April 13, 1954 H. ROHLING 2,675,429

MAGNETIC SOUND RECORDING METHOD

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Fig. 1

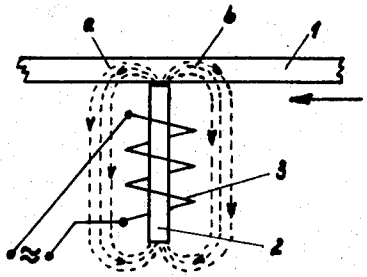


Fig. 2

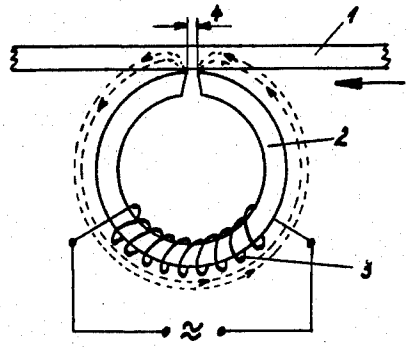


Fig. 3

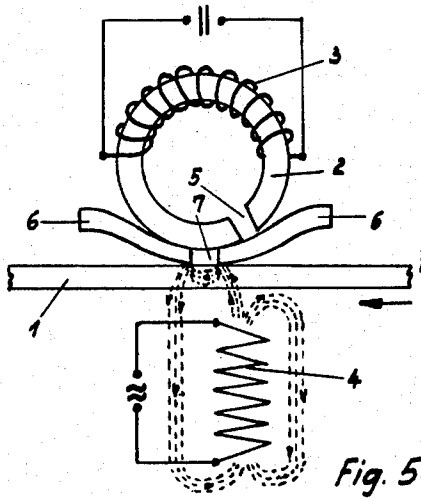


Fig. 4

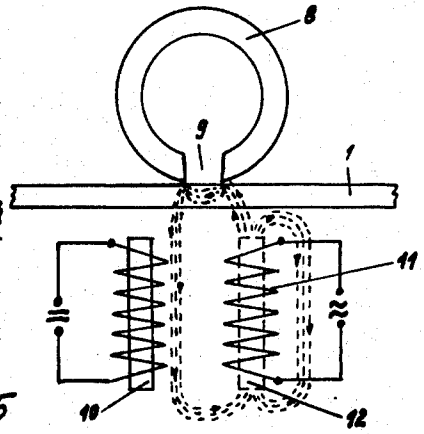


Fig. 5

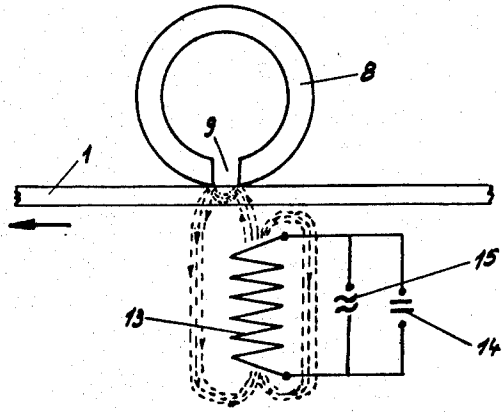


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Fig. 6

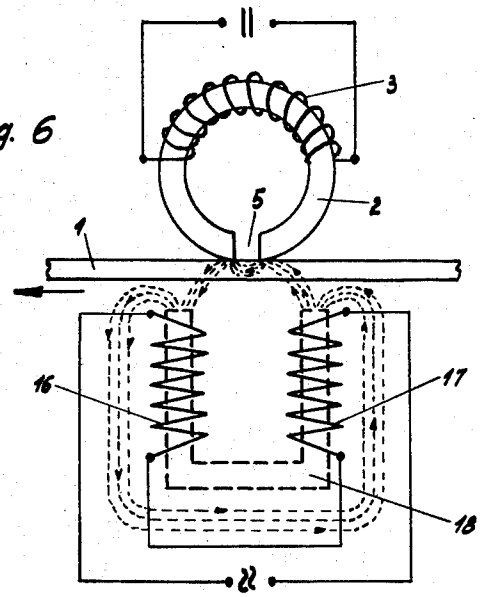
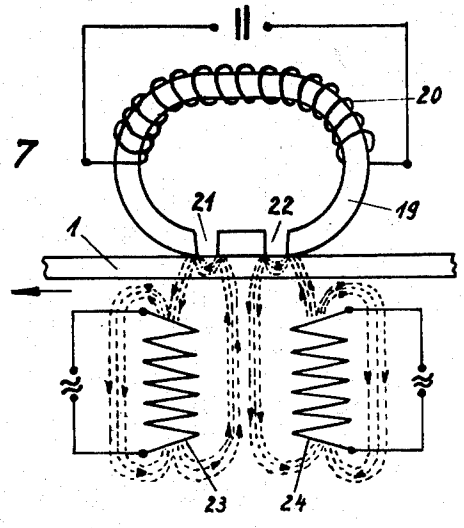



Fig. 7

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Patented Apr. 13, 1954 2,675,429

# UNITED STATES PATENT OFFICE

2,675,429

## MAGNETIC SOUND RECORDING METHOD

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Application July 3, 1950, Serial No. 171,945

Claims priority, application Austria July 4, 1949

7 Claims. (Cl. 179—100.2)

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In the magnetic recording of sound a so-called recording head is used which contains a ring magnet having an air gap which faces the record carrier travelling past the recording head. The recording head is supplied with speech frequency alternating voltage which correspondingly magnetises the carrier moving past it. The magnetic field produced in the air gap is not however homogeneous but is subject to considerable leakage.

