Nov. 13, 1945. E. O. THOMPSON 2,388,884

TWO-SPEED MOTOR

Filed Oct. 30, 1943

FIG. 1.

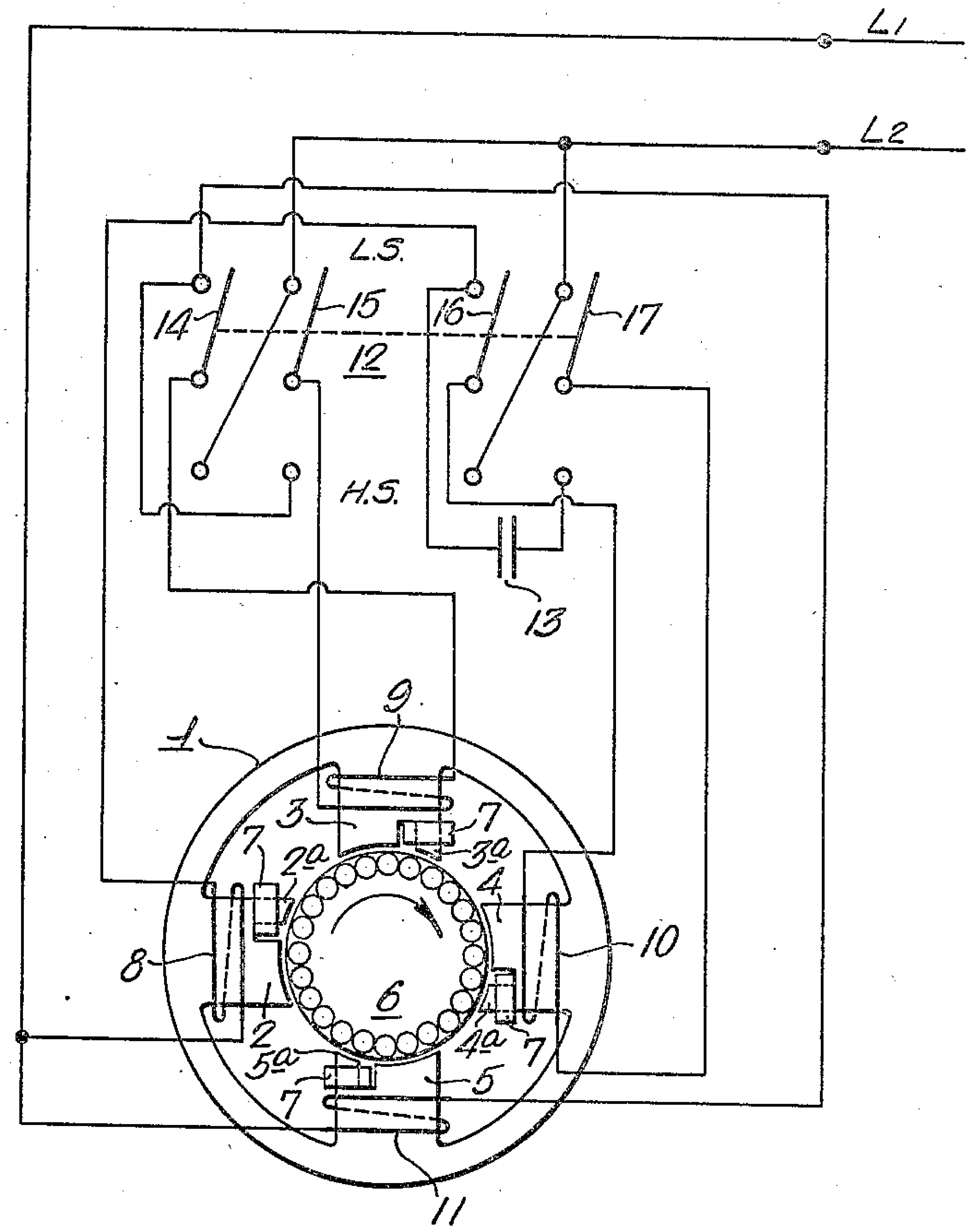
