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FUJI INTEGRATING WATT-HOUR METER (III)

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VIII. FUJI SINGLE PHASE A-C INTEGRATING WATT-HOUR METERS, MODELS E-12J AND E-12 (BSS Conformed Integrating Watt-hour Meter)

1. General

Besides the integrating watt-hour meter, Model E-71, which conforms to JIS as described in the previous issue of this journal, Fuji manufactures integrating watt-hour meters to conform to BS 37, Part 1 and Part 2, 1952, to meet the demands of various countries of the world. Fuji manufactures these meters based on its 40-year experience in the manufacture of JIS conformed watt-hour meters.

Two types of BSS comformed integrating watt-hour meters are manufactured: E12-J with molded Bakelite covers and E-12 with metal covers. The electrical characteristics, dimensions, terminals and the construction of the register, etc., conform completely to BS 37, Part 1 and Part 2, 1952; tests conducted at the National Physical Laboratory of Great Britain on Models E-12J and E-12 gave entirely satisfactory results.

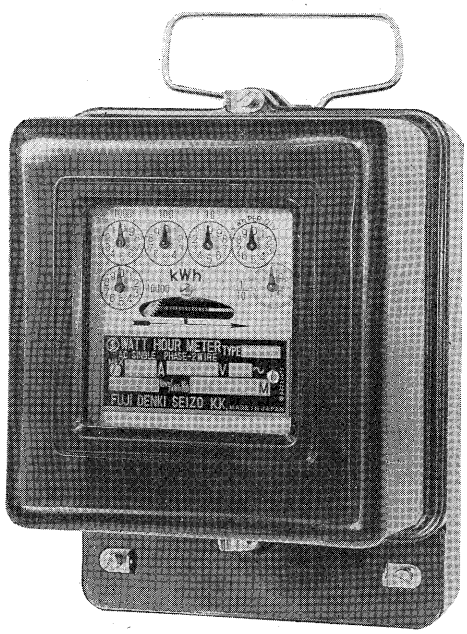


Fig. 44 Single phase 2-wire watt-hour meter with Bakelite molded cover and terminal cover, Model E-12J

Fig. 45 Single phase 2-wire watt-hour meter with metal cover and long metal terminal cover extension, Model E-12

2. Construction

One special feature of BS 37, Part 1 and Part 2 is that it demands a compensation of load characteristic from 1/60 of the marked current to the marked current. Because of the increase in the use of electrical appliances in the home after World War II, power consumption was increased by the use of higher wattage appliances such as electric heaters. These appliances are used for shorter periods than the almost continuous use of power for electric lights and radios. Since this caused the load factor to fluctuate, a highly accurate integrating watt-hour meter that would uniformly register the working power covering a wide range (from light load to overload condition) became necessary. BS 37 Part 1

Fig. 46 Internal construction of E-12J

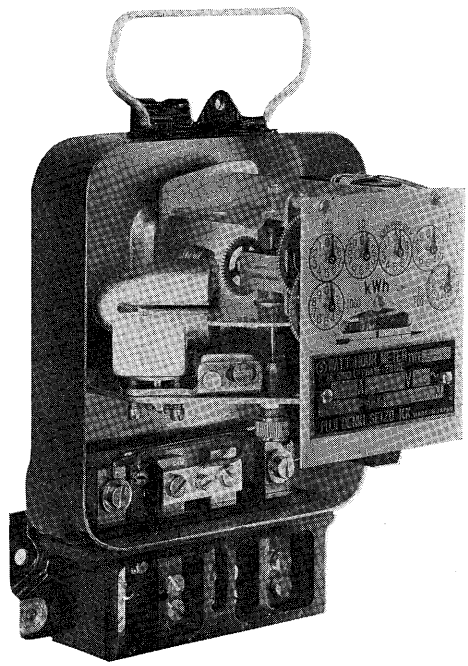


Fig. 47 Internal construction of E-12

and Part 2, to meet such a demand, was set up to establish the standards for a meter that can be used over a wide load range or a wide range integrating watt-hour meter, revising BS 37, 1937.

The technical problems encountered in the manufacture of wide range integrating watt-hour meters:

a) The problem of compensation of a wide load range.

b) The problem of temperature rise at overload.

