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METHOD OF MAKING SOUND RECORD TABLETS.

APPLICATION FILED NOV. 1, 1915. RENEWED APR. 19, 1919.

1,368,972. Patented Feb. 15, 1921.

3 SHEETS—SHEET 1.

Fig. 1.

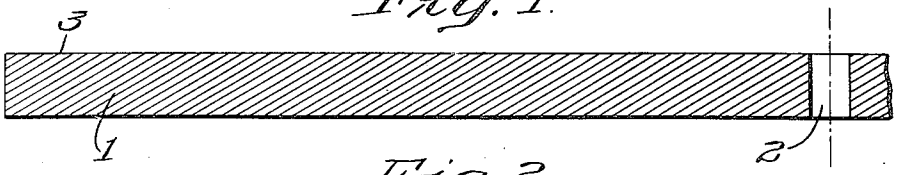


Fig. 2.

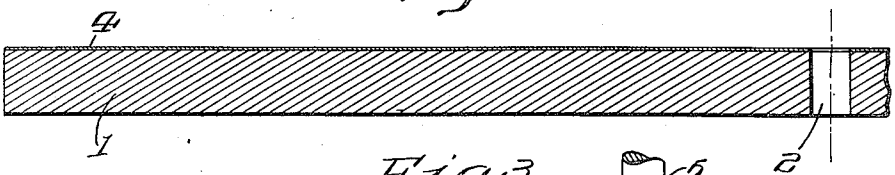


Fig. 3.

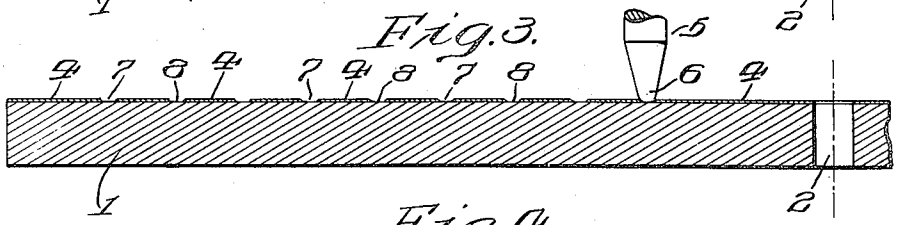


Fig. 4.

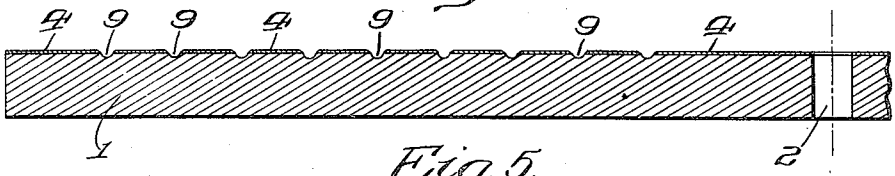


Fig. 5.

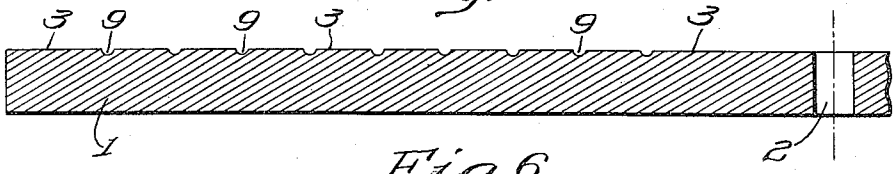


Fig. 6.

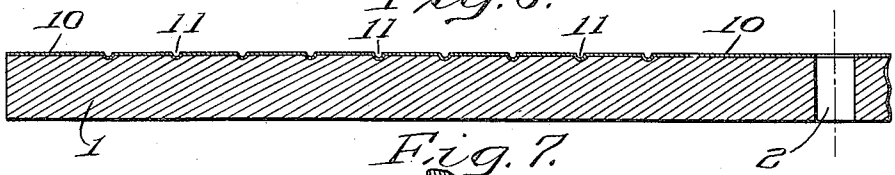
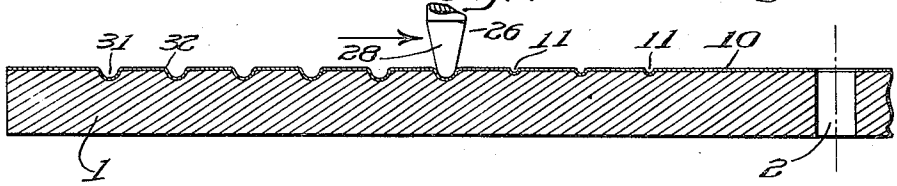


Fig. 7.



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3 SHEETS—SHEET 2.

Fig. 8.

