

G. J. MURDOCK.
SELF SEALING FUEL TANK.
APPLICATION FILED JUNE 23, 1917.

1,312,745.

Patented Aug. 12, 1919.

Fig. 1

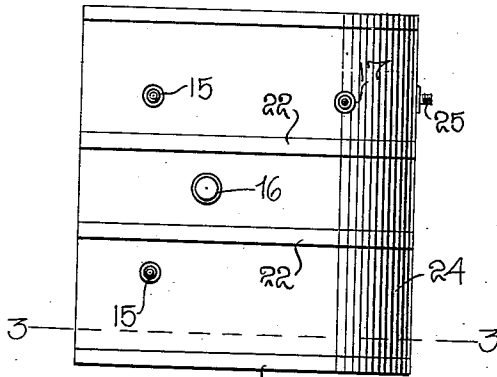


Fig. 2

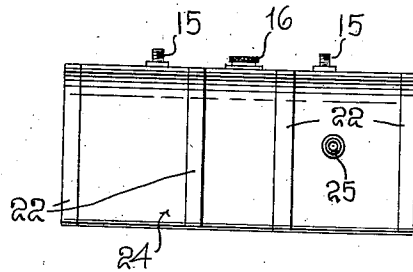


Fig. 3

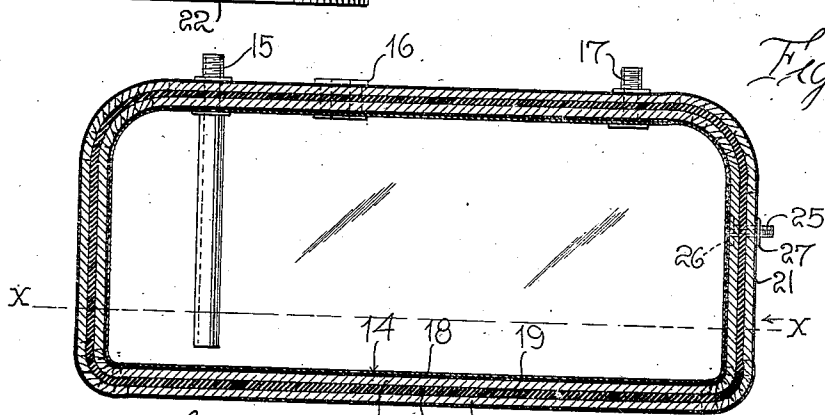


Fig. 4

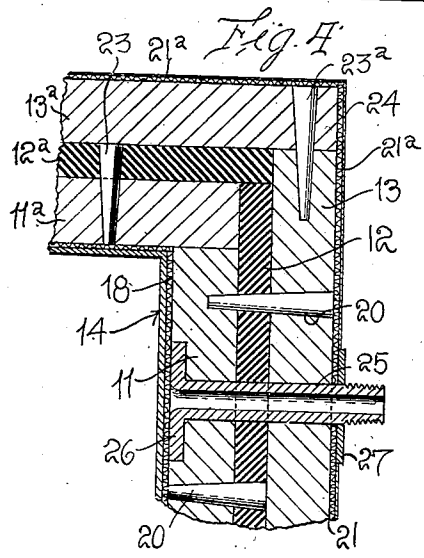
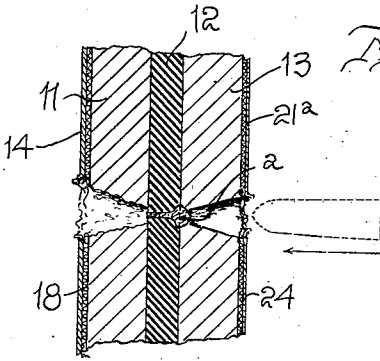


Fig. 5



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SELF-SEALING FUEL-TANK.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, GEORGE J. MURDOCK, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Self-Sealing Fuel-Tanks, of which the following is a specification, reference being had to the accompanying drawings.

10 This invention relates to tanks, and particularly to tanks for containing gasoline, such as are used in military automobiles, military tractors and on aeroplanes.

15 The general object of the invention is to provide a self sealing tank, that is, a tank wherein a puncture produced by a bullet passing through the wall of the tank will immediately become sealed to prevent the leakage of gasoline therefrom.

