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METHOD FOR MAGNETIC SOUND RECORDING

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This invention relates to an improved method of magnetic sound recording, especially with the aim to lower the background noise, and therefore with the possibility to enlarge the dynamic range of reproduction.

As commonly known, the magnetic sound recording is effected upon a paramagnetic material, preferably a steel wire or steel tape. This tape is moved with constant velocity along the pole pieces of a recording head fed by the currents to be recorded. The tape will thus be impressed with remanent variations of its magnetic properties which can be again converted into electric currents by passing the steel wire or tape along a properly constructed reproducing head.

It is known, that there arise serious difficulties with this simple method of recording and reproducing sound, as far as the fidelity and the lack of distortions are concerned. The reasons for these difficulties are for example: the non-linear character of magnetisation of a magnetizable body relative to the magnetic flux; phase shifts, hysteresis effects and so forth. Besides that there are the problems of erasing the past magnetic history of the tape, and of getting good recordings of the feeble signals as well as of the strong ones without distortions and rectifying effects by cutting off the half-waves.

Several possibilities are known for wiping out former recordings. Usually the tape is exposed to the influence of a strong constant magnetic field. Before recording, the magnetisation must be returned to a midpoint on the B—H curve or else to a neutral state. This is done by a polarizing magnetic field the direction of which is opposite to the first one. This method would be quite allright for a paramagnetic recording material with ideal magnetic properties. But experience showed that even the best tapes or steel wires available give serious difficulties by hysteresis effects, by the frequency dependence of the permeability and that of the inductivity of the recording head.

It is further known to wipe out past recordings by a high frequency current, thereby bringing down the magnetisation to the zero point of the B—H curve, and returning afterwards prior to the recording the magnetisation of the tape to an optimum value of said curve. This method, however, does not eleminate any of the difficulties mentioned.

Furthermore it has been proposed, to use a high frequency current superimposed to the speech currents for recording, hereby agitating the recording body. But even this procedure does not diminish the difficulties mentioned above.

In order to overcome all these difficulties, especially the inhomogeneity of the tape or wire in its magnetic properties, the dependence of frequency of the permeability as well as of the inductance of the heads, it has been also proposed to supply to the recording head high-frequency currents modulated in the rhythm of the low-frequency currents to be recorded. In using this method, the recording body has to be magnetized up to saturation before recording. With no signal frequency present, the tape will be demagnetized by the recording head down to a midpoint of the B—H curve. Recording is then effectuated up and down from this point within the extreme limits of saturation and zero-magnetisation.

It has been considered as advantage that in this method the whole recording energy is concentrated within a very small interval, namely within the carrier frequency and between both side bands. The difficulties arisen by the fact that both permeability and inductivity depend remarkably upon frequency are in this way eliminated, and the recording is free from serious distortions. This effect would not at all have been reached by simply superimposing radio frequency upon signal frequency; as in this case the interval of the utilized frequencies would not become smaller, as desired, but much more larger.

All these methods mentioned above have been developed chiefly to improve magnetic sound recording of telegraph signals or of speech currents, where no special stress was to be laid upon high quality. The measures proposed are by no means appropriate to ensure a perfect degree of reproduction e. g. of musical recordings. Even by using high frequency currents according to the prior art, the background noise which must be considered the most annoying factor cannot be suppressed down to a sufficiently low value.

The reason for this fact is a double one.

Firstly: The high frequency currents energizing the recording head involve eddy currents of considerable strength in the steel tape, the magnetic fields of these eddy currents reacting upon the recording field. According to the magnetic inhomogeneity of the metallic tape or wire the intensity of the eddy currents will vary from one point to the other even when no signal current is present, thus producing a variable reaction upon the recording field and therefore upon the impressed magnetism. When reproduced the variable magnetisation induces corresponding noise currents in the reproducing head. The

effect described above is not only a theoretical deduction but can be easily verified by experiments. Therefore it is shown that a perfect magnetic recording depends upon an absolute elimination of reaction of the tape towards the recording field.

Besides that the best suppression of background noise will be ensured by taking measures to bring the tape—with no speech currents present, that is in the intervals of performances—to an absolutely unmagnetic state when leaving the recording head. Such a neutral tape is quite unable to induce noise currents in the coils of reproducing heads.

This demand of completely neutralizing the magnetic state of the tape in the case when no desired speech current is present can be fulfilled by exposing the tape leaving the head to a high frequency alternating magnetic field, the influence of which upon the moving tape decreases continuously down to zero. This measure resembles well to the technical demagnetisation of ferro-magnetic bodies. Here the strength of the alternating field will be gradually decreased with the effect that the magnetic state of the body follows to smaller and smaller hysteresis loops. The difference between this technical procedure and the method proposed above is simply, that we do not change the magnetizing current, but remove gradually but continuously the point to be demagnetized out of the magnetic sphere of the head.

As explained above our invention consists in superimposing to the low frequency current to be recorded a relatively strong high frequency current, and in doing this to eliminate at one hand the reactions of the tape or wire upon the field of the recording head by properly choosing the material or the properties of the tape itself or by properly designing the head, and on the other hand to take precautions that the tape leaving the recording head will be exposed to the influence of a magnetic field which—as a function of distance from the head—decreases continuously down to zero.

The reaction of eddy currents produced in the tape under the influence of the high frequency currents upon the recording field can be eliminated by using a non-magnetic tape of sufficient rigidity with a magnetizable cover, the paramagnetic particles of which are insulated one against the other. In a surface of this type no eddy currents can be induced. The particles mentioned can be enclosed in an insulating cement the layer of which forms a cover of the non-magnetic film. A tape of this type has been described p. e. in German Patent No. 500,900.

The second condition to be fulfilled is the field which ensures a gradual continuous demagnetization of the tape leaving the recording head. The well known double pole open heads are not appropriate to cover this demand. In such a head we have two types of magnetic fluxes: between the pole pieces we have the direct flux or main flux which connects on the shortest path the pole pieces; outside this region we have the stray flux the intensity of which corresponds to a fraction (say $\frac{1}{3}$) of the main flux. This stray flux has a direction opposite to that of the main flux. Therefore a magnetic particle of the tape coming from the main flux passes a point of zero field strength which represents besides that a point of phase turning, and enters then the region of stray flux. The field form described does not correspond to the demands for a continuous demagnitization of the moving tape; it may be added that the decreasing stray flux alone is not able to produce a complete demagnetization because of its lower intensity. The disadvantages explaned above do not occur with heads of other construction, especially with circular heads which touch the tape only from one side. The field of heads of this type corresponds to the characteristics to be insisted upon.

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