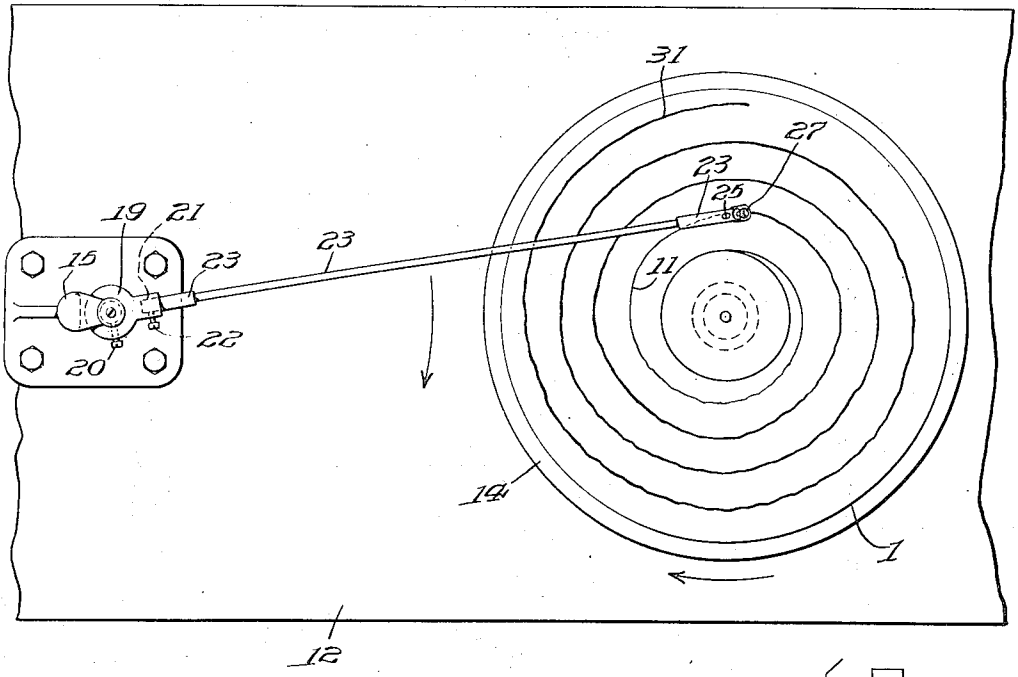

Fig. 10.

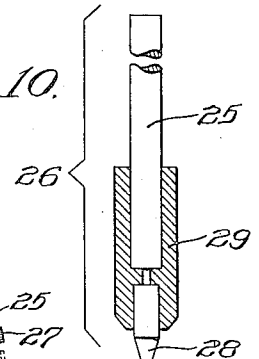

Fig. 9.

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3 SHEETS—SHEET 3.

Fig. 11.

Fig. 12.

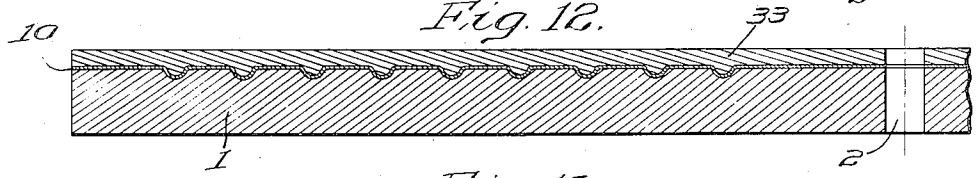


Fig. 13.

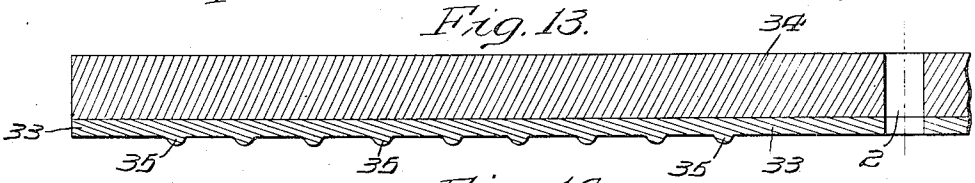


Fig. 14.

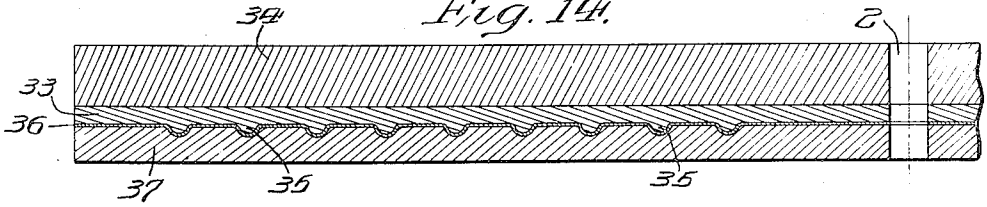


Fig. 15.

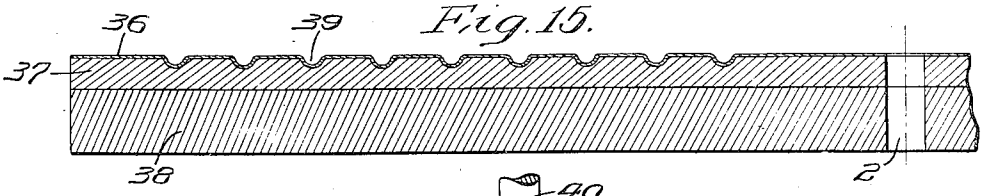


Fig. 16.