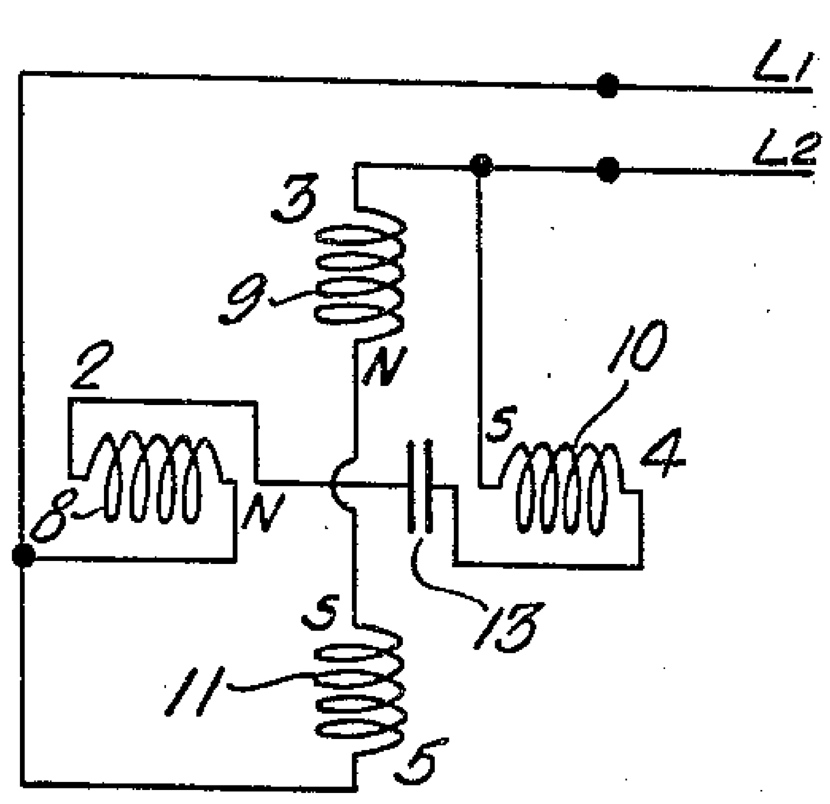
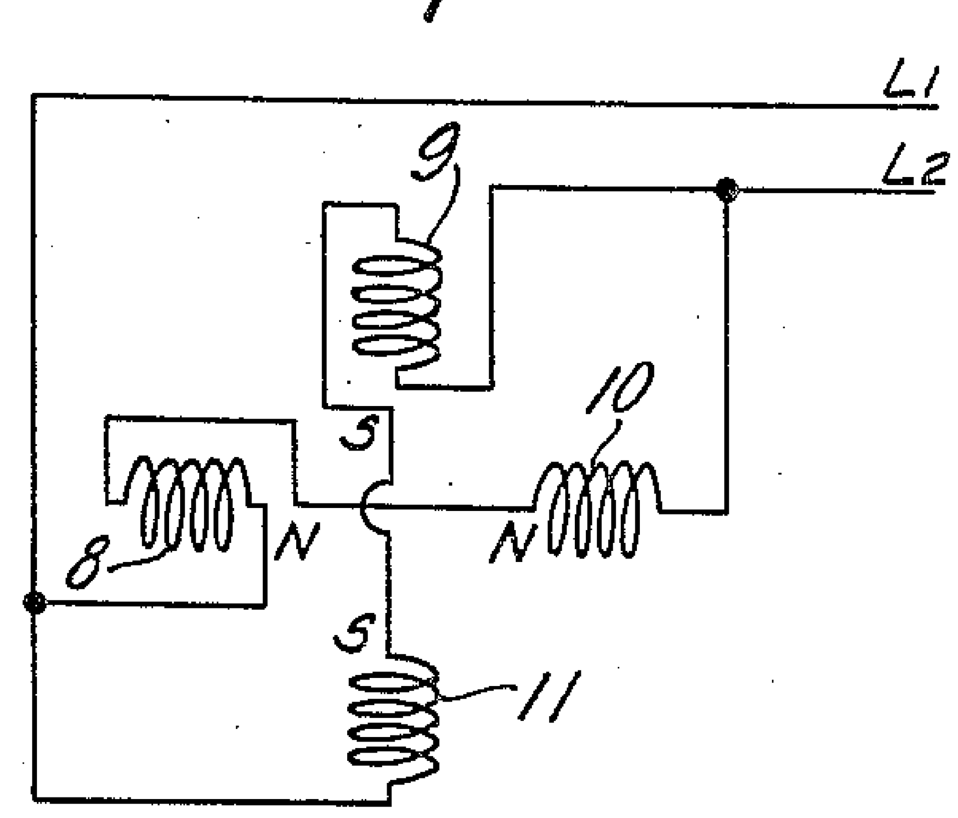


FIG. 2.



