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[54] **DEVICE FOR THE PERMEABILITY CONTROL OF THE LAYER OF MATERIAL TO BE SINTERED IN PLANTS FOR SINTERING ORES, IN PARTICULAR IRON ORES**

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[51] **Int. Cl.** **F27b 21/00**

[58] **Field of Search** 432/135, 137, 241, 5, 6, 432/7, 13, 14, 17, 24, 40; 75/3, 5, 8; 73/38, 37.8; 266/21, 20

[56] **References Cited**

UNITED STATES PATENTS

2,767,074	10/1956	Bradwell	75/5
2,162,782	6/1936	Middleboe	75/5
2,914,395	11/1959	Davies	75/5
2,931,718	4/1960	Greaves	266/20

FOREIGN PATENTS OR APPLICATIONS

1,010,488	11/1965	Great Britain	75/5
659,179	1/1964	Italy	432/13

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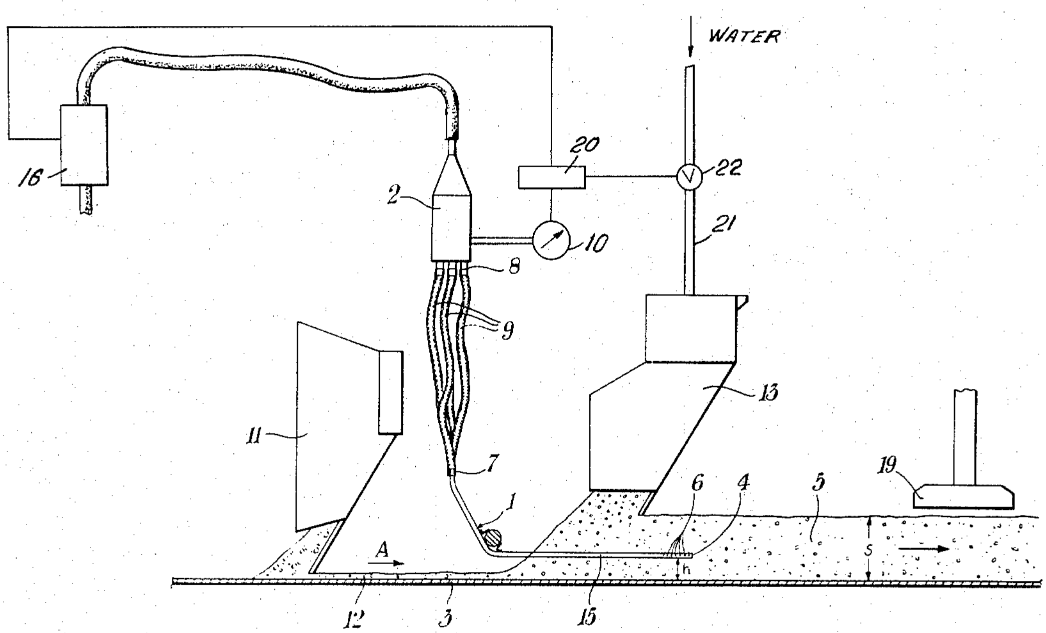
[57] **ABSTRACT**

The permeability of a layer of ore to be sintered is controlled by inserting a plurality of gas-injecting probes into the layer of ore with the probes extending horizontally and parallel to each other and spaced apart, and feeding gas to the probes from a manifold. The gas pressure and/or flow rate are monitored as a measure of permeability of the layer and water is automatically supplied to the feed hopper for the material to be sintered, in response to the monitored values.

