IMPROVED MAGNETIC INDUCTION STRUCTURES

ABSTRACT

An improved magnetic induction structure is provided which comprises cross laminated armatures, stators and cores.

Cross laminations provide eddy current pathways which divide magnetic polarity in such a way that one north pole becomes two north poles and one south pole becomes two south poles and so on with each lamination. The provided structures amplify magnetic pole strength and reduce hysteresis losses.

Magnetic induction structures may include electromagnets, solenoids, transducers, transformers, generators, motors and the like.

IMPROVED MAGNETIC INDUCTION STRUCTURES

This invention relates to magnetic structures that change one form of energy into another form of energy by means of induction. In all electromagnetic structures there is an inductance conductor. More particularly, the conductor is insulated magnet wire, as described in U.S. patent 4,806,834 which is assigned to the present inventor. Inductance conductors of magnet wire can be formed around a ferrous material as well as having the ferrous material formed around the conductor. The conductor circuit formed in mirror image symmetric relationship is superior to other conductor forms because the oppositely located magnetic poles of ferromagnetism are developed concurrently. Conductor circuits that are not formed in mirror image symmetry relationship can only develop one magnetic pole at a time, therefore unbalancing the electromagnetic process.

This unbalanced electromagnetic condition produces distortion in the form of vibration, instability, friction and excessive energy consumption. This condition often results in premature component degradation and failure, resulting in a reduction in the useful life of the structure.

As is described in patent 4,584,438, also assigned to the present inventor, a percussion air motor such as a loudspeaker produces a distortion free sound when actuated by a mirror image electromagnetic means.

It is known that electromagnetism results from the passage of an electric current flowing through a conductor circuit formed around a core of magnetizable material. In known electromagnetic structures, the current enters the wire conductor at one end, travels through the length of the wire conductor, and exits at the other end, with a magnetic force being produced as the current passes through the coil of wire conductor.

Fig. 1.

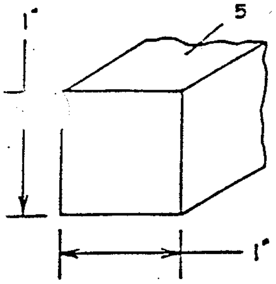

Fig. 2.

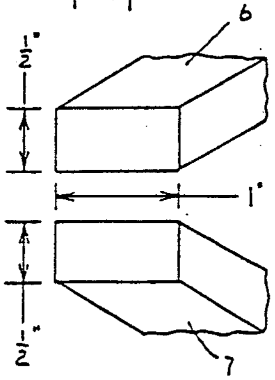

Fig. 3.

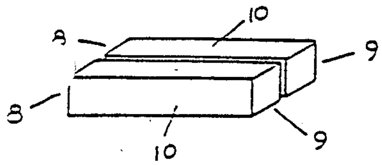

Fig. 4.

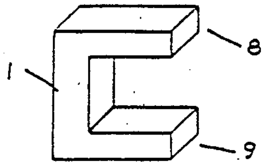

Fig. 5.

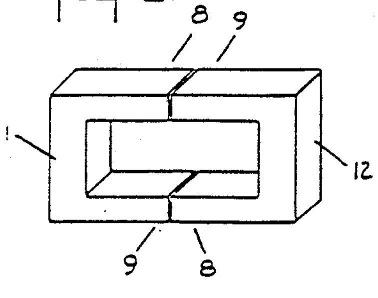

Fig. 6.

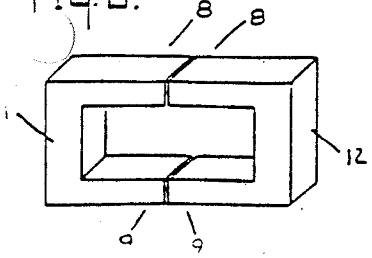

Fig. 11.
PRIOR ART

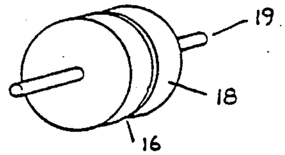

Fig. 12.
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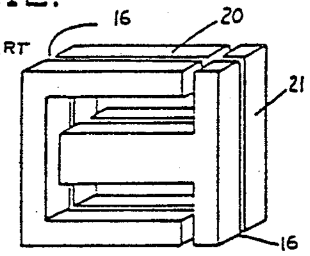