As has been described in Vol. 9, No. 4, 1963, of this journal, for the compensation of overload characteristic, the Fuji integrating watt-hour meter employs a method in which the current core is provided with a magnetic shunt, a method to decrease the meter constants and a method in which the current flux is small in comparison to the voltage flux. These are used in the most logical way and for this reason, with Fuji's integrating watt-hour meter, Model E–71, it is possible to obtain a characteristic curve that is flat over a wide range of loads from a light load to an overload to satisfy the requirements of BS 37, Part 1, and Part 2, 1952. The temperature rise at overload, even when it does not appear to have any effect, may accelerate the deterioration of the bearing lubricant and adversely affect the life of the meter. Thus, this problem requires serious study; as a solution, the following may be considered:

(1) Decrease the temperature rise by increasing the cross sectional area of the current coil.

(2) Increase the drive torque by making AT larger by increasing the current coil turns.

(3) Increase the drive torque by making the cross sectional area of the voltage core or current core large.

(4) Increase the torque by increasing the rotor thickness. This, however, has a disadvantage of making the frequency characteristic poor.

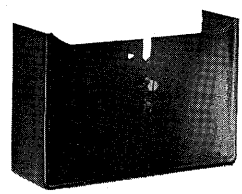
(5) Increase the torque by increasing the radius vector between the rotor and driving element.

Theoretically, (1) makes the use of a meter over a wide range possible by widening the working range at overload and (2)~(5) accomplish the same by widening the working range at light load. However, Fuji's integrating watt-hour meter Model E-71 also has a characteristic that fully satisfies BS specifications regarding temperature rise and characteristics.

As stated above, since Fuji's JIS conformed integrating watt-hour meter, Model E–71 characteristics completely satisfy BSS, its internal mechanisms such as the driving element, braking magnets, rotor and every adjusting device are the same as those of Model E–71. Consequently, for the internal mechanism and adjusting method of Model E–12J and E–12, please refer to the last issue of this journal.

Fig. 48 Terminal cover of E-12J (Bakelite molded standard short cover)

Figi. 49 Terminal cover of E-12 (Metal terminal cover extension)



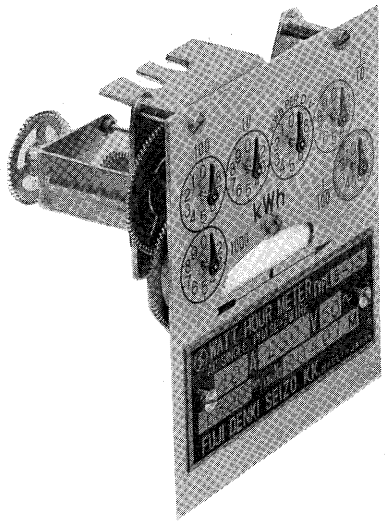


Fig. 50 Register

1) Base

The base for Model E–12J is made of high insulation molded Bakelite and has sufficient mechanical strengh. To prevent generation of harmful gases, the Bakelite used is of high quality and is given an "after cure" treatment.

The base for Model E–12 is pressed from highly finished steel plate; both the interior and exterior surfaces are given a careful rust-proofing treatment to make the base completely weather-proof. For easy transportation, both Models E–12J and E–12 are provided with carrying handles.

Attaching dimensions of the meter conform completely to BSS specifications.

2) Covers

The cover for Model E–12J, like the base, is molded of high quality Bakelite; the cover for Model E–12 is pressed from aluminum. Neoprene rubber packing is used between the base and cover to make the joining section completely dust-proof, water-proof, weather-proof and air-tight.

3) Terminal box and terminal cover

The terminal box is made of high insulation Bakelite to house the terminals. It fully ensures the insulation of each current circuit. The terminal cover for Model E–12J is of molded Backelite and it comes in two Models: a long extended cover and a standard short cover. The terminal cover for Model E–12 is a long extended cover made by pressing it out of a highly finished steel plate. This covers the terminal box and the attaching holes below; for dust- and moisture-proofing, a rubber packing is attached. Moreover, the terminal cover is constructed so that it can be sealed.

4) Register

The standard register used is a pointer type conforming to BSS; it has large clear figures and scale divisions for easy and accurate reading. The dial plate surfaces are given a weather-proofing treatment and do not fade or discolor even after many years of outdoor use. Because of the use of highly finished gears, shafts and bearings, the friction of the register is extremely small.

On request, a cyclometer type register of either 5 or 6 figures can be attached in place of the pointer type.

