PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventor: ERICH RABE

830,736

Date of Application and filing Complete Specification: Aug. 25, 1958.

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COMPLETE SPECIFICATION

An improved Magnetic Recording and Reproducing method and an apparatus for Carrying out such method

ERRATA

SPECIFICATION No. 830,736

Page 4, line 127, *for* "entensity" *read* "intensity"

Page 5, line 49, *after* "alternating" *insert* "magnetic"

Page 5, line 50, *for* "intersectiong" *read* "intersecting"

THE PATENT OFFICE

25th April, 1960

the tape and the maximum frequency to be recorded. The recording takes place in such a way that, in for example the so-called "high frequency biassing process," a high frequency super-imposed over the recording operation brings about a shifting of the working point on the magnetisation curve of the tape approximately midway of the straight portion of the curve, so that the recording operation is retained on the tape in the form of a magnetisation. In the intervals between speech the tape leaves the head in a demagnetised condition. The "molecular magnets" of the magnetic particles, by which are meant in the following the magnetic dipoles of the atoms or molecules, composed according to present-day conception of so-called Weiss ranges or molecular ranges, are in this connection always disposed in the direction of the lines of force proceeding from the gap. The intensity of the magnetisation is determined by the proportion of the magnetisable position by raising the intensity of the recording field by the corresponding superimposing of a direct field. Even in this case the recording is such that ordered and disordered magnets exist on the carrier.

It has also been proposed first to bias the record carrier in a certain direction and thereupon to carry out the sound magnetisation in a subsequent operation vertically thereto. This method, however, does not lead to any useful result in practice, as upon the sound recording considerable distortions are liable to occur in consequence of the coercive force of the magnetic material of the record carrier saturated by the preliminary magnetisation.

Quite recently it has also been proposed to effect recording by the fact that the field of permanent magnet is located in the position of rest in the middle of the tape, and the boundary line is displaced in the direction of the width in rhythmic fashion with the matter

[*Price 3s. 6d.*]

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An improved Magnetic Recording and Reproducing method and an apparatus for Carrying out such method

I, ERNST VOELK, a German citizen, of Dammstrasse 5, Nürnberg, Germany, trading as JOHANN DISTLER KG, a German company of Dammstrasse 5—11, Nürnberg, Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a magnetic recording and reproducing method, and to an apparatus for carrying out such method.

Heretofore recording on a magnetogram carrier has been effected in such a way that a voice-impressed carrier is demagnetised by means of an erasing head by the use of an alternating potential, whilst upon continual feed movement of the carrier (tape) a renewed magnetisation thereof, conforming to the recording operation, is carried out by means of a recording head, which possesses a width of gap dependent on the rate of movement of the tape and the maximum frequency to be recorded. The recording takes place in such a way that, in for example the so-called "high frequency biassing process," a high frequency super-imposed over the recording operation brings about a shifting of the working point on the magnetisation curve of the tape approximately midway of the straight portion of the curve, so that the recording operation is retained on the tape in the form of a magnetisation. In the intervals between speech the tape leaves the head in a demagnetised condition. The "molecular magnets" of the magnetic particles, by which are meant in the following the magnetic dipoles of the atoms or molecules, composed according to present-day conception of so-called Weiss ranges or molecular ranges, are in this connection always disposed in the direction of the lines of force proceeding from the gap. The intensity of the magnetisation is determined by the proportion of the magnetically directed molecular magnets in relation to the undirected magnets, which in consequence of their disordered disposal are not magnetically effective towards the outside. The position, however, is always such that the effective magnets are located in the same direction independently of the amplitude of the recording to be made, and the number of magnets so directed varies in accordance with the intensity of the data being recorded.

The density of the magnetic field of the magnetogram carrier effective towards the outside is accordingly determined, in the known high frequency recording methods, by the degree of homogeneity of the position of the molecular magnets. This disadvantage attendant on the existing method consists in the fact that, in order to avoid distortions, magnetisation may be effected only in the range of the straight portion of the hysteresis loop.

