

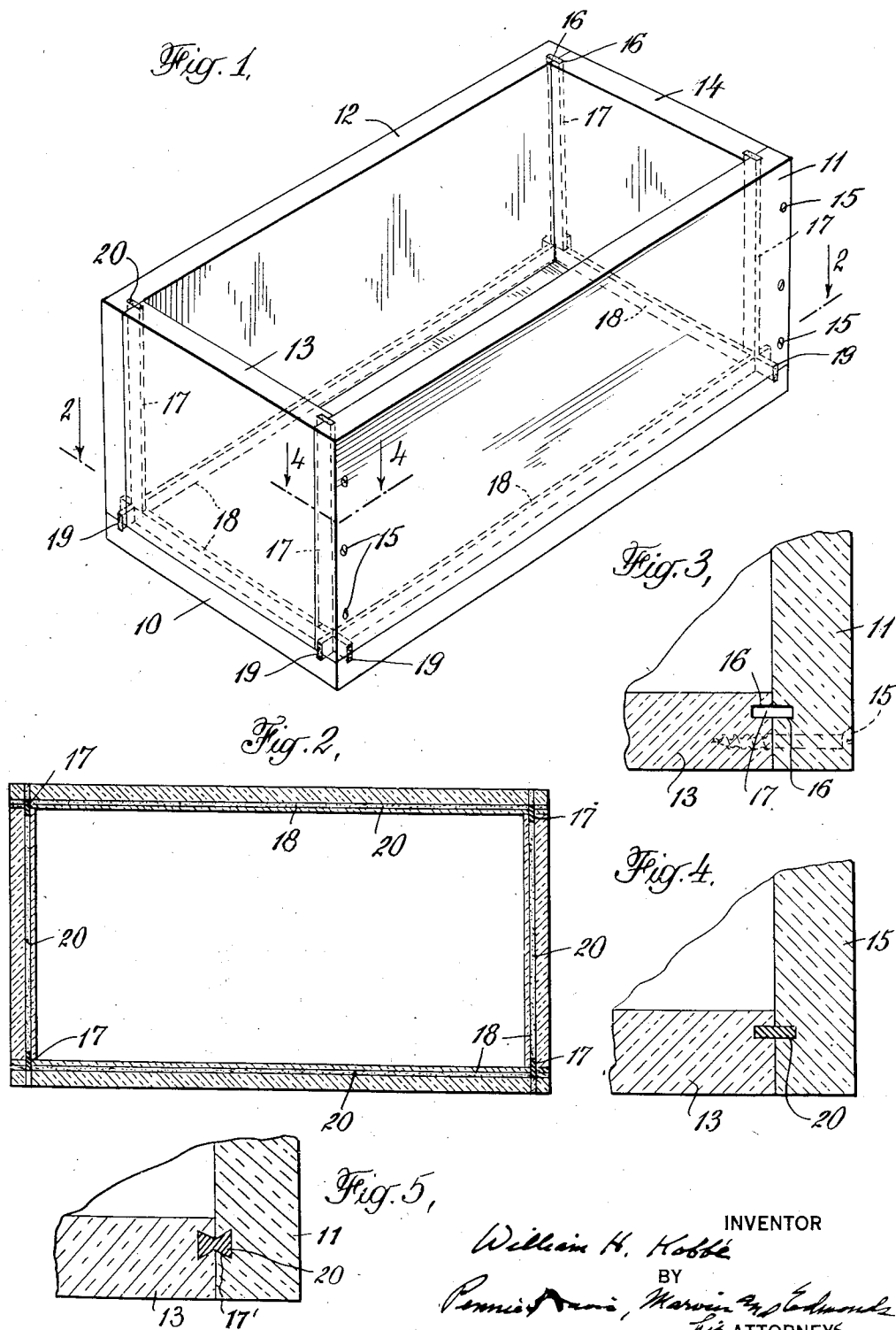
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CONTAINER MADE OF SULPHUR

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CONTAINER MADE OF SULPHUR.

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This invention relates to containers, and its object is to provide an improved container for acids or other corrosive liquids and an improved method for making a container of this character. The invention more particularly appertains to the construction of a container which is composed largely of sulphur.

The construction of a container by molding or casting sulphur, or sulphur compositions consisting of various proportions of sulphur and filling materials, is attended with difficulties on account of the shrinkage which takes place during cooling. This shrinkage or contraction may cause voids within the mass, or cracking of the solidified material, or both which weakens the container or causes it to leak.

