L. J. KIRCHENBAUER.

METHOD OF TREATING POROUS CASTINGS.

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1,187,746. Patented June 20, 1916.

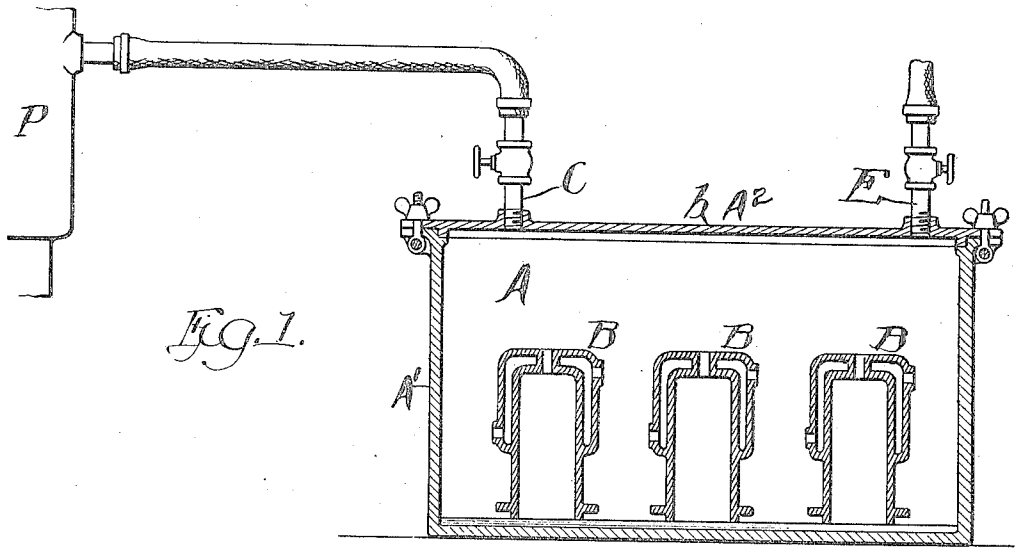


Fig. 1.

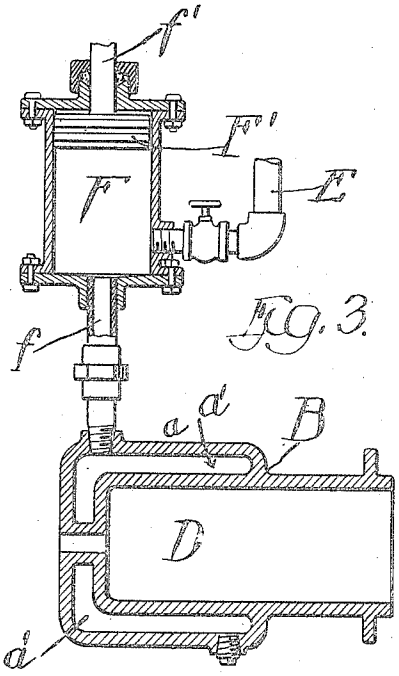


Fig. 3.

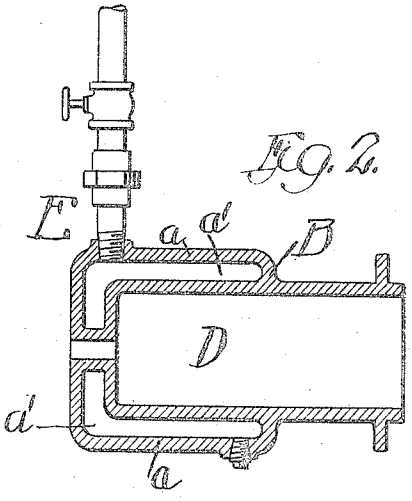


Fig. 2.

Witnesses:
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UNITED STATES PATENT OFFICE.

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METHOD OF TREATING POROUS CASTINGS.

1,187,746. Specification of Letters Patent. Patented June 20, 1916.