It is furthermore known to shift the working point on the magnetisation curve into a favourable position by raising the intensity of the recording field by the corresponding superimposing of a direct field. Even in this case the recording is such that ordered and disordered magnets exist on the carrier.

It has also been proposed first to bias the record carrier in a certain direction and thereupon to carry out the sound magnetisation in a subsequent operation vertically thereto. This method, however, does not lead to any useful result in practice, as upon the sound recording considerable distortions are liable to occur in consequence of the coercive force of the magnetic material of the record carrier saturated by the preliminary magnetisation.

Quite recently it has also been proposed to effect recording by the fact that the field of permanent magnet is located in the position of rest in the middle of the tape, and the boundary line is displaced in the direction of the width in rhythmic fashion with the matter

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to be recorded, so that a recording is obtained on the lines of the known variable-area recording process employed in conjunction with sound films. In this connection the molecular magnets are either undirected or they are located (practically completely) in one direction, viz., that of the effective fields.

The known methods are accompanied by considerable disadvantages.

In the first place there occurs therein a background noise, as the effects towards the outside of the molecular magnet particles, which are not in orderly disposal, can never be entirely eliminated in practice, so that in this way interference upon reproduction is unavoidable. Interfering noises of a very unpleasant kind also occur in consequence of the fact that for known reasons, due to the " turning about " of the molecular magnets upon the preliminary magnetisation, noises are produced which are included in the recording. An appreciable disadvantage of the known methods resides in the fact that if, as is usually the case, high frequency pre-magnetisation is employed, " differential frequencies " result, which cause considerable interference in the reproduction. The harmonics of the basic frequency being recorded (modulating frequency) create in conjunction with the biassing high frequency variable effects (" differential frequencies "), which are usually located in the recording range of the apparatus and upon the reproduction lead to distortions. Finally, it is a difficult matter to provide the high frequency necessary for the premagnetisation.

It is the main object of the present invention to avoid the disadvantages aforesaid.

The invention relates to a magnetic recording method in which a direct biassing field and a low frequency signal field are effective in the gap of the magnet head, and it is characterised in that upon a recording operation these two fields act simultaneously, i.e., are superimposed, on the magnetogram carrier, and the signal field, which is variable in amplitude and frequency or is constant in respect of both or one of these factors, acts at an angle in relation to the direct field, which in the majority of cases is preferably applied substantially vertically to the direction of movement of the carrier. Magnetisation of the record carrier accordingly takes place in such a way that the signal frequency is represented by the frequency of rotation of the magnetic vector about the zero line provided by the direction of the direct field, and the amplitude of the signal is represented by the angle of rotation of the magnetisation in relation to the zero direction of the direct field. In this connection the arrangement is such that—if for certain reasons other conditions are not required—the direct field is so disposed in its direction the magnetisation of the magnetogram carrier is brought about in such a way that the external magnetic field thereby produced does not have any effect in the reproducing apparatus, and in particular, therefore, does not result in the generation of any potentials, which is as well known dependent on the direction thereof. The vector of the magnetic field being recorded is then preferably vertical to the direction of the direct magnetic field, and it is located in the plane which brings about maximum effect, and in particular potentials, upon movement of the magnetogram carrier past the reproducing apparatus. Expressed schematically, the result of such a recording process is such that the tape—assuming, as before, the example of a record carrier in tape-like form and the recording of acoustical effects—has no external magnetic field effect of any kind at the points where it has not been speech-modulated when it moves past the reproducing apparatus, for the reason that at those points the molecular magnets, although disposed in perfectly unitary fashion, have a direction which is such that the external magnetic field generated thereby is so directed that it has no effect in the reproducing apparatus, and in particular does not induce potentials in reproducing heads of the known kind. However, immediately signals of any nature are recorded, there will always be effective simultaneously with the direct field, i.e., superimposed thereto, a magnetic vector, which is controlled by the signal being recorded, and which is so directed that preferably it has maximum effect in the reproducing apparatus. This " signal vector " is superimposed over the vector of the direct magnetic field, and it is accordingly the resultant of both vectors which is effective, viz., always limited by the magnetic saturation of the material, since for reasons of an obvious nature (the prevention of distortions) operations, so far as special circumstances do not prevail, are carried out as regards the magnetogram carrier within the range of its magnetic saturation, whilst for the purpose of avoiding as far as possible undistorted conversion into magnetic values of the matter being recorded operations in the case of the superimposed alternating field controlled by the signal being recorded will be effected within the range of the straight portion of its magnetisation curve. Whereas, therefore, the fact of a " turning " (even if only a minute one) of the molecular magnets in relation to the direction of the direct magnetic field depends on the rhythm of the data being recorded, the intensity thereof, i.e., the amplitude of the magnetic data (signal) being recorded and converted into magnetic values is retained as " zero line " by the magnetogram carrier by reason of the differing maximum angle as compared with the direction of the direct field. Fundamentally, however, at each moment of the recording operation all molecular magnets will be " turned " in the direction of the effective vector of both fields, so that accordingly there will