20 In all gasoline or other fuel tanks of the character above stated, known to me, a bullet passing through the tanks allows the gasoline to escape and where a pressure tank is in use, that is, a tank having a forced feed due to air pressure, several bullet holes will quickly empty the tank. Furthermore, the escaping gasoline runs out onto the aeroplane or other structure and is frequently set on fire by the engine exhaust, the firing of machine guns, or by other flame.

30 A further object of the invention is to provide a tank free from the defect above noted, which shall be light in weight and in which the punctures made by a bullet will close or become plugged to such an extent that an aviator may at least get back to his lines, after having been fired upon and having had his gasoline tank punctured.

40 A further object is to provide a tank surrounded by a sheet of rubber or other elastic and relatively thick material, and to provide a sheet or layer of relatively brittle and easily comminuted material disposed upon the sheet of rubber, this material being of such character that a bullet striking it and passing through it and through the sheet of rubber will pulverize the material of the relatively brittle layer and by reason of the vacuum caused by the passage of the bullet will draw this comminuted or pulverized material into the relatively small opening made by the bullet in its passage through the rubber layer.

50 A further object of the invention is to provide a metallic gasoline container with a protective covering, consisting of one or

more layers of wood, preferably light in weight and relatively stiff and brittle, with an intermediate layer of rubber or like elastic material, which will expand to the passage of the bullet, but will immediately contract so that only a small opening is left through the rubber.

And a further object is to provide means for preventing the splitting of the wooden layers.

Other objects will appear in the course of the following description.

My invention is illustrated in the accompanying drawings, wherein:—

70 Figure 1 is a top plan view of a tank constructed in accordance with my invention;

Fig. 2 is a side elevation thereof;

Fig. 3 is a sectional view on the line 3—3 of Fig. 1;

75 Fig. 4 is an enlarged detail horizontal section of one corner of the tank;

Fig. 5 is a fragmentary horizontal section showing the manner in which a hole in the tank is automatically plugged.

80 Referring now particularly to Fig. 5, which shows a fragmentary sectional view through the wall of a container, 14 designates an inner casing of sheet metal, which forms the container proper. Disposed against this casing 14 in Fig. 5 is illustrated a layer 11 of wood, preferably white wood, for a reason which will be later stated, and illustrated as disposed against this layer of white wood is a layer 12 of rubber, this rubber being approximately $\frac{1}{4}$ " thick. Disposed against the rubber layer 12 is a second layer of wood 13, which is preferably white wood. The rubber is placed between the boards or wooden layers 13 and firmly glued or cemented thereto. If a bullet is now fired from a rifle in the manner indicated in this figure, the point of the bullet striking the layer 13 pierces this wooden layer and breaks up and comminutes or pulverizes the fibers of the wood 13 and passes through the rubber layer 12. This rubber layer expands, because of its elasticity, to permit the passage of the bullet and then the bullet passes on through the layer 11. The opening through the rubber layer closes almost immediately and the exit end of this opening is extremely small in comparison with the size of the caliber of the bullet. The passage of the bullet through the wall causes a vacuum behind the bullet on account of the clinging nature of the rubber and the

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bullet being much faster in its movement than the rubber layer, allows a quantity of the finely pulverized wood to be drawn into the hole in the rubber layer before the rubber has time to close behind the bullet. The bullet, when it strikes the rubber layer 12, makes a sort of a cup-shaped and relatively large entrance opening and the pulverized wood which is drawn in behind the bullet forms a button *a* between the layer 13 and the rubber layer 12. This button compresses the rubber and causes it to still more firmly grip the plug so that this plug effectually seals up the hole made through the rubber by the bullet and will stand much greater pressure than the pressure which is used in the tank for causing the gasoline to flow by force feed to the engine. It will be noted that the exit end of the perforation through the layer 13 is slightly larger than that part of the perforation adjacent the exit end, so that the plug *a* is held firmly in place against any pressure within the tank.

It is particularly important to have both the wood and rubber of approximately the right thickness, as if the rubber layer is too thin, the hole made by the bullet will be relatively large and the vacuum caused by the bullet will draw both the plug and the button of pulverized wood through the rubber, leaving an open hole through which the gasoline, especially under pressure, will escape. If, on the other hand, the rubber is too thick, the hole through which the bullet has passed may partly close before the head or button has time to form. If the wooden layers 11 and 13 are too thick, a needless amount of wood is added to the tank and it adds needlessly to the amount of pulverized wood driven inward in front of the bullet. If the wooden layers are too thin, then sufficient pulverized wood may not be formed to make the button and plug.