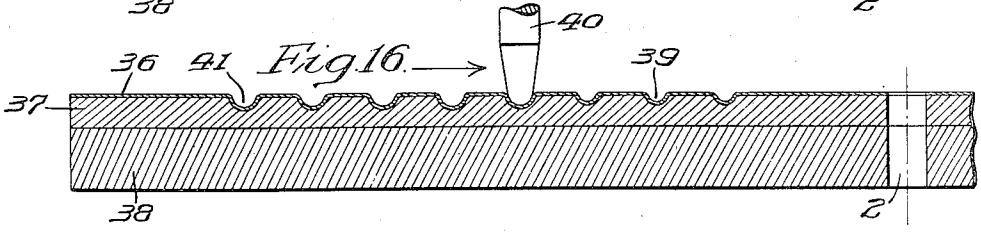
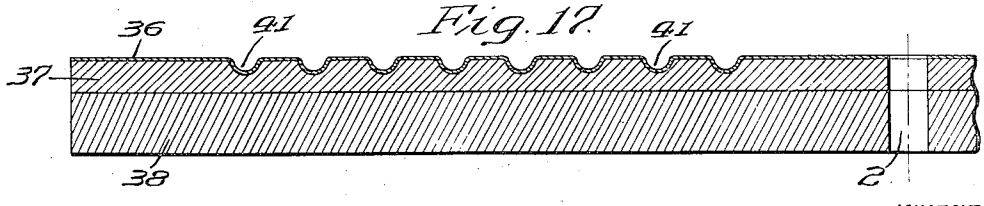


Fig. 17.



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METHOD OF MAKING SOUND-RECORD TABLETS.

1,368,972. Specification of Letters Patent. Patented Feb. 15, 1921.

Application filed November 1, 1915, Serial No. 58,984. Renewed April 19, 1919. Serial No. 291,414.

To all whom it may concern:

Be it known that I, BELFORD G. ROYAL, a citizen of the United States, and residing at Camden, in the county of Camden, State of New Jersey, have invented certain new and useful Improvements in Methods of Making Sound-Record Tablets, of which the following is a specification.

My invention relates to the making of tablets containing a record of sound and particularly the making of original or master records from which matrices may be made for impressing commercial sound record tablets suitable for reproducing the sound recorded on a suitable sound reproducing machine.

The objects of my invention are to make the original or master record a metal record which is, therefore, permanent and may be stored or filed away in a suitable repository without danger of deterioration; to produce a master sound record in metal in which the walls of the sound record groove have an exceedingly smooth surface and in which the sound record grooves may be made of any desired or standard size and shape in transverse cross-section; to impose as little resistance as possible to the free vibration of the recording or tracing stylus during the recording of sound and so obtaining a very accurate tracing of the sound impulses or vibrations impressed upon the recording diaphragm and thence to the recording stylus.

Other objects of my invention will appear in the specification and claims below.

In the drawings forming a part of this specification and in which the same reference numerals are employed to designate the same parts throughout the various views, Figures 1 to 7 are diagrammatic views, on a very enlarged and exaggerated scale, of the same section through a portion of a sound record tablet, showing the steps in sequence performed in carrying out the invention; Fig. 8 is a plan view and Fig. 9 is a side elevational view of an apparatus which may be employed in carrying out the spinning step indicated diagrammatically in Fig. 7; Fig. 10 is a longitudinal view, partly in section, on a more enlarged scale, of a stylus which may be used with the apparatus illustrated in Figs. 9 and 10; Fig. 11 is a diagrammatic section of a portion of the original master metal record; and Figs. 12 to 17 are diagrammatic views showing the steps employed in duplicating the metal record shown in Fig. 11 and spinning the groove to a greater extent.

In carrying out the process, I first dissolve a suitable wax in a suitable solvent and for the purpose I may dissolve Japan wax in gasolene.

I then prepare a suitable disk 1 of malleable or ductile copper of a diameter a little larger than that of a finished sound record tablet. This copper tablet 1 is preferably disk-like in form, is provided with a suitable hole 2 at its center for the reception of a spindle or centering device and its upper surface 3 is a plane surface very smooth, clean and highly burnished.

I then quickly flow some of the solution over the burnished face of the disk and then allow the solvent to evaporate. The elimination of the solvent, particularly when it is gasolene as above mentioned, may be readily accomplished by allowing the disk to stand in the open air for a short time, or the disk may be heated for the purpose of hastening the evaporation of the solvent, or further, the solvent, if gasolene or a similar material, may be ignited and burnt out of the solution. After the gasolene or other solvent has thus been expelled from the solution, the disk 1 will be provided on its polished face 3, with an exceedingly thin film or coating 4 of the wax which had been previously dissolved in the solvent, the thickness of which film is preferably much less than one one-thousandth of an inch.

This stage of the process is illustrated in Fig. 2 in an enlarged and exaggerated manner, it being obvious that the film 4 is in fact proportionally much thinner than it its possible to clearly illustrate on the scale of the drawing.

The tablet 1 so provided with the film 4 on the face thereof is then put on the turntable or rotating member, of any suitable sound recording machine, and the tablet is rotated. Simultaneously therewith, a sound recording sound box is caused to travel slowly across the face of the record with the tip of its recording stylus resting on the coated face of the tablet, while sound vibrations are directed against the sound recording diaphragm of the said sound box. Any suitable recording device may be employed for the purpose of causing the rota-

tion of the turntable and the relative travel of the recording sound box. The stylus is then caused to trace in and through the film 4 a spiral line or groove having lateral undulations corresponding to sound waves or impulses. It is, therefore, deemed unnecessary to illustrate any particular sound recording mechanism.

The stylus of the recording sound box is, however, preferably a jewel pointed stylus, the tip end of which, in engagement with the tablet, is provided with a spherical surface. In Fig. 3 is diagrammatically illustrated a stylus 5, the jewel tip 6 of which is spherical, the stylus being shown as having traced a helical line or groove 7 through the film 4 from the periphery of the disk or tablet to a position near the center thereof.