be no " undirected " magnets on the carrier and interfering noises will be avoided. By suitable selection of the intensity of the direct-magnetic field it may be accomplished that a special preliminary erasing of data already recorded on the magnetogram carrier is not required.

Since in the new method, therefore, operations are practically always carried out within the range of saturation of the carrier, a pre-magnetisation for the purpose of bringing about a favourable working point on the magnetisation curve of the carrier may be dispensed with.

It will be obvious in itself that the stated turning of the molecular magnets about the zero line provided by the direct field will take place in each case in one or the other direction of rotation according to the polarity of the data being recorded. The position is always such that all molecular magnets are turned to the components of both fields, but that the extent of turning in relation to the zero line depends on the intensity of the signal being recorded.

It may be added that carriers magnetized by the method according to the invention may be reproduced on known reproducing apparatus without any kind of modification.

An essential feature in accordance with the invention resides in action of the direct magnetic field, the vector of which is located in the " zero position," simultaneously with the alternating magnetic field controlled by the signal being recorded and intersecting the direct field, as it is only in the event of simultaneous action (superimposing) of both magnetic values that a recording is successful also in the case of comparatively weak " signal fields " and that an undistorted recording is possible, even of the highest frequencies.

The method according to the invention is suitable for all " signals " and it is not limited to the recording (and reproduction) of accoustical effects or of frequencies within the audible range.

The invention will now be described more fully with reference to the accompanying drawings, in which

Fig. 1 illustrates diagrammatically the recording operation in conjunction with a speech-modulated magnetic tape.

Figs. 2—4 illustrate an embodiment of an apparatus for carrying out the method according to the invention, being perspective, plan and front elevational views respectively.

Figs. 5 and 6 are perspective views of a further embodiment.

Fig. 1 shows diagrammatically the direction of the magnetic vectors of a magnetic tape speech-modulated with a sinus frequency in accordance with the invention. At the zero passage points of the sinus curve there is located the magnetic vector in the direction of the reproducing gap, i.e. generally speaking in the transverse direction of the tape in the zero position, that is to say, the polarity of the magnetic field is so disposed that it does not induce any potential upon movement past the reproducing head. At the potential peak of the sinus curve the magnetic vector is turned towards the right or the left accordingly, these points of the tape disclosing the maximum extent of rotation of the magnetic vector, which moves gradually from the zero direction into the extreme angular position and then returns to the zero direction, to move finally in the opposite direction, in unison with the frequency being recorded.

For the purpose of carrying out operations without distortion the direct magnetic field is made to intersect the alternating field at right angles. The intensity of the direct magnetic field, in order to effect a complete erasing, must be adapted to the saturation value and the other magnetic properties of the magnetic material of the magnetogram carrier. Maximum efficiency is obtained if the direct magnetic field vector is not greater than is necessary for the purpose of achieving a saturation of the magnetogram carrier.

There is then obtained by the superimposing of the signal field in accordance with the invention a maximum relative rotation of the resulting magnetic vector.