After many experiments I have found, all things considered, that the rubber layer 12 should be approximately $\frac{1}{4}$ " thick and that the wooden layers should be approximately $\frac{1}{2}$ " thick. Furthermore, in the course of extended experiments, I have found that white wood is the best wood for the purpose, by reason of its being light in weight, stiff, and very brittle when broken across the grain. This wood is, therefore, easily pulverized by the bullet. It will be seen that the essential principle of this invention is to enable the bullet to plug the hole by first pulverizing the soft or brittle material, whether it be wood or other substance, and then by means of the vacuum behind the bullet causing this comminuted material to plug the hole in the rubber or other yieldable material.

It has been found, by an extended series of experiments, that the hole made in a plank by a bullet, where no rubber is used, will have practically a uniform diameter

throughout its entire length, but if the rubber layer be cemented to the rear face of the board or plank, then the hole made by the bullet will invariably be tapered, the smaller end being next to the rubber, and that where two wooden layers are used on each side of a rubber layer, the hole will have the form illustrated in Fig. 5, that is, the perforation in the plank 13 will be inwardly tapering, the rubber will have a relatively large entrance end to the perforation, and a relatively small extension through to the rear side of the rubber, and that the perforation through the plank 11 will be outwardly flared.

Fig. 5 shows the general principle of my invention and, of course, this principle may be applied to tanks of various constructions and of different details. In the drawing, however, I have shown my invention as applied to a particular form of tank such as is used with the Curtiss aeroplane. This is a pressure tank, that is a tank wherein the gasoline or other fuel is forced out from the tank by compressed air within the upper portion of the tank. As illustrated, the tank is about two feet square in plan and about 14 inches deep, with somewhat rounded corners. The tank is formed of sheet metal, as for instance sheet tin, which is designated 14. One head of this tank 14 is put in place and then the delivery pipes, the filling pipe and the air inlet pipe are put in place, that is, the nipples for these pipes are put in place. In the figures, 15 designates the pipes through which the gasoline is forced to the engine. Two of these delivery pipes 15 are used so that if one should be cut off, the other would continue to supply the engine. 16 designates the inlet through which fuel is filled into the container or tank. The nipple 17 connects to means whereby air may be forced into the upper portion of the tank to exert a pressure on the liquid container therein. After the outlet nipples 15, 16 and 17 are put in place, the other head of the container is put in. This completes the metal portion of the container. The container is now inclosed within a sheathing of wood, rubber and cotton duck constructed as will now be described.

The inside layer of wood 11 is glued to a layer of cotton duck 18, the grain of the wood extending lengthwise of the tank, and holes being made in the proper places for the passages of the nipples 15, 16 and 17. After the glue between the wood and the sheet of cotton duck is nearly dry, the outside face of the wooden layer 11 is scored so as to make it rough. The rubber layer 12 is also scored on both faces and holes made in it to correspond to the nipples 15, 16 and 17. The surface of the wooden layer 11 and the inner surface of the rubber layer are now covered with glue and the rubber is

wrapped around the layer of wood, that is, extends transversely of the tank, the ends of the rubber layer being cemented together as at 19. The rubber is not stretched, however, and the ends of the rubber are vulcanized together. The layer of rubber is slightly wider than the length of the wooden layer 11 for a purpose which will be later stated. Small hard wood pegs 20 are now driven through the rubber into the wood 11 so as to cause the rubber to lie flat at all parts until the glue is dry. The use of nails or screws in the construction is omitted as far as possible, the hard wood pegs or pins being used instead.