9 Claims, 2 Drawing Figures



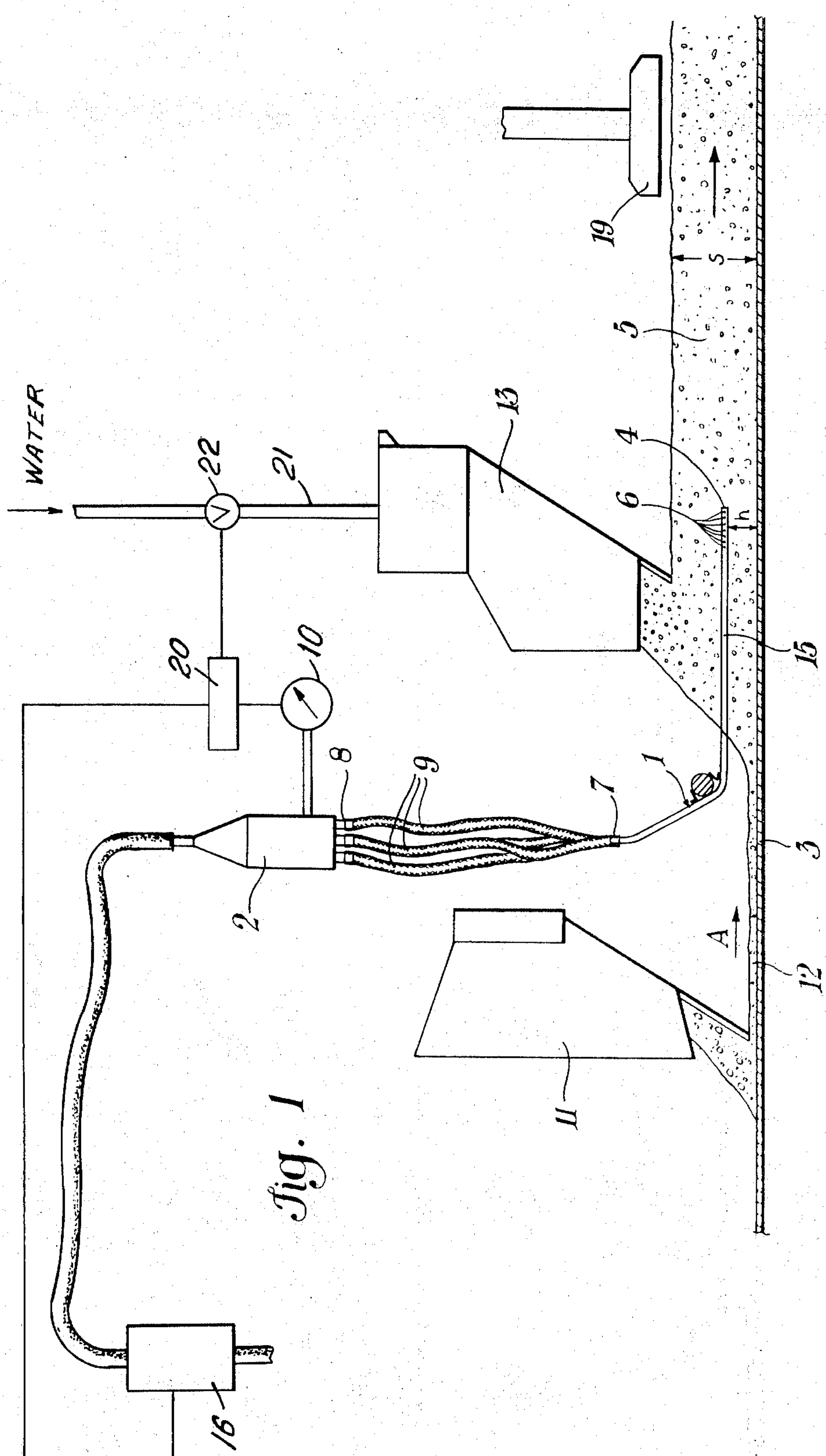


Fig. 1

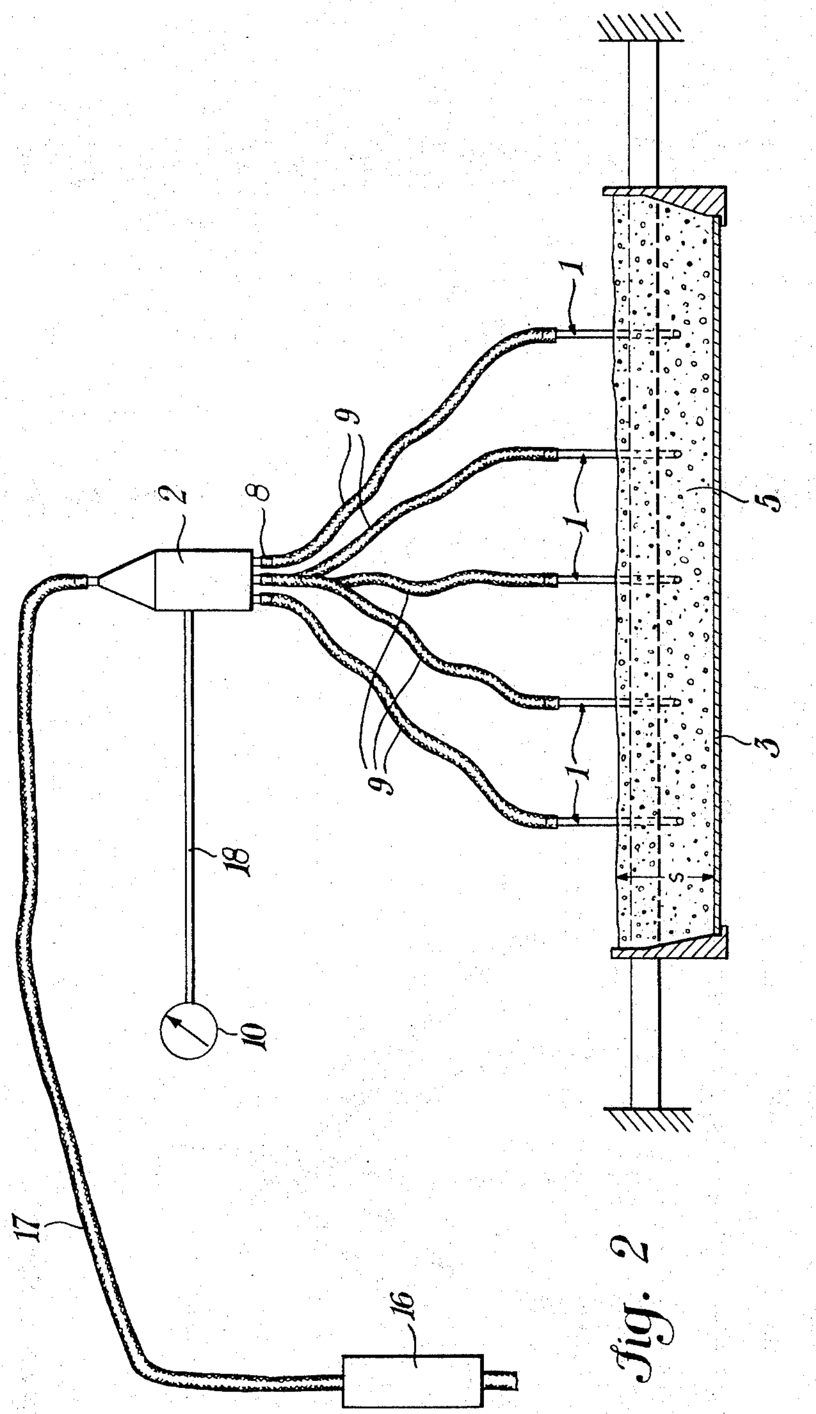


Fig. 2

DEVICE FOR THE PERMEABILITY CONTROL OF THE LAYER OF MATERIAL TO BE SINTERED IN PLANTS FOR SINTERING ORES, IN PARTICULAR IRON ORES

The present invention covers a device for the permeability control of the layer of the material to be sintered in plants for sintering ores, in particular iron ores. More precisely, the invention covers a device which allows one to measure and regulate, in a continuous way, the permeability of the mixture to be sintered, by maintaining continuously said permeability at about its maximum value, thus securing a high sintering speed, and permitting one to obtain both a larger production and a sintered product of improved quality.

It is known that, in the sintering processes, especially for the ores to be loaded into the blast furnaces, it is important to obtain a sinter displaying both optimal characteristics of hot and cold mechanical resistance and of reducibility at high temperatures, for the purpose of carrying out the most regular possible performance of the blast furnace and of insuring the smelting of the metal in a very short time.