When such a line is so traced with a stylus having a spherical tip, in reality but a wavy line or undulatory line will be cut or traced through the film to the metal, that is to say, the metal surface will be free of the coating or film only along a line of almost infinitesimal width. In Fig. 3, the exposed surface 8 of the disk at the bottom of the traced groove or line is shown on a very enlarged and exaggerated scale for the purpose of making clear the subsequent steps of the process.

After the line or groove 7 has thus been traced through the film 4 to expose the portion 8 of the surface of the tablet 1, the tablet is put into an electrolytic bath, the disk being use as the anode of the bath. A suitable current of electricity is then caused to pass through the bath from the anode to the cathode of the cell, with the result that copper is taken from that part 8 of the face of the disk or plate which is exposed through the groove 7 in the film 4, and is deposited on the cathode of the cell. The solution of the electrolytic cell may be any suitable one, as for instance, a weak copper sulfate bath. The result of this action is that a very fine groove or line is electrolytically etched in the metal surface of the plate or disk or tablet 1. This electrolytic etching has the advantage over ordinary forms of etching in that there is substantially no undercutting of the etching agent beneath the edges of the protective film on either side of the exposed line on the face of the disk. This electrolytic etching forms a groove 9 in the face of the disk, said groove, however, being a very narrow one,—that is to say, of a width substantially equal to the width of the exposed surface 8 of the plate at the bottom of the groove 7. The electrolytic etching may be carried on with any ordinary electroplating apparatus, and, therefore, it is not necessary to illustrate any particular type of such apparatus. The action is continued for about half an hour or until a groove 9 preferably of less than one one-thousandth of an inch has been etched below the burnished surface 3 of the plate or tablet. The plate or tablet, after having been thus treated in the manner above described, is diagrammatically indicated in Fig. 4, the groove (9) being shown on a greatly enlarged and exaggerated scale.

After having been so etched, the film or coating 4 is then removed in any suitable manner as by washing the same off in gasolene or any other suitable solvent and then lightly burnished or polished with the result that a tablet of malleable copper is formed having in the burnished face thereof a narrow line or groove 9, said groove being much smaller in transverse cross-section than ordinarily present in commercial sound record tablets. The surface of the etched groove 9 will be very much smoother than surfaces produced by the practice of ordinary etching processes. The etched tablet is illustrated in Fig. 5.

The next step of the process is to clean the face of the tablet and to deposit thereon an exceedingly thin film 10 of nickel. This nickel film 10 is preferably deposited in an electroplating bath in the ordinary and usual manner of electroplating metallic sound record tablets or any other similar metal object, but said film so deposited is preferably much less than one one-thousandth of an inch in thickness. The electroplated tablet is illustrated in Fig. 6.

The next step of the process is to change the cross-sectional size and shape of the electrolytically etched groove 9 to a standard and uniform commercial size and shape, and this step may be called the spinning step, because by it the metal of the tablet in and adjacent the sound record groove 9 therein, is spun or displaced without, however, injuriously affecting the undulations in the side walls of the groove or the characteristics of the sounds recorded therein. The spinning step is diagrammatically illustrated in Fig. 7 and the apparatus by means of which the spinning step is performed is illustrated in Figs. 8 and 9.

It is to be noted that in Figs. 6 and 7, the thickness of the film or plating of nickel 10 is indicated on a greatly exaggerated scale and that the groove 11, appearing in the face of the nickel plated disk, appears to be much smaller than the groove 9 on the face of the copper disk shown in Fig. 5. It is, of course, obvious that while groove 11 will be in practice somewhat smaller in cross-sectional area than the groove 9, the difference in size is, of course, not so marked or great as it would appear to be from the drawings, it being practically impossible to accurately illustrate these minute dimensions of the groove, the plating and the film in the scale of drawings. The drawings do, however, clearly indicate the successive steps

performed in carrying out the process of this application and diagrammatically show the results attained by the practice of it.

The spinning apparatus shown in Figs. 8 and 9 preferably consists of a base 12 in which is journaled a suitable spindle 13, provided at its upper end with a turntable 14 adapted to support and rotate the nickel plated tablet illustrated in Fig. 6.

The spindle 13 may be driven in any suitable manner and it is not deemed necessary to illustrate a motor or any other driving mechanism for rotating it and the turntable 14 carried thereby.

Upon the base 12 is a bracket 15 having two alined conical bearing points 16 and 17 between which is mounted a stiff rod or support 18 freely rotatable on said points as bearings. Around the rod or support 18 is a clamping member 19 adapted to be slid longitudinally of said rod or support 18 to any desired position thereon and then rigidly secured thereto by a set screw 20. Said member 19 is provided with a socket 21 within which one end of a resilient rod or arm 23 may be clamped or fastened by a set screw 22. The outer end of said arm 23 is provided with a hole or socket 24 through which the upper end or shank 25 of a stylus 26 may pass and within which the said shank may be rigidly clamped or secured by means of a binding screw 27. The hole 24 passes transversely through the end of the rod 23 but at a slight angle to the longitudinal axis of said rod or arm 23 so that the stylus 26 mounted therein may have a slight backward rake as clearly illustrated in Fig. 9.

The stylus 26 is shown on an enlarged scale in Fig. 10 and preferably consists of the shank 25 of steel or other hard metal, a stylus tip 28, preferably a jewel such as a sapphire or a diamond, and a coupling 29 for firmly uniting the said tip and shank.

