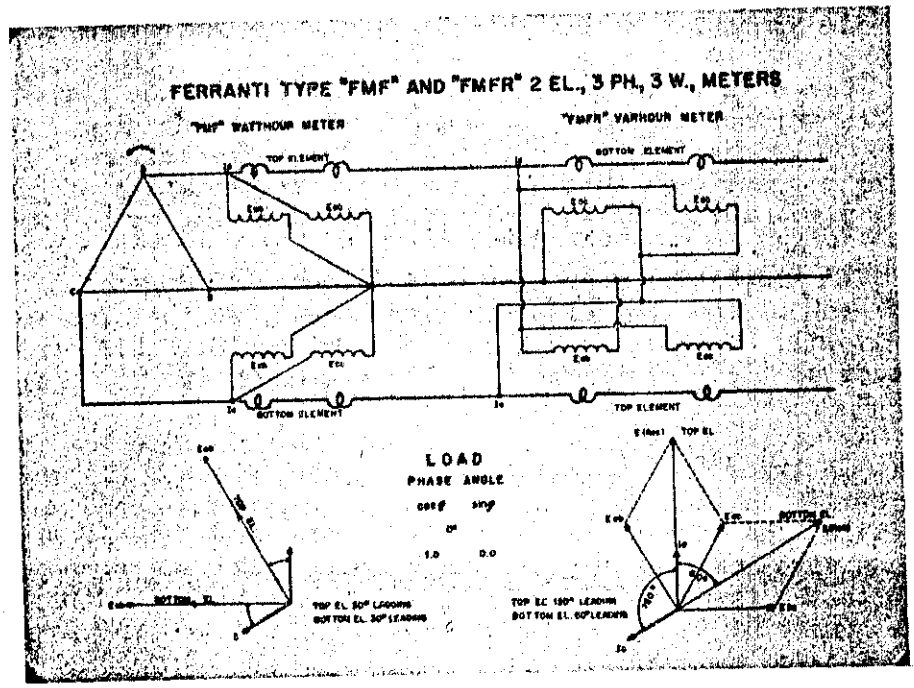
FERRANTI TYPE "FMFR" 2-ELEMENT POLYPHASE REACTIVE ENERGY METER



3 PHASE 3 WIRE



3-Phase 4-Wire Y 208 and 416 volts

Meters intended for use on this circuit have also 4 elements but the potential coils of the two top elements are connected together in parallel and the current coils are connected in series internally. The two bottom elements are connected in a similar manner.

The meter becomes in effect a 2-element meter similar to the type FMF (circular E-3) but having 208 or 416 volt potential coils. As stated before, in order to measure varhours, it is necessary to apply a voltage that is 90° out of phase with that applied to a corresponding watthour meter.

To obtain this required phase displacement, the potential coils of the type FMFR are connected "line-to-line", and the lines to which they are connected are those that have a voltage between them that is displaced by 90° the voltage applied to the potential coils of a corresponding watthour meter.

However, this voltage is $\sqrt{3}$ times the voltage applied to the watthour meter so that the meter and register ratio are adjusted to take care of this $\sqrt{3}$ factor and make the meter record correctly the varhours in the polyphase circuit.

This means that when this meter is verified on single phase with the same connections as the FMF, and the same voltage and current it will run slower by this $\sqrt{3}$ factor, and the single phase test constant will be $\sqrt{3}$ times the polyphase varhour constant, e.g., 2.5 x 1.732 = 4.33.

The register ratio is still related to the varhour constant so that 1 revolution of the test dial requires 1000/2.5 or 400 revolutions of the disc. The rotating standard will therefore record for 1 revolution of the test dial 400 x 4.33 or 1732 watthours.

As this meter is intended to measure the reactive energy in a 3-phase 4-wire Y circuit and has only 2 elements it is necessary to feed the current coils from the delta-connected secondaries of 3 current transformers, one in each line, in the same manner as that used for a 2-element watthour meter in the same circuit.

The terminal markings on the back of the meter are to be used in connecting it to the polyphase circuit, but when verifying, it is to be treated as a type FMF 2-element watthour meter and applying 208 or 416 volts as marked on the nameplate.

This circular supersedes E-4 to include meters for use on 3-phase 4-wire Y circuits in addition to those covered by E-4 which were for use on 3-phase 3-wire circuits.

Approval granted to: Ferranti-Packard Electric Limited,
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