Fig. 13.
PRIOR ART

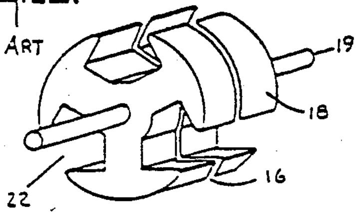

Fig. 14.
PRIOR ART

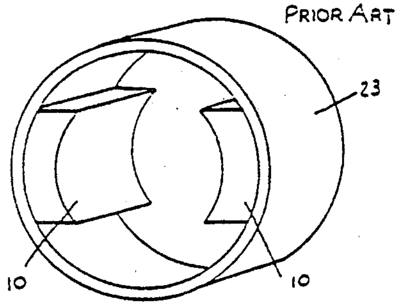

Fig. 7.

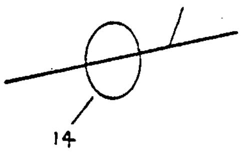

Fig. 8.

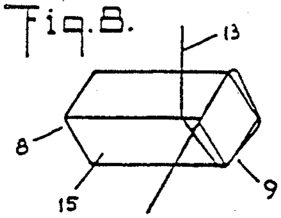

Fig. 15.

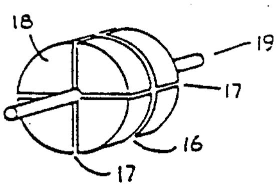

Fig. 16.

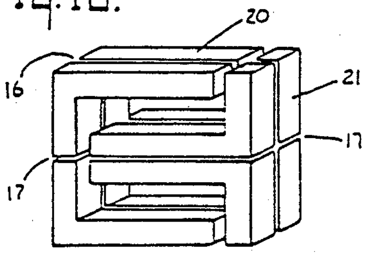

Fig. 17.

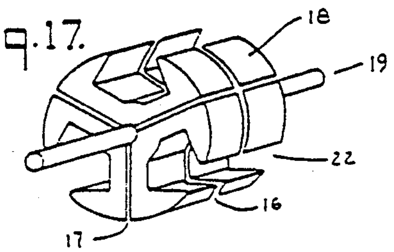

Fig. 18.

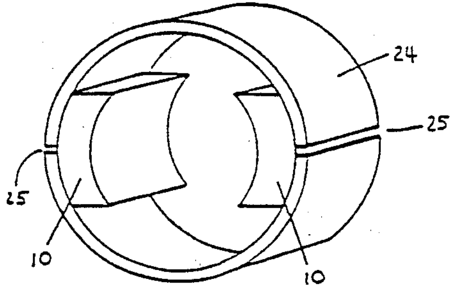

Fig. 9.
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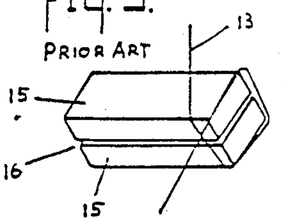

Fig. 10.

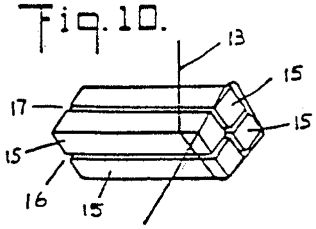

Fig. 19.

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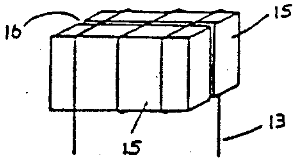

Fig. 23.

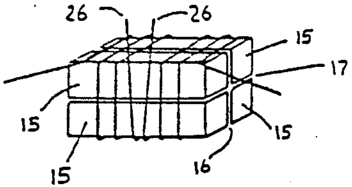

Fig. 20.

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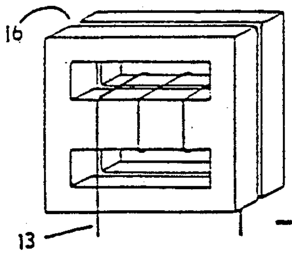


Fig. 24.