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To all whom it may concern:

Be it known that I, LOUIS J. KIRCHENBAUER, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Methods of Treating Porous Castings; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

The object of this invention is to remedy the defects in castings which are due to various causes. For example, it is well known that the metal of a casting is often neither solid nor homogeneous throughout, and that small cavities and blow-holes are not infrequently found scattered unevenly throughout the castings. Often these irregularities and defects do not appear on the surface of the casting; and this is particularly true of cored castings. In such castings the entire surface of the cored part is not always visible. In those cases where the cavity or imperfection does extend to the surface of the cored portion, such cavity may remain undetected, as equally in the case where the cavities or defects do not extend to the visible surfaces of the casting, and it is only after considerable machine work has been done, and not infrequently until after the casting is either put into use or subjected to a test, that the defects are revealed. In such cases, the cost of the casting and of the machine work is lost, because of the necessity of discarding the casting.

The defects which make up what is sometimes termed a porous or a spongy casting arise from various causes unnecessary to here relate at length. Sometimes these defects occur by reason of the improper admixture of metals in the furnace, sometimes because of air holes and the presence of gas, vapor or moisture entrained in the molten metal, and quite often to uneven shrinkage of the cast metal upon cooling.

In castings that are of uneven thickness or irregular conformation, for example, it is found that in cooling one part cools more rapidly than another, and the shrinkage and tendency to draw from one part of the casting to the other creates the spongy or porous condition adjacent to this part of the casting. Variations in the "mix" of ores and scrap iron in the melting furnace often result in the failure of one metal properly uniting and becoming fused with the other metal so as to form a proper homogeneous mass for the casting. Variations also in the degree of heat used and kinds of coke used in the furnace seem also to have a bearing upon the production of imperfect castings. Various means have been devised to remedy these defects, for use during the casting operation, attended with more or less success, but it nevertheless seems to be true that with the best known methods in use in this and foreign countries spongy or porous castings constantly occur and result in great loss.

Many combinations of elements have heretofore been devised to obtain a substance or compound adapted to plug or fill up openings in castings, but all of these as I am advised have been in the nature of a metallic putty to be worked into the casting or to lute or coat the casting. Such for example is the compound set forth by Sonnenshein (1901) in "*How to Make and Mend*," wherein chalk, fine metal powder and silicate of soda are recommended. The formula given makes a putty to be pressed into the holes or cracks of a casting and requires 24 hours to set hard. The *Scientific American Encyclopaedia* and other references give various formulæ for soluble glass cements, pastes and putties.

All such I disclaim as old and falling short of accomplishing the object to which the present invention is addressed, for several reasons. In the first place, as heretofore stated, the porous parts of the casting may occur in such location as to make it quite impossible to apply and press in the paste, putty or cements of the prior art, and, secondly, the openings of the porous part of the casting to be treated may be so minute at the surface of the casting as to make it quite impossible to force a putty or paste into the casting.

I have discovered that no filling compound can be properly used for permanently curing a porous casting unless it be a fluid capable of being drawn or forced through such minute openings of the casting.

It is the object, therefore, of this inven-

tion to devise a process or method of treating a finished casting, either before or after it has been machined, by impregnating the spongy or porous parts of a casting with a suitable fluid filling material which will enter and completely fill the pores or interstices of the casting, and, which, upon subjecting the filled casting to further treatment, will so adhere to, fuse or unite with the metal of the casting that to all intents and purposes the thus treated casting will be precisely the same as though the metal of the casting was originally one solid, homogeneous mass.

Another object of this invention is to produce a simple, effective and yet inexpensive compound or article of manufacture to be used in carrying out my process or method of treating porous and defective castings. To these ends the invention consists in the matters herein described and more particularly pointed out in the appended claim.

I will first describe my novel method or process of treating porous and defective castings, and in doing so will designate my novel filling compound by the convenient shop term "dope" and will then describe the composition of the latter.