When the rubber layer is firmly attached to the boards or plank 11, the outer layer 13 of wood is placed upon the rubber, the inner face of the wood being scored. This outer layer is glued or cemented firmly to the rubber, holes being made for the nipples to pass through, of course. A layer of heavy cotton duck 21 is now glued to the outer layer of wood and then brass bands 22 are tightly secured upon the tank like hoops. The tank is now kiln dried until all moisture from the glue is dispelled. The heads composed of two layers of plank 11 and 13 with an intermediate layer 12 of rubber and the inner layer of duck are now put in place. The heads are constructed in precisely the same manner as described for the body of the container, the only difference being that the inner layer 11^a of wood is small enough in outside measurement to fit closely inside the layer of rubber 12 at the sides of the tank. This layer 11^a of wood is now glued and pinned to the projecting ends of the top, sides and bottom of the tank. The rubber layer 12^a is then put in place in the manner heretofore described, the edges of the rubber layer being scored, as well as the faces, and vulcanizing rubber cement is applied to the ends or edges of the rubber 12^a so as to engage it with the rubber sheet 12. It will now be seen that as the continuous sheet of rubber which surrounds the tank is vulcanized together at 19 and the sheets forming the heads or ends are vulcanized together at their edges, there is an unbroken casing of rubber surrounding the gasoline container and the inner layer of wood. The outer layer of wood 13^a is now glued to the outer surface of the rubber 12^a and small hard wood pins 23 are driven through both layers of wood and the layer of rubber, this outer layer of wood being also pegged and glued to the ends of the wood layer 13, the outer wooden layer is now covered with cotton duck 21^a and the whole container painted with fireproof paint 24 or in place of this the whole container may be covered with thin tin or aluminum.

The object of using the cotton duck fabric 18 and 21 is to prevent the wood from splintering and splitting as the bullets pass through it and further it assists in keeping the wood from warping. If a bullet should strike one of the hard wood pegs 23 or 20 used in putting the covering of the tank together, it simply cuts it off whereas if metal nails were used or screws were used and a bullet happened to strike the nail or screw at an angle, it would be likely to cut a long gash through the wood, rubber and the metal tank, which would be much harder to seal than a puncture made by the bullet alone.

The object in having a wooden layer on both sides of the rubber is as follows: Referring to Fig. 3, it will be assumed that a bullet is fired at the tank on the line X—X, the bullet going in the direction of the arrow in this figure. As the bullet enters, it seals up the hole in the rubber on the side toward which it is traveling in the manner heretofore explained. After it has passed through this opposite wall, however, and the metal inner container, it strikes the opposite wall of the tank and in passing through it seals up this hole in the rubber in exactly the same way as first described and as illustrated in Fig. 5, but the button *a* is formed on the side of the rubber nearest to the inside of the tank, instead of on the side of the rubber nearest to the outside of the tank. Now it will be obvious that if there was no inner layer of wood 11, there would be no button formed on the side of the wall where the bullet last passed through, as the tin container or tank would be next to the rubber on the inside with no pulverized wood to fall in the path of the bullet and plug the holes.

It will be noted from Fig. 3 that I provide in one side wall of the container, a nipple 25, this nipple being provided with a head 26. The head 26 of the nipple is let into the wood of the layer 11 and the nipple projects out through the rubber layer 12 and out through the wooden layer 13. A tight connection is made between the nipple and the several layers by packing and cement and by a nut 27, which is screwed down against the outside of the casing. This nipple 25 is for the purpose of ascertaining whether the rubber layer which extends all over the tank is air tight and this is ascertained by pumping air into the nipple 25, there being a suitable pressure gage, not shown, attached to the nipple 25 by means of a T fitting. The rubber must be air tight so that if a leak in the tin container 14 occurs, the rubber will retain the fluid for a reasonable length of time. Inasmuch as the several nipples 15, 16 and 17 pass through both the wood and rubber, there is no way for the air to get out except through some defect in the rubber or tin container. By plugging up all holes in the container but the opening 17,

and applying a pressure gage to the metallic container 14, proof can be immediately had whether the rubber or the tin container is leaking.

5 Of course the layer of rubber would slowly deteriorate were it in contact with the gasoline, but even where the rubber layer is in contact with the gasoline, experiments have proved that the vulcanized joints and the
10 rubber layer will remain tight for several weeks. It will, therefore, be obvious that a mere puncture of the metallic tank and of the wooden inner layer will not affect the tank in any way as the gasoline, while it will come in contact with the rubber to some
15 slight extent, will have very little effect thereon. Furthermore, the only object of the construction which has been described is to enable the aviator to get back to his
20 lines, which he will have to do within a few hours at the longest. The plug formed by the comminuted wood coacting with the rubber will be ample to prevent any leakage of gasoline, even when the gasoline is under
25 pressure for a considerable length of time.