HIGH SPEED

FIG. 3.



LOW SPEED

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TWO-SPEED MOTOR

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6 Claims. (Cl. 172—278)

This invention relates to electric motors and has for its main object to provide a dual-speed, single-phase alternating current machine which is dependable and possessed of good operating characteristics and yet is susceptible of being manufactured very cheaply.

More specifically, the object is to provide a low cost, dual-speed fractional horse-power motor which is suitable for operating phonograph recorders and reproducers.

The standard turntable speed for commercial phonograph disc recording is 78 R. P. M. and, with a few possible exceptions, all outstanding home recorders and reproducers are designed to operate only at that speed. However, by using somewhat larger discs, it is feasible to record at much lower speeds and thus greatly increase the playing time per unit of record cost without detracting from the quality. Furthermore, as respects the kind of material most commonly inscribed on home recordings, it makes but little difference whether or not the higher frequencies are excessively attenuated; and it is believed that the majority of people who use home recorders and small discs would prefer to sacrifice the higher frequencies in favor of increased playing time—especially when the recording is speech and not music.

In order to play standard recordings, it is, of course, essential that a reproducer operate at a turntable speed of 78 R. P. M.; and if the same machine is to be adapted for recording and reproducing at slow speed, it obviously is necessary to provide for two-speed operation. This can readily be done through the agency of a speed-changing gear or through the employment of high and low speed motors or a dual-speed motor; and no major problem is involved so long as the machine is intended to sell at a price which permits of the use of comparatively costly component parts. But a very substantial if not major part of the market for home recorders and reproducers lies in the extreme low-price field, and it has been found that the costs of satisfactory speed-changing gears and, likewise, those of suitable dual-speed motors, such as have heretofore been available, are too high to permit of incorporation in the cheapest machines. Yet no reputable manufacturer can afford to attach his name to a product, no matter how cheap, which will not stand up and give satisfaction.

The prior art affords many excellent dual-speed alternating current motors which would be perfectly satisfactory operationally; but so far as is known there is no prior motor of that character which is both acceptable from the performance standpoint and capable of being manufactured at a cost low enough to permit of incorporation in very low-priced phonographs.

The problem which this situation presented was a difficult one, in view of the very low permissible manufacturing cost, but it has been solved by the present invention which is based on the discovery that it is possible to utilize, in combination, the known principle of the shaded pole motor and the known principle of the capacitor type motor and thereby achieve a dual-speed motor which, with the necessary external controls, is but little more costly than the cheapest of single-speed induction motors.

A feature of the invention is that it enables the employment of concentrated pole-pieces, each with a single preformed winding which can be quickly put in place, together with a single turn shading coil consisting of a copper loop which likewise is quickly applicable to the shaded poles.

Another feature is that all of the main windings are used for both high and low speed—it being unnecessary to provide separate high and low speed windings.

Still another feature is that the shading coils, which are provided primarily for low-speed operation, aid rather than hinder the high speed operation of the motor.

The preferred embodiment of this invention is illustrated in the accompanying drawing, wherein:

Fig. 1 shows, somewhat diagrammatically, a dual-speed induction motor with external circuit connections including a speed-changing switch and electrostatic capacitor;

Fig. 2 is a schematic diagram showing the manner in which the stator coils and capacitor are interconnected, and, in turn, connected to the power-supply feed line to bring about high-speed operation; and

Fig. 3 is a schematic diagram showing the manner in which the stator coils are interconnected, and, in turn, connected to the power-supply feed line to bring about low-speed operation.

The motor per se, shown in Fig. 1, comprises a stator frame 1 having four concentrated pole-pieces 2, 3, 4 and 5 spaced 90 degrees apart and including a conventional squirrel cage rotor 6. Each of said pole-pieces is slotted to accommodate a shading coil, which may be a single loop of copper slipped into place and secured frictionally. By reason of the shading coils the magnetic flux in pole portions 2a, 3a, 4a and 5a is caused to lag behind the flux through the main portions of the pole-pieces and, hence, said pole-portions $2a$—$5a$ constitute auxiliary poles, or so-called shaded poles, which are so spaced with respect to the main poles as to bring about rotation of the magnetic field.