In carrying out my method or process, I take a casting after it has left the foundry and is supposed to be ready for use or for the usual machining operations, but which has been found to be or is supposed to be defective. I subject such casting to the action of heat at a temperature sufficient to cause, by the normal expansion of the metal, a slight enlargement or accentuation of the porous portion. While in this heated condition, I fill the pores or spongy portion of the casting with the filling material or "dope," applying the latter either by steam, air, mechanical or gravity pressure or by suction. The amount of pressure or suction applied will be sufficient to either force or draw the "dope" into and through the porous part of the casting until the interstices thereof are completely filled with the "dope." After the casting has been thus impregnated with this material, I reheat the casting at a temperature sufficiently high to cause the filling material to adhere or fuse to the walls of the cavities or openings in the metal casting, and to thoroughly and permanently unite therewith. This last mentioned step of permanently fixing the "dope" in the casting usually requires but a very short period of time. The casting may then be withdrawn from the influence of heat and be machined and prepared in the usual way for its intended use.

After a casting has been subjected to my process, as just stated, it may be subjected to any of the familiar tests to reveal or detect defects, and it will then be found that said casting is as strong, solid and durable in the previously defective or porous portions so treated, as it is in any other portion. Moreover, said casting will not thereafter be affected by either heat or cold, or by any use for which the casting is designed or intended. In other words, heat or cold that is insufficient to destroy or injure the metal, *per se*, of the casting itself will be equally non-injurious to the "dope" or filling material used in carrying out my process or method of treating such casting. Thus, if a casting upon being found porous or defective, be treated by my process, it may be machined and put into use instead of being broken up and lost. Moreover, if new castings, after they come from the foundry, be subjected to my process, any defect or porous portion will be cured without the necessity of preliminary machining and testing, and in the event of the new casting being substantially sound no harm will have been done to it by my treatment, but rather will its soundness be insured, since all infinitesimal defects or pores will have been permanently filled up.

I will now describe my process or method by reference to the accompanying drawings, in which I have illustrated several forms of apparatus that may be used in carrying out my invention.

In the drawings:—Figure 1 illustrates a tank or vacuum chamber A, in which a plurality of castings B B, may be treated, said tank comprising a body portion A^1 having a removably attached cover A^2, a valved conduit C leading to a suitable exhauster or vacuum pump P and a second valved supply pipe or conduit E. Fig. 2 illustrates a familiar form of automobile water-jacketed cylinder casting B. This casting has a cylinder D provided with a surrounding shell *a* and a water space or jacket a^1. To this casting I affix a valved pressure pipe E. Fig. 3 illustrates a casting similar to that shown in Fig. 2. Affixed to this casting, I have shown a piston pressure cylinder F, suitably secured in a familiar manner to the cylinder casting. The pressure cylinder is connected with the water jacket space a^1 by the conduit *f*. At a convenient point, a valved inlet conduit or pipe E is attached, whereby the filling material or dope may be supplied to the interior of the pressure cylinder and through the conduit *f* find its way into the jacketed part a^1 of the casting to be treated. A piston F^1 is attached to a piston-rod f^1 leading through the top of the pressure cylinder, and may be actuated in a familiar manner by any suitable means (not shown) to compress the material supplied to the cylinder through the pipe E.

In carrying out my invention by means of the apparatus shown in Fig. 1, the first step in my method or process is to subject

the porous or defective casting to the action heat. This may be done by placing the casting in an oven, such as a Japan oven, a core baking oven or the like, or by heating the casting in any other convenient manner. The temperature applied should be only such as will cause a slight enlargement or accentuation of the openings or porous portions of the casting by the well understood normal action or expansion of the metal under heat. This will depend somewhat on the size and shape of the casting but I have found by experience that an ordinary automobile cylinder casting, such as I have illustrated in the drawing, will be heated sufficiently if subjected to a temperature of about 212 degrees Fahrenheit for a period of from ten to twenty minutes. While in this heated condition, I place the castings or cylinders B, B, in the vacuum tank A, secure the top A^2 thereon, open the valve in the conduit C and exhaust the air from the tank A. I then open the valve in the supply pipe E and allow the "dope" to flow into the vacuum tank A.