Referring to Figs. 2—6, the arrangements therein shown are based substantially on the fact that the two magnetic circuits, viz., the circuit which, by reason of its direct field, moves the molecular magnets into the so-called zero position, and the alternating magnetic circuit carrying the recording signal, which circuit is superposed over the direct field and accordingly by the vectoral addition of both fields moves the direct field into the direction of magnetisation corresponding to the signal, possess in common a portion of a magnetic conductor in the form of a common pole, whereby it is ensured by suitable embodiment of the recording means that the direct magnetic field is not again made effective by reason of leakage zones after the zone in which the superimposing of the alternating field and the direct field is effective has been traversed by the magnetogram carrier.

The direct magnetic field may also be produced by a permanent magnet, in which connection particular attention should be paid to the leakage zones thereof. After the direct magnetic field has been eliminated, for example by a rocking away and short-circuiting of the permanent magnet, the recording device may also be employed for the purpose of reproduction.

One embodiment of apparatus is shown in Figs. 2—4, Fig. 2 being a perspective view and Figs. 3 and 4 plan and front views respectively. There is shown at 5 an electromagnet having the D.C. winding 7. This magnet comprises at right angles a toroidal magnet 3,

which at 8 possesses a portion in common with the D.C. magnet 5. The data to be recorded is induced in the toroidal magnet 3 by the winding 4. The usual gap of the toroidal magnet 3 is shown at 2, whilst 6 is an edge common to both magnetic circuits. The tape is moved forward in front of the gap 2, in such a way that there is first effective the direct magnetic field of the magnet 5, the intensity of which is so great that a previous magnetisation of the record carrier is reliably erased and the molecular magnets are accordingly saturated and directed in the longitudinal direction of the gap 2, i.e., have a polarity imparted thereto such as is indicated by arrows at the points designated " O " on the tape 1 shown diagrammatically in the lower part of Fig. 1.

Upon further movement of the tape, which in Fig. 3 is conducted past the gap 2 from the right to the left, the tape now enters the zone in which the magnetic fields of 5 and 3 are superimposed, being staggered by 90° in relation to one another. Dependent on the intensity of the vector (controlled by the matter being recorded) of the magnetic field produced by the magnet 3 in the gap 2 and concentrated at the edge 6 there is produced by a superimposing of the magnetic fields of 3 and 5 in the leakage zone at the edge 6 a resulting magnetic field, the magnetic vector of which by reason of its rotation in relation to the direction of the magnetic field produced by 5 represents the intensity of the operation being recorded, whilst the periodicity of this magnetic field corresponds to the frequency of the data. Greater or smaller amplitude of the data being recorded accordingly corresponds to an equally greater or smaller rotation of the " molecular magnets " out of their zero position, i.e., out of the position in which, in the subsequent reproducing operation, an induction is not brought about by the outer magnetic field radiated by the magnetic record carrier. The change in direction corresponds to the passage through zero on the part of the frequency being recorded. In this connection operations are always carried out fundamentally within the magnetic saturation zone of the magnetogram carrier.

In Figs. 3 and 4 the apparatus just described is again shown in two views shifted by 90° in relation to one another. The same reference numerals have been employed as in Fig. 2.

The current lead in respect of the frequency coils controlling the magnetic field of the magnet 3 is shown at 4. At 9 there is provided a gap, which in known manner attenuates the remnant magnetism of the highly permeable magnetic circuit 3. If the record carrier, for example a tape, is moved upon the recording operation in the direction of the arrow past the edge 6, the same receives at this point the magnetic properties corresponding to the matter to be recorded in the manner described above.

Upon reproduction the tape moves in the same direction. In this connection the direct magnetic field must be eliminated in the manner known per se, or at least rendered ineffective in its entensity, to such an extent that it has no magnetic effect on the tape.

A further embodiment of apparatus in accordance with the invention is shown diagrammatically in Figs. 5 and 6.

The core of the direct magnetic field is again shown at 5, 3 being the core of the alternating magnetic field controlled by the signal to be recorded.

Both cores have at 6 their common edge, which forms one pole of the speech gap 2, past which there moves the record carrier. The D.C. leads are shown at 7, whilst the leads in respect of the signal to be recorded are indicated at 4.