The turntable 15 is preferably arranged in a horizontal plane and the axis on which the stiff rod or support 18 rotates is preferably in a vertical plane so that the arm 23 may freely swing in a plane parallel to the face of the turntable 14.

The lower end of the stylus tip 28 preferably terminates in a rounded point, the curvature of which is preferably spherical;—that is to say, the surface 30 of the end of the tip of the jewel point is preferably spherical where it engages the groove of the sound record tablet.

The size of the end 30 of the tip 28 is of the size of a standard sound record groove in transverse cross-section, and when caused to traverse the groove 11 of the sound record tablet shown in Fig. 6 will tend to spin said groove to one of standard or desired size and shape in transverse cross-section.

The rod or arm 23 is stiff but resilient, and if desired, a set of rods 23 may be made for use in the apparatus each having different degrees of resiliency dependent upon the extent to which the groove 11 in the tablet shown in Fig. 6 is to be changed.

In setting up the apparatus, the rod or arm 23 is normally horizontal and the tip end 30 of the stylus securely clamped in the end of said rod is below the top surface of the metal record when it is on the turntable 14, as clearly indicated in dotted lines in Fig. 9. The end of the rod or arm 23 is then sprung upwardly by the operator and swung over toward the center of the turntable so that the surface of the tip end 30 of the jewel 28 will rest in the end of the outer convolution of the spiral groove. The pressure with which the stylus bears upon the record will depend upon the position of the member 19 with respect to the rod or support 18. In other words, the member 19 is secured in such a position as to give the requisite yielding pressure between the end of the stylus and the surface of the record groove 11.

Before the stylus is actually placed in the spiral groove of the metal record, the surface of the record is preferably given a thin layer or coating of a suitable lubricant, such as lard oil, and the pressure with which the stylus 26 engages the metal record during the operation of the device is adjusted to correspond to the extent of the change to be made in the sound record groove 11. It may be said, however, that the tension of the rod 23 is so adjusted as above described that the tip bears with considerable pressure against the surface of the metal record.

After the surface of the metal record has thus been lubricated and the jewel tip 28 placed in the end of the groove as aforesaid, the metal record is slowly revolved. The tip of the stylus will track or follow in the groove 11 of the metal record until it has traversed the entire length of the sound record groove and in so doing will faithfully follow all of the minute undulations in the side walls of the sound record groove. The jewel tip 28 will spin or spread the metal forming the wall of the sound record groove, make all parts of the said groove uniform and of the shape, in transverse cross-section, of the surface of the end 30 of the jewel tip 28.

In Fig. 7 is diagrammatically illustrated the traversing of a stylus having a spherical surface through the convolutions of the grooves 11 in the tablet shown in Fig. 6. Thus, the groove 31 to the left of the stylus 26 has been spun and changed into a groove of standard size and shape, while the groove 11, to the right of the stylus 26 has not been traversed by the stylus. Of course, it is to be understood that in Fig. 7 the groove 31 is shown on a greatly enlarged and exaggerated scale for the pur-

pose of clearly illustrating what is performed by traversing the stylus 26 through the smaller groove 11 of the tablet having the nickel face. The completed original metal master record is similarly illustrated in Fig. 11.

It is to be observed that as the stylus 26 traverses the groove 11 it spins the ductile soft copper plate adjacent the groove, enlarging the groove and shaping it to conform to the shape of the tip of the stylus 26 and in so doing, it appears to draw down or round off slightly the corners 32 of the groove. The nickel facing probably assists in producing the slightly rounded corners 32, and it also provides a surface on the plate which does not substantially lap or wear away the jewel of the spinning stylus.

The angle which the stylus 26 makes with the plane of the record is preferably as near 90 degrees as possible, that is to say, generally speaking the nearer perpendicular to the surface of the record the stylus is, the more uniform in transverse cross-section will be the groove ultimately formed. But it has also been found that the stylus is liable to independently vibrate or chatter if the angle which it makes with the surface of the metal record is exactly 90 degrees. It is, therefore, preferable to give the stylus the slight backward rake, previously referred to and as indicated in Fig. 9. Good results are obtained when the stylus is set at an angle of from 80 degrees to 88 degrees to the plane of the top surface of the metal record. In this way the final sound record groove 31 is spun out in the malleable or ductile copper disk 1 and made to conform to the size and shape of the hard jewel tip of the spinning stylus 26. Inasmuch as the thin nickel plating 10, when suitably lubricated, does not substantially wear or change the shape of the surface of the tip of the spinning stylus 26, the resulting groove will be uniform in size and shape throughout its length. Moreover, it will be apparent that by adjusting the pressure with which the tip of the spinning stylus 27 bears against the face of a metal record subjected to the action thereof, the grooves so produced in a plurality of records may be made to be substantially identical irrespective of the exact size and shape of the original etched groove 9 therein.

This process, therefore, provides a means in which the size and shape of the sound record grooves in master records as well as in the commercial tablets made therefrom may be substantially standardized irrespective of the conditions under which the original sound record groove was etched in the master record and irrespective of the depth of the original etched groove therein, because the original etched groove mainly serves merely as an accurate guide for the spinning stylus to cause it to vibrate during the spinning process, to the same extent and in the identical manner (except of course as to the rapidity of vibration) as did the original tracing or recording stylus 5. In this spinning process, the ultimate effective sound record groove in the master record is formed by the spinning action of the spinning tool or stylus. The resultant groove suitable for duplication or even for sound reproducing purposes is produced directly in metal, and may be of such size and shape in transverse cross-section as to be capable of being used as a master from which matrices may be made for pressing sound records in commercial record material.