The action of the vacuum pump or exhauster P connected with the conduit C will not only exhaust the air from the tank A, but also the air that is in the castings to be treated. The vacuum thus created will cause the "dope" to completely and quickly fill all the porous or spongy places in the casting, saturating, so to speak, the casting with the dope. The latter is in fluid form, as will be hereinafter explained, and the fact that the casting is warm causes the fluid to more readily impregnate the casting and fill up the interstices and pores thereof. The temperature of the casting must not be so great, however, as to harden or cause the fluid dope to "set" or change its condition before it has completely saturated the casting.

The next step in my process of treatment is to remove the dope filled castings from the vacuum tank A and pour out or empty the filling dope from the jacketed space a^1 of the castings. I then again subject the castings to the action of heat, by placing the same in a heating oven or otherwise, at a temperature sufficient to cause the absorption of all moisture from the "dope," to harden the latter and cause it to adhere, fuse or unite with the adjacent metal of the casting. This will require, in the case of the castings illustrated, only from ten to twenty minutes at a temperature of from 212 to 225 degrees Fahrenheit, but the time of application of this second heating step will vary with the size of the casting and the degree of temperature used. Manifestly, the higher the temperature used in this "affixing" step, the shorter the period of time required. The period, however, as well as the degree of temperature may depend somewhat on the nature or specific combination used for the dope.

In the use of the apparatus such as shown in Fig. 2, I subject the cylinder casting B to the preparing action of heat as before explained, to enlarge or accentuate the porous condition. I then open the valve in the pressure pipe E to supply the dope to the space a^1, and by gas, air, gravity, water or steam pressure from a suitable source of supply connected with the pipe E (not shown) I force the "dope" into the openings or interstices of the casting. If there are any imperfections in the shell a of the casting, the dope will be forced, under the pressure applied thereto, completely into porous portions and will be visible upon the outside of the shell a. The material will also permeate the walls of the cylinder proper and be visible upon the inside of the cylinder. When the cylinder casting has been thus treated, I disconnect it from the pressure supply pipe E, pour out any surplus material or dope remaining in the jacketed space a^1 and then subject the casting to the second heating step as before explained, after which the casting will be found to be in perfect condition.

In the use of the apparatus shown in Fig. 3, the cylinder casting is first heated and then it is secured to the pressure cylinder F. The valve in the supply pipe E is opened and the dope is allowed to turn into or is forced into the cylinder from a suitable source of supply (not shown) connected with said pipe. When the dope has filled the jacketed space a^1 and stands in some quantity in the cylinder F, the valve in the supply pipe E is closed and the pressure piston F^1 caused to descend by any suitable means (not shown). The mechanical pressure thus exerted will cause the casting to be impregnated and saturated with the filling material. I then disconnect the cylinder casting, pour off the surplus material from the jacketed space a^1 and subject the casting to the final heating operation as before explained.

In water cooled or jacketed cylinders and in castings which are not subjected to high temperatures in use, the last heating step of my method does not require a very great degree of heat. That is to say, in such cases it is not essential that the temperature be such as to cause the filling dope to actually fuse with the metal but merely to set and be firmly affixed therein. In other cases, such for example as air cooled cylinders or other castings which are subjected in use to high temperature or to varying temperatures, it is desirable to use such a degree of heat in the final step or reheating of the treated casting as to cause the filling dope to fuse

with the metal of the casting. This will be readily comprehended by those skilled in the art.

My novel filling material or "dope" is composed of a carbonate of an alkaline earth metal, a silicate of an alkali metal, and a lead oxid. Any lead that will alloy with most metals may be used, such as yellow lead oxid or litharge. Of the group of silicates of alkali metals, I have found sodium silicate will answer to every requirement. Of the carbonates of alkaline earth metals, prepared calcium carbonate, commonly referred to as chalk, combines splendidly with the other elements named. Barium, strontium and, to some degree, magnesium have chemical properties similar to calcium carbonate, so far at least as the requirements of my filling material are concerned and may be used instead of chalk.