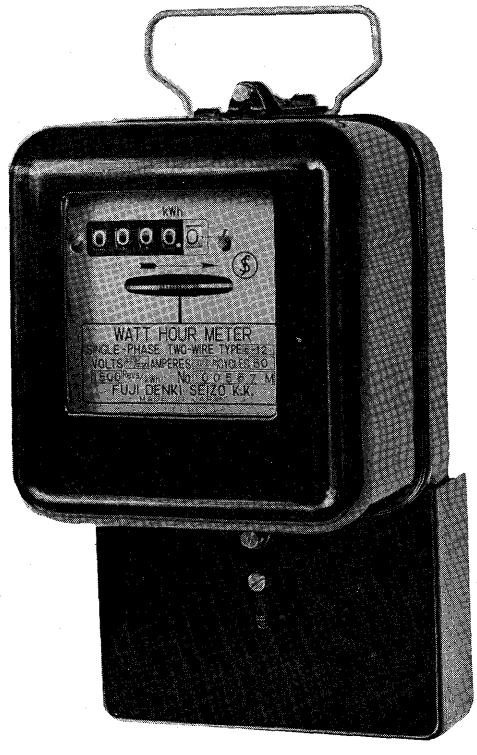


Fig. 51 Model E-12 with 5-figure-cyclometer type register

3. Rating

The standard marked currents, based on BS 37, Part 1 and Part 2, 1952, are 10, 40 and 80 amp; however, on request, meters with almost all kinds of marked currents less than 100 amp, can be manufactured. Standard rated frequency is 50 or 60 cycles. Meters with all kinds of marked voltage are available on request.

4. Characteristics

Typical examples for Models E–12J and E–12 are shown in *Fig. 52*

5. Technical Data

Starting current

Less 0.25 % of the marked current

Voltage circuit: The power loss of the marked voltage is less than 0.7~0.9 w or 3.04~3.67 va approx.

Current circuit: The power loss of the marked current:

At 10 amp less than 3.73 w approx.
At 40 amp " 3.48 w "
At 80 amp " 4.43 w "

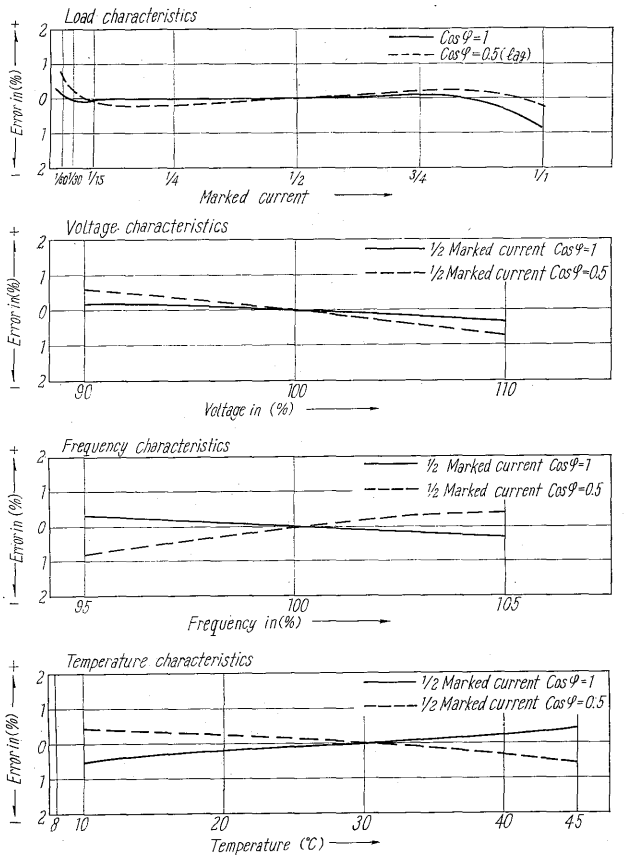


Fig. 52 Charactereristic curves of Model E-12 & E-12J

Driving torque : Average torque at marked voltage and current, unity power factor
At 10 amp and 40 amp 11 g-cm
At 70 amp 10 g-cm

Rotor weight : Approx. 18.8 g.

Rotor speed : Rotor speed when the marked voltage and current, unity power factor is 1 : 60 rpm.

