July 12, 1955 G. J. THEVENON 2,713,148

DEVICE FOR IMPROVING THE ERROR CURVES OF INDUCTION TYPE METERS WITH SEVERAL DRIVING ELEMENTS

Filed July 30, 1951 2 Sheets-Sheet 1

Fig. 1

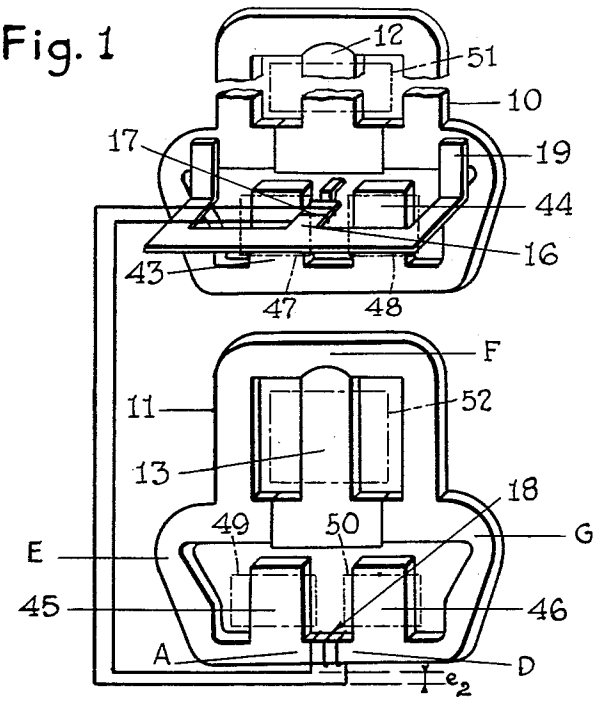
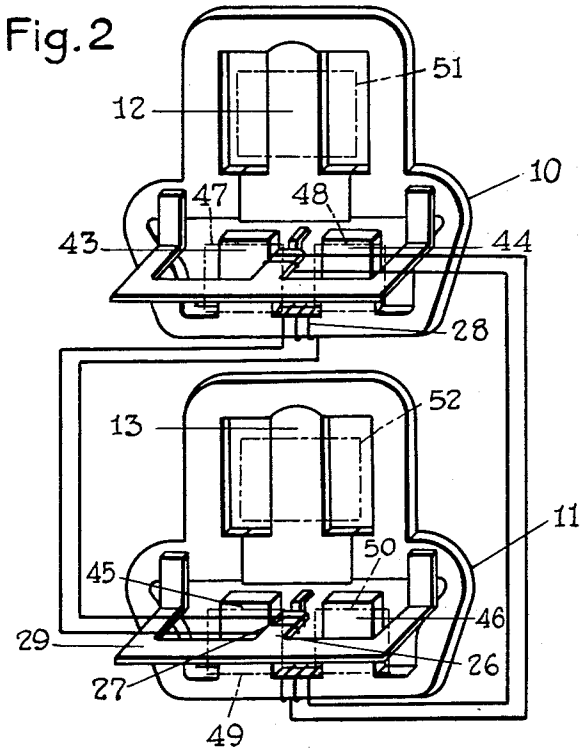


Fig. 2



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Filed July 30, 1951 2 Sheets-Sheet 2