Each pole-piece is provided with a coil 8, 9, 10 and 11, respectively, which are identical one with the other and hereinafter referred to as principal windings or principal coils. These principal coils are preferably machine wound and pre-formed so that they can easily be slipped onto the pole-pieces; and they require no attachment other than their frictional adherence to the pole-pieces. Obviously, the job of assembling the motor is exceedingly simple; and the component parts are equally simple and cheap, as will be self-evident. Moreover, since all four principal coils may be identical, there is no time lost in ascertaining that the right coil is applied to each pole-piece.

Two leads from each principal coil are brought out through one or more suitable openings in the motor frame and these may conveniently be identified by means of colored clips.

A switch 12, shown diagrammatically in Fig. 1, is mounted outside the motor at any convenient point, as is also a capacitor 13.

The connections between the motor, switch 12 and capacitor 13 are such that when the switch is in one of its two positions the motor is conditioned for high speed operation, whereas throwing of the switch to its alternate position so changes the connections as to bring about low speed operation. The wiring is fully illustrated in Fig. 1 and needs no detailed explanation aside from mentioning that L_1 and L_2 are the two wires of the feed line.

Switch 12 has four blades 14, 15, 16 and 17 which, in the upper position marked "L. S.," establish the several connections for low speed operation, and in the lower position, marked "H. S.," establish the alternate connections for high speed operation.

Fig. 2 shows in simplified form the circuit arrangement for high speed operation while Fig. 3 shows the circuit arrangement for low speed operation.

It will be noted that principal coils 8, 9, 10 and 11 are used for both speeds. This is an important consideration since it means that an irreducible minimum number of windings are required.

The high speed connections of Fig. 2 correspond to those of the familiar single-speed capacitor type motor wherein principal coils 9 and 11 constitute what are usually termed the main windings, while principal coils 8 and 10 constitute what are usually termed the auxiliary windings. These latter coils are in series with capacitor 13. By virtue of the latter, the current is caused to lag in the auxiliary windings, and this serves to engender the necessary rotating field. The relative polarities are indicated in Fig. 2, from which it will be apparent that the motor is of the two-pole variety when thus connected. It is to be understood that due to the phase difference between the currents flowing in the main and auxiliary windings the indicated like polarities are really phase displaced and not in-phase as might otherwise be imagined.

The circuit arrangement of Fig. 3 is the one conventionally employed in shaded pole motors. This, obviously represents a four-pole motor having an operating speed one-half that of the two-pole motor of Fig. 2.

The switch 12, as actually used on electric phonographs, is a very small device adapted for mounting near the turntable. In one physical embodiment of the invention comprising a motor structure of conventional phonograph size, the capacitor 13 had a capacity of about 2 microfarads.

While only a four-pole motor has been shown and described, it will be self-evident that the number of poles can be multiplied to any desired extent. Such other modifications as fall within the scope of the appended claims are also to be deemed within the scope of the invention.

I claim:

1. A dual-speed, single-phase induction motor and control system therefor comprising, in combination: a rotor, four field pole-pieces spaced in quadrature about said rotor, each of said pole-pieces including a main pole portion and a shaded pole portion, four principal windings, each wound on one of said pole-pieces individually, four shading coils, each wound on one of said shaded pole portions individually, a pair of feed-line terminals, a two-way switch having a high-speed position and a low-speed position, an electrostatic capacitor and leads interconnecting said principal windings with said switch and said feed line terminals, the interconnections being such, when said switch is in its high-speed position, that said capacitor is connected in series with one pair only of oppositely situated principal windings, and all of said principal windings are so connected to said feed-line terminals that the main pole faces at diametrically opposite sides of said rotor are of magnetically opposite polarity, said capacitor being of such magnitude that the current flow in one pair of oppositely situated principal windings is substantially phase-displaced with respect to the current flow in the other pair of principal windings, said interconnections also being such, when said switch is in its low-speed position, that the current in all said principal windings is in phase, and adjacent main poles are of opposite magnetic polarity.

