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METHOD OF PRODUCING PERFORATED GLASS

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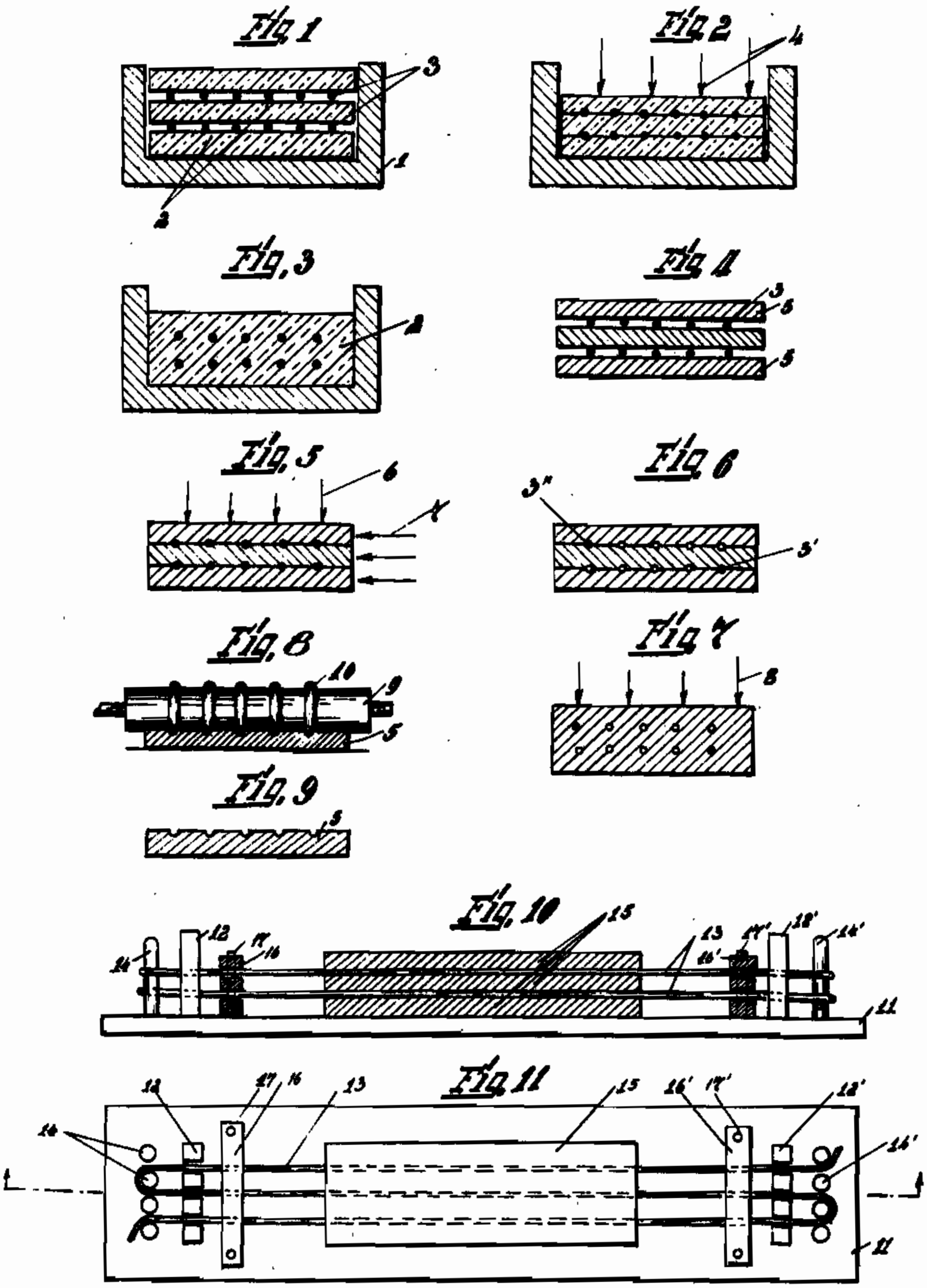

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PRODUCTION OF THIN PERFORATED SHEETS OF GLASS OR METAL

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This invention relates to a method of producing thin sheets of glass or metal, provided with uniform holes of very small diameter, such as are used for example as spinning nozzles.

It is known to produce small holes in glass by fusing platinum wires individually into glass plates, and etching the wires away again after the completion of the other operations required, such as grinding and polishing. In this way an accurate hole is obtained. This process is complicated, and furthermore platinum has been found to be the only metal that can be used therein. A method is hereinafter described which obviates these disadvantages.

Upon the bottom of a framework which is provided with devices for winding wires to and fro and stretching them, in such a way that the wires lie parallel to one another at uniform distances apart, a sheet of glass is laid. Above this sheet of glass a wire is wound to and fro in uniform parallel turns. Upon this layer of wire a fresh sheet of glass is laid. This again is followed by a layer of wires, and this is continued until the superposed sheets of glass, with the layers of wire interposed between them, attain a substantially square cross section. The sheets of glass preferably lie between lateral struts in a more or less trough-like holder. Between the sheets of glass and the internal surfaces of the holder is provided an insulating layer, of thin asbestos paper for instance, in order to prevent the glass from subsequently uniting with the holder or with the side walls of the trough. Upon the uppermost sheet of glass is placed a cover in the form of an iron filling the trough, with an insulating layer of asbestos paper between the outer cover and the glass. The block formed of the glass plates with the interposed wires is then heated in the trough with a gas flame, while at the same time pressure is exerted upon the outer cover that closes the trough. The pressure depends upon the kind of glass employed and upon the thickness of the sheets. In many cases the intrinsic weight of the glass itself may be sufficient without extraneous pressure. Under the influence of the heat the glass passes into a viscous condition, so that the plates unite, until by diffusion in consequence of the pressure and of the correspondingly high temperature, a homogeneous block of glass is obtained. In many cases it will be more advantageous to weld the block from the individual layers one after another, so that in the first instance two layers are united to one another, then a third layer is united to the first two, and so forth, until a completely homogeneous block is obtained.