I do not, however, wish my invention to be construed as necessarily limited to the immediate conversion of the identical etched plate or disk shown in Fig. 5, into a disk or plate having a spun record groove of a size capable of being used for all kinds of commercial sound record tablets, for the etched groove 9 might be so shallow or small as to make it difficult to spin it out, in one operation into the size and shape required for commercial purposes. I may, therefore, cause the spinning stylus 26 to track through such an etched groove 9 and spin a groove of greater depth than that of the etched groove, although the so spun groove may not even then be of a size, depth or shape best adapted for directly duplicating in commercial sound records. In some cases, however, after the metal record with the spun groove as indicated in Fig. 11, has been produced, a matrix may be made directly therefrom, in any of the old and well known ways of producing metal matrices, as, for instance, by the electroplating process, and from the matrix so formed, records may be pressed in any suitable record material. The records so pressed from said matrix will have in them a sound record groove which is an exact duplicate of the spun metal groove 31 in the metal record shown in Fig. 11.

In practising this invention, however, it is not easy to obtain a spun sound record groove 31 directly from the etched record groove 11 in a single spinning operation. In many instances it is necessary to substantially repeat the process on a metal record, which is a duplicate of the original spun metal record 11, in order to obtain a sound record groove of the size in cross-section of a standard commercial sound record tablet. This fact does not change the character of the invention, however, because, if desired, the original metal master having a spun sound record groove shown in Fig. 11 may be preserved as the original master sound record and the step of obtaining therefrom a metal record having a groove of the standard size and shape may be carried out in

connection with the making of each pressing matrix thereafter made therefrom. On the other hand, it might be desirable to produce a second metal record, such record having a sound record groove therein of standard commercial size in cross-sectional area, and to preserve said second record as the master record, to obviate the intermediate steps otherwise made necessary, in making a pressing matrix from the original metal master. For this reason, I have illustrated, and will now describe, the subsequent steps by means of which such a second metal record, having a sound record groove of standard dimensions, may be made from the original metal master illustrated in Fig. 11.

The face of the original metal master record shown in Fig. 11 is first treated in such a manner so that metal electrodeposited thereon may be readily separated from said surface. This is done by any of the well known ways of treating such a metal surface, as for instance, by subjecting it to the action of silver nitrate or to a tincture of iodin solution.

Upon the so treated face of the metal record shown in Fig. 11 is then electrodeposited a shell 33 of copper or any other suitable material. When a sufficient thickness of metal has been so deposited thereon, the record is removed from the electroplating bath, the shell 33 is stripped therefrom and provided with the usual stiff metal backing 34. The matrix so formed is indicated in Fig. 13.

It may here be noted that this matrix, if imprinted into a layer of plastic record material would produce a pressed sound record tablet having a groove therein 31, which is an exact duplicate of that in the original master metal record. Such a groove might be, and in some instance is, of sufficient depth and width to coöperate satisfactorily with the stylus of a sound reproducing machine, but, generally speaking, such a groove would be somewhat shallow for commercial purposes. The matrix shown in Fig. 13 has the record of sound thereon in the form of a ridge 35, an exact negative of the groove 31 in the original metal master record.

The next step is to electrodeposit on the face of the matrix shown in Fig. 13 a thin film of nickel. This is readily accomplished in any ordinary nickel plating bath, and a film of nickel 36, of a thickness substantially the same as the film of nickel 10 on the etched record shown in Fig. 6, is built up, after which the matrix is removed from the nickel plating bath, and is placed in a copper plating bath, where a comparatively thick layer of soft copper 37 is deposited over the nickel film 36. These steps in the process are clearly illustrated in Fig. 14.

After a sufficient thickness of copper is so deposited, the matrix is removed from the copper electroplating bath, the shell is removed or stripped from the face of the matrix, and is provided with the usual backing 38, of stiff metal. A backed-up metal record, such as is shown in Fig. 15, is thus produced and will consist of the backing 38, the layer of soft ductile electrodeposited copper 37 and a nickel face or film 36. It will be further observed that the sound record groove 39 formed therein is of the identical size and shape of the sound record groove 31 in the original master metal record.

The surface of the metal record shown in Fig. 15 may be next lightly burnished and polished and is then placed on the turntable of the spinning apparatus shown in Fig. 9 where the groove 39 is spun in the same manner as the groove 11 of the tablet shown in Fig. 6 was spun, as above described. After the tablet has been lubricated the spinning stylus 40 is caused to slowly traverse throughout the length of the sound record groove 39. This stylus 40 may be slightly larger than the stylus 26 and its shape in longitudinal cross-section is made to be of the size and shape of a standard commercial sound record groove. It is substantially spherical at its tip end and it is made of very hard material, preferably a jewel. As a matter of fact, the same stylus 26 may be employed in spinning the groove 39 for the spherical tip will enlarge the groove in one direction as it spins into the soft copper.

In Fig. 16 is diagrammatically illustrated the stylus 40 traversing and spinning out the groove 39 of the duplicate metal record shown in Fig. 15 to produce a spun sound record groove 41 of standard size and shape and depth. In this manner the second metal record shown in Fig. 17 having a spun groove is produced.

