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STAYBOLT PLUG AND METHOD OF MAKING THE SAME

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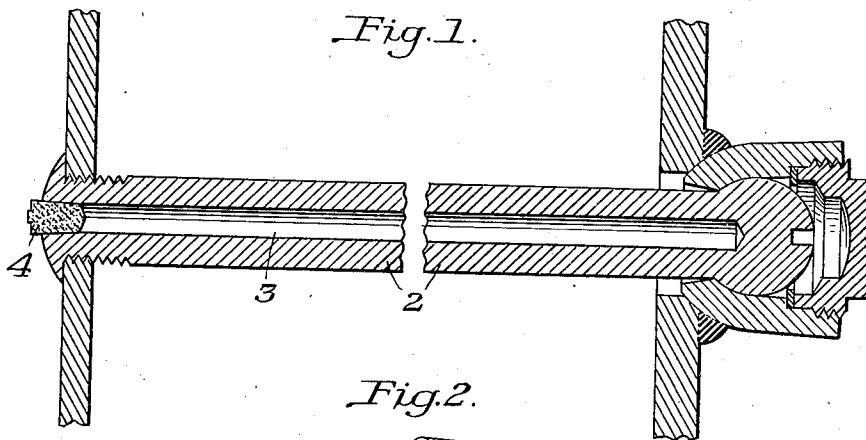
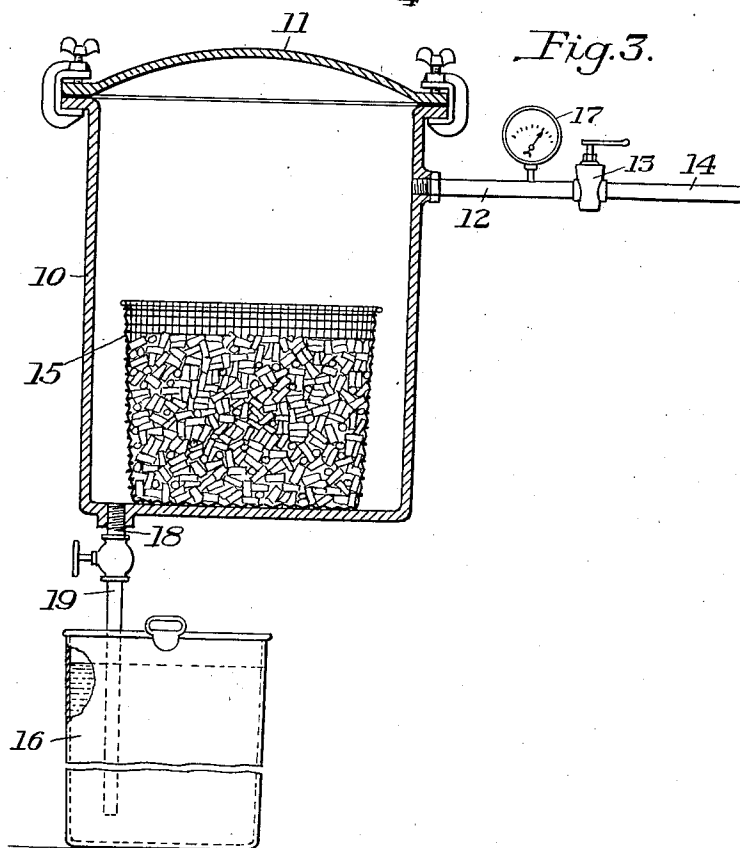


Fig. 2.



Fig. 3.