Containers may be successfully made by impregnating with sulphur a previously formed body of porous material such as a molded wood pulp receptacle, but these molded wood pulp receptacles are difficult to obtain in large sizes. The cost of molding the wood pulp is high and the cost of impregnation with sulphur is also excessive as special molds and other apparatus are required for carrying out these processes.

Containers may also be made by assembling slabs of sulphur or sulphur compositions, or of sulphur impregnated porous materials, such as sulphur impregnated wood pulp boards, or boards of wood, and sulphur impregnated blocks of concrete or sandstone. It is difficult, however, to secure these elements together so that they will be strong mechanically and it is particularly difficult to provide liquid-tight joints between the contiguous surfaces of the elements. The contiguous surfaces may be calked with twine or other fibrous material or may be separated by gaskets of similar material or with metallic wire or strips of lead. But joints packed in this manner are apt to leak, from the unequal rate of expansion of the packing material and the material of the assembled elements of the tank, or from other causes, and are generally unsatisfactory.

By the present invention I have provided a corrosion-resisting container which is capable of being constructed in extremely large as well as in extremely small sizes and have overcome the objectionable features at-

tendant upon the shrinkage of sulphur in casting as well as the objectionable features of the container made by impregnating a previously molded body of porous material. The improved container of the invention will not leak and possesses great strength without being brittle and moreover possesses all of the corrosion-resisting qualities of sulphur and is not affected by sudden changes in temperature.

In accordance with the present invention the container is assembled of elements composed largely of sulphur, and having a continuous spline joining the contiguous surfaces of these elements. The elements preferably comprise wood pulp board which are fabricated or assembled together to form a container of the shape desired, these boards, prior to assembly having slots cut in their surfaces which are contiguous in the assembled container, these slots in the contiguous surfaces registering with one another and forming a plurality of passage-ways within the walls of the container which are all interconnected with one another. After the pulp boards have been assembled in this manner, the container is impregnated by immersion in a bath of molten sulphur and then allowed to cool so that the sulphur congeals within the pores of the pulp board. Any sulphur which enters the passage-ways formed by the registering slots is allowed to flow out before it congeals so as to leave the passage-ways throughout the entire structure entirely free and unobstructed.

After the impregnated container has cooled, the passage-ways formed by the registering grooves are filled with the material which makes a bond with the sulphur of the container, and which has a coefficient expansion comparable to that of sulphur, thereby forming a spline joining the contiguous surfaces of the assembled elements and forming a liquid-tight joint throughout all of these surfaces. The passage-ways are preferably filled with molten sulphur which readily bonds with the sulphur of the assembled elements of the container and which expands and contracts with the material of the container walls. The molten sulphur is introduced into the passage-ways at a temperature sufficiently above the melting point of sulphur to allow all of the passageways to be filled with the molten sulphur before the

flow of sulphur therein is stopped by the congealing of the sulphur so that all of the spline-ways or channels shall be completely filled.

6 The method of making the container forms the subject matter of my copending application Serial No. 19,943, filed Apr. 1, 1925.

Although I prefer to employ pulp boards as the porous material or vehicle for the sulphur, other porous material, such for example as wood may be employed. Moreover, these elements may be impregnated with molten sulphur prior to assembling if it is desired, or the container may be assembled of elements or slabs of sulphur impregnated sandstone or concrete or other similar material. Also powdered or granular material such as sand or other inert filler may be placed in a mold of suitable shape to form an element for use in constructing the container, the powdered material being shaken down until it occupies the minimum possible space so as to produce a fixed mass of particles which is not subject to appreciable further compression. This mass may then be impregnated with molten sulphur so as, upon the congealing of the sulphur, to form a slab of material composed largely of sulphur.

30 By filling the interconnecting passageways above referred to with sulphur or other appropriate spline material, a single unitary spline is formed which joins all of the contiguous surfaces between the elements of the entire container. This produces an effective liquid-tight joint between the surfaces of the container elements and produces a container which will hold even the thinnest of liquids without leakage.

40 The invention will be better understood by referring to the accompanying drawings illustrating by way of example one embodiment of the invention. In these drawings,

45 Fig. 1 is a perspective view of a rectangular box-like container illustrating the unitary spline which is continuous throughout the walls of the container.

Fig. 2 is a horizontal section taken on the plane indicated by line 2—2 of Fig. 1 and which is just at the upper surface of the bottom splines.

50 Figs. 3 and 4 are enlarged sectional views of a corner of the container taken on the plane indicated by the line 4—4 of Fig. 2.