It is also known that the productivity of the sinter plant, the processing speed and the quality of the final product are functions of the permeability of the sintering bed which, in turn, is a function of the moisture of the mixture to be sintered. Because of this close dependence, many attempts have been made to regulate the permeability of the sintering layer, by acting upon the moisture. The simplest solution may appear that of maintaining the mixture moisture constantly equal to the value corresponding to the maximum permeability, but it is not possible to do so because the moisture of the mixture varies in accordance with the composition of the ore, its granulometry, and the amount of fines recycled.

Other solutions, put into practice in the past, envisaged the determination of the moisture of the mixture by means of a small pilot plant in order to regulate thereafter, the amount of the moistening water of the mixture fed into the industrial plant. However, in this way the moisture regulation turns out to be somewhat approximate since various factors, among which are possible variations of the mixture grain size, cannot be taken into account.

There have been suggested devices such as the neutron probe (measuring the total hydrogen) which however is influenced by the combination water of the ore, or the electrical resistivity probes which are affected by the iron content variations of the ores and, because of the humidity of the mixture, by the presence of ions (for example Ca^{2+}), which alter the measurement. Furthermore, these methods cannot take into account the possible variations of the dependence between permeability and moisture, which variations are due to the type of ore, to its size and to many other factors.

It has been suggested, then, to perform a direct measure of the permeability before the ignition of the bed of the material to be sintered. In this field the following methods are known:

a. Measurements of the permeability by means of probes inserted into the loading hopper of the endless belt conveyor. This method presents the drawback that it cannot take into account, either the thickness differences of the material in the hopper and on the belt, or the differences in compactness of the ore; its practical efficacy is hence doubtful,

b. Measurements of the permeability in the laboratory, on samples withdrawn from the conveyor belt. This method also has several drawbacks due, above all, to the difficulty of interpretation of the data obtained, even if the samples are withdrawn frequently, and to the discrepancies existing between the data obtained in the laboratory and the reality of the industrial plant,

c. Determination of the permeability by means of depression measurements performed across the belt, before the ignition box, by means of a suction plant, outside the sintering belt, as disclosed in Italian Pat. No. 659,179, which describes a process for the determination of the permeability whereby the mixture to be sintered is crossed by an air flow before its ignition, and then the amount of water introduced into the mixture is varied gradually, either increasing or decreasing it until the permeability attains a value different from that of the immediately preceeding measurement, then decreasing, and respectively increasing the water amount in such a manner that the permeability is regulated in a very short time interval.

It should be emphasized now that, in the plant described in the herein mentioned Italian patent, the device described and illustrated for the determination of permeability measurement according to the herein mentioned process, for the insufflation of the said air flow across the agglomeration layer a ventilation duct is envisaged ending above the layer without penetrating it.

The use of such a device, however, has not given completely satisfactory results because considerable air infiltrations, along the edges of the suction box, could not be avoided.

The device of the present invention, carrying out an analogous process, aims to eliminate the aforementioned drawbacks, allowing a continuous and reliable measurement of the permeability of the sinter mixture eliminating, in particular, the said air infiltrations along the edges of the suction box.

In a specific way, it is a purpose of the present invention to supply a controlling device for the permeability of the sintering material, which allows one to carry out continuously permeability measurements of the sintering material, in connection with the layer of the said material already set on the strand of the sintering plant, performing a gas (air) insufflation inside the said layer.

For this purpose, there is envisaged a group of probes which penetrate the inside of the layer, paralleling the motion direction of the moving grate or belt, being fed with the gas, preferably air, from a technologically suitable source. Therefore, a specific object of the present invention is a device for the control of the permeability of the layer of sintering material in plants for the sintering of ores, in particular iron ores, which comprises, in combination:

a group of probes which penetrate inside the sintering layer,

a collector system connected with one of the ends of the said probes

a system to measure the pressure or the flow rate variations, and a system for the regulation of the amount of the moistening water of the sintering material.