IX. FUJI SINGLE PHASE A-C INTEGRATING WATT-HOUR METER, MODEL E-16Z (NEMA Specifications Conformed Integrating Watt-hour Meter)

1. General

Model E–16 is a socket type, single phase three wire, single element, single disc integrating watt-hour meter meeting NEMA specifications. The NEMA specifications demand assurance of characteristics over a wide range : from 100% to 1% of the class and the socket type in construction. In above two pionts, this specification is very different from JIS and BSS. Fuji, utilizing its many years of experience in the manufacture of integrating watt-hour meters, has developed and is manufacturing a new meter, Model E–16Z. A description of this meter will be given in the following paragraphs.

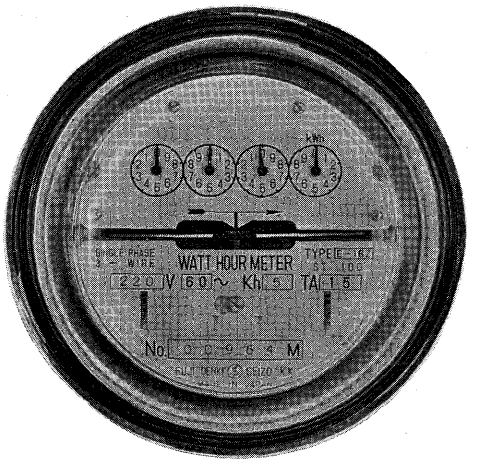


Fig. 53 Single phase 3-wire watt-hour meter, Model E-16Z

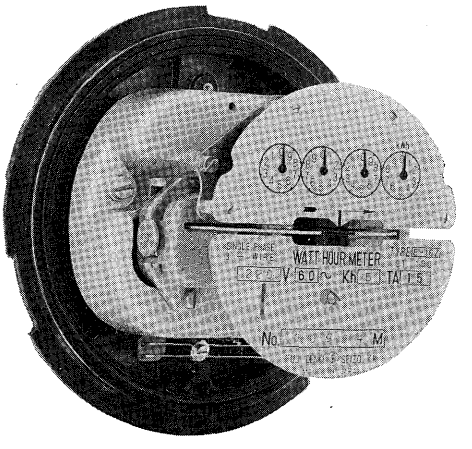


Fig. 54 Internal construction of Model E-16Z

2. Construction

1) Base

The base is made of Bakelite which has high insulation resistance, sufficient mechanical strength and weather resisting qualities. A voltage circuit separator device and lightning arrestor are attached to the base. (*Fig. 55*)

2) Cover

The cover is made of a stainless steel frame and high quality glass ; the inner surface of the cover is coated with a special chemical liquid to prevent clouding. A highly weather-resistant neoprene packing is used between the cover and base to prevent the invasion of dust and moisture. (*Fig. 56*)

3) Frame

The frame requires sufficient strength for mounting the principal parts of the meter ; the frame for Model E–16Z is made by die-casting an aluminum alloy ; since it is constructed with full mechanical strength, it can withstand vibrations and impacts. The outer surface, after a rust-proofing treatment, is given an attractive coat of paint. (*Fig. 57*)

4) Current element

The current element is composed of one current core and two sets of current coils. Between the poles of the current core a magnetic shunt is provided to compensate the load characteristic over a wide range.

5) Voltage element

The voltage element is made up of a voltage core and voltage coils. The core is made of laminated high quality silicon steel plates with excellent magnetic characteristics; to increase the torque for improving the load characteristic over a wide range, the core cross-sectional area is made larger in comparison to Models E–71 and E–12. For temperature characteristic compensation, a piece of magnetic alloy steel is attached on the top of the core. (*Fig. 58*)

6) Braking magnets

For the braking magnets, Alnico steel magnets having a large coercive force die-casted with an alminum alloy are used. This magnet does not demagnetize when heated, shocked or placed in external disturbance field; because of its stabilized characteristics, it is suitable for equipment such as watt-hour meters requiring constant charactersstics for a long time. Two magnets of this type are attached symmetrically in respect to the rotor. Since they balance during magnetization, no lateral thrust or abnormal vibration is created on the disc and only the rotating thrust acts on it. A full load adjusting device is attached on each magnet and can be fine adjusted easily with a screw driver. (*Fig. 59*)