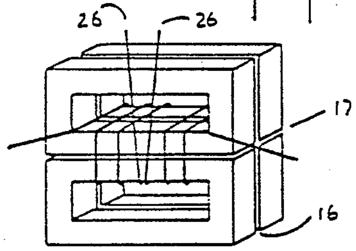


Fig. 21.

PRIOR ART

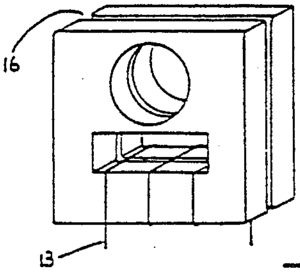


Fig. 25.

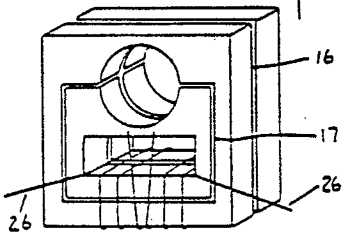


Fig. 22.

PRIOR ART

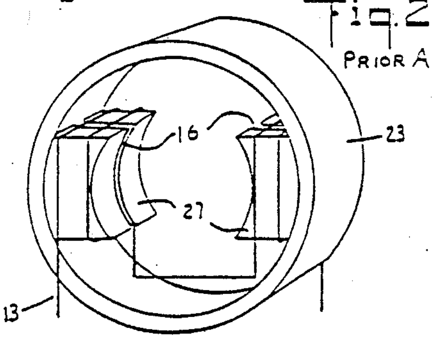


Fig. 26.

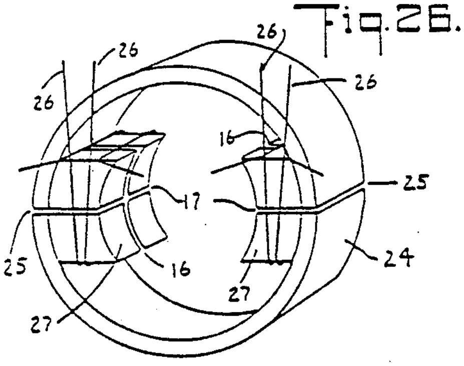


Fig. 27.

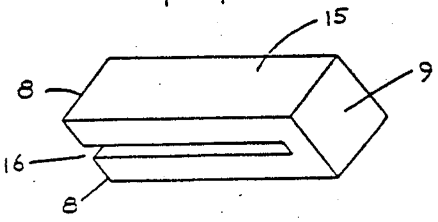


Fig. 29.

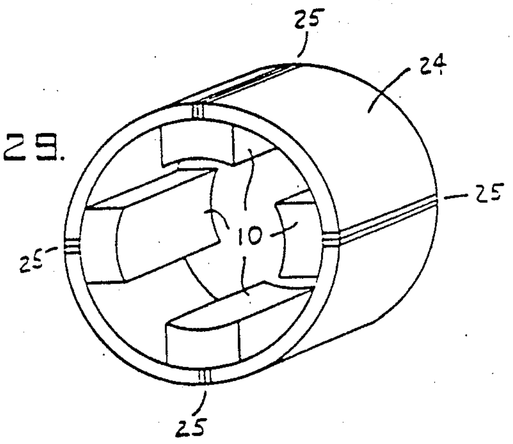
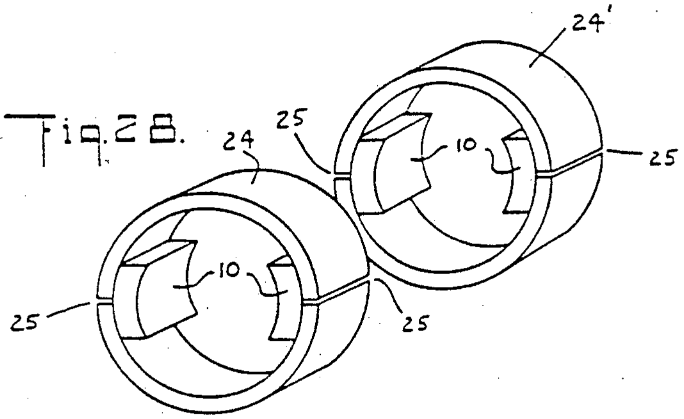


Fig. 28.