Fig. 6 is a fragmentary view showing the speech gap 2 with the common edge 6 in respect of the two right-angularly disposed circuits 5 (direct field) and 3 (alternating field).

The direct electrical field may naturally also in this case be replaced by the field of permanent magnet. Upon the recording operation the tape must move towards the gap from the direction of the direct field.

So far as reference has been made in the above to a " gap " or " speech gap," this does not of necessity imply an air gap, but refers to a point at which there is a break in permeability.

The apparatus according to the invention may also be employed for the reproduction of record carriers magnetised by the method referred to. In this connection the direct magnetic field must naturally be made ineffective by a rocking aside of the permanent magnet or by disconnection of the direct current, with simultaneous elimination of the remnant magnetism in the manner known per se, for example by the connection of a condenser in parallel with the head inductance 7, whereby a fading oscillation is achieved.

From the foregoing it will be appreciated that the invention is not limited by the embodiments described and that the method of magnetic recording and apparatus therefor according to the invention may be employed for recording and reproducing frequencies on the acoustical range. Moreover in employing the present invention it is possible to record and reproduce all periodic occurrences for example control signals.

WHAT WE CLAIM IS:—

1. A magnetic recording method, in which a direct biassing field and an alternating magnetic field intersecting therewith and controlled in its entensity and frequency by the signal being recorded are effective, characterised in that upon a recording operation the two magnetic fields are superimposed, so that mag-

netisation of the record carrier takes place in such a way that the frequency of the signal, which signal is variable in amplitude and frequency or is constant in respect of one or both of these factors, is represented by the frequency of rotation of the magnetic vector about the zero line provided by the direction of the direct magnetic field, and the amplitude of the signal is represented by the angle of rotation of the magnetisation in relation to the zero line.

2. A method according to Claim 1, characterised in that the intensity of the direct biassing field is so great that a previous erasing of data previously recorded on the magnetogram carrier is not required.

3. An apparatus for carrying out the method according to Claim 1 or Claim 2, characterised by means arranged to form a direct biassing magnetic field and an alternating magnetic field intersection therewith and controlled by a signal to be recorded, said fields being arranged to extend in common over a predetermined distance to form a section representing one pole shoe in respect of the speech gap.

4. An apparatus according to Claim 3, characterised in that the two magnetic fields in the part in which they extend in common are disposed at right angles to one another.

5. An apparatus according to Claim 3 or Claim 4, characterised in that the direct biassing magnetic field is produced by a permanent magnet.

6. An apparatus for the reproduction of matter recorded by the method according to Claim 1 or Claim 2, characterised by a permanent magnet arranged to form the direct magnetic field and a D.C. electromagnet to form the alternating magnetic field, the arrangement being such that the direct biassing magnetic field is eliminated by a rocking aside of the permanent magnet or by disconnection of the current fed to the D.C. electromagnet and elimination of the remnant magnetism by oscillation fade out by means of a parallel-connected condenser, whereupon the apparatus may be employed for reproducing purposes.

7. A magnetic recording method in which a direct biassing field and an alternating field intersectiong therewith and controlled in its intensity and frequency by the signal being recorded are effective, substantially as hereinbefore described with reference to the accompanying drawings.

8. A magnetic recording apparatus, in which a direct biassing field and an alternating magnetic field intersecting therewith and controlled in its intensity and frequency by the signal being recorded are effective, substantially as hereinbefore described with reference to the accompanying drawings.

PAGE, WHITE & FARRER,
Chartered Patent Agents,
27, Chancery Lane, London, W.C.2,
Agents for the Applicant.

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Published by The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

FIG. 1.

