Oct. 31, 1944 J. M. S. KAUFMAN ET AL 2,361,548

CONSTRUCTION OF MAGNETIC COMPASSES

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FIG. 1.

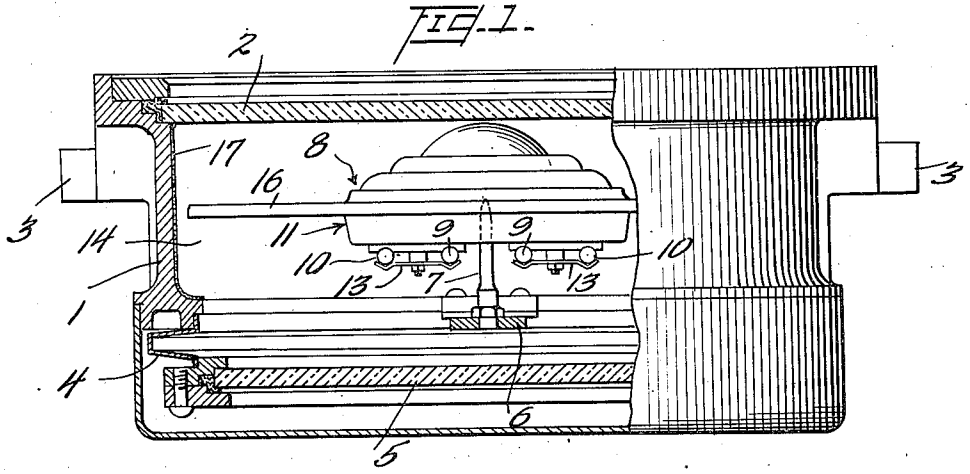
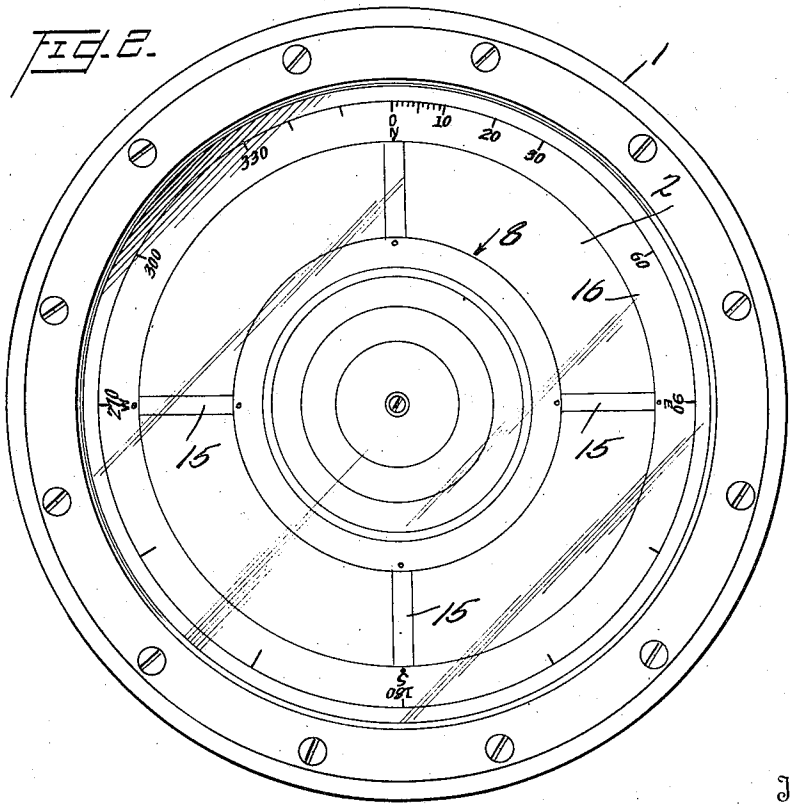


FIG. 2.



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FIG. 3.

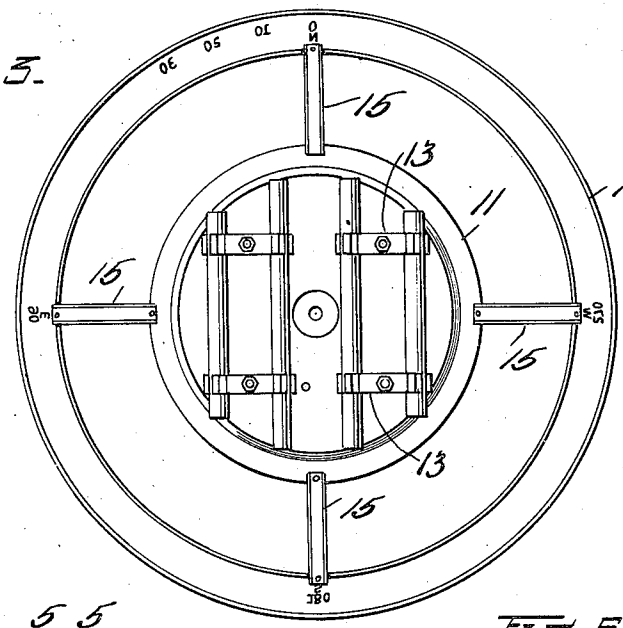


FIG. 4.