It is also known that this circuit is inefficient and produces distortion.

The magnetic strength produced in an electromagnetic circuit is associated with a proportional amount of work. It is known that an increase in magnet strength and a corresponding increase in work output can be accomplished by increasing the flow rate of electricity through the coiled wire conductor.

In the existing state of the art, magnetic induction structures generally are designed using a single wire conductor formed around a magnetizable core laminated in one plane. The present invention is designed using a wire conductor circuit associated with a magnetizable core laminated in two planes and paths that increase the resistance of the eddy currents.

In prior art, the ferrous material associated with conductor circuits may have been a solid. It is known that eddy currents radiate perpendicularly from the conductor in the form of a vortex. Solid ferrous material offers minimum eddy current resistance. This results in greater energy consumption and minimum magnetic strength. This structure is known to be inefficient due to hysteresis losses.

The existing practice of laminating ferrous material in an electromagnetic circuit increases eddy current resistance, thereby reducing energy consumption and increasing magnetic strength.

The utilization of cross laminated ferrous material in the present invention increases eddy current resistance, also results in a reduction of energy consumption, increases magnetic strength and further decreases hysteresis losses.

Energy potential has heretofore been under utilized by existing methods of laminating induction structures in one plane only. In existing structures, the eddy current potential is only partially utilized and therefore wasted. The induction structures herein described harness this eddy current potential by cross laminating ferrous materials, increasing eddy current resistance, and achieving greater efficiency. More work can thus be accomplished in the same time period.

In induction structures, motion is always associated with eddy current potential. By incorporating the present invention along with the teachings of patents 4,584,438 and 4,806,834, a synergistic assembly of components is achieved.

Solenoids, transducers, motors and the like generally have an armature, or motion component and a stator, or stationary component.

It is known that an armature motion produces a stator reaction motion. In hydroelectric generators, for example, the stator is fixed to a stationary foundation so that the stator will not rotate while the armature rotates from water falling on a propeller which is fastened to the shaft of the armature.

High output electric rotating generators have high torque associated with the stator that is fixed to the foundation. This stator torque is wasted energy. This wasted stator torque is energy that can be captured when a mirror image symmetry second induction structure is added to the first induction structure. Such an assembly is described in U.S. patent 4,584,438. The combining of two conductors, two armatures and two stators in one assembly becomes an efficient structure when the conductors' direction, armatures' direction and eddy currents' direction are counter-rotating. That is to say the first induction structure moves to the left at the same time the second inductance structure moves to the right, when viewed from either end of the structure. Thus it may be seen that a more efficient structure results when the teachings of the present invention are incorporated into those of U.S. patents 4,584,438 and 4,806,834.

Accordingly it is an object of the present invention to capture and utilize for the production of work, the electric potential present in eddy currents circulating around the magnetic circuit.

It is another object of the invention to provide a magnetic induction structure which provides a reduction in the size of the structure needed to do a given amount of work because hysteresis losses are reduced.

It is another object of the invention to provide a magnetic induction structure which provides a decrease in the amount of energy required to perform a given amount of work for the same time period as compared to prior art magnetic induction structures.

It is another object of the invention to provide a magnetic induction structure which has a longer life span due to reduction of vibration, friction and heat.

It is another object of the invention to provide a magnetic induction structure that reduces stray and harmful magnetic radiation. Deflected eddy currents such as are found associated with solid cores are minimized by the herein described cross laminated core structures.

It is another object of the invention to combine two magnetic induction structures in order to achieve synchronization and efficiency within the two structures.

In sum, the invention provides a magnetic induction structure with a novel ferromagnetic geometry in which the magnetic force is enhanced by increasing the number and orientation of eddy current ferromagnetic paths. The improved path geometry increases the magnetic force present in eddy currents by multiplying the number of magnetic poles.