The latter could be minimised by the use of low speech voltages but this is not possible owing to the high permeability of the record carrier and its great susceptibility to residual magnetism. The recording head and the record carrier have two entirely different magnetisation curves. For these reasons speech frequency magnetisation is based upon a point on the straight portion of the hysteresis loop of the record carrier, this point being called the working point. This is achieved by bias magnetisation, the speech frequency alternating current having a bias magnetisation current superimposed thereon.

However, bias magnetisation considerably impairs the high frequencies of the speech current in the recording head and this gives rise to non-linear distortion. The reason for this is that large leakage regularly occurs in the recording head, particularly if direct current is used for bias magnetisation. Attempts have been made to overcome these difficulties by the use of high frequency bias, but this has the disadvantage of necessitating the use of expensive amplifiers and generators in the electrical equipment of the recording apparatus.

The large leakage associated with bias magnetisation and the disturbance of the useful magnetisation caused thereby has been reduced in the past by making the magnetising recording head of annular form. In this annular head there is cut an air gap at the point where it touches the record carrier. In this way however the object aimed at is partly defeated again, because leakage current once more occurs at the air gap and causes a considerable amount of distortion, the removal of which is the object of the present invention.

The invention is based on the notion that what matters is to avoid as completely as possible the occurrence at the point of contact between recording head and record carrier of any leakage lines which are opposed to the direction of speech magnetisation. To this end it is proposed in accordance with the invention that the speech field should be arranged separately from the recording head in such a manner that part of the flux of the control field is induced in the recording head or its recording gap. The building up of the speech field is therefore independent of the recording head which however may carry the bias magnetising coil in a manner known per se. With advantage the bias magnetisation is produced by a magnetic field of constant field strength whereas speech excitation is brought about by a controlling field (hereinafter called a "speech frequency field") which overlaps the bias magnetisation field only within the range of excitation of the record carrier.

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An air-cored coil is preferably used for exciting the speech frequency field. For example, a coil of 400 turns of 0.45 mm. diameter enamelled copper wire may be used, its length being 30 mm. and its diameter 10 mm. It has been found that such a coil placed at a distance of a few millimeters from the record carrier gives perfect control of the record carrier when a recording power of about 1 watt is used. The record gives a reproduction with good freedom from distortion and pronounced sensitivity to frequency changes as well as large band width.

A comparison of this result with a known arrangement of the same dimensions, using the same record carrier material and the same recording gap shows that in the known recording methods there are present large-scale detrimental influences the cause of which are the leakage lines proceeding from the recording gap whereas in the arrangement according to the invention there is only a very small quantity of ferromagnetic medium in the total path of the lines of force of the speech frequency field where the latter is produced separately from the recording gap, and in this way distortions are suppressed.

This separation of the speech frequency exciter from the recording head may be brought about for example by placing the speech field exciter opposite the recording head which is in contact with the record carrier and on the other side of the latter. The coil of the speech frequency exciter may be arranged at an angle to the record carrier for example perpendicularly thereto. In that case the speech frequency field should be arranged staggered in such a manner with respect to the place where the recording head is adjacent the record carrier that only one half of the speech frequency field comes within the range of the recording head whereas the other half faces away from the recording head, preferably towards the direction from which the record carrier is moving.

The speech frequency field is only induced in the recording head at or adjacent the record carrier and in the portion of the record carrier adjacent thereto. The recording head itself may be of any desired dimensions, the only essential point being that the lines of force leaving the speech coil should excite the iron of the recording head only where it lies adjacent to the record carrier.

The drawing shows several embodiments of the invention;

Figs. 1 and 2 show two known forms of recording heads,

Figs. 3 to 7 show different arrangements in accordance with the invention.

In all figures the lines of force are shown in broken lines. In order to be able to show more clearly the lines of force within the carrier 1 which is extremely thin, the carrier and the recording gap are shown in the drawing with a purposely exaggerated cross-section.

In the known arrangement according to Fig. 1 a record carrier 1 is shown with a very simple recording head consisting of an iron core 2 and a coil 3. With this arrangement the record carrier slides over the iron core and is magnetised at that point. So-called bias magnetisation can also be effected in known manner either by means of the coil 3 or by means of a stationary magnetic field.