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STAYBOLT PLUG AND METHOD OF MAKING
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This invention relates to the porous ceramic plugs which are used in the fire box end of staybolts to close the opening in said bolts and to a method of making the same. Porous plugs of the character to which the present invention generally pertains are disclosed in United States Patent No. 1,428,541 dated September 12, 1922, to J. Rogers Flannery, and the present invention constitutes an improvement over the invention disclosed in a prior application of William T. Kilborn and Frederick K. Landgraf, Serial No. 77,186 filed April 30, 1936. In many boiler installations hollow staybolts are used. These so-called hollow staybolts have a longitudinally extending passageway which extends almost but not entirely throughout the length of the bolt, the passageway being open, however, at the fire box end of the bolt. The purpose of the passageway or hole, which is commonly referred to as a tell-tale hole, is for detecting a fracture or break in the staybolt. If the staybolt is fractured, the fracture will open when the boiler is placed under hydrostatic pressure as it periodically is for the purpose of inspection, and the water in the boiler will seep through the fracture and out the tell-tale hole. These bolts are very extensively used in locomotive boilers, and the Interstate Commerce Commission requires that porous plugs be inserted in the fire box end of the tell-tale hole for the purpose of allowing water or steam that might enter the hole through a fracture in the bolt during the operation of the boiler to escape into the fire box and at the same time serve to protect the tell-tale hole from becoming filled with a deposit of ash, flue dust, and rust. The Interstate Commerce Commission further requires that locomotive boilers be periodically subjected to hydrostatic tests and that the porous plugs be removed from the ends of the bolts during such hydrostatic tests. The testing procedure required by the Interstate Commerce Commission also provides that the tell-tale holes in the bolts shall be clean and open throughout their length before the boiler is tested so that the detection of a fracture in a tell-tale bolt will not be avoided by the escape of water being closed off through any accumulation of foreign material in the tell-tale hole.

Several difficulties are encountered in the use of these porous plugs as heretofore manufactured and generally used. They are of a ceramic nature and hence very brittle. At the same time they must be retained in the fire box end of the bolt entirely by friction. This requires that

they be strong enough that they can be driven into the end of a bolt without being crushed or broken when they are hammered into place and yet they must be large enough so as to have a sufficient frictional contact with the walls of the tell-tale hole to retain them in place. As a matter of practice, a great deal of difficulty is encountered because of the continuous vibration that takes place in a boiler which is being operated and also because of the vibration which exists in a locomotive due to its operation. This vibration causes the plugs to fall out into the fire box. The condition is aggravated also by the expansion and contraction that takes place due to changes in temperature.

A second difficulty which is encountered is one that has heretofore been thought to be unavoidable by virtue of the very necessity of having a plug which is porous. This is the fact that as heretofore made small particles of ash and foreign matter sift through the porous plug into the tell-tale hole and under the conditions of operation this foreign material often cements itself into the hole to a point where it is necessary to use a drill to remove it before the bolt can be tested. This infiltration of foreign matter into the tell-tale hole through the porous plug is attributed largely to "breathing" which takes place in the tell-tale hole, especially with the changes of temperature tending to expand or contract the body of air within the tell-tale hole. The choking up of the tell-tale holes is particularly aggravated in that portion of a locomotive fire box most remote from the fire door and in the lower portion of the combustion chamber, these bolts being located just rearwardly of the plate which supports the rear ends of the fire tubes of the boiler. These bolts are in a vertical position with the plug substantially flush with the bottom of the interior of the fire box. Soot and dust naturally deposit in this part of the fire box and steam blowers are provided for periodically blowing out the soot and ash dust which accumulates at this point and in the fire tubes. Condensation of steam always takes place in this blowing apparatus when it is not in use so that when the blower is first turned on, water is discharged. This water mixes with the soot and ash, is sucked or seeps through the porous plug carrying with it foreign material. It serves to cement foreign material which has previously entered the tell-tale hole and it is evaporated leaving a further deposit of the foreign material which is washed into the hole with the result that there is often found in the staybolts

located in this particular part of the boiler a dense compaction of foreign materials that has to be drilled out.