These and other objects and advantages of the invention will become more apparent from the following description and accompanying drawings in which:

FIG. 1 shows a solid conductor.

FIG. 2 shows two conductors in mirror image symmetry relationship with a cross section equal to the cross section of FIG. 1.

FIG. 3 shows two permanent bar magnets arranged in mirror image symmetry.

FIG. 4 shows a single horseshoe permanent magnet.

FIG. 5 shows two horseshoe permanent magnets arranged in non mirror image symmetry.

FIG. 6 shows two horseshoe permanent magnets arranged in mirror image symmetry.

FIG. 7 shows a magnet wire inductance conductor depicting the circular radiating eddy current.

FIG. 8 illustrates a wire conductor formed around a core of solid ferrous material which becomes an electromagnet when the conductor is energized.

FIG. 9 shows a prior art laminated core electromagnet.

FIG. 10 shows a cross laminated core electromagnet.

FIG. 11 shows a prior art laminated ferrous armature mounted on an axial shaft.

FIG. 12 shows a prior art solenoid with laminated ferrous stator and laminated ferrous armature.

FIG. 13 shows a prior art segmented laminated ferrous armature mounted on an axial shaft.

FIG. 14 shows a prior art continuous uninterrupted ferrous stator casement surrounding a magnetic means.

FIG. 15 shows a cross laminated ferrous armature mounted on an axial shaft.

FIG. 16 shows a solenoid with a cross laminated ferrous stator and a cross laminated ferrous armature.

FIG. 17 shows a segmented cross laminated ferrous armature mounted on an axial shaft.

FIG. 18 shows a slotted ferrous stator casement surrounding a magnetic means.

FIG. 19 shows a prior art laminated ferrous core electromagnet with a single wire conductor.

FIG. 20 shows a prior art laminated ferrous transformer core with a single wire conductor.

FIG. 21 shows a prior art laminated ferrous stator with a single wire conductor.

FIG. 22 shows prior art laminated ferrous stators with a single wire conductor surrounded by a closed uninterrupted ferrous casement.

FIG. 23 depicts a cross laminated ferrous core electromagnet with mirror image symmetry formed wire conductors.

FIG. 24 depicts a cross laminated ferrous transformer core with mirror image symmetry formed wire conductors.

FIG. 25 depicts a cross laminated ferrous stator with mirror image symmetry formed wire conductors.

FIG. 26 depicts cross laminated ferrous stators with mirror image symmetry formed wire conductors surrounded by a slotted ferrous casement.

FIG. 27 shows a slotted ferrous core whereby the slot does not extend from one pole to the other.

FIG. 28 illustrates an axially aligned pair of slotted motor stator casements.

FIG. 29 depicts a slotted motor stator casement with laminations inserted into the slots.

The invention will be best understood by the following detailed descriptions.

Referring to FIG. 1, the single conductor 5 has a cross section area of, for example, one square inch and a circumference of four inches.

Referring to FIG. 2, two conductors 6 and 7 in mirror image symmetry also have a combined cross section area of, for example, one square inch, however, their combined total circumference is six inches.

When two conductors have a cross section area identical to that of a single conductor's cross section area, two conductors combined circumference increases. This structure also increases the conductor's skin surface area. The increase in conductor skin and associated increased eddy current potential is fundamental to the operation of the magnetic induction structures herein described. The same benefits occur in cross laminated magnetic materials and interrupted motor casements.

Referring to FIG. 3, the bar shaped permanent magnets 10 have north poles and south poles that are arranged in mirror image symmetry relationship. The like north poles 8 and the like south poles 9 are proximal to each other. The division is between like poles, whereby, as is known each magnet repels the other.

FIG. 4 shows a horseshoe shaped permanent magnet 11 which possesses north pole 8 and south pole 9.

FIG. 5 shows one of two possible arrangements of two horseshoe magnets facing each other. Unlike poles 8 and 9 are proximal. The magnetic strength between poles 8 and 9 of magnet 11 is reduced when magnet 12 is positioned so, as is known, the two magnets attract each other.

