UNITED STATES PATENT OFFICE.

EMILE BERLINER, OF WASHINGTON, DISTRICT OF COLUMBIA.

PROCESS OF PRODUCING RECORDS OF SOUND.

SPECIFICATION forming part of Letters Patent No. 382,790, dated May 15, 1888.

Application filed March 17, 1888. Serial No. 267,565. (No model.)

To all whom it may concern:

Be it known that I, EMILE BERLINER, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Producing Records of Sounds, of which the following is a specification.

In a patent granted to me November 8, 1887, No. 372,786, I have described a method of recording and reproducing spoken words and other sounds; and in connection therewith and as a part thereof I have described a process of producing a record of sound-waves in solid resisting material by photo-engraving, the phonautographic record of such sound-waves having first been produced as an undulatory line of even depth in a traveling layer of non-resisting material.

My present invention is an improvement upon that described in my aforesaid patent; and it has for its object the production of a record of sound-waves in solid resisting material, principally metal, by the process of direct etching, whereby a solid unchangeable sound-record is obtained more cheaply and more readily, either upon a flat or upon a curved surface, without the delicate and intricate manipulations incidental to the process of photo-engraving. All this will more fully appear from the following detailed description, in which I shall freely refer to what is shown and described in my aforesaid patent as a part of the now common knowledge of mankind.

In accordance with the rules laid down in my patent, I produced a phonautographic record upon a traveling layer of lamp-black or other non-resisting material. Then this phonautographic record was transferred by photo-engraving upon metal, and the metallic record thus obtained was used for reproducing the recorded sounds.

In the course of my experiments I have found that in place of lamp-black other substances may be used as the non-resisting medium for receiving the original phonautographic record, and I have also found that among these substances are such as will resist the chemical action of acids, but which offer no perceptible mechanical resistance to the movement of the recording-stylus. Upon this discovery my present invention is based, and it consists, broadly speaking, in producing a phonautographic record through a film of a suitable etching-ground deposited upon a traveling surface of resisting material, such as metal or glass, and then subjecting said surface to the action of a suitable etching agent, which attacks said surface at the places only where the etching-ground has been removed by the recording-stylus.

The etching-ground, which is to serve as the non-resisting medium for the phonautographic record, I prepare by dissolving beeswax, paraffine, or other like substance in a suitable solvent. By preference I use beeswax, and dissolve the same in benzine, so as to obtain a saturated solution. This solution is filtered, and care is taken to exclude as much as possible all dust, which is always present in the ambient air. The surface which is intended to receive this ground, which may be a flat disk or a cylinder of metal or glass, should be smoothly polished, and must be cleansed and dried. The wax solution is then poured over this surface, so as to cover the same at all points, and the solvent is then allowed to evaporate, which it does in one or two minutes. An exceedingly-fine film of wax then remains adhering to the surface of the metal or glass, and the consistency of this wax is such that it offers no perceptible mechanical resistance to the action of the recording-stylus, while at the same time it resists the chemical action of ordinary etching agents. In this respect the film of wax deposited from the solution is quite different from a layer of wax produced by melting. The latter has such consistency and adheres to the supporting-surface with such tenacity that considerable force must be used to penetrate the same and remove it from its support, while the wax film deposited in the manner described is so delicate that a camel's-hair brush will disturb it perceptibly.

Partly on account of the too great sensitiveness of a single film, and also as an additional protection against the action of the acids employed in the subsequent etching, I ordinarily, but not necessarily, apply a second coating of the solution, which, when dry, leaves a film of wax of such thickness as I have found to answer all requirements. A plate or cylinder thus prepared may be preserved in-

definitely, and is at all times in good condition to receive the phonautographic record. Such record is produced by moving the prepared surface under a stylus actuated by sound-waves to remove an undulatory line of the non-resisting film from its support, whereby the latter is laid bare along the said line, as is fully described in my patent above referred to, and as is now well understood by those skilled in the art. The plate or cylinder is then subjected to the action of a suitable etching agent, the nature of which varies according to the material of the support. For metals—such as zinc, copper, or brass—diluted nitric, hydrochloric, or other acid is used, while for glass or other like materials fluoric acid, or the fumes of the same, must be used. In either case I obtain upon the support within a few minutes an undulatory groove of even depth representing the sound-waves which acted upon the recording-stylus, and this groove is of sufficient depth to guide and control a reproducing-stylus in the manner set forth in my Patent No. 372,786.