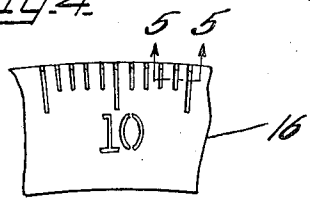


FIG. 6.

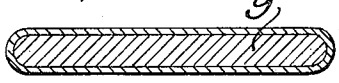


FIG. 5.



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2,361,548

CONSTRUCTION OF MAGNETIC COMPASSES

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6 Claims. (Cl. 33—223)

This invention relates to magnetic compasses of the type ordinarily used on ships. The invention is particularly drawn to such magnetic instruments as are used in the presence of corrosive fluid, which fluid may be either air having corrosive constituents, or liquid contained within the bowl forming the outer casing of the said compass.

It is an object of the invention to provide corrosion resisting surfaces which may be easily and economically applied, which surfaces will afterwards permit repair with facility, will avoid any magnetic difficulties and will provide a pleasant dull surface of non-glaring quality, resembling white paint.

It is a further object of the invention to provide a superior corrosion resisting base for paint to be applied under corrosive conditions. It is a further object of the invention to provide a corrosion resistant and adherent coating for permanent magnet material having high proportions of aluminum. It is a further object of the invention to provide a means for coating the moving system of compasses, which parts are joined with solder, the said coating serving to perfect the soldered joints. It is a further object of the invention to provide a manner of coating the said portions of the compass in such a manner as to avoid development of undesired strain during the coating operation. It is a further object of the invention to perfect the corrosion-resistant properties of such compasses and to correct any injuries done by abrasion or otherwise.

While a specific type of liquid-filled compass is described herein, it will be understood that the same type of construction may be applied under other conditions where corrosion exists. Such mode of fabrication may also be employed wherever it is desired to apply paint to metallic surfaces to obtain good bonding.

Such techniques may also be applied to any other objects which are fabricated of separate soldered parts, which are required to be either leakproof or corrosion-proof, or to have an attractive non-glare surface. Further still, the technique described herein may be applied to magnet materials of any nature or of any shape although it is particularly applicable to those having a significant aluminum content. Such materials may be utilized either inside or outside of magnetic indicating instruments and may be employed in electromagnetic or magnetic devices of any type where corrosive conditions are found.

Other objects and advantages of the invention will be evident from the following drawings in which:

Figure 1 indicates a general cross-sectional view of an instrument constructed according to the invention.

Figure 2 shows a top view of an instrument such as shown in Figure 1.

Figure 3 shows the bottom view of the moving system of this instrument.

Figure 4 shows a portion of the dial of the instrument as shown in Figure 3.

Figure 5 shows a cross-sectional view of a portion of the dial shown in Figure 4, taken across the line 5—5.

Figure 6 shows a longitudinal cross-sectional view of a cylindrical bar magnet plated according to the method of the invention.

Referring now to Figure 1, 1 shows the outer casing or bowl of a compass which is ordinarily used for steering ships and boats. This bowl is covered with a transparent cover 2. At the sides of the bowl 1 are knife edges 3, 3, upon which the entire compass rests. At the lower part of the bowl 1 is an expansion chamber usually made of corrugated metal and represented as 4. The compass is closed at the bottom by a cover which may or may not be transparent and is designated as 5. Within the bowl is a pivot support 6, upon which rests a pivot 7. Upon this pivot, mounted so as to be free to rotate about any axis, is the moving system 8. This moving system is ordinarily observable through the top of the glass cover 2, and has mounted upon it magnets 9, 9, and 10, 10, which orient it is the direction of the magnetic meridian.

The moving system 8 is more fully shown in Figure 3. Here a dial is represented as 16. This dial is in the form of a rim of metal, which is formed with overhanging portions so as to stiffen it. It is fastened by means of channel shaped members or tubes 15, to a float assembly indicated as 11.

In Figures 1 and 3, the outer dial, the connecting tubes or channels 15, and the float member 11, composed of an upper part and a lower part are shown. Fastened to the bottom of the float 11, in adjustable fashion are magnets 9, 9, and 10, 10. These are held by clamps 13, 13, so as to be movable over a limited range and to allow orienting the magnets 9, 9, and 10, 10, to obtain the correct setting of the card relative to the magnetic meridian.

With these clamps the magnets may be moved forward or backward to balance the card in the

direction of their length. They may also be shifted bodily sidewise, or may be twisted slightly. Thus, by moving the clamps and shifting the magnets, one can balance the card and magnet assembly and can also orient the magnetic axis so that it coincides with the geometric North-South axis of the moving system.

A portion of the card or dial 16 is shown in Figure 5. Here the lines and numerals are shown as being cut completely through the metal so as to be permanent and ineffaceable. If the card is illuminated from below, these figures and lines appear especially distinct. Alternatively, the lines and numerals cut through the metal may be filled either with a paint or with a luminous material, thus providing a firm bond and an accurate location for the paint.