7) Rotor

The rotor is constructed of a high quality aluminum disc die-casted on the rotor shaft with a special alloy. For tests by the master meter method, the periphery of the disc is divided into 100 equal divisions and for tests by the stroboscopic method, 250 equal slits are also cut. To prevent creeping, the disc is provided with two small holes at positions symmetrical to each other. A pinion for coupling to the register and a bearing for the shaft needle of the upper bearing are attached on the rotor shaft. The bearing holding this needle is a jewel bearing

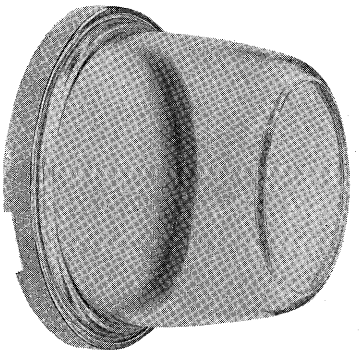


Fig. 56 Cover

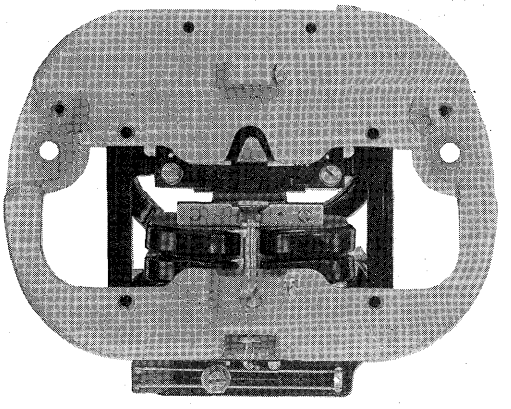


Fig. 57 Frame

to reduce friction. The radius of this rotor disc is larger than those of Models E–71 and E–12. The purpose of this is to make the acting radius of the driving element large in order to improve load characteristics over a wide range.

8) Upper bearing

The upper bearing is a needle bearing and is attached to the frame with a spring.

9) Lower bearing

To decrease deterioration, a double jewel bearing is used as the lower bearing. The surfaces of the steel ball and jewel are highly polished and only those which have passed rigid microscopic tests are used. For this reason, this bearing has very little friction and is stable even after long use. (*Fig. 60*)

10) Register

The register is the pointer type with either 4 or 6 figures and is the standard type manufactured. The bearing of the spur gear that meshes with the pinion of the rotor shaft is a jewel bearing to decrease friction; because of careful assembly, the friction

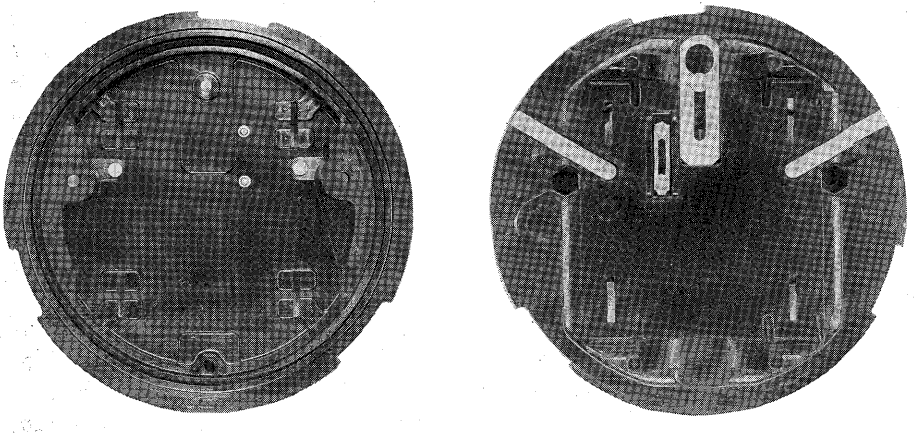


Fig. 55 Base

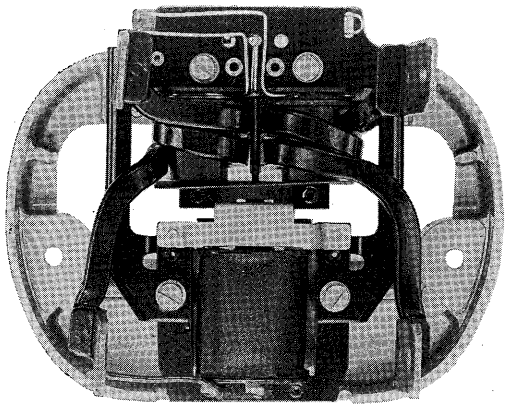
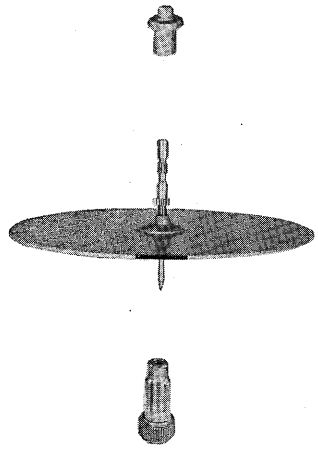


