

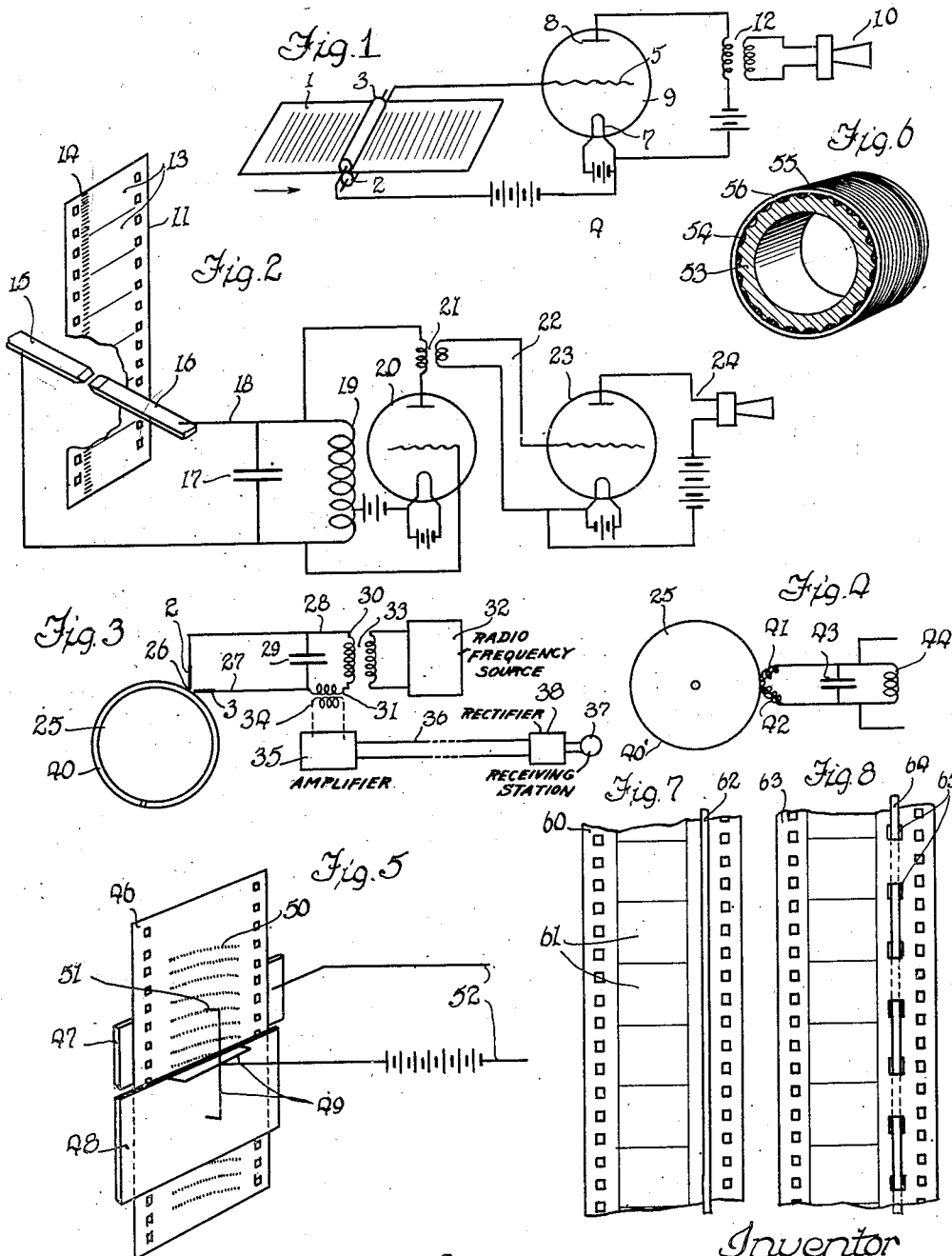
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METHOD OF AND MEANS FOR REPRODUCING SOUND

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METHOD OF AND MEANS FOR REPRODUCING SOUND.

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My invention relates to a method of and means for reproducing sound.

In my co-pending application, Serial No. 565,727 filed June 3, 1922 (Case 1), I have described the manner of producing records of sound photographically and of reproducing the sound so recorded by means of light variations caused by said record, which light variations act upon a photo-sensitive cell to influence current variations in a circuit, which current variations may be translated into sound waves. As disclosed in that application, the light is either transmitted thru the record or is reflected from a part of the same to a variable extent depending upon the sound record.