Fig. 3

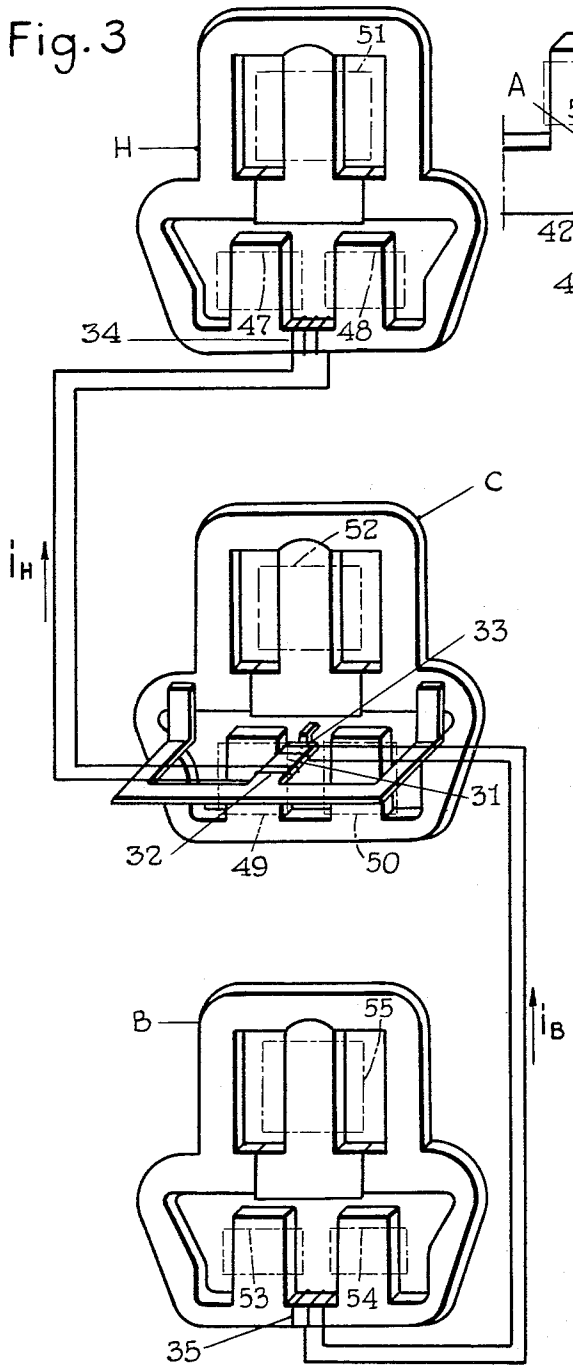
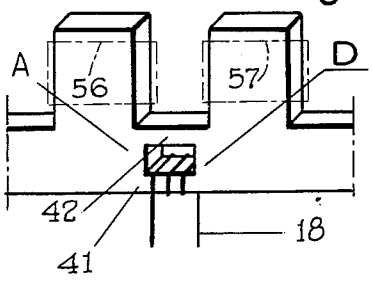


Fig. 4



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United States Patent Office 2,713,148 Patented July 12, 1955

2,713,148

DEVICE FOR IMPROVING THE ERROR CURVES OF INDUCTION TYPE METERS WITH SEVERAL DRIVING ELEMENTS

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Application July 30, 1951, Serial No. 239,244

Claims priority, application France October 6, 1950

6 Claims. (Cl. 324—137)

Numerous devices are known for improving, at heavy loads, the error curves of single phase induction type meters. These devices most frequently consisting of a magnetic part (shunt) placed in shunt on the main flux set up by the current electromagnet, are dimensioned so as to become saturated at a predetermined value Is of this current, so that when the current exceeds this value, an additional torque appears for compensating the braking torque generated by the main flux set up by the current electro-magnet.

When dealing with polyphased meters with multiple driving elements, and, in particular, with three-phase meters, the compensation obtained is much less satisfactory. It is possible to dimension the shunts for obtaining the desired compensation on the error curve, in three phase, balanced loads, but an undesirable hyper-compensation is then obtained of the error curves of each one of the driving elements considered separately.

Obviously, one may be content with dimensioning the shunts for obtaining a correct compensation of each one of the driving elements taken separately, but the compensation obtained is distinctly insufficient for the error curve recorded with three phase, balanced loads.

The object of the present invention is a device for improving the error curves of induction type meters with several driving elements, at heavy loads, while considerably reducing the deviation between the mean of the errors read on each driving element considered separately and the error read with polyphase current, all the driving elements being under equal loads.

This device is characterized in that at least one of the driving elements is provided with an auxiliary pole piece, placed on the axis of symmetry of the current and voltage electro-magnets of said driving element, said auxiliary pole piece being provided with a winding through which flows a current produced by an electromotive force induced in a second winding and proportional only to the magnetic flux set up by the windings of the current electro-magnet of another driving element, the whole being so arranged that the interaction of the magnetic flux caused by said auxiliary pole piece with the magnetic flux set up by the windings of the current electro-magnet of the driving element comprising said auxiliary pole piece, generates a torque which adds to the torque generated by the driving elements of the meter.

The invention will be more clearly understood from the following description, when read with reference to the appended drawings, said description and drawings being, of course, given chiefly by way of indication and having no limitative meaning.

Figure 1 shows an induction type meter with two driving elements, which is provided with the device according to the invention.

Figure 2 shows an induction type meter with two driving elements, which is provided with two devices according to the invention.

Figure 3 shows an induction type, three phase meter

with three driving elements, in which the device according to the invention has been incorporated.

Figure 4 illustrates a particular type of embodiment of one of the features of the invention.