The materials required for the filler or dope must be such as may be physically mixed and combined while cold, that is, without the application of any appreciable degree of heat. The dope compound must be in fluid form and not soluble in water. The melting point of this fluid filler or dope may vary. The melting point must be such that the dope will unite and fuse immediately upon entering the pores of the casting, thus clogging or filling the aperture at the entering end thereof. In such event the filling material would not permeate the casting and fill up all of the porous spaces, the casting would be merely luted or coated, instead of being saturated with the dope, and only a partial correction of the defective casting would be obtained. The melting point, therefore, of the dope should be considerably above the temperature used in first warming up or heating the casting, in order that the filling material may be forced or drawn entirely through the pores and open spaces of the casting.

The material with which castings are thus treated, and which I have above designated as the "dope", may be composed of various elements such as a combination of a prepared calcium carbonate in powdered form, sodium silicate, and lead oxid, commonly called litharge. I have found by careful experimentation that a very good general mixture for the purposes herein specified consists of one ounce of litharge or lead oxid (PbO), one pound of calcium carbonate, or chalk ($CaCO_3$), and one gallon of silicate of soda or sodium silicate. This formula forms a liquid solution that may be easily forced by pressure or drawn by suction into the porous or spongy parts of the casting in a very few moments and that will very quickly set and harden under the action of heat, and that will not shrink, become loosened, or be worked out of the casting into which it has thus been forced or drawn, in the subsequent use of the casting,—whether the casting be used cold or be used hot, or be alternately heated and cooled in use,—and which will not prevent the subsequent machining of the casting or otherwise interfere with the subsequent intended use of such casting.

Another substance or dope which may be used would consist of flowers of sulfur and finely ground metallic iron. After this is forced or drawn into the casting the latter is heated preferably to a dull red heat whereupon the sulfur, the iron powder and the iron of the casting enter into such a chemical combination as no appreciable variation of heat or cold in the ordinary subsequent use of the casting would effect in the slightest.

It will be obvious that different sizes and shapes of castings may require different forms of apparatus to be used in carrying out the process of my invention, and therefore I do not intend to be limited to the apparatus herein illustrated nor to have the illustrated apparatus treated as in any manner restricting the scope of my invention since, manifestly, many details and changes thereof will suggest themselves to the skilled mechanic who undertakes to make use of and to practise my invention for practical purposes. Neither do I desire to be limited in the practice of my invention to the particular degrees of temperature hereinabove stated, as it will be perfectly obvious that the degree of heat and the length of time for which the castings should be subjected to heat will vary with the size and kind of castings treated and also with the character of the dope used. The temperatures above stated are those I have found to be desirable for the instances mentioned. Nor do I desire to be limited, except as hereinafter pointed out in the claim, to the particular elements constituting the filling material or dope which I have hereinabove set forth, or to the proportions herein set forth, as there may be other materials which will combine as do the elements above named, for the purpose of forming a fluid that may be forced into or drawn through the porous castings and which will properly adhere, fuse and unite, either chemically or physically, or both, with the metal of such casting whether of steel, iron, brass, or the like, and accomplish the same results as the particular material or dope described.

I claim as my invention:—

The process of treating porous castings which consists in subjecting the casting to the action of heat at approximately 212 degrees, in then impregnating the porous portion of the casting with a fluid compound or

filling material composed of litharge, calcium carbonate and sodium silicate, and then again subjecting the casting to the action of heat at a temperature sufficient to set said compound in the casting and fuse and unite the same with the metal of the casting.

In testimony, that I, claim the foregoing as my invention I affix my signature in the presence of two witnesses, this 17th day of May, A. D. 1913.

LOUIS J. KIRCHENBAUER.

Witnesses:
GAYLOR C. BROWNE,
A. J. OEHRING.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."