In particular, according to the present invention and for the herein mentioned purposes, there is, firmly set within the sintering layer, before the ignition hood, a group of probes, with an elongated shape, connected at one of their ends to a single collector or manifold and supplied, at the opposite end, with a series of holes, the said probes being set longitudinally, paralleling the motion direction of the moving belt, with their main axis at a constant distance from the said moving belt, and in the neighborhood of the horizontal central plane of the said sintering layer. By means of the said manifold the probes are fed with a gas, preferably air, at a constant pressure and flow rate. The said gas outflows from the said holes and crosses the sintering layer, meeting a resistance which is a function of the permeability of the said layer. Because of this resistance, variations either in the flow rate (if the operation is performed at a constant pressure), or in the pressure (if the operation is performed at a constant flow rate), are set up, the said variations being continuously measured with instruments and methods already known. After the first measurement of the said variation has been performed, a variation of the amount of water added from a water delivery conduit to the sintering mixture is effected automatically by means of a known device and subsequently another measurement of the said flow rate or pressure variations is performed. If the said new measurement indicates an increase in the permeability of the agglomeration layer, the new variation of the amount of moistening water is maintained constant in the same direction as the first one while, if a decrease of permeability is detected, the variation of the moistening water is effected in an opposite direction with respect to the first one.

According to the present invention, the said measurement operations of the gas flow rate variations and of the amount of moistening water variations are repeated continuously until the maximum value of the permeability of the layer is attained and, thereafter, they are continued in order to maintain the said permeability value at about its maximum.

As already mentioned, according to the present invention the said probes penetrate inside the sintering layer for a distance ranging from 1.5 to 2.5 times the thickness of the said layer, as measured in a direction away from the device which makes the sintering layer thickness constant, and besides this penetration distance must not allow the probes themselves to reach into the zone covered by the ignition hood.

The device of this invention permits one to obtain very good results, it being possible to regulate the moisture of the mixture in an exceedingly good way (in fact, variations of the mixture permeability corresponding to variations of the humidity of the said mixture of the order of 0.1 – 0.2 percent are detected) that error being practically eliminated, with the use of several probes each supplied with several holes, which may occur with only a single probe, due to the fact that a fissure or a zone of a suddenly and casually lesser resistance than that of the remainder of the layer, may give rise to a completely abnormal permeability measurement and hence to abnormal additions of humidification water.

Another advantage of the device of the invention is its independence from the errors caused by air infiltrations, which are a characteristic of the aspiration hoods used for this purpose and which have rendered ineffectual other techniques previously suggested.

The present invention will be described now with particular reference to the drawings attached wherein preferred embodiments of the same are presented only for illustrative and not limitative purposes.

In particular, in the drawings:

FIG. **1** represents a longitudinal, sectional view of the device according to the invention applied to sintering plant with a continuous sintering strand.

FIG. **2** represents a cross section of the device mentioned in FIG. **1.**

With particular reference to FIG. **1,** there may be observed the device according to the invention applied to a sintering plant of the type with a continuous conveyor belt **3,** movable in the direction of arrow A, upon which, from hopper **11,** an initial thin layer **12** of material, with a coarse size is unloaded; upon the said initial layer **12,** the material with a finer grain size is placed when unloaded from hopper **13,** until forming the final sintering layer **5,** with a thickness *s*, inside which there penetrate the terminal lengths **15** of the probes **1,** supplied with holes **6,** arranged in a series in correspondence with some generatrices of the cylindrical mantle of the said probes **1.** The said terminal lengths are parallel to the motion direction of the continuous belt **3,** and are closed at their ends **4.** They are equidistant from each other and are located above the belt **3** at a height $h \ll s/2$ (half of the layer thickness). At their other end **7,** the probes **1** are connected to the gas (air) inlet manifold, supplied with fittings **8** for connecting the pipes **9** with the said probes **1.**

FIG. **2,** represents a cross section of the agglomeration belt, at the probes level. In the sintering layer **5,** having thickness s, placed on the continuous belt **3,** there penetrate the probes (five probes), supplied with holes **6** (see FIG. **1**), located, as already mentioned for FIG. **1,** along the terminal lengths **15,** closed at their ends **4,** and paralleling the continuous belt **3,** in respect of which they are located above, at the height $h \ll s/2$. At their other end **7,** the probes **1** are connected to the air inlet manifold **2,** supplied with fittings **8** for connecting the pipes **9** with the said probes **1.** The manifold **2** is fed with gas, preferably air, through the control flowmeter **16,** along pipe **17,** there being also a metallic pipe **18,** ending at one end in an apparatus, already known, for the measurement and the recording of the said pressure variations and connected at the other end, to the manifold **2.**