Referring to FIG. 6 which is the only alternate option for arranging two horseshoe magnets face to face, like poles 8 and 8 are proximal. The magnetic strength between poles 8 and 9 of magnet 11 is increased when another magnet 12 is positioned in mirror image symmetry relationship, whereby, as is known, said magnets repel one another.

This conjunction of like poles is the fundamental cause of the increase in magnetic strength between north pole 8 and south pole 9. The conjunction of unlike poles is the fundamental cause of loss of magnetic strength between north pole 8 and south pole 9.

FIG. 7 shows a wire conductor 13 and circular eddy currents 14 radiating from the conductor. The eddy currents are in the shape of a vortex, not shown, which increases in intensity as conductor electrification increases.

FIG. 8 shows the conductor 13 formed around a solid ferrous core 15. When the conductor 13 is formed in a coil and then electrified, a north magnetic pole 8 and a south magnetic pole 9 is created. The eddy currents 14, not shown, are not allowed to penetrate the ferrous core 15 because there is no path in the core 15 for the eddy currents to enter. The eddy currents thus deflect off the core 15 resulting in low magnetic strength and a consequent waste of energy. This deflection of the eddy currents causes stray magnetic fields to propagate from the solid ferrous core 15. These stray fields are known to be dangerous to humans and other life within the fields.

FIG. 9 shows the conventional ferrous laminations utilized in the current state of the art. It can be seen that open paths 16, one shown, between the two ferrous cores 15 wrapped by conductor 13 allows the eddy currents to enter. The open paths 16, one shown, increase magnetic strength without increasing energy consumption.

Referring to FIG. 10, it can be seen that cross laminating the ferrous core 15 provides additional paths 17, one shown, for the eddy currents to enter. It is understood that paths 16 and 17 can be increased to any number until saturation of the ferrous core 15 occurs. Lamination interface characteristics and proportions are well known and need not be further described.

Proportions of the cross laminations will depend on magnetic strength required, type of materials needed and space between the magnetic poles. By experimenting with different combinations of the associated variables, an optimum number of open ferrous paths may be obtained. Optimum lamination, will therefore, depend upon the application.

FIG. 11 shows a prior art laminated ferrous armature 18 mounted on an axial shaft 19. It should be understood that laminations 16 can be plural.

FIG. 12 shows a prior art solenoid comprising a stator 20 with lamination paths 16, one shown, and an armature 21 with lamination paths 16, one shown.

FIG. 13 shows a prior art segmented laminated ferrous armature 18 with an axial shaft 19, cavities 22, and laminated paths 16, one shown. The three cavities 22 are provided to accomodate the inductance conductor circuit.

FIG. 14 shows a prior art continuous uninterrupted ferrous stator casement 23 surrounding magnetic means 10. This annular continuous casement fuses the north pole and south pole magnetic means 10 together producing the magnetic condition described in FIG. 5.

FIG. 15 shows a cross laminated ferrous armature 18 mounted on an axial shaft 19 with lamination paths 16, one shown, and cross laminated paths 17, one shown. This type of rotating armature can be utilized in magnetic induction motors energized by single phase, dual phase or three phase energy sources.

FIG. 16 shows a cross laminated ferrous solenoid comprising a stator 20 with laminated paths 16, one shown, and cross laminations 17, one shown. An armature 21 with laminated paths 16, one shown, and cross laminations 17, one shown.

FIG. 17 shows a segmented cross laminated ferrous armature 18 on an axial shaft 19, cavities 22, laminated paths 16, one shown, and cross laminated paths 17, one shown. It should be noted that some prior art armature designs are partially slotted. An example of a partial slot for eddy current paths are illustrated in FIG. 27. This structure will cause unequal magnet pole strength.

FIG. 18 shows a slotted ferrous casement 24, casement interruption slots 25 and magnetic means 10. The interrupted casement surfaces in slots 25 possess magnetic polarity in mirror image symmetry, ie: they are of the same pole identity. The same magnetic polarity condition exists when magnetic means 10 are replaced by electromagnets 27, as shown in FIG. 26.