I do not confine myself to any particular mode of etching, the ordinary process being followed in this respect. The same is true of the practice of rebiting, if a single exposure to the etching agent should prove to be insufficient to produce a groove of sufficient depth. From a record produced in the manner described any number of copies may be obtained by electro-deposition, especially if the original record is etched in metal. In that case, however, I have found it advisable to burnish the original record-groove before the plate or cylinder is placed into the depositing-bath. This is a very simple process, and consists in holding and gently pressing a pointed burnishing-tool in the record-groove while the plate or cylinder is rotated. The tool is held in one hand while the plate or cylinder is rotated by the other. In this manner the burnishing-tool is guided through the record-groove from one end to the other, and the slightly-granular structure of the etched groove is thus polished without losing any of its essential characteristics. This process occupies only a very few minutes, and while it improves the galvano-plastic copy obtained from the original record, it is not absolutely essential. In place of a special burnishing-tool the reproducing-stylus may be used, the point of which is ordinarily of hard metal—such as iridium—so that the burnishing is effected by simply using the record once or twice for reproducing the recorded sounds in the ordinary manner.

It has been stated above that the dissolved and filtered wax or other ground should be carefully protected against dust, which is always present in the surrounding air, and it is obvious that the same precaution should also be taken with respect to the plate or cylinder upon which the record is made; but experience has shown that it is almost impossible to guard effectually against the accession of fine filamentary particles of dust to and into the body of the tracing or etching ground. These dust particles are so fine that they cannot, as a rule, be detected by the most searching inspection of the prepared plate; but they become very conspicuous and a very serious source of annoyance when the record is made. As the recording stylus passes through the wax or other ground, a fine undulatory line of the latter is removed, and the removed material drops away from the stylus as soon as removed, so that the point of the stylus always remains clean. This, however, is only the case when the ground is free of filamentary impurities; but if filaments of dust are embedded in the ground they adhere to the stylus, and, together with a coating of the ground, are dragged through newly-formed grooves, whereby the latter become uneven and receive ragged edges, which seriously impair the accuracy of the record. I have discovered an effective means for overcoming this difficulty, and it consists in simply moistening the record-surface with a fluid that slightly adheres to the ground and keeping it moist while the record is being made. I have found strong alcohol to be very effective for this purpose when wax is used as a tracing-ground, and it is used by pouring it over the ground just before the plate or cylinder is started to move under the recording-stylus. The alcohol evaporates rapidly, but not so rapidly as to disappear entirely before the record is finished, and this record now shows no trace of inequality, the lines being as sharp and well defined as if cut by a graver. The point of the stylus remains quite clean, and it seems as if the filamentary particles had disappeared. I have no definite theory by which to explain this surprising result. It is possible that the exceedingly-fine dust particles are forced against the walls of the grooves and are there held when the ground is in the peculiar state of dampness which it receives when alcohol is poured over the same. It is also possible that these particles of dust, being probably of organic matter, are dissolved by the alcohol, and it is also possible that both causes operate to keep the point of the stylus clean, so as to make a sharp and well-defined record; but whatever be the mode of action of the alcohol poured over the ground its effect is highly beneficial and its use constitutes one of my improvements.

The film of ground which I employ is so exceedingly thin that it is practically colorless and transparent. The record is for this reason almost invisible to the naked eye. In some cases, however, it is desirable to be able to inspect and scrutinize the record before it is exposed to the action of the etching agent, or to watch the progress of the record, and for this reason it is advisable to slightly color the ground before the record is made. I accomplish this by adding a small quantity of aniline-dye or other coloring-matter to the solu-

tion of wax or other ground. The record is then plainly visible as a pale line upon a dark ground.

Having now fully described my invention, I claim and desire to secure by Letters Patent—

1. The method or process of producing a record of sound-waves in solid resisting material for reproduction of the recorded sounds, which consists in covering the surface of such material with a film of etching-ground that offers no perceptible mechanical resistance, then making a phonautographic record upon and through the etching-ground, and then exposing the record to the action of a suitable etching agent, substantially as described.

2. The method or process of producing a record of sound-waves in solid resisting material for reproduction of the recorded sounds, which consists in depositing upon the surface of such material a film of wax from a solution of the same in a suitable menstruum, then making a phonautographic record upon and through the wax film, and then exposing the record to the action of a suitable etching agent, substantially as described.

3. The method or process of producing a record of sound-waves in solid resisting material for reproduction of the recorded sounds, which consists in depositing upon the surface of such material a film of wax from a solution of the same in benzine, then making a phonautographic record upon and through the wax film, and then exposing the record to the action of a suitable etching agent, substantially as described.

4. The method or process of preparing solid surfaces for the reception of a phonautographic record, which consists in depositing upon said surfaces a film of tracing or etching ground and then moistening such film with an adhering fluid, substantially as described.

5. The method or process of preparing solid surfaces for the reception of a phonautographic record, which consists in depositing upon said surfaces a film of wax and then moistening the wax film with alcohol, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EMILE BERLINER.

Witnesses:

JOSEPH LYONS,

S. WOLF.