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B. WEMPE

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METHOD OF PRODUCING PERFORATED METAL SHEETS

Original Filed Feb. 15, 1937

*Fig. 1.*

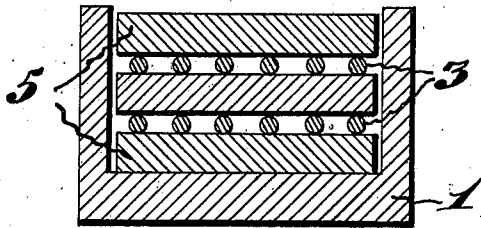


*Fig. 3.*

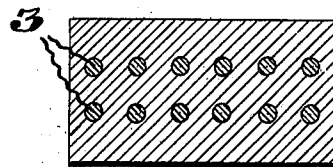


*Fig. 2.*

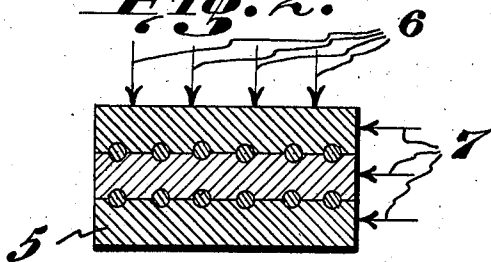


*Fig. 4.*

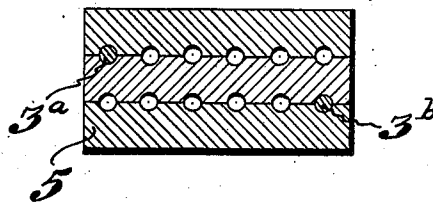
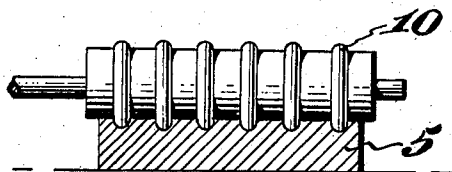


*Fig. 5.*



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## UNITED STATES PATENT OFFICE

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## METHOD OF PRODUCING PERFORATED METAL SHEETS

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8 Claims. (Cl. 29—163.5)

The present invention relates to a method of producing holes in thin sheets of metal wherein the holes are of a very small diameter, such as are necessary for example in spinning nozzles. This application is a division of my copending application Serial No. 125,892 filed February 15, 1937.

An object of the invention is to provide perforated metal wherein many minute holes may be formed without boring the metal.

Other and further features and objects of the invention will be apparent to those skilled in the art upon a consideration of the accompanying drawing and the following description wherein several exemplary embodiments of the invention are disclosed.

In the drawing:

Fig. 1 is a sectional view of the trough-like holder illustrating a series of plates and wires arranged therein.

Fig. 2 is a sectional view of the metal plates showing the manner in which pressure may be applied thereto.

Fig. 3 is a sectional view of the block after fusion of the metal plates.

Fig. 4 is a sectional view of the plates illustrating the manner in which the wires may be arranged in grooves of the plates.

Fig. 5 illustrates a modification of the process by the employment of a profile roll.

A plate of metal 5 is first arranged on a suitable support as shown in Figure 1. Above this plate of metal wires 3 are arranged in uniform parallel spaced relation. Each wire must be harder than the metal. Upon this layer of wire a fresh plate 5 of metal is positioned. This again is followed by a layer of wires 3, and this is continued until the superposed plates of metal, with the layers of wire interposed between them, attain a substantially square cross section. The plates of metal preferably lie between lateral struts in a more or less trough-like holder as shown at 1 in Figure 1.

Upon the uppermost plate of metal a cover (not shown) may be placed with an insulating layer of asbestos paper between the outer cover and the metal plate. Pressure is then exerted upon the block of the metal plates or upon the outer cover that closes the trough. The pressure depends upon the kind of metal employed. The block is also heated and under the influence of heat and pressure the plates unite by fusion in consequence of the pressure and of the correspondingly high temperature, a homogeneous block of metal is obtained as shown in Figure 3.

After the block of metal in the trough has

been allowed to cool down to some extent it is placed in an annealing lehr, made free from stress, and then cut into sheets. In this way sheets of metal are obtained with a number of wires embedded therein parallel to one another and accurately spaced. If the wires 3 are now etched out by the action of acid, sheets of metal of any desired thickness are obtained with accurately calibrated holes.