According to the present invention, the sound may be reproduced from such a record or from any similar record without the use of light or other photo-active radiations.

According to my invention, I utilize other properties of the record. The properties which I employ are of such a character as to influence a magnetic or electric circuit. For the purpose of my present invention, it is immaterial how the record may be produced as for instance, photographically, photo-mechanically, chemically, or by purely mechanical methods, such as printing or the like, so long as the record exhibits differences in dielectric or magnetic properties, in accordance with the sound record, so that the variations in properties will permit of a detection by suitable magnetic or electric circuits of differences which may be amplified to produce sound waves.

In order to acquaint those skilled in the art with the manner of constructing and operating my invention, I shall now describe a particular embodiment, and various modifications thereof, in connection with the accompanying drawings, which form a part of the present specification.

In the drawings, Fig. 1 is a diagram illustrating a system for reproducing sound from a record having variations in dielectric properties.

Fig. 2 is a diagrammatic illustration of a system employing the variations of dielectric capacity of the film in connection with radio frequency current.

Fig. 3 illustrates diagrammatically a system depending upon the variations in di-

electric properties between the electrodes, which lie on the same side of the record.

Fig. 4 illustrates a system in which the magnetic characteristic of the record is relied upon for changing the inductance of the reproducing circuit.

Fig. 5 shows how a record with a transverse trace may be employed in connection with the above method.

Fig. 6 indicates a mechanically produced record having a filling of substance having a dielectric constant difference from that of the record.

Fig. 7 illustrates a moving picture film having a Poulsen wire mounted thereupon for the production of sound by variation of magnetism, and

Fig. 8 is a modification of the device shown in Fig. 7.

An ordinary unexposed photographic film or plate contains light sensitive substances which are distributed evenly throughout the emulsion and which show at all points the same physical and chemical properties. After the action of light, the physical properties including electric and magnetic properties of the substance have undergone a change in accordance with the action of the light upon the same. Places which were subjected to a greater amount of light differ from places which were subjected to a less amount of light or no light at all. This difference may be increased with the proper development of the film. Still greater differences, particularly with respect to the magnetic and dielectric properties of the film can be secured by treating the records chemically or mechanically, with substances showing large magnetic susceptibility or large dielectric inductivity. For instance, ferrocyanides, similar salts of nickel or cobalt and other ferromagnetic salts may be used directly in the light sensitive substance or after exposure. The hygroscopic properties of said substances may be used in connection with the preparation of the film so that the film or paper which forms a record, may, while wet, be so dusted or treated with ferromagnetic powder or with carbon, graphite, mica, glass or metallic powders, as to form a record specifically differing in magnetic or dielectric properties, in accordance with the varying effect of light. A convenient method of multiplying such

records consists in using known photo-mechanical processes and printing the records on metallic or paper ribbons, rolls or plates. The printing ink or dyes are themselves

sufficient to produce dielectric changes in the record, but considerable improvement may be achieved by applying metallic powder to the sticky printed places as at present gilded letters or illustrations are produced. It is also feasible within the present invention, to employ photographic or mechanical methods of producing impressions of variable thickness whereby the record is characterized by variable thickness of either the entire record or certain layers which will produce, when the record is in motion, changes in the magnetic or dielectric constant of the circuit producing the field, the variations of which may be suitably translated into sound.

The record 1 shown in Fig. 1 has traces of dielectric material distributed transversely along its length in lines perpendicular to the general line of motion as is apparent in Fig. 2. The record passes between two electrodes, 2 and 3 which electrodes form a condenser in connection with the variable dielectric of the record 1. This condenser is charged by suitable battery 4, to the desired potential. The electric charge stored in the condenser will vary with the consequent change in the dielectric properties of the record 1, and these variations of capacity will produce changes of potential on the grid 5 of the amplifying tube 9. The variations in grid potential influence the plate circuit 6, 7, 8 of the amplifying tube 9. This plate circuit contains the primary of an induction coil 12 which connects to the circuit of a receiver or loud speaking telephone 10. Thus, the variations in the dielectric characteristics of the record 1 are translated into sound waves as desired. Any suitable indicating device instead of the telephone 10 may be employed if desired. Even if the lines on the record 1 were produced by mechanical impressions or cutting as by a phonograph or by photographically obtained relief, still the indicator 10 will indicate variations of current so long as the distance between the electrodes 2 and 3 remains constant. The material of the record possesses a different dielectric constant from that of air and thereby changes the capacity of the condenser in accordance with the changes in thickness of the dielectric.