The present invention has for its purpose to provide a porous plug which will meet the requirements of the Interstate Commerce Commission and yet which will practically prevent foreign material from entering the tell-tale hole through the plug and which will provide a plug that will remain in the hole much better than plugs heretofore provided for the purpose. It has heretofore been considered necessary for the plugs in order to have sufficient porosity, to be formed of granular material, all particles of which are about the same mesh. Heretofore it has been common to make the plugs of a material in which all of the particles are between 80 and 90 mesh. With the present invention, the material employed is not graded to eliminate the fines, and furthermore the largest grain size is very substantially less than any heretofore employed. I may use a maximum grain size of 150 mesh, but I prefer that the maximum grain size shall not exceed 240 meshes to the inch. The basic mixture contains particles from 240 grains down to powder. After a ceramic mix has been prepared from particles of the grain size above mentioned, the plugs are formed into rods from it. The usual method is to make the material in rod-like form, fire the rods and cut the rods into pieces which are then ground to tapered form. When the plugs are otherwise completed they are placed in a vacuum chamber and subjected to a relatively high degree of vacuum which removes most of the air from the porous mass and while still in a vacuum chamber they are immersed in a material such as water glass which penetrates the porous mass. The plugs are then removed from the vacuum chamber and baked and then treated with an acid which tends to render the water glass more resistant to dissolution in water. The resulting plug has a porosity adequate to meet the requirements of the Interstate Commerce Commission and to enable water to seep therethrough, but the pore spaces are very much finer than in plugs of the type presently being used. In other words, an adequate pore area exists, but the individual cells or spaces are very much smaller. The plugs, therefore, more effectively filter the air stream so that solid materials of the character which have heretofore caused difficulty cannot get into the tell-tale hole and water which is carrying solid material will be filtered. Moreover, the water which is present when the blow-out jets are turned on will flow through the porous plugs less rapidly; therefore most of it will be evaporated before it gets to the interior of the bolt. On the other hand, water which has leaked into the tell-tale hole from a fracture in the bolt will be readily forced through the plug by the pressure within the boiler.

My invention may be more readily understood by reference to the accompanying drawing in which

Figure 1 illustrates a tell-tale bolt having a porous plug therein;

Figure 2 is a detailed view of the plug; and

Figure 3 is a more or less schematic view of an apparatus for treating the plugs.

Referring first to Figure 1, 2 represents a typical hollow staybolt joining two boiler plates. It is provided with a tell-tale hole 3 and the porous plug 4 embodying the present invention has a driven fit in the end of the tell-tale hole.

The porous plug 4 embodying the present in-

vention is in the form of a truncated cone having a very slight taper. It is of a ceramic nature of bonded granular material. The coarsest grain size is preferably considerably smaller than 150 meshes per square inch and preferably is of a screen mesh of the order of 240. From a maximum grain size of 240 mesh the material contains varying grain sizes down to and including the extreme fines. The porous interstices of the plug are further restricted by having deposited in situ therein a dried substance in the pores after the article has been otherwise formed and completed. This dried material is preferably in the nature of a silicate such as sodium silicate or potassium silicate or a combination of these two silicates which has been treated to render the same less soluble in water.

In preparing the porous plugs, a ceramic mix is prepared in the usual way except that extremely fine mesh material which is ungraded except to eliminate particles over 240 mesh size is prepared, molded into rods, and fired. The porous plugs are then formed from the rods by grinding, subjected to treatment to remove air from the pores thereof and after the entrapped air has been removed, the plugs are immersed in a silicate solution or like liquid filling material and then dried by baking.

One method of treating the plugs is disclosed in Figure 3 wherein 10 designates a receptacle having a removable cover 11 which can be sealed thereon to form an air-tight seal. Leading from the receptacle 10 is a pipe 12 having a two-way valve 13 therein. Leading from one passage of the valve 13 is a pipe 14 connected to a vacuum pump, not shown. The arrangement is such that when the valve 13 is turned in one direction the interior of the container 10 will be in communication with a vacuum pump, and when the valve 13 is turned to another position, atmospheric air may be admitted to the receptacle. Within the receptacle 10 is a wire basket 15 into which several thousand of the plugs 4 are charged at a time. At 16 is an open receptacle that is adapted to hold a solution of sodium silicate or water glass or like treating material. At 18 is indicated a pipe having a valve 19 therein leading from the bottom of the vessel 10 into the receptacle 16 and terminating well below the top of the normal liquid level therein.

