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APPARATUS FOR RECEIVING AND STRENGTHENING THE REPRODUCTION OF MESSAGES, SIGNALS, &c.

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2 SHEETS—SHEET 1.

Witnesses:

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To all whom it may concern:

Be it known that I, Emil Schack Hagemann, a subject of the King of Denmark, residing at Copenhagen, in the Kingdom of Denmark, have invented certain new and useful Improvements entitled "An Apparatus for Receiving and Strengthening the Reproduction of Messages, Signals, and the Like," (for which I have applied for patents in Germany and Denmark, and which applications are dated April 20, 1900, April 21, 1900,) of which the following is a specification.

This invention relates to an apparatus for electro-magnetically recording speech or other signals, and reproducing the same, and has special reference to the principle disclosed in Letters Patent of the United States No. 661,619, issued November 13, 1900, to V. Poulsen.

The object of the present invention is, primarily, to provide means for amplifying or strengthening the sounds or electrical impulses reproduced from the instrument and delivered to the receiving apparatus, to an extent more than can be done with the instrument as described in the said Poulsen patent. In accomplishing this, I produce a species of relay or repeater, which may be used in transmitting telephonic and telegraphic messages over long distances. In the Poulsen instrument referred to, the electrical impulses set up by the transmitting instrument, flow through an electro-magnet, whose poles are resting in contact with a steel wire, the wire being simultaneously moved or dragged past the poles. The varying magnetism thus created in the magnet, is imparted to successive portions of the steel wire, which retains the impressions, since steel is a paramagnetic body. After the record has thus been made, it can be reproduced by again passing the same or a similar magnet over that portion of the wire which received the impressions and connecting the magnet in circuit with a receiving apparatus, such as a telephone receiver. In this case the magnetic lines of force in the wire are communicated to the core of the electro-magnet and thus induce corresponding currents of electricity in the coil of the electro-magnet which flow to, and affect the receiving apparatus, and reproduce therein the same sounds or signals that were originally sent through the transmitting apparatus.

The said Poulsen invention also describes a method of wiping out or eliminating the magnetic record or impression made in the wire, which consists in connecting up the same electro-magnet or any other electro-magnet with a source of constant current, such as a battery, and again passing the wire from end to end across the poles of the magnet. This "demagnetizes" or produces a neutral condition throughout the whole length of wire, whereupon it is again ready to receive another record.

The strength of the reproduced message in the receiving apparatus, largely depends upon the amount of resistance in the several electric circuits utilized in the recording and reproducing operations; for instance, a given record will be reproduced from the machine, more loudly or forcibly in the receiving apparatus over a short circuit than over a long circuit. The present invention is therefore intended to amplify the sounds, or force of the reproduced speech or signal, with any given condition of resistance of circuits. In accomplishing this I record the message upon a plurality of different steel wires or bodics, and in reproducing, I utilize all of the records simultaneously, to produce a joint or cumulative effect in the circuit containing the receiving apparatus. The amount or extent of the amplification or increase in the reproduction is therefore theoretically limited only by the number of records made and simultaneously reproduced, and it is evident that for transmitting messages telephonically over long distances, unattainable in ordinary telephone practice, it is only necessary to insert at one or more points in the circuit, an amplifying apparatus of the character herein described.

My invention will be described in detail with reference to the accompanying drawing, in which

Figure 1 is a side elevation of my improved relay apparatus; Fig. 2 is an end elevation thereof; Fig. 3 is a diagrammatical or conventional view, corresponding to Fig. 1; Fig. 4 is a similar view corresponding to Fig. 2, and Figs. 5 and 6 show modifications of my invention.

Referring to the drawing by letter, A indicates a cylinder or drum mounted on a shaft a in bearings a', and fitted with a pulley a'.
through which it may be rotated from any suitable source of power. On the surface of this cylinder, are applied a number of steel rings or bands, lettered respectively, 1, 2, 3, 4, etc. Each of these is a completely closed ring, so as to present a smooth endless surface. Facing ring 1 is an arc-shaped frame e, carrying, on its inner face, a series of electro-magnets respectively lettered e, e', e", e", e" etc. The pole pieces of these magnets are presented to and preferably rest in contact with the ring 1. d is another frame piece, extending diagonally around the face of the cylinder and properly secured above and below, to the main frame; this frame piece also carries a number of electro-magnets f', f", f", f", etc. on its inner face, whose pole pieces are presented to, and preferably rest against, the respective rings 2, 3, 4, etc. These magnets correspond respectively with the magnets e', e" e", e", etc. and the corresponding magnets are fixed in the same horizontal line on the face of the cylinder. Each corresponding pair are connected together in a closed circuit, by the wires g, said wires being connected to the terminals of the coils of each magnet. h, h', h", h", etc. indicate another series of electro-magnets, supported by a suitable part of the framework, as shown, being attached to the base of the instrument, and arranged in a horizontal line with their poles presented to and preferably in contact with the respective rings, 1, 2, 3, etc. These magnets h, h' are all connected in circuit with a source of constant current, such as a battery I. The initial message is sent to the instrument through a circuit j, k, containing a transmitter T and the usual equipment of battery M, and may also contain an induction coil in the usual way, this, however, not being illustrated. The circuit j, k leads to and includes magnet e, which is the main recording magnet of the instrument. The circuit r, r' includes a suitable receiving apparatus R, which may be a telephone receiver.