Fig. 2 represents another application of the above described method and a different method of utilizing the same. The record 11 here shown is a combined moving picture and sound record, the moving picture views appearing as shown at 13, and the sound record appearing at 14. The record consists, for instance, of a film with distributed

variations of the dielectric material along the portion 14, these variations corresponding to sound waves, and consisting of variations of the dielectric material of the record. These variations of material produce as they pass the electrodes 15 and 16, changes in electric capacity of the condenser formed by said electrodes and the interposed dielectric. The electrodes 15 and 16, in connection with the condenser 17 form part of an oscillatory circuit 18 which includes the inductance 19. The oscillatory circuit is operated by a continuous wave device consisting of the electron tube 20 arranged as is well understood in the art to maintain the circuit in oscillation. The plate circuit contains a primary of the induction coil 21, the secondary of which leads to the grid circuit 22 of another amplifying tube 23. The amplifier 23 has in its plate circuit, a suitable indicator 10 which may be in the form of a telephone receiver, loud speaking device or the like.

Fig. 3 shows means for reproducing variations of audio frequency or of higher frequency from any suitable record, such for instance, as a picture to be transmitted by telegraph or telephone line. In the transmission of pictures the record may be prepared in the flat and the film is then rolled over a cylinder 25, a pair of electrodes 26, 27 slide over the surface of the cylinder; these electrodes being included in a suitable oscillating circuit 28, containing the condenser 29 and the coils 30 and 31. A source of radio frequency 32 is connected thru a transformer 33, the secondary of which forms the coil 30. This source of radio frequency supplies current at a constant frequency and constant amplitude to the oscillating circuit and the variations in amplitude of the oscillating circuit are transmitted through a transformer 34 of which the primary winding is the coil 31. This radio frequency of varying amplitude may be amplified in the amplifier 35 and then transmitted over the line wires 36 to the receiving station 37, a detector or rectifier 38 converting the variations in radio frequency into audio frequency variations or waves. If desired, the detector or rectifier may be placed at the transmitting end of the line 36 and only audio frequency transmitted to the receiving station 37. The receiving station 37 may include a telephone receiver or any suitable indicator or recording device as desired.

It will be apparent that the variations in the record 40, which is mounted upon the cylinder 25, cause changes in the electrostatic relation of the pointed electrodes 26 and 27. This change may be partly due to conduction, or it may be merely due to variations in the dielectric medium between the two electrodes.

In my copending application herein above referred to methods and apparatus were described to record photographically variations of current. When used at receiving station 37, these methods serve to convert vibrations of carrier currents into an image or picture.

The system shown in Fig. 4 shows a modification in which instead of having electrodes forming parts of a variable condenser, electromagnets 41 and 42 are varied in accordance with the magnetic permeability of the record 40', these variations in the magnetic properties of the record serving to influence the natural period of vibration of the circuit to which these electromagnets 41 and 42 are connected. The circuit of the magnet 41 42 contains a condenser 43 and a coil 44 and is adapted to influence an indicating device or receiving device as described in connection with Figs. 2 or 3.

Fig. 5 shows the manner in which records which have been made with an arcuate transverse trace on the film may be used in connection with the above methods of reproducing. The film 46 bearing the sound record is passed between fixed plates 47 and 48. A rotating spider having radial arms 49 is driven at a fixed rate of speed which rate of speed is definitely related to the speed at which the record film 46 passes between the plate, so as to maintain registration between the arcuate record portions 50 and the end 51 of the radial arm 49 which sweeps over the record at a particular instant of time. In the form illustrated in Fig. 5, the plate 47 forms one electrode and the radial arms form the other electrode of a variable condenser which is connected in a suitable circuit 52. The lower plate 48 keeps the inactive radial arms 49 from being influenced by the adjacent part of the film. Only one electrode at a time is effective. As the electrodes sweep over the arcuate path 50, the capacity of the circuit 52 is varied and may be made to influence either an oscillating circuit or may influence directly the grid circuit of an amplifier as above explained, for translating the variations in the record into sound waves.