In using the apparatus shown in Fig. 3, several hundred or several thousand of the formed plugs 4 are placed in the basket 15 which is then placed in the receptacle 10 and the cover 11 is clamped on. With valve 19 closed, valve 13 is operated to evacuate the interior of the receptacle. This causes the air or most of the air trapped within the porous plugs 4 to be evacuated. After a desired degree of vacuum has been reached in the receptacle 10 as indicated for example by a gauge 17, valve 19 is opened allowing liquid solution in the reservoir 16 to flow under atmospheric pressure up the pipe 18 into the receptacle 10 and immerse the porous plugs. Since the air has been removed from the porous plugs, the solution will rapidly and thoroughly permeate the porous interiors of the plugs. After the plugs have thus been immersed, valve 13 is operated to allow air to enter the receptacle and the liquid to drain back through pipe 18 to receptacle 16. When the vacuum in the vessel 10 has been relieved, the cover 11 may be removed. After the excess liquid has drained out of the vessel, the basket 15 may be removed after which the plugs are emptied into a baking

apparatus of any suitable kind and heated and baked until thoroughly dry. A typical baking apparatus for accomplishing this operation may be a rotary drum in which there is a gas burner and in which the articles are tumbled as the drum is rotated, the tumbling of the plugs preventing their sticking together.

After the plugs have been dried, they may be immersed in a weak solution of an acid such as sulphuric acid which is capable of rendering the water glass resistant to dissolution by water. The step of immersing the articles in the treating bath after they have been evacuated is an important step in securing substantially uniform porosity in the articles and uniform porosity between the same articles of a bath. If the air were not first removed from the pores, the treating solution would not penetrate to a uniform depth in different parts of the same article or to a uniform depth in different articles. By evacuating the plugs the silicate solution or other treating solution is enabled to penetrate freely through the mass of the plugs. When this silicate dries, it of course shrinks in volume so as to leave the article still porous but with the individual pore spaces or interstices more restricted than they were in the article before treatment. Moreover, the film of silicate which dries on the exterior of the plugs tends to fill in the small spaces between the grains on the exterior of the plug and thereby increase the area for frictional contact between the surface of the plug and the bore of the bolt into which the plug is driven. Vibration tests on plugs made in accordance with the present invention show that under severe conditions of vibration the plugs will remain in the bolt holes. The superior ability of these plugs to remain in the bolts is due not only to the increase in the frictional area provided by the added film of sodium silicate, but also by the use of small size grains. Where the plug is made of coarse grains as has heretofore been the practice, relatively few edges of outstanding grains on the surface of the plug contact with the metal to hold the plug in place. By using smaller grains and by using grains which are not graded as to grain size, more grains contact with the surface of the metal and more edges are provided to frictionally engage the metal, and the area for frictional contact with the metal is very enormously increased.

An important advantage of the present invention is the accurate control over the porosity which the invention secures. The ceramic mixture assures a uniform porosity in the plugs, the presence of fines in the mixture avoiding the formation of pores or fissures of appreciable size. Then, by varying the gravity or viscosity or concentration of the water glass and water mixture, any desired reduction of porosity down to practically none is obtainable. I can thereby choose a viscosity which will give an optimum porosity for the purpose; that is, one which will have the pores just sufficiently large to allow steam generated under pressure to issue through the pores and no greater.

While the plugs made in accordance with the present invention have an adequate degree of porosity to meet all of the requirements of the Interstate Commerce Commission for porous plugs, the individual pores in a plug are very much smaller and therefore the plugs more effectively prevent the passage of foreign substances through them. Extensive tests have shown that the interior of the bolts will remain

clean for a vastly longer time than where the old forms of plugs were used and that the necessity for drilling out the holes prior to testing has been eliminated through the use of plugs made in accordance with the present invention. The slight amount of fine material that does get through is readily dissipated by blowing a current of air under pressure into the tell-tale holes.