The operation of heating and fusing may take place in a vacuum or in an atmosphere of hydrogen, or in an atmosphere of inert or neutral gas, as a result of which oxidation is precluded. For instance wires of a base metal can then be used without risk.

The process may also be modified in the following manner:

The metal plates are pressed together under a high pressure, the pressure preferably being applied not only in one direction, that is, vertically, but also at right angles thereto or in a horizontal direction as indicated by the arrows 6 and 7 of Fig. 2. During the pressing, however, no heating generally takes place at first. After pressing and before heat is applied the plates are taken apart in an orderly manner and the wires, with the exception of one or two for each layer, such as 3a and 3b of Fig. 4, which serve for fixing the position of the metal plates, are taken out. The metal plates are then superposed again in the same order, their positions being fixed by the one or two wires that have been left in the plates in each layer. The block of metal plates is now exposed to a high pressure again, and at the same time is heated to a high temperature in an atmosphere of hydrogen or inert gas or in a vacuum. The degree of heat must be such that the fusion that now sets in proceeds with appreciable velocity, and is therefore completed under ordinary conditions in about half an hour. The metal plates are thereby united to form a completely homogeneous block of metal, as shown in Figure 3, and may be taken out of the heating furnace.

To enable the block to be cut into sheets without the fine perforations becoming choked, the holes are preferably filled, before drying, with a salt or the like of low melting point. The block is then cut into sheets so that sheets of a thickness of from 0.3 to 3 millimeters, or even of other thicknesses if required, are obtained.

Instead of impressing the ducts by inserting wires of harder metal, they may be produced by moving the metal plates adjacent a profile roll as shown in Fig. 5. If a profile roll is employed, as

illustrated in Figure 5, the annular projections 10 on this roll impress grooves in the plates 5, which are thus given the same form, as the plates 5 that have been treated with wires and illustrated in Figures 1 and 2. While only one profile roll is shown in the drawing it will be apparent that grooves may be provided in both faces of a plate by passing the metal sheet between two such rolls.

10 In order to obtain a block which is homogeneous in every respect, it is necessary for the materials of the plates and of the wires to be correctly related to one another. For instance if it is desired to obtain thin sheets of tantalum, difficulties are liable to arise because the metal has a high fusion temperature. By coating the tantalum plates in advance, however, by electrolytic means for example, with a thin layer of nickel of a thickness of 0.001 of a millimeter, the fusion 20 during the pressing operation, even at a low temperature, is sufficiently accelerated, so that the inconvenient property of tantalum is thereby obviated. Other metals may also be employed for this purpose, for instance iron or niobium, or in any case a metal that combines easily with tantalum. Obviously the wires inserted must also be of a metal having a high fusion temperature, such as tungsten or molybdenum wire for example. Instead of tantalum, niobium may be 30 employed.

Alternatively the method may be modified by using plates of metal that are very stable chemically, such as tantalum, niobium, gold, platinum or the like, and selecting wires of base metal, 35 which may then be left in between the metal plates during the pressing, and only etched away after the block has been finished.

Tantalum and niobium may alternatively be replaced by cheaper metals, such as nickel, iron 40 and the like, or by alloys, such as the steel alloy marketed under the trade mark V2A, vacuum fused alloys, or the like. With these metals, however, the material of the wire must be very carefully selected, in order that when the wire 45 is subsequently being etched away the material of the plate may not be attacked. For this reason it is preferable to take the wires out before the fusion.

When perforated metal sheets are to be employed in spinning nozzles, it is necessary that the sheets should be chemically stable. If a nickel block has been produced, the nickel sheets are at first not chemically stable. They may however be made chemically stable by exposing the nickel 55 sheets to an atmosphere of tantalum, niobium, tungsten, or molybdenum chloride, or some other halogenide. Compounds of boron may alternatively be employed instead. Such a chloride atmosphere is of such a high temperature that 60 a reaction of the chloride with the nickel or other metals employed occurs, while the metal of the halogenide, the tantalum for example, is deposited upon the nickel, and, in consequence of the high temperature, diffuses into the nickel. In 65 this manner there is formed inside the capillaries and around the apertures a uniformly thin and chemically stable coating.