Fig. 58 Driving element



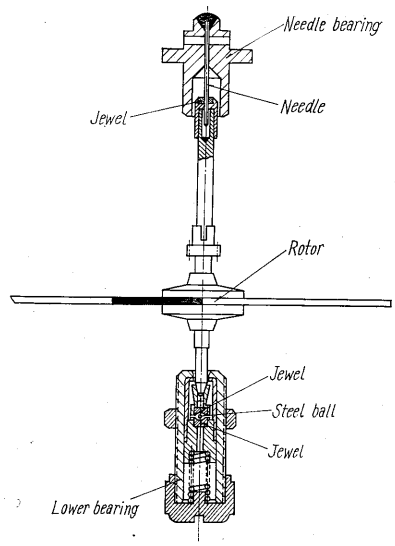


Fig. 60 Rator and bearings

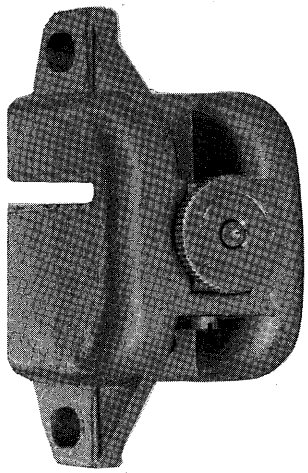


Fig. 59 Braking magnet

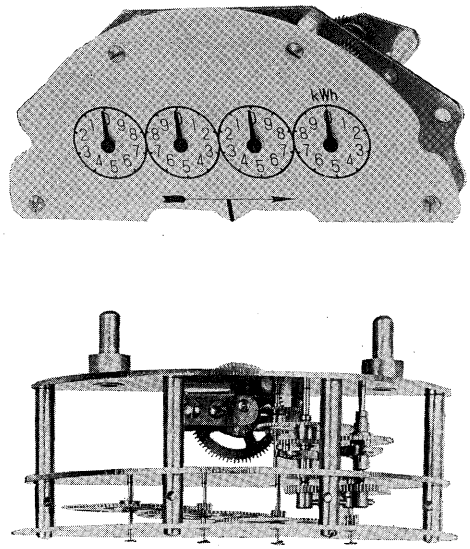


Fig. 61 Register

that adversely affects the meter characteristics is small. Moreover, because of a reverse rotation addition device, even when the rotor turns in the reverse direction, the register adds the calculating amount. (*Fig. 61*)

3. Adjusting

1) Full load adjusting

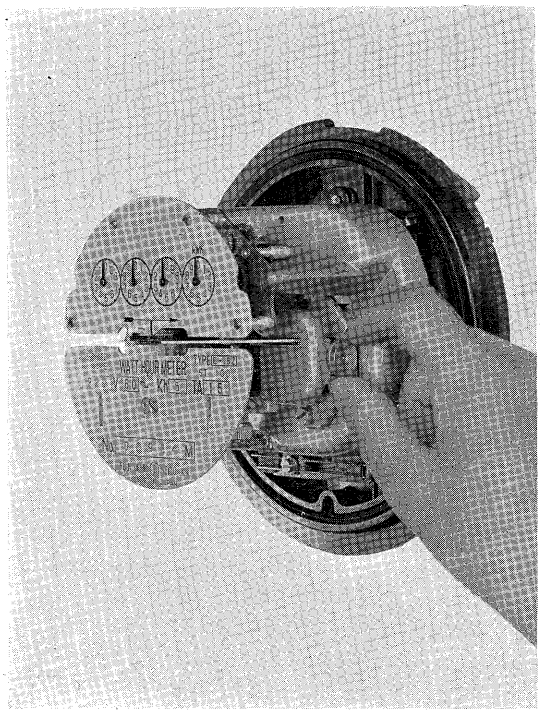
Full load adjusting can be accomplished by turning the adjusting screw attached on the braking magnet clockwise (+) or counterclockwise from side of meter. The error due to the rotation of the adjusting screw is as shown in the diagram below. (*Fig. 62*)