Both the transmitting and receiving circuits may extend any distances from the relay instrument, whose operation is as follows: Let it be assumed that the cylinder is being rotated at a constant speed in the direction of the arrow in Fig. 2. Speech or other signal is delivered to the transmitting apparatus T, and electrical impulses corresponding thereto, are thus created in the circuit j, k, which includes magnet e. This magnet is therefore variably magnetized by the successive impulses, and its magnetic condition is imparted to successive portions of the steel rings 1, against which its pole or poles rest. These magnetic impressions are retained by the ring, and in the rotation of the drum, are carried successively past the poles of the magnets e', e", e", etc. In thus passing the poles of these magnets, a current is induced or generated in the coils of the said magnet e', e", e", etc., in the well understood manner of a dynamo electric machine, the power being supplied by the motor which rotates the cylinder. The current generated in the magnet e', flows over the connecting wires g, through the magnet e", which is resting upon ring 2; hence the instant a magnetic impulse or impression in the ring 1, passes the magnet e', it will be accompanied in its further movement onward, by an exactly similar magnetic impression in the ring 2, the two impressions traveling abreast, as it were, towards the receiving magnets h, h', etc. The impression in the ring 1 reaches the magnet h at the same instant that the impression in the ring 2 reaches the magnet h'; hence magnets h, h' which then become receiving magnets, will have similar current impulses generated in their coils, and since these coils are connected together in the same circuit, their electromotive forces will combine and be theoretically double that which is produced by either magnet acting alone. After a given magnetic impression in the ring 1, has passed the magnet e', it acts upon the magnet e" and sends therewith a current which energizes magnet f, which, in turn, impresses a corresponding magnetic impression on ring 3, hence the ring 3 will present the same magnetic impression to magnet h' which rings 1 and 2 are at the same time presenting to magnets h and h', and we thus have in the circuit r, r', theoretically, three times the electromotive force that could be reproduced from any one ring. In like manner the same magnetic impression in ring 1, will be communicated to ring 3, and act upon the circuit r, r' at the same time with the others, and so on throughout the entire capacity of the instrument, a given magnetic impression being conveyed and simultaneously presented to the magnets h, h', etc. upon respective rings 1, 2, 3, etc. The result in the receiving circuit r, r' is a current impulse having an electromotive force equal to the combined electromotive forces produced by the respective rings. The current impulses leaving the instrument and proceeding to the receiver R, are thus much stronger than could be obtained by the use of a single reproducing magnet only.

It will be understood that there will be some loss due to the resistance of the coils and circuits, and to the several transfers of the record, but a satisfactory increase can be obtained by using a sufficient number of rings and corresponding magnets; for instance, assuming that a message, when transferred to the ring 1 by magnet e, has only one
fifth of its original intensity, and further that in transmitting the message from the ring 1 to the rings 2, 3, 4, etc., only one-fifth of the intensity of the ring 1, is obtained on each ring 2, 3, 4, etc., then 25 rings will be necessary in order to reproduce the message with its original intensity. By comparing the relay instrument with the instrument described in the Poulsen patent referred to, it will be seen that the ring 1 and the magnet e' correspond with the steel wire and magnet of the Poulsen instrument, and that instead of using the same magnet for reproducing as for recording, I use a second, a third and a fourth, etc. magnet of similar character, represented by e', e'', e''', etc., placed on the same wire, so that the reproduction therefrom is obtained immediately after the record is made, the speed of the drum being such that the message is not perceptibly interrupted or retarded in traveling from the transmitting instrument T to the receiving instrument R. It will be seen that the magnet e' is a recording magnet, the magnets e'', e''', etc. are all reproducing magnets, the magnets f', f'', f''', etc. are all recording magnets and the magnets h', h'', etc. are all reproducing magnets. Hence the instrument embodies a number of Poulsen instruments all working together.

In order to be able to use the instrument continuously for transmitting a message, it is necessary to eliminate the magnetic impressions from each of the rings after they have been utilized to repeat the message, and before the same portions of the rings again pass the poles of the recording magnets. To accomplish this, the magnets t, t', t'', etc. connected with the constant source of current I, are placed beyond the reproducing magnets h, h', etc. in the direction of the rotation, and they wipe off the message and allow the rings to be presented clean and ready for the new message or another part of the same message.