In Figure 1, **10** and **11** are two driving elements of a well known type, used in the construction of a three phase meter, for instance. Each one of these driving elements comprises respectively a central voltage pole piece **12** and **13**, and two current pole-pieces **43—44** and **45—46**. The two discs, not shown, are placed respectively in the air gaps included between the pole pieces **12** and **43—44** on the one hand, **13** and **45—46** on the other hand. The current windings are illustrated at **47**, **48** and **49**, **50**, and the voltage windings at **51**, **52**.

According to the invention, a soft steel tongue element **16**, forming an auxiliary pole piece, is arranged between the two current pole pieces **43** and **44** and along the axis of the central voltage pole piece **12** of the driving element **10**. A winding **17** is placed on this tongue **16**. This winding is closed on another winding **18**, wound between the two current pole pieces **45** and **46** and along the axis of the central voltage pole piece **13** of the driving element **11**.

The tongue **16** forms part of a member **19** which is secured on the driving element **10** at two points which are at the same magnetic potential.

An electromotive force e_2 is produced in the winding **18** when current flows through the windings **49** and **50** of the pole pieces **45** and **46**. This electromotive force is proportional only to the flux ϕ_2 caused by the windings **49** and **50** of the pole-pieces **45** and **46**. The flux produced by the voltage coil **52** of the central voltage pole piece **13** does not act in the winding **18**, in particular, due to its symmetrical arrangement between the two current pole pieces **45** and **46** in the portion AD of the magnetic circuit of the electro-magnet **11**. This electromotive force e_2 gives rise to a current i_2 in the winding **17**. The flux φ_2 produced by this current is coaxial with the main flux produced by the voltage coil **51** of the central voltage pole piece **12**, due to the position of the tongue **16** on the axis of said voltage pole piece. Under the circumstances, the extraneous torques due to the interaction of these two fluxes cancel one another.

The interaction of the flux φ_2 and the flux ϕ_1, proportional to the current flowing through the windings **47** and **48** of the pole pieces **43** and **44**, generates an additional torque C which is expressed by

$$C=K.\phi_1.\varphi_2 \sin \alpha$$

K being a proportionality coefficient and α the angle between ϕ_1 and φ_2.

The directions of the windings on **17** and **18** are such that the additional torque C adds with the driving torque produced by the driving element **10**.

The ampere-turns applied to the tongue **16** are determined in such a manner that the additional torque C be just sufficient to give an exact compensation at a given load (for instance at full load), for the braking torques generated by the fluxes produced by the current electro-magnets.

This compensation, once effected for a predetermined load, remains valid over a wide measuring range, since the additional torque produced, being proportional to the product of the two current fluxes, obeys the same law of variation as the braking torques generated by the current electro-magnets, which are proportional to the square of each one of the two current fluxes.

In Figure 2, the induction type meter with two driving elements is provided with two devices according to the invention. In this figure, wherein the same numerals have the same signification as in Figure 1, a soft steel

tongue **26** can be seen, forming a second auxiliary pole piece, placed between the current pole pieces **45** and **46**, and on the axis of the central voltage pole piece **13** of the lower driving element **11**. This tongue **26** forms part of a member **29** which is secured to the driving element **11** at two points which are at the same magnetic potential. On this tongue **26** is placed a winding **27** which is closed on another winding **28** wound on the driving element **10**, between the current pole pieces **43** and **44** and on the axis of the central voltage pole piece **12**.

An induction type, three phase meter, with three driving elements, can be provided with three devices according to the invention. Designating by H, C and B the three driving elements, the winding on the tongue placed between the two current pole pieces of H will be supplied, for instance, by a winding wound between the two current pole pieces of C; the winding on the tongue placed between the two current pole pieces of C will be supplied from a winding wound between the two current pole pieces of B and the winding on the tongue placed between the two current pole pieces of B will be supplied from a winding wound between the two current pole pieces of H.

However, a simpler device, shown in Figure 3, can also be used in such a meter. In this figure, where H, C and B represent the three driving elements and where **47**, **48**, **49**, **50**, **53**, **54** and **51**, **52**, **55** are respectively the current windings and voltage windings of H, C and B, only the C driving element is provided with a tongue **31**, forming an auxiliary pole piece, placed between its two current pole pieces, and on the axis of the central voltage pole piece. Two windings, **32** and **33**, insulated from each other, are wound on this tongue. The winding **32** is closed on another winding **34**, wound between the two current pole pieces of the driving element H and on the axis of its central voltage pole piece. A current i_H flows through the winding **32**. The winding **33** is closed on another winding **35**, wound between the two current pole pieces of the driving element B, and on the axis of its central voltage pole piece. A current i_B flows through the winding **33**.