The interruption slots 25 can be made the same dimension as magnetic means 10 and ferrous laminations inserted into the slots, as shown in FIG. 29. Number of laminations and dimensions will depend on the size of the specific structure and ultimate application. Experimentation will establish proper material and dimension for the laminations.

FIG. 19 shows a prior art laminated ferrous core 15 with a single wire conductor 13 and laminated paths 16, one shown. This illustration further depicts FIG. 9, with the magnet pole condition that results from a lamination path 16.

FIG. 20 shows a prior art laminated ferrous transformer core with a single wire conductor 13 and laminated paths 16, one shown.

FIG. 21 shows a prior art laminated ferrous stator with a single wire conductor 13 and laminated paths 16, one shown.

FIG. 22 shows two prior art laminated ferrous stators 27 with a single wire conductor 13 surrounded by a closed ferrous casement 23 and laminated paths 16, one shown for each stator 27.

FIG. 23 shows a cross laminated ferrous core with mirror image symmetry formed conductors 26, laminated paths 16, one shown, and cross laminated paths 17, one shown. The mirror image symmetry conductors 26 can be substituted by a conventional single inductance conductor 13, as shown in prior art structure FIG. 19. A reduction of magnet pole strength will occur with the single conductor. In addition, an unbalanced magnet pole development occurs with the single conductor.

FIG. 24 shows a cross laminated ferrous transformer core with mirror image symmetry formed wire conductors 26, laminated paths 16, one shown, and cross laminated paths 17, one shown. The single cross lamination path 17 divides the transformer core into equal half sections. Optimum magnetic induction is believed to occur when the number of lamination paths 16 are equal to the number of cross lamination paths 17 for a square shaped core surrounded by the conductor circuit 26.

FIG. 25 shows a cross laminated ferrous stator with mirror image symmetry formed wire conductors 26, laminated paths 16, one shown, and cross laminated paths 17, one shown. This type of structure is employed in fractional horsepower shaded pole induction motors.

FIG. 26 shows cross laminated ferrous stators 27 with mirror image symmetry formed wire conductors 26, laminated paths 16, one shown for each stator, cross laminated paths 17, one shown for each stator, and a ferrous casement 24 which is slotted 25. The interrupted casement surfaces in slots 25 possess magnetic polarity in mirror image symmetry, ie: they are of the same pole identity. The method to secure ferrous components created by cross laminating will vary depending on structure type. Any suitable method is acceptable.

FIG. 27 shows a slotted ferrous core 15 with slot 16 not extending through to the south pole face 9. When the ferrous core 15 is wrapped with an inductance conductor circuit and then electrified, the two north pole faces 8 are magnetically stronger than the one south pole face 9. The magnet pole strength is not balanced. It should be noted that with FIG. 9, and FIG. 10, the paths 16, and 17, extend completely through the ferrous material from one magnet pole face to the other magnet pole face. A reduction in work output results when pathways do not extend completely through the ferrous material such as shown in FIG. 27.

FIG. 28 shows a two slotted ferrous motor casement 24 that when combined axially with another two slotted ferrous motor casement 24' will comprise a structure with synchronizing ability. It should be noted that without the slots 25 in casements 24 and 24' the casements 24 and 24' do not possess magnetic poles. That is to say, the north and south poles of magnetic means 10 will be fused together by the solid closed uninterrupted casements. The fusing of magnet poles by a continuous casement, as shown in FIG. 14, will thus reduce the strength of the stator field magnetic means 10.

FIG. 29 shows a slotted ferrous motor casement 24. Inserted in slots 25 are ferrous laminations whereby optimal lamination dimensions and space between laminations will vary according to motor horsepower and motor requirements.

It should be understood that the structures described together with the modifications considered to be the best embodiments, are merely illustrative and that the purposes of the invention may be carried out by other means.

By incorporating the ferrous path geometry of the present invention, along with the mirror image symmetry formed inductance conductor circuit as illustrated in FIG. 23, two separate magnetic structures can be combined so that their magnetic pole characteristics are synchronized.