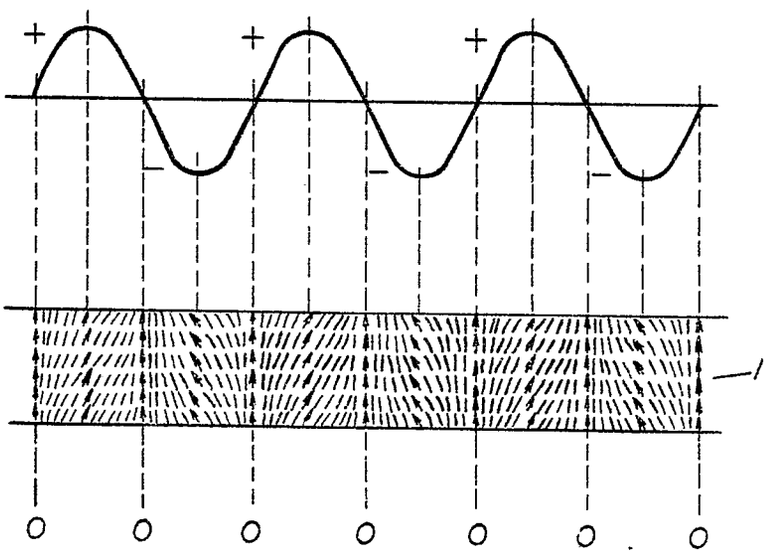
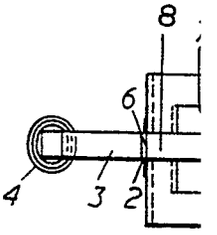


FIG.



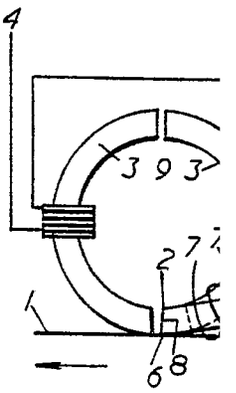
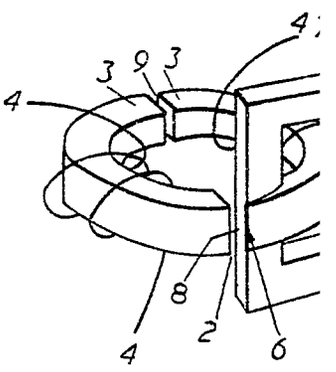
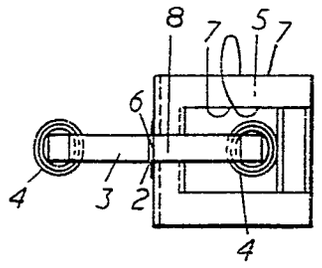


FIG.



830.736 COMPLETE SPECIFICATION
3 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1, 2 & 3

FIG. 4.



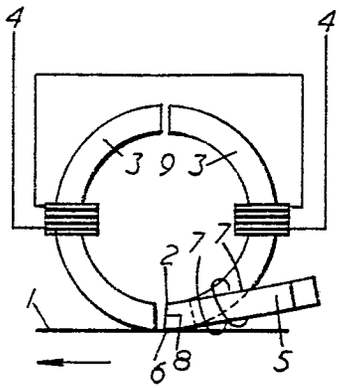


FIG. 3.

FIG. 5.

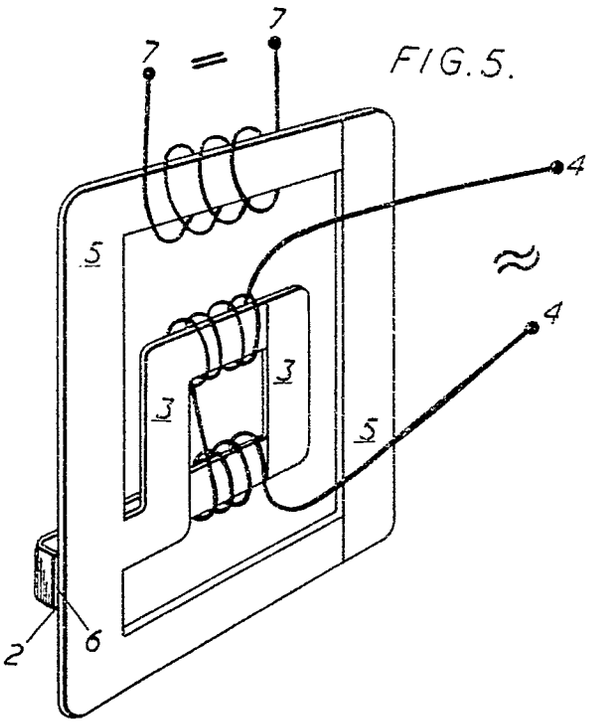


FIG. 6.

