No. 806,573. PATENTED DEC. 5, 1905.

J. L. ROUTIN.

MEANS FOR ASCERTAINING THE POWER FACTOR IN ALTERNATING CURRENT SYSTEMS.

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Fig. 1

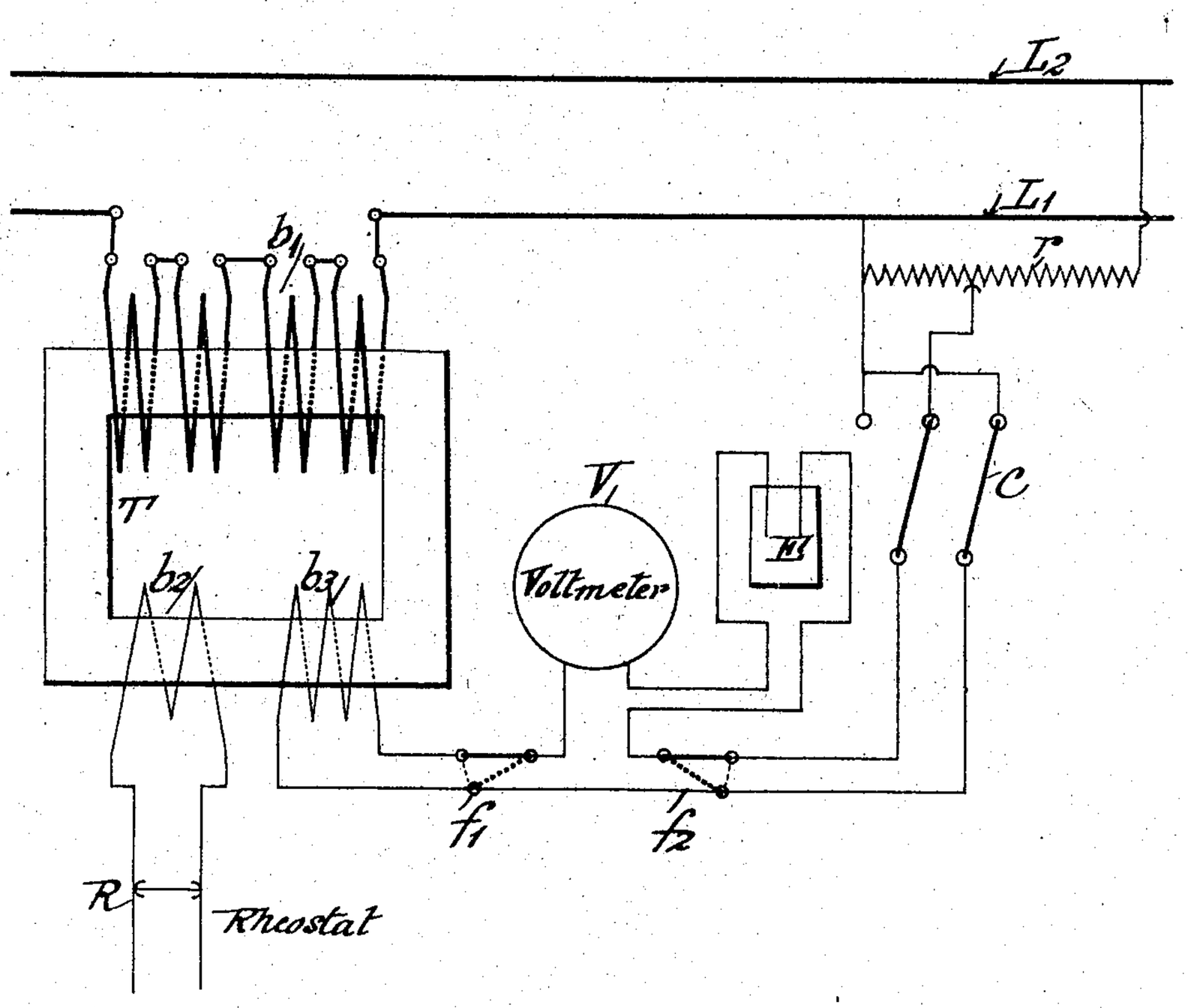
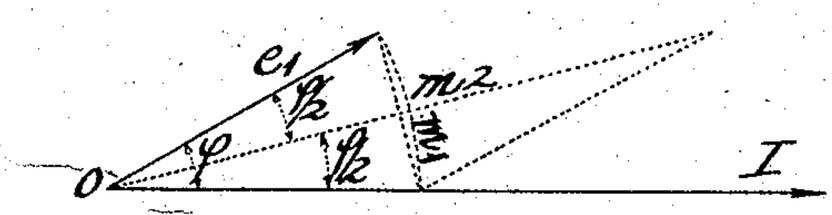


Fig. 2



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JOSEPH LOUIS ROUTIN, OF LYON, FRANCE.

MEANS FOR ASCERTAINING THE POWER FACTOR IN ALTERNATING-CURRENT SYSTEMS.

No. 806,573. Specification of Letters Patent. Patented Dec. 5, 1905.

Application filed November 21, 1904. Serial No. 233,682.

To all whom it may concern:

Be it known that I, JOSEPH LOUIS ROUTIN, engineer, a citizen of the French Republic, residing at Lyon, France, have invented certain new and useful Improvements in Means for Ascertaining the Power Factor in Alternating-Current Systems, of which the following is a specification.

This invention relates to new or improved means for ascertaining in alternating-current systems the factor by which the apparent power must be multiplied in order to obtain the actual power in watts.

In the accompanying drawings, Figures 1 and 2 are diagrams illustrating the invention.