2. A dual-speed, single-phase induction motor and control system therefor comprising, in combination: a rotor, four field pole-pieces spaced in quadrature about said rotor, each of said pole-pieces including a main pole portion and a shaded pole portion, four principal windings, each wound on one of said pole-pieces individually, four shading coils, each wound on one of said shaded poles individually, a pair of feed-line terminals, a two-way switch having a high-speed position and a low-speed position, a non-inductive impedance, and leads interconnecting said principal windings with said switch and said feedline terminals, the interconnections being such, when said switch is in its high-speed position, that said impedance is connected in series with one pair only of oppositely situated principal windings, and all of said principal windings are so connected to said feed-line terminals that the pole faces at diametrically opposite sides of said rotor are of magnetically opposite polarity, said impedance being of such magnitude that the current flow in one pair of oppositely situated principal windings is substantially phase displaced with respect to the current flow in the other pair of principal windings, said interconnections also being such, when said switch is in its low-speed position, that the current in all said principal windings is in phase, and adjacent main poles are of opposite magnetic polarity.

3. In combination, an induction motor comprising a rotor, a stator including at least two pairs of poles, the poles of each pair being oppo-

sitely situated and each pole having a main pole portion and a shaded pole portion, similar principal windings on said main pole portions and similar shading coils on said shaded pole portions, a non-inductive impedance, means operable at will to interconnect said principal windings and said impedance so as to condition said motor for operation at one speed, and means operable at will to interconnect said principal windings exclusive of said impedance so as to condition said motor for operation at a different speed.

4. In combination, an induction motor comprising a rotor, a stator including two pairs of poles, the poles of each pair being oppositely situated and each pole having a main pole portion and a shaded pole portion, similar principal windings on said main pole portions and similar shading coils on said shaded pole portions, a capacitor, means operable at will to interconnect said principal windings and said capacitor so that each opposed pair of windings are serially connected in such fashion that the opposed poles are of opposite magnetic polarity, and said capacitor is connected in series with one pair of windings, whereby the motor is connected as a two-pole motor and operates at a predetermined high speed, and means operable at will to reverse the connections of two adjacent windings and to remove said capacitor from the motor circuit, whereby the opposed poles are caused to be of the same magnetic polarity and the motor is connected as a four-pole motor and operates at a predetermined low speed.

5. In combination, a single-phase induction motor comprising a rotor, a stator including plural pairs of oppositely situated poles arranged about said rotor, field windings on the respective poles, a pair of feed-line terminals, a capacitor, means operable at will to interconnect said windings and said capacitor so that the windings on each pair of opposed poles are serially connected between said terminals in parallel with the other windings in a manner to impart opposite magnetic polarity to the opposed poles, and so that said capacitor is connected in series with one pair of opposed windings, and means operable at will to interconnect said windings, exclusive of said capacitor, so that each pair of opposed windings are serially connected between said terminals in parallel with the other windings in a manner to impart similar magnetic polarity to the opposed poles.

6. A dual-speed, single-phase induction motor and control system therefor, comprising in combination a rotor, four-field pole-pieces each including a main pole portion and a shaded pole portion, four principal windings, each wound on one of said pole-pieces individually, four shading coils, each wound on one of said shaded pole portions individually, a pair of feed-line terminals, a two-way switch having a high-speed position and a low-speed position, an electrostatic capacitor and leads interconnecting said principal windings with said switch and said feed-line terminals, the interconnections being such, when said switch is in its high-speed position, that the principal windings on opposed pole-pieces are connected in series with each other and the series connected windings are connected in parallel to the feed-line terminals with said capacitor connected in series with one pair only of oppositely situated series windings, so that the main pole faces at diametrically opposite sides of said rotor are of magnetically opposite polarity, said capacitor being of such magnitude that the current flow in one pair of oppositely situated principal windings is substantially phase-displaced with respect to the current flow in the other pair of principal windings, said interconnections also being such, when said switch is in its low-speed position, that the principal windings on opposite pole-pieces are series connected with each other and the series connected windings are connected in parallel with said feed-line terminals with the current in all said principal windings in phase, and with adjacent main poles being of opposite magnetic polarity and with said capacitor open circuited with respect to all said windings.

ELMER O. THOMPSON.