Referring to FIG. 28, two motor casements 24 of the type shown in FIG. 18, were assembled in axial alignment to one another and fixed to a common mount. Installed in said first casement 24 was a clockwise wound mirror image symmetry inductance conductor circuit formed on an armature, as shown in FIG. 17. This inductance conductor is further described in U.S. patent 4,806,834. Installed in said second casement 24' was a counterclockwise wound mirror image symmetry inductance conductor circuit formed on a second armature, as shown in FIG. 17.

In one exemplary embodiment, these motor casements and armatures comprised two separate DC-05 permanent magnet motors, each measuring 1.4 inches long by 1.4 inches in diameter. A common mount was provided for both motors, whereby each motor shaft faced one another. The clockwise armature with shaft had a 10 inch left pitch propeller while the counterclockwise armature with shaft had a 10 inch right pitch propeller. When energized by a 12 Volt DC battery, the dual assembly with counterrotating propellers lifted vertically displaying no distortion or vibration from the magnet pole interaction and eddy current interaction.

In the same embodiment as the above structure, without mirror image symmetry formed inductance conductor circuits, without cross laminated armatures and without slotted motor casements, the assembly did not lift when equally energized. When additional energy was supplied so lift could be accomplished, severe vibration was exhibited, no synchronization between the two motors occured, and higher operating temperature was experienced, which all led to rapid component failure.

Synchronization is accomplished in the above structure when the assembly of two motor stators are fixed to a common mount and one motor armature rotates clockwise while the other motor armature rotates counterclockwise. A synchronized condition exists when there is no torque or rotary motion applied to the stator assembly. It is clear that if the first motor is magnetically stronger than the second motor, there will then be a torque or rotary motion applied to the stator assembly.

It is not possible to synchronize a two motor assembly as exemplified in the above structure if both armatures were formed with an inductance conductor circuit wound in the same direction, ie: clockwise and clockwise or counterclockwise and counterclockwise. Also, no synchronization is possible when the inductance conductor circuit does not produce equal north pole and south pole magnetic strength at the same time, a condition I have termed "concurrent magnetic pole development".

Synchronization is also not possible if the motor stator magnet surround is continuous, a structure absent of an eddy current path.

As shown in FIG. 29, a one third horsepower 115 VOLT, AC, 60 cycle split phase motor, for example, was modified by slotting the casement 24. The ferrous stator electromagnets 27 were left in an unmodified state, as shown in prior art FIG. 22. The slots were .051 inch wide. Two .025 inch thick ferrous laminations were inserted into each of four slots located every 90 degrees around the circumference of the casement. Energy consumption, temperature and vibration measurements were taken before and after casement modification. The casement slots improved motor performance by reducing energy consumption by 5%, reducing temperature by 7 degrees fahrenheit, and reducing vertical-horizontal vibration from .172 "G" RMS to .083 "G" RMS. The 60 cycle vibration disappeared and was replaced by a 120 cycle vibration after the casement was modified.

Stator surround paths and casement interruption slots are centered at the magnetic pole location in all electric rotating machinery.

In another exemplary embodiment, comparison measurements were made on a prior art solenoid, as shown in FIG. 12, and a modified solenoid, as shown in FIG. 16. The prior art FIG. 12 solenoid may, for example, measure 1" x 3" x 3". The stator 20, had twenty seven (27) lamination paths

16 and the armature 21, had twenty seven (27) lamination paths 16. Positioned around the armature 21 is an inductance conductor circuit of 6.5 ohms resistance which is removable so it can be used for the modified solenoid, as shown in FIG. 16. When the prior art FIG. 12 solenoid was energized with a 3 volt, 300 milliamp DC source, it lifted a 4½ oz. weight. The same solenoid was then modified by sawing it in half, which created path 17 that was .025 inch wide, the width of the saw blade. Utilizing the same inductance conductor circuit and the same 3 volt, 300 milliamp DC source, an increase in magnetic strength was noted. The structure was now able to lift a 6½ oz. weight.

In summary, eddy current potential and hysteresis loss is influenced by the ferrous lamination geometry and the quantity of like magnetic poles which are proximal in the structure.

The present invention proposes a novel eddy current pathway geometry that amplifies magnetic polarity strength and reduces hysteresis losses in magnetic induction structures.