In place of using water glass as the treating solution it is contemplated that various kinds of glazing substance may be used, for example, the plugs may be immersed in a concentrated salt solution and then dried and fired or baked to glaze the salt inside the plugs. This is merely typical of one type of glazing solution other than water glass. It will also be understood that the apparatus for carrying out my invention may be variously constructed and modified and that the invention is not limited to the particular apparatus shown and described.

I claim as my invention:

1. A porous plug for staybolts comprising a porous ceramic body having an applied filling material permeating the same throughout the mass thereof and partially and materially restricting the natural pore spaces within the body.
2. A porous plug for staybolts comprising a porous ceramic body having the original pore spaces therein partly and materially restricted throughout the entire mass of the body by a dry deposit of water glass permeating throughout the mass of the ceramic body.
3. A porous plug for staybolts comprising a porous ceramic body having dried water glass deposited in situ in the pore spaces thereof throughout the body in an amount sufficient to substantially reduce the porosity thereof and to a controlled degree.
4. A porous plug for staybolts comprising a porous ceramic body having dried water glass deposited in situ in the pore spaces thereof throughout the body in an amount sufficient to substantially reduce the porosity thereof, the water glass having been rendered resistant to water.
5. A porous plug comprised of ceramic particles ranging from not larger than 150 mesh down to fines and having deposited material in the pores throughout its mass for restricting the porosity thereof and having such material on the surface thereof for increasing the effective friction surface thereof whereby the plug is more effectively retained in the hole of the staybolt into which it is driven.
6. A porous plug comprised of ceramic particles ranging from a maximum not substantially exceeding 240 mesh and finer having deposited therein throughout the mass thereof a material which restricts the natural pore space of the ceramic body, said material also being on the surface of the plug.
7. The method of preparing porous plugs for use in staybolts which comprises forming the plugs from a granular ceramic mass containing coarse and fine particles wherein the coarsest particles are of a mesh not substantially exceeding 240 and wherein the other particles range from 240 mesh down, evacuating the entrapped air from the plugs so formed and while the plugs are under vacuum, immersing them in a water glass solution whereby the water glass thoroughly penetrates the same and thereafter drying the plugs in the air so that the plugs have a controlled porosity.
8. The method of preparing porous plugs for

use in staybolts which comprises evacuating air from porous ceramic plugs, immersing them in a salt solution while they are evacuated for sufficient time that the solution will thoroughly penetrate the same under conditions which will force the solution into the pore spaces of the article, and thereafter drying the plugs and baking them to glaze the salt which has been deposited in the pore spaces thereof, the solution being of a density sufficient upon the evaporation of the solvent to form a deposit capable of materially diminishing the porosity of the ceramic.

9. A ceramic plug for closing the tell-tale hole of a staybolt and having a substantially predetermined porosity characterized by having a highly uniform pore distribution therethrough obtained from the use of ceramic particles of selected size and in which the pores throughout the mass are restricted to a controlled and predetermined extent through the replacement of air in the pores with a water glass deposit.

10. The method of making porous plugs for use in staybolts which comprises forming the

plugs from a ceramic mass prepared from varying grain sizes selected to produce a relatively dense mass with minute portions substantially uniformly distributed therethrough, removing air from the pores of the plug and replacing it with a viscous water glass solution of a high gravity to insure the introduction into the internal pore spaces of a solid equivalent of silicate sufficient to materially alter the original porosity of the article, and then drying the water glass to deposit the silicate in the pore spaces as a solid.

11. A porous ceramic plug of the class described, characterized by having the pore spaces thereof of closely uniform size and uniformly distributed throughout the ceramic mass, such pore structure obtaining from the selection of the grain sizes of the particles from which the ceramic is formed, said body having pore spaces throughout the mass thereof partially filled to a predetermined extent with a foreign deposit to controllably reduce the permeability of the mass.

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