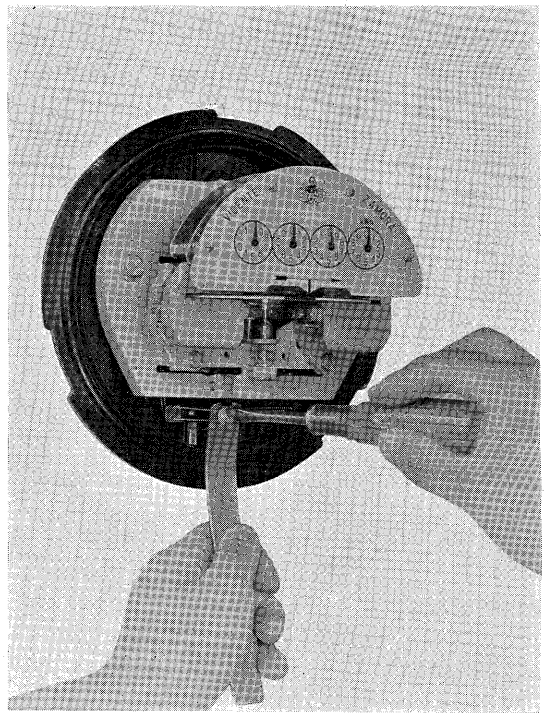
2) Light load adjusting device

The light load adjusting device is attached on the voltage element; the adjusting piece attached on the tip of the iron connector that protrudes in the direction of the rotor center is turned with a screw driver from the lower side of the meter either clockwise (+) or counterclockwise (−) for adjustment. The error due to the light load adjusting piece is as shown in the diagram below. (*Fig. 63*)

3) Power factor adjusting device

The power factor is adjusted by moving a shorting metal piece attached on a resistor connected in series with the power factor adjuster coils wound on both legs of the current core either to the right (−) or to the left with a screw driver and shorting piece holder. The variation of error due to the movement of the shorting piece is as shown in the diagram below. (*Fig. 64*)





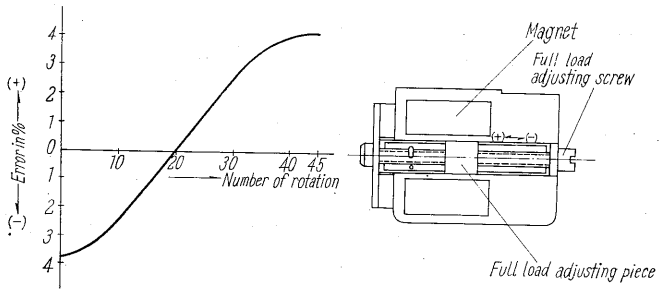


Fig. 62 Full load adjuster

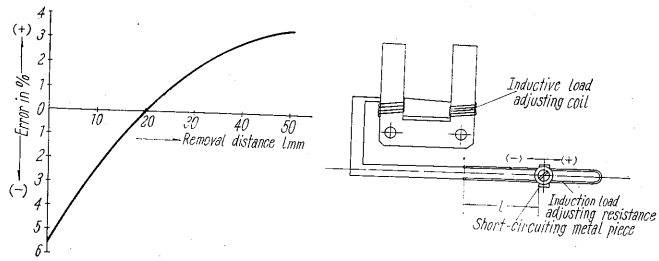
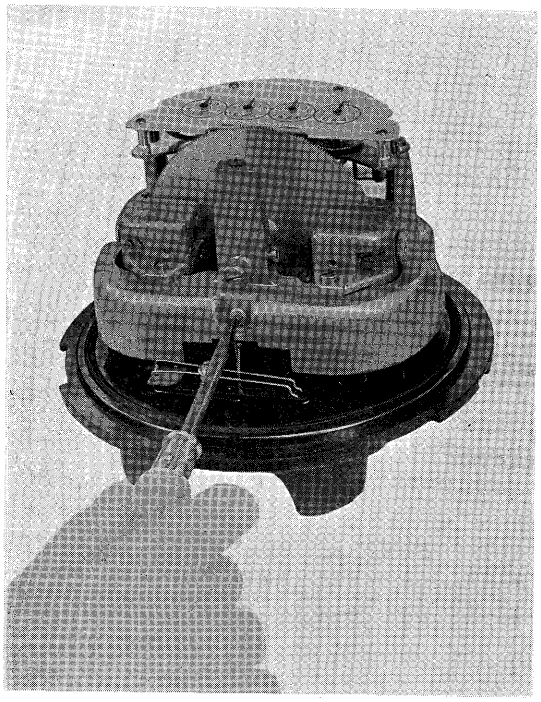