A resultant flux φ (i_B+i_H) is obtained in the tongue **31**, which produces an additional torque proportional to ϕ_C. φ (i_B+i_H) sin α, ϕ_C being the main current flux in the C driving element.

Whatever may be the order of the phases, the flux φ (i_B+i_H) is always leading in phase with respect to ϕ_C by an angle α, and it can easily be seen that this additional torque remains constant in magnitude and direction.

Referring again to Figure 1, it will be noted that the tongue **16** which forms an auxiliary pole piece, is linked with a fraction of the main voltage flux, so that an induced electromotive force, due to this flux appears in the winding **17**, which produces, in the circuit **17—18**, a circulating current proportional to this voltage flux. This current gives rise, in **18**, to an extraneous flux. To avoid the interaction of this flux with the main voltage flux which flows through the driving element **11** and, consequently, undesirable extraneous torques, it will be convenient for this flux to be closed by a magnetic circuit having an extremely low reluctance so as to prevent it from going through the main air-gap in which the disc rotates.

In a driving element similar to that shown in Figure 1, the extraneous flux produced by **18** will close along the path A—E—F—G—D. The arrangement of one or more magnetic metal bridges between A and D (the frame forming possibly part of one of these bridges) could also be contemplated.

Figure 4 where **56** and **57** are the current windings shows a specific embodiment of the above mentioned bridge. The portion AD of the current electromagnet is divided into two branches **41—42** by a longitudinal aperture. The winding **18** is wound on the branch **41**, for instance. Under the circumstances, the flux which originates in the branch **41** closes substantially entirely in the branch **42**, the reluctance of which is extremely low.

It should be understood that the application of the device, object of the present invention, is not limited to the driving elements described and illustrated, but that it extends to any form of driving element.

What is claimed is:

1. In an induction type meter comprising at least two driving elements each of which includes, one voltage electromagnet comprising three poles, and one current electromagnet comprising two poles, the poles of said electromagnets defining an air gap for a conductive metal rotary disc, a device for improving the error curve, said device comprising a first auxiliary pole piece placed between the two poles of said current electromagnet and on the axis of the central pole of said voltage electromagnet of the first driving element, a second auxiliary pole piece placed between the two poles of said current electromagnet and in the axis of the central pole of the voltage electromagnet of the second driving element, a first electrical circuit comprising a first winding coiled around said first auxiliary pole and a second winding coiled around the said current electromagnet of said second driving element between the bases of the current poles and on the axis of the central pole of the voltage electromagnet of said second driving element, and a second electrical circuit comprising a first winding coiled around said second auxiliary pole and a second winding coiled around the current electromagnet of said first driving element between the bases of the current poles and on the axis of the central pole of the voltage electromagnet of said first driving element.

2. In an induction type meter comprising at least two driving elements each of which includes one voltage electromagnet comprising three poles and one current electromagnet comprising two poles, the poles of said electromagnets defining an air gap for a conductive rotary disc, a device for improving the error curve, said device comprising at least one auxiliary pole placed between the two poles of said current electromagnet and on the axis of the central pole of the voltage electromagnet of one of said driving elements, a first winding coiled around said auxiliary pole and at least a second winding coiled around the current electromagnet of the other driving element between the bases of the current poles and on the axis of the central pole of the voltage electromagnet of said driving element.

3. A device according to claim 2 wherein there is provided a magnetic circuit with an extremely low reluctance, through which closes the extraneous flux generated in the winding coiled around the current electromagnet, between the bases of the current poles and on the axis of the central pole of the voltage electromagnet of one of said driving elements.

4. An induction type meter comprising at least two driving elements each of which includes one voltage electromagnet comprising three poles and one current electromagnet comprising two poles, the poles of said electromagnets defining an air gap for a conductive rotary disc, one auxiliary pole piece placed between the two poles of said current electromagnet and on the axis of the central pole of said voltage electromagnet of the first of said driving elements and means for generating an electromotive force by the current electromagnet only of the second driving element and applying said electromotive force on said auxiliary pole piece to thereby set up in the first driving element an additional magnetic field generating an additional motor couple.

5. A device according to claim 2 wherein there are provided two different windings coiled around said auxiliary pole piece, each one of said windings being connected electrically with a second winding coiled around the cur-

rent electromagnet of one of said driving elements and placed between the bases of the current poles and on the axis of the central pole of the voltage electromagnet of said driving element.

6. A device according to claim 2 wherein said second winding is coiled, between the bases of the current poles and on the axis of the central pole of the voltage electromagnet of one of said driving elements, around one of the two branches of a longitudinal aperture provided in the magnetic circuit of said driving element and between the bases of said current poles.

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