The apparatus comprises a transformer T, Fig. 1, comprising three coils b_1, b_2, and b_3. The coil b_1 carries the main current, the coil b_2, consisting of a small number of turns of thick wire, is connected to a rheostat R of adjustable resistance and free from self-induction, and the coil b_3 is connected to one of the mains L_1 and to one terminal of a voltmeter V, the other terminal of which is connected to the other main L_2, but these connections to the mains are interchangeable at will by means of a switch C.

Two keys f_1 and f_2 allow of using the voltmeter V for measuring the potential D between the mains L_1 and L_2 or the potential D between the terminals of the coil b_3.

The method for making a measurement is as follows: The key f_1 is moved into the position indicated in the drawings by dotted lines, and the potential between the mains, which shall be called e_1, is read off the voltmeter. The key f_1 is thereupon moved back to its original position and the key f_2 is moved into the position indicated in the drawings by dotted lines. The rheostat R is thereupon adjusted until the potential between the terminals of the coil b_3, which shall be called ε_1, is equal to e_1. The transformer T is so constructed that under these conditions the potential on the coil b_3 is substantially in phase with the current on the mains and that the said potential is also at all times proportional to the said current. The key f_2 is then moved back to its original position, and the potential m_1 resulting from the opposition of ε_1 to e_1 is noted. Then

$$\cos.\ \varphi = 1 - \frac{m_1^2}{2\ e_1^2},$$

as will be demonstrated hereinafter. Since e_1 is in practice a constant, a special scale can be traced on the voltmeter to directly indicate φ or the power factor $\left(1 - \frac{m_1^2}{2\ e_1^2}\right)$. To obtain a larger approximation, the potential m_2 resulting from the addition of ε_1 to e_1 can be ascertained. To do this, the switch C is operated. The angle φ will then be given by the equation $\tan. \frac{\varphi}{2} = \frac{m_1}{m_2}$, as will be seen from Fig. 2. I will now demonstrate the first equation cited. Let e be the instantaneous potential on the terminals, e_1 the effective potential on the terminals, i the instantaneous tension, i_1 the effective tension, T the inverse frequency, W the power in watts, ε the auxiliary electromotive force supplied by the transformer, ε_1 the effective value of ε, m_1 the effective value of the resultant of e and ε. The value to be ascertained is

$$W = \frac{1}{T}\int e\ i\ d\ t,$$

now

$$i = \frac{\varepsilon}{K},$$

$$\therefore \quad W = \frac{1}{K}\frac{1}{T}\int e\ \varepsilon\ d\ t.$$

The reading on the voltmeter gives

$$m_1^2 = \frac{1}{T}\int (e - \varepsilon)^2\ d\ t,$$

$$\frac{1}{T}\int e\ \varepsilon\ d\ t = \frac{e_1^2 + \varepsilon_1^2 - m_1^2}{2},$$

$$\therefore \quad W = \frac{1}{K}\frac{e^2 + \varepsilon_1^2 - m_1^2}{2}.$$

If the resistance in the secondary circuit is so regulated that $\varepsilon_1 = e_1$, then

$$W = \frac{1}{K}\ e_1^2\ \left(1 - \frac{m_1^2}{2\ c_1^2}\right\} = \frac{1}{K}\ e^2\ \cos.\ \varphi.$$

$$\cos.\ \varphi = 1 - \frac{m_1^2}{2\ e_1^2}.$$

The voltmeter V must have sufficient resistance to render the consumption of power therein immaterial to the measurements, for this purpose a direct-current voltmeter preferably used in series with a small electrolytic cell E.

If the coil b_2 were dispensed with and the rheostat R connected to the terminals of the coil b_3, the rheostat must have a very much higher resistance and must comprise a long thin wire instead of massive bars. This would

render it difficult to obtain a continuous variation of its resistance by means of a sliding contact. It is solely for this reason that the auxiliary coil b_2 is used for regulating the resultant flux. If it is desired to obtain low-tension readings with the same approximation as for the full load, the coil b_1 is preferably divided into sections, as indicated in Fig. 1, adapted to be placed in series or in parallel with each other in order to allow of using approximately the same number of ampere-turns.

To avoid the necessity of using a too-large number of turns in the coil b_3, lower tension than e_1 can be used for exciting the coil b_3. For this purpose an ordinary transformer can be used or a resistance r, Fig. 1, free from self-induction placed between the mains L_1 L_2, one terminal of the coil b_1 being connected to a suitable point on this resistance and the other terminal being connected to the main. These arrangements allow of regulating at will the fraction of e_1 to be used and of keeping this fraction of a constant value in order that the special scale on the voltmeter can be used for ascertaining the power factor.

I declare that what I claim is—

1. In alternating-current systems, means for ascertaining the voltage factor of power, comprising in combination with two mains a transformer excited by said mains, means for controlling the potential on the terminals of the secondary transformer-coil independently from the mains, means for measuring said potential, means for measuring the potential on said mains, and for measuring the resultant of said potential differences.

2. In alternating-current systems means for ascertaining the voltage factor of power, comprising in combination with two mains a transformer excited by said mains, means for controlling the potential on the terminals of the secondary transformer-coil independently from the mains, means for measuring said potential, for measuring the potential on said mains and for measuring the resultant of said potential differences in parallel and in series.

3. In alternating-current systems, means for ascertaining the voltage factor of power, comprising in combination with two mains a transformer excited by said mains, means for reducing the amperage in the primary coil of said transformer, means for controlling the potential on the terminals of the secondary transformer-coil independently from the mains, means for measuring said potential, for measuring the potential on said mains and for measuring the resultant of said potential differences.

In witness whereof I have signed this specification in the presence of two witnesses.

JOSEPH LOUIS ROUTIN.

Witnesses:
MARIN VACHORY,
AIMÉ FLÉCHET.