The purpose of the nipple 25 as before stated is to provide means whereby the tank may be tested. The layer of cotton duck 18 is not cemented to the tank 14, but is cemented to the wooden layer 11. Therefore, there
30 will be a free space all around between the duck 18 and the container 14. Now if air under pressure is introduced into the nipple 25, it will be free to pass anywhere between the metal container and the cotton duck. If
35 a leak should exist in the tin container 14, the air would pass through the opening and with the pipes 15 and 16 closed up tight, a pressure gage disposed on the nipple 17
40 would show that air had passed into the metal container 14 from the air pump, which is forcing the air through the nipple 25. If air should be delivered by the pump attached to the nipple 25 and no pressure
45 showed at the gage or nipple 17, then it would be proven that the air must either leak through the wood and rubber at some point or through the holes made in the wood and rubber for the nipples 15, 16 and 17 to
50 pass. Thus I have provided a means whereby the tank may be tested at intervals to show whether defective conditions exist or not. Of course mere cracks in the wooden
55 layers would not affect the operative condition of the tank, but the rubber should have practically no solution of continuity.

While I have particularly designed this tank for use on aeroplanes, it will be obvious that it may be used with dirigible balloons, military automobiles and tractors, or
60 anywhere, where it is desired to provide a tank for containing liquid which tank will seal itself when punctured by a bullet. It will also be obvious that the details of construction which I have described may be
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varied in many ways, without departing at all from the spirit of the invention and that I do not wish to be limited to these details, I have merely described these details so as to indicate how a tank of a certain type may
70 be constructed.

Having described my invention, what I claim is:—

1. A self puncture-sealing tank including a wall formed of a layer of material which,
75 when perforated by a projectile, will provide a plug, and a layer of elastically expandible and contractible material which will be expanded by the passage of a projectile through it and will then contract to
80 leave a relatively small passage into which said plug is carried by the passage of the projectile.

2. A self puncture-sealing tank including a wall formed of a layer of fibrous, brittle
85 material, which, when perforated by a projectile, will become pulverized by the impact of the projectile, and a layer of elastically expandible and contractible material disposed against the first named layer, which
90 will be expanded by the passage of a projectile through it and will then contract to leave a relatively small passage into which the pulverized material will be drawn by the flight of the projectile, to thereby form
95 a plug closing the passage.

3. A self puncture-sealing tank including a wall formed of an inner layer of metal, layers of relatively brittle, fibrous material
100 disposed exteriorly of the metallic walls and spaced from each other, which material, when perforated by a projectile, will become pulverized, and an intermediate layer of elastically expandible and contractible material which will be expanded by the passage
105 of the projectile and will then contract to leave a relatively small passage where the material has been perforated.

4. A self puncture-sealing tank wall comprising an inner layer of metal, two layers
110 of relatively brittle, fibrous material disposed exteriorly to the metallic layer and spaced from each other, which material when perforated by a projectile will become pulverized by the impact of the projectile,
115 and an intermediate layer of sheet rubber disposed between the two fibrous layers and in contact therewith, which will be expanded by the passage of a projectile through it and will then contract to leave a relatively small
120 passage into which the pulverized material will be drawn by the flight of the projectile to thereby form a plug closing the passage.

5. A self puncture-sealing tank including an inner metallic container and a sheathing
125 surrounding the container composed of inner and outer layers spaced from each other and, formed of material, which will become comminuted under the impact of a projectile, and an intermediate layer disposed be-
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tween said inner and outer layers and composed of material which will elastically yield to the passage of a projectile and elastically contract to reduce the cross sectional area of the perforation.

5 6. A self puncture-sealing tank comprising an inner metallic container and a sheathing therefor composed of alternate layers of wood and rubber, the layers being cemented to each other, and a nipple passing through the sheathing and communicating with the space between the inner layer of the sheathing and the metallic container and adapted to be connected to a source of air under pressure whereby to test the tank.

10 7. A self puncture-sealing tank comprising an inner metallic container and a sheathing therefor composed of alternate layers of

wood and rubber, the layers being cemented to each other, an inner layer of canvas cemented to the sheathing, and a nipple passing through the sheathing and the canvas and having a head at its inner end bearing against the inner layer of canvas and communicating with the space between said layer of canvas and the container, the nipple being adapted to be connected to a source of air under pressure whereby to test the tank.

In testimony whereof I hereunto affix my signature in the presence of two witnesses.

GEORGE J. MURDOCK.

Witnesses:

JEANNETTE P. MURDOCK,
WM. J. MURDOCK.