55 Fig. 3 shows the passageway formed by a pair of registering slots.

Fig. 4 shows this passageway filled with material to form the spline, and

60 Fig. 5 shows a passageway of modified shape filled with sulphur.

Referring now to these drawings, the container shown in Fig. 1 comprises a bottom 10, front and rear sides 11 and 12 respectively and left and right end pieces 13 and 14 respectively. These members or elements

may be mechanically fastened together by any appropriate means which will afford the mechanical strength desired and as shown in Fig. 1, screws 15 have been used.

In the preferred form of the invention 70 these members of the container consist of boards of wood pulp or other fibrous or porous material. A wood pulp board which is available in the market is known as agasote, this board being made of a sulfite or chemical wood pulp. Boards made of vegetable or mineral fibers may also be used. 75

Prior to the assembly of these members as shown in Fig. 1, slots 16 are cut by means of a saw, or otherwise formed, in the members 10 to 14 respectively, these slots being placed in the edges or surfaces of the members which are in contact with one another when the members are assembled to form the container. The slots are disposed in a different plane from the screws 15 and preferably inwardly of these screws for a purpose that will hereinafter appear. The grooves 16 are also placed in the respective members so that when the members are assembled, 80 pairs of these grooves will register with one another to form rectangular channels or spline-ways. Vertical spline-ways 17 are formed at each of the four corners of the container and horizontal spline-ways 18 extend along the bottom sides and across the ends of the container. Each of the vertical spline-ways 17 is so positioned as to communicate with the horizontal spline-ways 18 at the bottom of the tank or other receptacle 85 as may be clearly seen from Fig. 2.

After the elements or members 10 to 15 respectively have been grooved or slotted as just described, they are assembled into the container shown in Fig. 1 and then secured 105 together by means of the screws 15 or other appropriate fastening means. The entire container is then submerged in a bath of molten sulphur, preferably at a temperature slightly above the melting point of sulphur at which temperature sulphur exists as a relatively thin mobile liquid. After submersion in this sulphur bath for a sufficient length of time for the pores of the members to be completely filled with sulphur, the receptacle is removed from the bath while the bath is still hot and any sulphur which may have occupied the channels or spline-ways 17 and 18 during submersion is allowed to completely drain out from the ends of 120 the several channels.

After the sulphur from the bath has drained out of these channels the container is allowed to cool and when using wood pulp board or material of a similar porosity, it 125 will be found to now contain in the neighborhood of 80% by weight of sulphur. The amount of sulphur which will be absorbed during the impregnation process depends upon the nature of the vehicle or porous or 130

fibrous material used as the foundation, but after impregnation the container will be composed largely of sulphur.

The specific gravity of liquid sulphur at the melting point is 1.81. When this sulphur passes into the solid monoclinic form its specific gravity becomes 1.96 and when it passes through this transition stage to the stable rhombic form a further increase in density occurs and the specific gravity rises to 2.07. Thus, sulphur contracts to a marked degree upon solidifying and to this physical characteristic I am inclined to attribute its tremendous binding qualities when impregnated in liquid form into any porous material and allowed to congeal or crystallize in the pores thereof. In other words, a piece of sandstone fully impregnated with molten sulphur has all of its interstices and voids filled with sulphur, which, upon cooling, contracts and binds the mass together with the forces exerted by the process of crystallization. These interstices and voids are interconnecting and the contained sulphur when shrinking exerts a bonding or pulling effect in all directions. This probably explains the great strength imparted to various materials by impregnation with sulphur, such, for example, as diatomaceous earth, sandstone, concrete, wood pulp, various paper products and in fact any and all materials into which molten sulphur may be forced. This increase in strength is about three times in the case of sandstone and from 5 to 10 times in the case of concrete, the extraordinary increase in strength of the latter probably being explained by the occurrence of some chemical action in addition to the physical effect above described.

This shrinkage of sulphur which so modifies the characteristics of an impregnated material renders difficult the construction of containers made of sulphur in its pure state or simply admixed with inert fillers. This distinction becomes apparent in the following example: If a quantity of sand, talc, graphite or other filler is gradually added to a quantity of molten sulphur, each individual particle and grain of the filler is coated and surrounded by sulphur. The resultant mass after solidifying acts very much as does pure sulphur in that contraction takes place without hindrance and is compensated for by the formation of voids, their distribution depending very largely upon the way in which solidification has proceeded. The voids usually occur in any portion of a mass which solidifies last. Hence when the mass cools quickly from the exterior surfaces inwardly the voids occur near the center.