Lines of force leave the recording pole of the core 2 as indicated in dotted lines, the direction of the lines of force at the departure side *a* being the reverse of that at the arrival side *b* with respect to the direction of movement of the carrier. The resulting magnetisation record on the record carrier can therefore only consist of the difference from the arrival to the departure of the record carrier. This fact is known from prior literature and has led to different attempts at providing a solution.

Fig. 2 shows what happens when a ring recording head 2 is used. Depending on the dimension of the gap width 4, leakage fields occur in this case also to a greater or lesser degree, which likewise influence the record carrier at the departure side of the recording head 2 by their opposite direction.

In the embodiment of the invention according to Fig. 3 there is disposed on one side of the record carrier 1, which may consist for example of a steel wire of 0.06 mm. diameter, a bias magnetisation ring 2 whose coil 3 is supplied with direct current, whereas on the other side of the carrier there is disposed an air-cored coil 4 for the speech frequency voltage, and it is staggered with respect to the head 2. The ring 2 is slightly rotated so that the air gap 5 is not pointed straight at the carrier and the gap is closed by a magnetic conductor 6, for example of transformer sheet metal, the gap 7 of which is in contact with the carrier.

In the embodiment according to Fig. 4 there is disposed on one side of the carrier a recording head comprising a simple iron ring 8 with its air gap 9 facing the carrier. On the other side there are a bar magnet 10 (which may be excited by direct current or may be a permanent magnet) and a speech frequency control coil 11. Both coils may be disposed in the same plane or they may be in different planes. They are however so arranged with respect to each other and to the ring 8 that the latter draws the lines of force both of the bias magnetisation and of the speech frequency field towards the gap 9.



In some cases it may be possible to use a simple iron pole piece instead of the ring. Also the coil 11 could be provided with a core 12 of the lowest possible remanence.

Fig. 5 shows the combination of bias magnetisation and speech frequency field in a single coil 13, an iron ring 8 with an air gap 9 staggered with respect to the coil 13 being provided as in Fig. 4. Direct current voltage and speech frequency voltage are in this case applied to the same coil 13 from sources 14 and 15 respectively, the coil 13 being an air-cored coil. The lines of force of the combined bias magnetisation and speech frequency field are induced in the gap 9.

Fig. 6 shows an embodiment with several speech frequency coils. In this case a bias magnetisation recording head 2 with a direct current coil 3 is arranged as in Fig. 3 on one side of the carrier, whereas on the opposite side there are coils 16 and 17 which may be connected in parallel. One of the coils, for example 16, may be especially adapted for high tone frequencies and the other, for example 17, for low tone frequencies, anti-distortion means being connected in the circuit. The direction of the lines of force is arranged to be such that the field lines reinforce each other. If desired both coils can be provided with a U-shaped iron core. This has for effect that the control field produced is stronger though dependent on frequency.

Fig. 7 shows an arrangement for tone recording with echo effect. A recording head in the form of a ring 19 with a direct current coil 20 serves for bias magnetisation and has two air gaps 21 and 22. Staggered with respect to the latter, and on the opposite side of the carrier, are two air-cored coils 23 and 24 which are energised by two separate speech frequency currents from two different microphones via different amplifiers. The distance between the gaps is calculated for a time interval of say, $\frac{1}{120}$ of a second, taking into account the speed of movement of the carrier 1. Similar arrangements are also possible with three gaps in the recording head and three speech coils.

In all embodiments shown, high frequency may be used for bias magnetisation instead of direct current, if desired.

What I claim and desire to secure by Letters Patent is:

1. Magnetic sound recording apparatus comprising an electromagnetic transducer head, a magnetic record member adapted to move past said head, said head being positioned on one side of said member, a signal coil for producing a magnetic field proportional to the signal impressed thereon, said coil being positioned on the opposite side of said member to said head, the axis of said coil being laterally spaced from a plane passing through the center of said head and through said member at right angles thereto whereby a part of said signal coil magnetic field is induced in said record member adjacent said head and in said head adjacent said record member.

2. Apparatus as defined by claim 1 further including a means to bias magnetically said record member to a point on the straight line portion of the hysteresis loop thereof.

3. Apparatus as defined in claim 1 wherein said electromagnetic transducer head includes a C-shaped iron core having a gap defined thereby, said gap being positioned adjacent said

member wherein said part of said signal coil magnetic field is induced in said member only in the area thereof immediately below said gap and not the extremities of said iron core defining said gap.

4. A magnetic sound recording apparatus as defined by claim 2 further characterized in that the bias magnetization field is produced by direct current and is of constant field strength.

5. Magnetic sound recording apparatus as defined by claim 1 further characterized in that said coil is an air-cored coil for producing the signal coil magnetic field.

6. Magnetic sound recording apparatus as defined by claim 1 further characterized in that only those field lines of the signal coil magnetic field which are parallel with the direction of movement of the record member are induced in the record member adjacent the transducer head.



7. Magnetic sound recording apparatus as defined by claim 1 further characterized in that said coil is offset in the direction from which the record member is moving.

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