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

In order to enable any desired metal wires to be employed instead of being restricted to platinum, it is sufficient to allow the heating and diffusing operation to take place in a vacuum or in an atmosphere of hydrogen, or else in an atmosphere of inert or neutral gas, as a result of which any oxidation of the wire is precluded. Wires of a base metal can then be used without risk.

In the case of boro-silicate glass there is the advantage that repeated fusing of the glass block can be effected without bubbles forming therein. Sheets of such glass can thus be directly inserted as nozzle plates in nozzle bodies, without difficulties arising, when the insertion margin is heated, by the formation of bubbles.

This method is applicable not only to glass plates but also to metal plates which are softer than the wire to be arranged between them. The metal plates are pressed together under a high pressure, this pressure preferably being applied not only in one direction, that is, vertically, but also at right angles thereto in a horizontal direction. During the pressing, however, no heating generally takes place at first, the process thus being distinct from that employed in the case of glass plates. After the pressing the plates are taken apart in an orderly manner and the wires, with the exception of one or two for each layer, 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 highly heated in an atmosphere of hydrogen or inert gas or in a vacuum. The degree of heat must be such that the diffusion 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, which can now be taken out of the furnace, in which the heating has taken place.

To enable the block to be cut up into sheets in the same manner as the block of glass without the fine perforations becoming choked, the latter are preferably filled, before drying, with a salt or the like of low melting point. The block is then sawn into sheets with a diamond saw, so that sheets of a thickness of from 0.3 to 3 millimetres, 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 passing the metal plates between profile rolls.

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 diffusion 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 millimetre, the diffusion during the pressing operation, even at a low temperature, is sufficiently accelerated, so that the inconvenient property of the 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 then also be of a metal having a high diffusion temperature, such as tungsten or molybdenum wire for example. Instead of tantalum, niobium may be employed.

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

Tantalum and niobium may alternatively be replaced by cheaper metals, such as nickel, iron 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 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 diffusion.

When employing perforated metal sheets 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 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 a reaction of the chloride with the nickel or other metals employed occurs, while the metal of the halogenated, the tantalum for example, is deposited upon the nickel, and, in consequence of the high temperature, diffuses into the nickel. In 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 them without affecting the surface colour 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 hydride is formed, which is exceedingly hard and chemically very 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 similarly very hard layer is obtained by coating solid tantalum nozzles with a layer of tungsten.

The invention is diagrammatically illustrated in various examples in the accompanying drawings, in which

Figures 1 to 3 illustrate diagrammatically the production of homogeneous glass blocks;

Figures 4 to 7 illustrate the production of homogeneous metal blocks;

Figures 8 to 9 illustrate a modification of the process illustrated in Figures 4 to 7 by the employment of profile rolls;

Figures 10 and 11 illustrate diagrammatically in sectional elevation and in plan respectively a piece of apparatus by the aid of which the wires can be very simply introduced between the individual plates parallel to one another and at uniform distances apart.

In a trough 1, shown in Figures 1 to 3, lie glass plates 2, and between these glass plates a number of wires 3 are laid parallel to one another and at equal distances apart. In the direction of the arrows 4 in Figure 2 a pressure is exerted, by which, with simultaneous heating of the compressed plates, a homogeneous block is obtained as represented in Figure 3.

In the case of metal plates 5 (Figures 4 to 7), the plates are first superposed in the same manner as the glass plates 2, with wires 3 between them. Then, without heating, a vertical pressure in the direction of the arrows 6 in Figure 5 is exerted, and also a horizontal pressure in the direction of the arrows 7, whereupon the heating is only effected, after the wires have been removed, with the exception of one or two, 3' and 3'', in each layer, the plates then being secured in position by these remaining wires 3' and 3'' when superposed again. By pressure in the direction of the arrows 8 in Figure 7, accompanied by heating, the metal plates are converted by diffusion into a homogeneous block.

If profile rolls 9 are employed, as illustrated in Figure 8, the annular projections 10 on these rolls impress grooves in the plates 5, which are thus given the same form, shown in Figure 9, as the plates 5 that have been treated with wires, as illustrated in Figures 5 and 6.

A simple piece of apparatus for ensuring the accurate spacing and parallelism of the wires is obtained, as shown in Figures 10 and 11, by providing a base plate 11 with distance pins 12 and 12', arranged in the form of combs, and winding a wire 13 to and fro in a horizontal plane between the spacing pins 12 and 12' and round reversing pins 14 and 14' located behind them, a plate 15 of glass or metal being laid upon the base plate 11 before the first wire is wound. In a vertical direction the distance between the layers of wire is determined by spacing members 16 and 16', which are superposed like the plates 15, and may be guided for instance by means of pins 17 and 17'.

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