If it is desired to take advantage of the variations in magnetic permeability of the record 46, the plates 47 and 48 may be of magnetic material and the arms 49 may then become poles of an electromagnet which is included in the circuit, the characteristics of which are changed by the variations induced by the record 46.

Fig. 6 shows a section of a phonograph cylinder carrying a sound or other record in the form of a helical groove 54 of varying depth. The outer circle 55 represents the outer surface of the cylinder and the inner circle 56 represents the bottom of the guiding groove below which the undulations of

the record are formed. The groove of variable depth is preferably filled with a substance differing in value as to its dielectric constant from the dielectric constant of the material which is used for the cylinder. A pair of thin electrodes are guided in the guiding groove over the deposited material in the sound record groove 54, and as the cylinder rotates the amount of dielectric material subjected to the action of the field between said electrodes, varies from point to point, thus causing a change in the natural frequency of the circuit, which changes in frequency may be translated into sound waves as above indicated. In this manner, mechanically formed records may be used to reproduce sounds thru the variations of the dielectric constant or the magnetic permeability of the record.

In Figs. 7 and 8 I have shown a moving picture film which is provided with a magnetic sound record.

As shown in Fig. 7 the moving picture film 60 has a portion thereof as shown at 61 devoted to successive views of an object. Along one margin of the film 60, I provide a very thin strip 62 of steel or other magnetic material which is magnetized. This magnetic strip 62 is preferably glued or otherwise cemented to the film 60. In the preparation of the film, the steel strip 62 is moved past a recording magnet which magnet is varied as to its strength in accordance with telephonic current, leaving a definite variation of magnetism in the steel tape 62. These variations of magnetism may be detected as indicated in Fig. 4, as by means of an oscillating circuit, or they may be read directly by induction, that is, by passing a small coil with an electric winding adjacent to the surface of the steel tape 62, the variations of magnetism of the strip 62 causing fluctuations of magnetism of the detecting magnet which variations may be translated to current variations and these in turn amplified and translated into sound.

In Fig. 8 I have shown a similar moving picture film 63, having a steel tape threaded thru the openings 65 in the body of the film. This steel tape is also preferably secured by cementing the same in addition to the interlacing with the substance of the film.

As explained in my co-pending application, (Case 1), for the simultaneous production of moving picture and sound records upon a single moving record, the record is first passed in front of the sound recording device where the record moves with a uniform velocity and thereafter the record is passed in front of the optical system of the motion picture camera where the motion is intermittent. The two parts of the film are separated by a loop, which permits the intermittent motion to occur. In the film

shown in Fig. 8, the magnetic tape 64 may be passed between two fixed detecting magnets, so that the variation laterally of the tape 64 does not affect the reading of the sound record thereupon.

In preparing the records of Figs. 7 and 8, the film bearing the steel tape is first passed in front of the Poulsen recording magnet, to make the magnetic sound record. The film then passes the loop and is fed past the optical system of the moving picture camera with an intermittent motion. In reproducing the sound and moving pictures, the same spacing of the sound reproducer and the picture projection and the same loop of film are maintained and the film with the sound record is first fed past the Poulsen reproducer and then past the moving picture projector.

I do not intend to be limited to the precise details shown and described.

I claim:

1. In combination, a sound record having arcuate transverse portions of a continuous sound record disposed thereupon, plates on opposite sides of said sound record, a rotating member related to said plates, said rotating member being adapted to follow said

arcuate parts of the record, and an electric circuit controlled by the variations of the sound record as detected by said rotating member.

2. A sound record comprising a ribbon like strip of material having arcuate portions of a continuous sound record disposed transversely thereupon, means for advancing said ribbon like strip at a uniform rate, and a rotating member having arms for tracing along successive portions of said arcuate parts of the record.

3. The method of preparing copies of the kind described from a photographic record which comprises varying the hygroscopic character of the copy in accordance with the image and distributing finely divided material upon said surface.

4. The method of preparing copies of the kind described from a photographic record which comprises printing a photolithographic image with a sticky liquid, and dusting a powdered material upon said printed image.

In witness whereof, I hereunto subscribe my name this 29th day of May, 1922.

JOSEPH TYKOCINSKI-TYKOCINER.