Such coated nozzles also have the advantage that it is possible in a certain sense to harden 70 them without affecting the surface color of the metal. The hardening may be effected in the case of tantalum and niobium coatings, for example, by means of hydrogen, as a result of which a layer of tantalum hydride or a layer of niobium 75 hydride is formed, which is exceedingly hard and

chemically stable. Boron and oxygen may also be employed. A hardening of solid tantalum nozzles for instance may of course also be effected by coating these nozzles with a suitable metallic layer or with boron or with oxygen. A 5 similarly very hard layer is obtained by coating solid tantalum nozzles with a layer of tungsten.

Although several preferred embodiments of the invention have been described it is apparent that modifications may be made therein by those 10 skilled in the art. Such modifications may be made without departing from the spirit or scope of the invention as set forth in the appended claims.

What I claim is:

1. A method of producing thin sheets of metal 15 provided with uniform holes of small diameter, which comprises, superposing polished plates of metal with a layer of parallel wires of harder material between each two adjacent plates to form 20 a block, applying pressure to the block until the wires have been forced into the surface of the metal plates and are in contact with the latter throughout their surface, removing some of the wires from each layer, applying pressure and 25 heat to the block and thereby converting it by fusion into a homogeneous body, and cutting the homogeneous body thus formed into thin sheets.

2. A method of producing thin sheets of metal 30 provided with uniform holes of small diameter which comprises, forming parallel grooves in the faces of polished metal plates, arranging a wire in some of the grooves, superposing the plates to form a block with some of the grooves engaging 35 said wires, applying pressure and heat to the block and thereby converting it by fusion into a homogeneous body, cutting the homogeneous body thus formed into thin sheets, and removing said wires by etching.

3. A method of producing perforated thin sheets 40 of chemically stable metal such as tantalum, niobium, gold and platinum which comprises, superposing polished plates of said metal with a layer of parallel wires of base metal between each two adjacent plates to form a block, applying pres- 45 sure and heat to the block and thereby converting it by fusion into a homogeneous body, cutting the homogeneous body thus formed into thin sheets, and removing the wires by etching.

4. A method of producing perforated thin 50 sheets of chemically stable metal such as tantalum, niobium, gold and platinum which comprises, coating polished plates of said metal with a thin layer of nickel, superposing the nickel-coated plates with a layer of parallel wires of 55 base metal between each two adjacent plates to form a block, heating the block in a vacuum and applying pressure to the block thereby converting it by fusion into a homogeneous body, cutting the homogeneous body thus formed into thin 60 sheets, and removing the wires by etching.

5. A method of producing thin sheets of nickel 65 provided with uniform holes of small diameter which comprises, superposing polished plates of nickel with a layer of parallel wires of base metal between each two adjacent plates to form a block, applying pressure and heat to the block and thereby converting it by fusion into a homogeneous body, cutting the body into thin sheets, removing the wires by etching, and hardening 7 the thin perforated sheets thus produced by exposing them to an atmosphere of metal chlorides.

6. A method of producing thin sheets of tantalum provided with uniform holes of small diameter which comprises, superposing polished 7

plates of tantalum with a layer of parallel wires of base metal between each two adjacent plates to form a block, applying pressure and heat to the block and thereby converting it by fusion into a homogeneous body, removing the wires by etching, cutting the homogeneous body thus formed into thin sheets, and hardening the thin perforated sheets thus produced by coating them with a metallic layer which forms a hard alloy with the tantalum.

7. A method of producing thin sheets of tantalum provided with uniform holes of small diameter which comprises, superposing polished plates of tantalum with a layer of parallel wires of base metal between each two adjacent plates to form a block, applying pressure and heat to the block and thereby converting it by fusion into a homogeneous body, removing the wires by

etching, cutting the homogeneous body thus formed into thin sheets, and hardening the thin perforated sheets thus produced by the action of gases which combine chemically with the metal to form a compound which is of greater hardness than the metal.

8. A method of producing thin sheets of metal provided with holes of small diameter which comprises, superposing plates of metal with a layer of wires of harder material between each two adjacent plates to form a block, applying pressure and heat to the block so as to convert the same by fusion into a homogeneous body, cutting the homogeneous body thus formed into relatively thin sheets, and removing the wires by etching.

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