Fig. 64 Inductive load adjuster



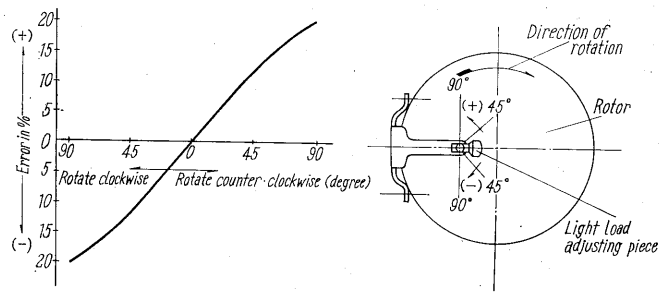
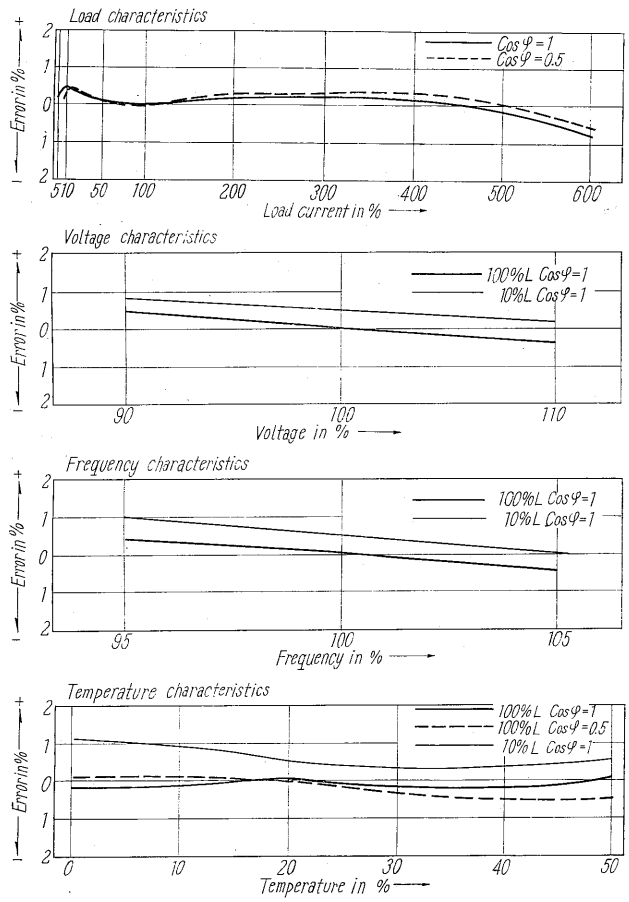


Fig. 63 Light load adjuster

4. Characteristics

Typical characteristics of Model E-16Z are shown in the diagram below.



Fg. 65 Characteristic cuvres

5. Technical Data

Rpm at test current: 11 rpm
Torque at test current: 3.5 g-cm.
Rotating parts weight: 22.4 g
Torque at test current/rotating parts weight: 0.156
Mechanical factor of merit at test current: 0.301

	Potential circuit (220v 60cy)	Current circuit (15amp)
Apparent power (va)	4.18	0.346
Exciting current (ma)	19	—
Power loss (w)	1.08	0.284
Voltage drop (v)	—	0.02305
Resistance (ohm)	847	0.00153

Starting current: With rated voltage and unity power factor, will start with under 1.0% of test current and continue its rotation.

Voltage creeping: Under 110% of rated voltage and at rated frequency when no load, meter armature will not rotate more than 1 turn.

Insulation resistance: When measured with d-c 500 v, for insulation resistance of meter value will be maintained above 10 M ohm for both between electric circuit and base and between voltage circuit and current circuit.

Insulation strength: Meter can withstand sine wave a-c voltage of 2000 v, 50 cy or 60 cy between electric circuit and base for 1 minute.

Meter weight: 2.4 kg.