It is apparent that a pressing matrix may be formed from the second metal record shown in Fig. 17 in the same manner that the matrix shown in Fig. 13 is formed from the original master metal record shown in Fig. 11, and this second metal record may, if desired be preserved as a permanent metal master record.

The process of this application may be considered in one respect an improvement over those processes in which the original master record is of wax or similar non-conductive material and which is to be given a coating of graphite in order to deposit thereon metal, because the original master record produced by the practice of my invention above set forth, is a metal record electrically conductive throughout.

It is to be further noted that the process disclosed in this application comprehends broadly the steps of applying a thin film of resistant material to a record blank, tracing a sound record therethrough, etching the blank at the exposed surface and thereafter

enlarging the sound record groove thus produced. In this manner an extremely accurate reproduction may be made, since little resistance is offered to the recording of the sound waves so that the record conforms accurately to the sound transmitted to the recorder. After the line produced thereon has been etched, the groove produced is smaller in transverse cross-section than that of the standard commercial gramophone and the enlarging step is therefore necessary to complete the process. By this combination of steps, an extremely accurate reproduction is produced, due particularly to the very thin film of etch resisting material which offers a very slight mechanical resistance to the stylus, and the steps of etching and enlarging transform the record thus produced into such proportions as may be commercially used in making sound records with grooves of sufficient size to produce the desired amplitude of vibration necessary for the ordinary reproduction of sound.

Attention is further called to the fact that the invention disclosed herein includes the use of a metal blank upon which a sound record is traced through a film of etching material and thereupon etched by an electrolytic process. The metal blank forms a conductor and facilitates the etching step avoiding the necessity of graphiting a wax blank to form an electrodeposited permanent metal record. Furthermore, the electrolytic process of etching avoids the undercutting usually attendant in the process of etching by acid baths.

Having thus described my invention what I claim and desire to protect by Letters Patent of the United States, is:

1. The method of making an original sound record tablet which consists in applying to the smooth surface of a metal blank an electrically non-conductive film, tracing through said film a generally spiral line having lateral undulations therein corresponding to sound waves to expose through said film a generally spiral undulatory line-like portion of the said smooth surface of said tablet, using said tablet as an anode in an electrolytic bath to change said undulatory line of exposed metal into a similarly undulatory groove electrolytically etched into said surface of said tablet, removing said film from the surface of said tablet and progressively spinning said etched groove into a larger size in transverse cross-section than that of the said etched groove.

2. The method of producing an original sound record tablet which consists in applying to a smooth face of a ductile metal disk a wax film, tracing through said film a generally spiral line having lateral undulations corresponding to sound waves to expose through said film a generally spiral undulatory line-like portion of the surface of said face of said disk, using the exposed face of said disk as an anode in an electrolytic bath to change said undulatory line of exposed metal into a similarly undulatory groove electrolytically etched into the face of said disk, said etched groove being smaller in transverse cross-section than that of a standard commercial gramophone sound record tablet, removing said film from the face of said disk and progressively spinning said etched groove into a sound record groove of larger size in transverse cross-section than that of the said etched groove.

3. The method of producing an original sound record tablet which consists in burnishing the surface of a disk of soft ductile copper, applying to the face of said disk an electrically non-conductive film, tracing through said film a laterally undulatory line corresponding to sound waves to expose through said film an undulatory line-like portion of the surface of said disk, electrolytically etching said exposed line-like portion of the surface of said disk, removing said film from said disk and progressively spinning the etched groove so produced in said disk into a groove larger than said etched groove and having undulations in the side walls thereof corresponding to those in said etched groove.

4. The method of producing an original sound record tablet which consists in burnishing a plane face of a disk of soft ductile copper, applying to said burnished face a film of Japan wax, tracing through said film a laterally undulatory line corresponding to sound waves to expose through said film an undulatory line-like portion of the surface of said face of said disk, electrolytically etching said exposed portion of said face in an electrolytic bath containing a solution of weak copper sulfate, removing said film from the face of said disk and progressively spinning the etched groove so formed therein to produce a corresponding laterally undulatory sound record groove therein having smooth highly burnished walls.

5. The method of producing an original sound record tablet which consists in burnishing a plane face of a disk of soft ductile copper, applying to the burnished face of said disk an electrically non-conductive film, tracing through said film an undulatory line corresponding to sound waves to expose through said film a similar undulatory line-like portion of the surface of said face of said disk, electrolytically etching said exposed surface of said face, removing said film from said face of said disk, providing said face with a thin electroplating of nickel and progressively spinning the nickel plated groove so formed to produce a sound record groove having in the smooth burnished walls thereof undulations corresponding to the undulations of said traced line.

6. The method of producing an original sound record tablet which consists in burnishing a plane face of a disk of soft ductile copper, applying to the burnished face of said disk an electrically non-conductive film, tracing through said film an undulatory line corresponding to sound waves to expose through said film a similar undulatory line-like portion of the surface of said face of said disk, electrolytically etching said exposed surface of said face, removing said film from said face of said disk, providing said face with a thin electroplating of nickel and progressively spinning the nickel plated groove so formed to produce a sound record groove having undulations in the smooth burnished walls thereof corresponding to the undulations of said traced line, and having rounded edges where the side walls of said groove merge into the adjacent face of said tablet.