On the other hand, if this same quantity of sand or other inert filler is placed in a glass or other container or mold and shaken until it occupies the minimum possible space,

each particle or grain thereof is in contact with other particles. A stabilized and fixed mass of particles is produced which is not subject to further compression or distortion irrespective of the amount of the compressive force applied. If this mass is now impregnated with molten sulphur, I have discovered that a very different product results from that produced by simply admixing this same number of particles with the same quantity of sulphur as described in the preceding paragraph. When impregnated, such a stabilized mass of particles has all of its voids and interstices filled with molten sulphur which, upon contracting during the process of congealing, finds an unyielding foundation. The forces of crystallization serve to bind and hold the particles of this foundation in close contact with one another. I am unable to state whether actual shrinkage is thus prevented or the resulting voids, if any, are so minute and widely and evenly distributed that they are not noticeable.

With this explanation in mind, it will be understood that this very quality of sulphur which imparts a stone-like character to wood pulp board upon impregnation therewith, exerts exactly the opposite tendency on the joints in a fabricated tank or other vessel made from such boards. Even though the fabricated tank above described is mechanically tight before submerging it in the molten sulphur bath, the shrinkage of the sides, ends and bottom when the sulphur crystallizes will cause the tank to leak unless the screws are taken up while the tank is hot to compensate for such shrinkage. This procedure is, however, unreliable and at best a mere expedient. By splining the joints of the fabricated tank in accordance with one of the features of the present invention, this difficulty is however entirely obviated.

In order to form these splined joints between the various members of the container shown in Fig. 1, the channels or spline-ways 17 and 18 are completely filled with a material which makes a bond with the sulphur of the walls of the container 10 to 14 inclusive. Any fluid may be used as the spline material which is capable of solidifying after solidification, and which has a coefficient of thermal expansion which is comparable to that of sulphur. Thus, low melting point metallic alloys, rubber, rubber substitutes, phenolitic condensation products, asphalt, ozokerite, mineral wax, various gums and resins, and argillaceous and calcareous cements may be used. I find, however, that sulphur itself is preferable as a spline material.

It is important that the spline material be carefully introduced into spline-ways so that a continuous or unitary spline is produced. Hence, in order to introduce sulphur

into the spline-ways 17 and 18 the end openings 19 of the lower channels 18 are closed in any appropriate manner so as to prevent the flow of molten sulphur therefrom. Also the contacting surfaces of joints of the bottom, sides and ends of the container may be temporarily calked with twine or sulphur cement in order to prevent the leakage of small quantities of sulphur from the channels between these contiguous surfaces. A supply of molten sulphur is now provided at a comparatively elevated temperature above the melting point of sulphur, say at a temperature in the neighborhood of 140 or 150° C. This hot molten sulphur is now allowed to flow into the open top of one of the vertical spline-ways 17 through a tube leading directly from the supply of hot sulphur, this tube having been previously heated so as to cool the sulphur as little as possible as it flows therethrough. Another way of introducing the molten sulphur is to employ a small funnel and convey the molten sulphur from the hot supply to the funnel in a closed transfer vessel having a spout. In this case, however, both the funnel and the closed transfer vessel should be previously heated to avoid chilling the hot sulphur.

This hot sulphur flows to the bottom of the upright channel 17 through which it is introduced thence into the two adjacent horizontal spline-ways 18 through which it flows to the other horizontal spline-ways 18 connected thereto and the remaining vertical spline-ways 17. Because of the fact that the molten sulphur is at such an elevated temperature and because the spline-ways themselves are generous in cross section, the molten sulphur completely fills all of the horizontal spline-ways 18, then rises in the vertical spline-ways 17, thus entirely filling the entire spline-way structure before the congealing of the sulphur in any portion of these passageways cuts off its flow. However, because of the fact that the container has been allowed to cool at least to room temperature after its impregnation, the relatively cool walls of the spline-ways cause the hot sulphur introduced therein to be chilled and to congeal on the exterior of the surfaces of the splines before solidifying at their centers. Thus the cores of the splines remain soft until all of the passageways have been completely filled and the contraction which takes place by the increase in density of the sulphur splines upon their crystallization is taken up by the formation of voids at the cores of the splines. Their exterior surfaces which have become to a certain extent bonded with the sulphur of the container by the softening thereof due to the heating of the sulphur and the splines are not contracted or shrunk by the solidification so as to break this bond.

The sulphur which has thus been intro-

duced into the spline-ways 17 and 18 is indicated at 20 and it will be seen that on account of the fact that all of the spline-ways are interconnected and because of the formation of these splines at a single pouring of the liquid spline material, a unitary and continuous spline for the joints of all of the contacting or contiguous surfaces of the side, bottom and ends of the container is provided. While a spline of rectangular shape is easy to construct, the cross sectional form of the spline may vary considerably. Thus it may be circular or square or it may be of a form adapted to aid in mechanically fastening the members of the vessel together. Such a spline is illustrated in Fig. 5 where two undercut slots have been made in the assembled members so as to form a double dove-tailed channel 17' which, when filled with sulphur 20 forms a spline of similar shape.