It is not necessary to use a cylinder or drum with rings upon its surface, as described, since steel ribbons suitably mounted to move with respect to the poles of the magnets, can be used to produce the same result. It is also obvious that since the function of the connected magnets e' and f', etc. is merely to transfer magnetism from a magnetized body to one which is not magnetized, an iron bridge connecting the two bodies together, could also be used, this construction is shown in Fig. 5. The magnetic impression from the ring 1 magnetizes the bridge s, which, in turn, similarly magnetizes the ring 2, 3 or 4, with which it is connected. It is also obvious that the transmitting circuit j, k, could be made to act directly upon all of the rings 1, 2, 4, 5, etc. by simply connecting a number of the magnets e in the circuit q, r, s, and applying one magnet to each of the rings. This method, however, has its objections, from a practical standpoint, and is merely mentioned as a possible way of operating.

Having described my invention, I claim:

1. The combination of a telephone transmitting circuit and a telephone receiving circuit, with an instrument adapted to electromagnetically record a message from the transmitting circuit and simultaneously electromagnetically reproduce the said message in the receiving circuit, and means whereby the strength of the message delivered to the receiving circuit is made greater than that recorded from the transmitting circuit.

2. In an apparatus for electromagnetically recording and reproducing speech or signals, the combination of a receptive device, a transmitting circuit, means for making a plurality of records in said device of the speech or signals traversing the transmitting circuit, a receiving circuit and means for simultaneously reproducing corresponding portions of each record in said receiving circuit, substantially as described.

3. In an apparatus for recording and reproducing speech or signals, the combination of a receptive or recording body or surface, a recording device adapted to act upon said body or surface, a reproducing device and an obliterating device presented at successive points thereto, whereby speech or signals may be recorded on the body or surface, reproduced therefrom and obliterated in succession, substantially as described.

4. In an apparatus for electromagnetically recording and reproducing speech or signals, the combination of a receptive device in or upon which a record of the speech or signals is to be made, a transmitting circuit leading to said device, recording mechanism operated by said transmitting circuit, a receiving circuit leading from said device and means for reproducing and augmenting the record in said receiving circuit.

5. In an apparatus for electromagnetically recording messages and signals, the combination of a receptive body or surface, two electro-magnets presented at successive points thereto, one for recording a message or signal on the body or surface, and the other for reproducing it therefrom, and one or more receptive bodies or surfaces, each having a recording and reproducing magnet presented to it at successive points; the reproducing magnet of the first set being connected with the recording magnet of the second, and so on throughout the series, and means for moving all of the bodies or surfaces and their respective magnets simultaneously with respect to each other, whereby the message or signal may be successively recorded, reproduced and transmitted, substantially as described.

6. In an apparatus for electro-magnetic-
ally recording and reproducing messages or signals, a receptive body or surface, a recording magnet presented thereto, one or more reproducing magnets also presented thereto at successive points following the recording magnet, one or more other receptive bodies or surfaces, a recording magnet for each of the same, connected respectively with the reproducing magnets presented to the first receptive body or surface, a receiving electric circuit containing a plurality of magnets presented respectively to the said receptive bodies or surfaces, and means whereby similar magnetic impressions will be made in each receptive body or surface, and all simultaneously magnetized electrically impressed upon the said receiving circuit, substantially as described.

7. In an apparatus for electro-magnetically recording and reproducing messages or signals, the combination of a receptive body or surface, a recording magnet, a reproducing magnet and an obliterating magnet presented at successive points thereto, whereby a message or signal may be recorded on the body or surface, reproduced therefrom and obliterated in succession, substantially as described.

8. In an apparatus for electro-magnetically recording and reproducing messages or signals, the combination of an endless receptive body or surface, a recording magnet, a reproducing magnet and an obliterating magnet presented at successive points thereto, whereby a message or signal may be recorded on the body or surface, reproduced therefrom and obliterated in succession, substantially as described.

9. In an apparatus for electro-magnetically recording and reproducing messages or signals, the combination of a plurality of receptive bodies or surfaces, means whereby a message or signal can be impressed upon each of said bodies or surfaces and means for reproducing the message or signal simultaneously from all of said bodies or surfaces.

10. A telephone relay consisting of a plurality of para-magnetic bodies, means for making a permanent magnetic record of speech thereon and means for simultaneously reproducing the speech from said bodies in a single receiving apparatus, substantially as described.

11. A telephone or telegraph relay consisting of means for making a plurality of permanent magnetic records of a message or signal, in combination with means for simultaneously reproducing all of said records in a receiving apparatus.

In testimony whereof I have hereunto set my hand in the presence of two witnesses.

EMIL SCHACK HAGEMANN.

Witnesses:

A. LEISNER,
A. LIMOMEN.