More particularly, the device of the invention is essentially constituted by the said group of probes **1,** by the said manifold **2,** connected to one of the ends **7** of said probes, and by a system for measuring the pressure, or the flow rate variations, which governs, for example through computing units, a system for the regulation of the amount of the water for moistening the material to be sintered. The said probes **1** have the shape of an elongated cylindrical body, closed at the end **4,** opposite to the said manifold **2,** and with an external diameter ranging from 1 to 5 cm; the said probes **1** are, furthermore, placed with their main axis paralleling the said moving belt **3,** and pointing towards the motion direction of the said moving belt, at a distance *h* from it $\ll s/2$, and penetrating inside the layer for a length ranging from 1.5 to 2.5 times the values of the thickness *s* of the layer, however, in such a way as not to reach the zone covered by the ignition hood **19.** The said probes can vary in number, according to the width of the sintering layer, and they are located in a proportion of one for each 0.3 to 0.7 m of width of the said layer, the outermost probes being displaced from the lateral walls of the said layer **5,** by a distance no less than the thickness s of the layer itself. Furthermore, the probes are supplied, towards the end **4** opposite to the said manifold **2,** with holes arranged in series, in correspondence with some generatrices, of the cylindrical mantle of the said probes, for a length, measured from the closed end **4** of the said probes, ranging from 0.3 to 1.5 times the total thickness *s* of the sintering layer **5.** The said holes **6** are arranged at least along four generatrices of the said cylindrical mantle and, furthermore, are equidistant from each other.

The said manifold **2** carries also the system for the measurement of flow rate or pressure variations, already known in the art and not shown in detail in the figures, which for example governs by means of a computing unit **20** and in a way already known, e.g. through conduit **21** controlled by valve **22,** the regulation of the amount of moistening water of the mixture to be agglomerated.

The device of the present invention, allows one to attain many advantages in respect to similar known devices. For example, the great number of holes for the gas flow, and the plurality of the probes, makes almost negligible the probability that either a zone with a casually greater permeability of the agglomeration layer, or the occlusion of one or more holes, may cause unreliable measurements and, therefore, erroneous estimates of the variations of the amount of moistening water. Furthermore, the device is of small dimensions and easily assembled in any type of sinter plant and therefore its use is simple as it requires no important or substantial modification of the preexisting plant.

The present invention has been described with particular reference to preferred embodiments thereof, but it is intended that variations or modifications may be introduced therein, without departing from the scope of the appended claims.

Having thus described the present invention, what is claimed is:

1. A device for the control of the permeability of a layer of material in plants for the sintering of ores, comprising in combination a plurality of gas-injecting probes penetrating into said layer of material, a gas manifold having a plurality of outputs, a plurality of conduits connecting said manifold outputs with said plurality of gas probes, means feeding gas to said manifold, gas flow measurement means for said gas feed means, gas pressure measurement means connected to said manifold, means delivering water to the sintering mixture, and means responsive to said flow and pressure measurement means for automatically regulating the amount of water added to said layer of material.

2. Device according to claim **1,** in which said probes are elongated in shape and are connected at one of their ends to said conduits while their other ends have holes for the passage of said gas.

3. Device according to claim **1,** in which said probes penetrate inside the sintering layer for a length from 1.5 to 2.5 times the total thickness of said sintering layer.

4. Device according to claim **2,** in which said probes are elongated cylindrical pipes with an external diameter from 1 to 5 cm. and closed at the extremity opposite to said conduits.

5. Device according to claim **1,** in which said probes are horizontal.

6. Device according to claim **1,** in which said probes vary in number according to the width of the said sintering layer and are arranged in the proportion of one for each 0.3 – 0.7 meter of width of the layer.

7. Device according to claim **1,** in which the probes nearest to the lateral edges of the sintering layer are located at a distance, from the edges, greater than the thickness of the said layer.

8. Device according to claim **1,** in which said probes carry, toward their end opposite to the said conduits, holes arranged in several series for a length, measured from the closed end of the probes, ranging from 0.3 to 1.5 times the total thickness of the said sintering layer.

9. Device according to claim **8,** in which said holes are arranged along at least four equidistant series.

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