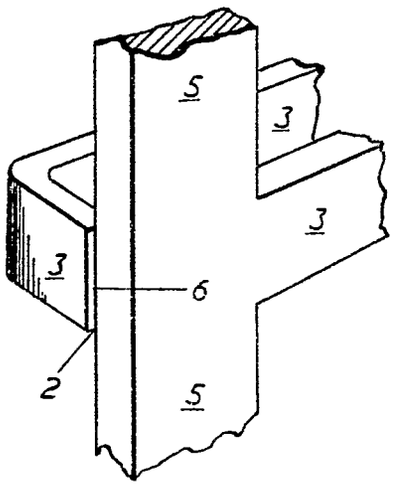
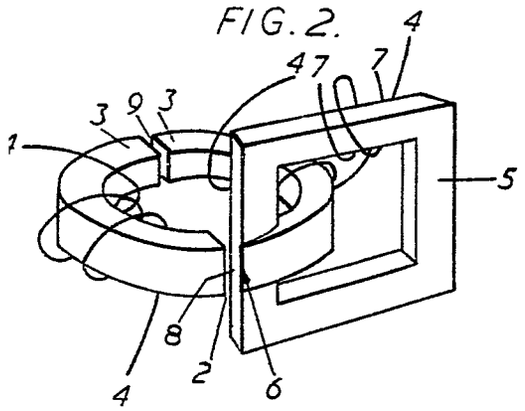


FIG. 2.



830,736 COMPLETE SPECIFICATION
3 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1, 2 & 3

FIG. 1.

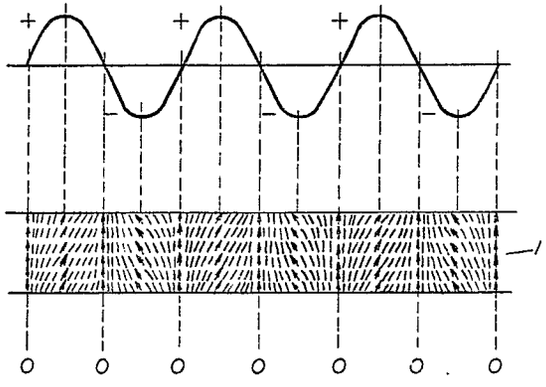


FIG. 4.

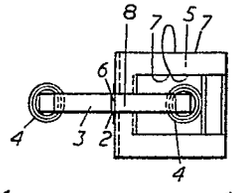


FIG. 3.

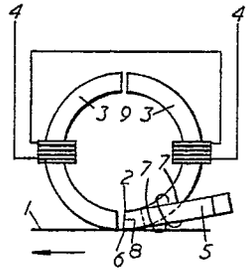


FIG. 5.

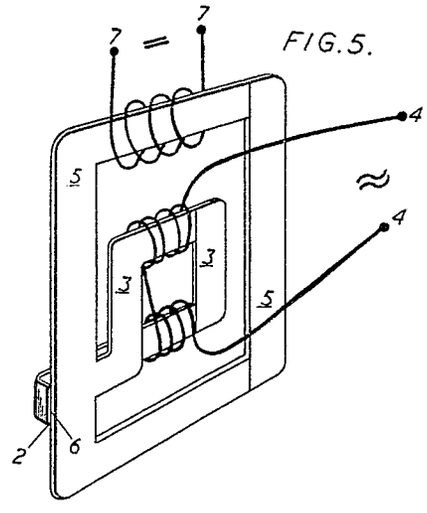


FIG. 2.

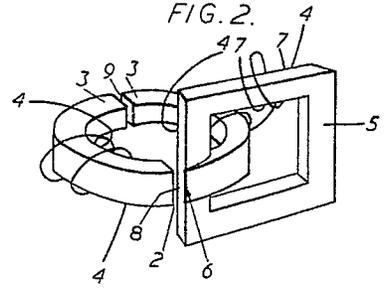


FIG. 6.