7. The method of producing an original sound record tablet which consists of tracing through a wax-like film on the face of a metal tablet an undulatory line corresponding to sound waves, etching the exposed line-like surface of the face of said tablet at the bottom of said groove so traced, removing said film, providing the face of the etched tablet with a film of electrodeposited nickel, lubricating the surface of said tablet so formed and causing a smooth spinning tool of unwearing material to traverse said etched groove and spin said groove into the size and shape in cross-section of the tip of said stylus in engagement therewith.

8. The method of making an original sound record tablet which consists in applying to a smooth face of a ductile metal disk a wax film, tracing through said film a generally spiral line having undulations corresponding to sound waves to expose through said film a generally spiral undulatory line-like portion of the surface of said disk, etching the exposed face of said disk to form an undulatory groove in the face of said disk, removing said film and then progressively spinning said etched groove so formed to form an undulatory sound record groove of greater cross-sectional area than that of said etched groove.

9. The method of making an original sound record tablet which consists in applying to a smooth face of a ductile metal disk a wax film, tracing through said film a generally spiral line having undulations corresponding to sound waves to expose through said film a generally spiral undulatory line-like portion of the surface of said disk, etching the exposed face of said disk to form an undulatory groove in the face of said disk, removing said film, progressively spinning said etched groove so formed to form a metal master record having an undulatory sound record groove of greater cross-sectional area than that of said etched groove, making a metal duplicate of said master record and spinning the sound record groove in said duplicate disk into the size and shape of a sound record groove in a standard commercial gramophone sound record tablet.

10. The method of making an original sound record tablet which consists in applying to a smooth face of a ductile metal blank a film of an etch resistant, tracing through said film a line having undulations corresponding to sound waves to expose through said film an undulatory line-like portion of the surface of said blank, etching the exposed face of said blank to form an undulatory groove in the face of said blank, removing said film and then progressively spinning said etched groove so formed to form an undulatory sound record groove of greater cross-sectional area than that of said etched groove.

11. The method of producing a sound record tablet which consists in covering a suitable record blank with a thin film of etching resistant material which offers slight mechanical resistance to a stylus adapted to vibrate in accordance with sound waves, tracing through said film an undulatory line corresponding to sound waves to expose the surface of the record blank, etching the exposed surface, and enlarging the undulatory sound record groove thus formed.

12. The method of producing sound record tablets consisting in tracing on a record blank an undulatory line corresponding to sound waves through a film of etch resistant material which offers slight mechanical resistance to the tracing stylus, etching the surface of the record blank thereby exposed, and then enlarging the record groove thus produced into substantially the size of a sound record groove in a standard commercial gramophone sound record tablet.

13. The method of producing an original sound record tablet which consists in covering a suitable record blank with a thin film of an etching resistant which offers slight mechanical resistance to a tracing stylus, tracing through said film an undulatory line corresponding to sound waves to expose the surface of the record blank, etching the exposed surface to form an undulatory groove similar to the traced undulatory line and smaller in size than a standard commercial record groove and thereupon enlarging said etched groove to form an undulatory groove of substantially the size of a groove in a standard commercial sound record.

14. The method of producing a sound record which consists in applying to the smooth face of a suitable metallic sound

record blank a film of suitable material which is electrically non-conductive, tracing through said film a generally spiral line having lateral undulations corresponding to sound waves thereby exposing the surface of the metallic blank, and thereupon submitting the blank to an electrolytic bath to change said undulatory line of exposed metal into a similarly undulatory groove electrolytically etched into the surface of said sound record blank.

15. The method of producing a sound record which consists in burnishing a plane face of a metallic sound record blank, applying thereto a film of suitable material which is electrically non-conductive, tracing through said film a generally spiral line having lateral undulations corresponding to sound waves thereby exposing the surface of the metallic blank, and thereupon submitting the blank to an electrolytic bath to change said undulatory line of exposed metal into a similarly undulatory groove electrolytically etched into the surface of said sound record blank.

16. In the process of making sound record tablets of the laterally undulatory type, lightly etching a guiding groove in a metallic tablet and traversing the etched groove by a spinning stylus guided by the groove to achieve the required depth and width of the same for reproducing.

17. In the process of making a sound record tablet of the laterally undulatory type, lightly etching a guiding groove in a metallic tablet and repeatedly traversing the etched groove by a spinning stylus guided to achieve the required depth and width of the same for reproducing.

18. In the process of making sound record tablets of a laterally undulatory type, lightly etching a guiding groove in a metallic tablet and traversing the etched groove by a spinning stylus of a shape corresponding to a reproducing stylus, guided by the groove to achieve the required depth and width of the same for reproducing.

19. In the process of making a sound record tablet of the laterally undulatory type, lightly etching a guiding groove in a metallic tablet and repeatedly traversing the etched groove by a spinning stylus of a shape corresponding to a reproducing stylus, guided by the groove to achieve the required depth and width of the same for reproducing.

20. In the process of making sound record tablets of the laterally undulatory type, lightly etching a guiding groove in a metallic tablet and traversing the etched groove by a spinning stylus guided by said groove to spin said groove into a shape corresponding to that of a reproducing stylus and to depth and width required for reproducing sound.

21. In the process of making a sound record tablet of the laterally undulatory type, lightly etching a guiding groove in a metallic tablet and repeatedly traversing the etched groove by a spinning stylus guided by said groove to spin said groove into a shape corresponding to that of a reproducing stylus and to a depth and width requisite for reproducing sound.

In witness whereof, I have hereunto set my hand this 28th day of October, 1915.

BELFORD G. ROYAL