If desired, instead of completely fabricating the container before impregnation, the individual elements may be shaped and the spline slots formed therein and impregnated with sulphur prior to assembly. While the stone-like character of the impregnated elements renders it more difficult to mechanically fasten them together in constructing the tank, this method of making the tank is desirable when constructing tanks of extreme size. Relatively small individual members may be more easily and cheaply impregnated than a large assembled tank structure. These individual members may be conveniently shipped to the place where the tank is to be set up and there assembled.

The confining of a mass of sand or other inert filler in a suitable mold and shaking down the particles so as to produce a stabilized fixed mass, and impregnating this mass with sulphur was mentioned above. The members of the tank structure may be made in this manner, including the molding of the spline-ways if it is so desired and the term "element" as used in the appended claims is intended to include such a structure.

Containers which have two or more joints coming together at an angle to one another, such, for example, as the three joints each at a right angle to each other at the corner of a rectangular tank, can be easily constructed by following the principles of the invention. Ordinarily such joints are difficult to make tight because of the necessary joints in the calking strips or other packing material employed. With the unitary spline structure of the present invention, however, the packing is continuous and there is no opportunity for leakage.

Many containers made in accordance with the principles of the present invention have been subjected to leakage tests by filling with water and allowing them to stand for days and even weeks without showing a

trace of leakage. The improved container of the invention has many and varied uses because of its great strength and resistance to shock and mechanical injury and on account of its corrosion resisting properties. The following are some of the uses to which containers made in accordance with the principles of the invention may be put: forming tanks for the manufacture of storage battery plates; electrolytic cells for use in metallurgical, mining and electroplating fields; pickling tanks for the steel, galvanizing and tinning industries; acid dip tanks in the metal working trades; laundry tubs (in place of soapstone); window boxes and other containers for growing plants; burial boxes and other mortuary appurtenances; beehives; septic tanks in sewage disposal installations; drainboards; sinks; flush tanks; hydrochloric acid towers; acid storage tanks; dye vats; fermentation tanks; refrigerator cars and refrigerator construction; poultry houses and similar structures; troughs for the conveyance of acids; acid carboys; swimming pools; and insect and rodent proof storage bins.

I claim:

1. A container comprising assembled elements composed largely of sulphur, and having a continuous spline joining all adjacent contiguous surfaces of the elements thereof.

2. A container comprising assembled elements composed largely of sulphur, and having a unitary spline structure joining all the contiguous surfaces of the elements thereof.

3. A container fabricated from elements of porous material impregnated with sulphur, and having a continuous spline joining all adjacent contiguous surfaces of the elements thereof.

4. A container fabricated from elements of porous material impregnated with sulphur, and having a unitary spline structure joining all of the contiguous surfaces of the elements thereof.

5. A container fabricated from pulp boards impregnated with sulphur, and having a continuous spline joining all adjacent contiguous surfaces of the boards.

6. A container fabricated from pulp boards impregnated with sulphur, and having a unitary spline structure joining all of the contiguous surfaces of the boards.

7. A container fabricated from elements of porous material impregnated with sulphur, and having a spline joining all contiguous surfaces of the elements thereof, said spline being formed of a material which makes a bond with the surfaces of the elements in contact therewith.

8. A container fabricated from elements of porous material impregnated with sulphur, and having a spline joining all contiguous surfaces of the elements, said spline being formed of a molten material which upon congealing makes a bond with the surfaces of the elements in contact therewith.

9. A container fabricated from pulp boards impregnated with sulphur, and having a sulphur spline joining all of the contiguous surfaces of said boards.

10. An article comprising assembled structural members having a continuous spline comprising a solidified liquid sulphur material which makes a bond with the material of the structural members joining the contiguous surfaces of said members.

11. An article comprising a plurality of assembled members having a plurality of joints therebetween at an angle to one another, and a continuous spline of sulphur crossing the planes of said joints and forming a single unitary spline structure therefor.

12. A container comprising assembled members having a plurality of contiguous surfaces and a continuous spline of sulphur joining said surfaces and forming a single unitary spline structure for the whole container.

13. A container comprising assembled members having a plurality of contiguous surfaces forming joints at an angle with one another, and a continuous spline of sulphur crossing the planes of said joints and forming a single unitary spline structure for the whole container.

In testimony whereof I affix my signature.

WILLIAM HOFFMAN KOBBE.