In use the bowl shown in Figure 1 is ordinarily filled with liquid 14. This is often a mixture of alcohol and water, which has intrinsic unavoidable corrosive properties. Metals without protecting coating will suffer extreme corrosion if placed in this liquid. Where the liquid is omitted from the bowl, the air itself, especially in marine atmospheres, may have considerable corroding power. All parts of and especially the interior of the bowl 1 must therefore be protected against corrosion.

Furthermore, since readings are to be made and since the illumination available is often weak, the interior of the bowl should be of a light color. Further still, because sun occasionally shines upon the compass, it is necessary that the interior be of a non-glaring nature. In the normal use of the compass, it is often mounted in a binnacle which serves to support it and also to provide illumination. This illumination is often furnished by a light above or below the compass. In either case, the light will introduce glare if any brightly reflecting surfaces are present in the compass.

In the present invention the following procedure is followed in order to fabricate the bowl 1. Such a bowl is often made of bronze, brass, copper, or some other non-magnetic material. To the bottom of this bowl is then soldered the expansion chamber or capsule 4, the joint being made with ordinary soft solder made of tin and lead. The interior of the bowl is next covered electrolytically with a deposit of tin 17, applied in a manner which will be hereinafter described. The coating of tin is applied simultaneously to the interior of the expansion chamber, the interior of the bowl, and to all of the soldered joints. Tin is particularly beneficial for this purpose, since in the proper sort of bath it has great "throwing" power. Thus, it will seek out and cover minute crevices, porous spots, small holes, etc. If any such porous or open spots exist in the casing 1, providing they are not too large, they will be sealed effectively by the tin coating. The same applies to any defects which may exist in the soldered joints between the expansion capsule 4, and the bowl 1, or indeed between the parts of the expansion capsule itself.

It is to be emphasized here that the beneficial effects of using tin for the various parts of the compass arise from its application by electrolytic deposition from the proper sort of solution. In the case of the magnets, since these are often provided in rough cast form, they will have a number of deep pits and blow-holes. The tin will "throw" or deposit in these cavities, preventing the opportunities for later corrosion, which would be observed with other types of plating.

In the case of the interior of the bowl, here also, one usually uses a cast bowl and although this is often machined on the interior, there will be the inevitable porous spots and blow-holes in the interior surface. Here also, tin deposited properly will protect the metal in these cavities and prevent later corrosion therein. Further still, the interior of the bowl is of complicated shape and has re-entrant surfaces, particularly in the interior of the expansion chamber. Because of the extreme "throwing" power in the technique described, the tin will be deposited in ample quantity on all the surfaces in one simple operation.

In the case of the card assembly, referred to below, it will be seen that there also, there are a number of re-entrant surfaces and cavities which will be properly plated due to the "throwing" power of the tin. Furthermore, the plating of the assembled moving system hereinafter described, is possible because of the "throwing" power of the tin in the bath described. Were other materials or other techniques to be utilized, the plating of the assembled piece would be futile, since it would be impossible to obtain deposition of metal in the many crevices present in an assembled piece, and it is precisely in these crevices that the coating previously applied is most apt to be abraded and to require protection.

The coating of tin applied in the manner taught herein is crystalline in nature. When viewed with the naked eye, such a surface appears a dull grayish white, giving a pleasing appearance resembling dull white paint. Such a surface is entirely suitable for use, without any further coating. However, where paint is desired, it can be applied to the interior of the bowl 1 after the crystalline deposit of tin has been placed. This crystalline deposit, being formed of minute particles or minute crystals of tin, provides a roughened surface to which paint adheres better than to the smooth surface left by hot tinning.

A suitable coating for the interior of the compass bowl is a paint made with vinyl resin. This can be made white with some pigment such as titanium oxide, and after application and drying will be found to resist the solvent action of alcohol and water. It will also resist the solvent action of other organic liquids which may be used as the compass fluid. Alternatively, the vinyl resin may be formed in the shape of a liner and pressed into the interior of the bowl. A white paint made with vinyl resin may also be applied to the moving system. This paint may be made very thin in contradistinction to the albumin paint previously used. The latter had to be used in thickened form. The paint made with vinyl resin may be so thin that it will not fill any graduations which are cut through the moving system. The vinyl resin paint need not have any great covering power, since the undercoat of crystalline tin has a whitish color.

In the case of the moving system, such as shown in Figure 3, the dull or crystalline tin provides a particularly effective coating for such a member as shown in detail in Figure 5. Because of the "throwing" power of the tin, the vertical wall left by cutting away the metal will be effectively coated and will resist corrosion. Furthermore, the surface of the dial will have a particularly pleasing dull appearance, such as described before for the interior of the bowl. The float portion 11, coated in the same way, will have the same corrosion resistance as described before and will present the same pleasing grayish-white appearance. The coating has particular advan-

tages when applied to magnets such as 9, 9, and 10, 10.

The coating of Alnico magnet material with a corrosion resistance material has proved to be a particularly vexing problem. Because of the solvent effect of the alcohol-water mixture customarily used, ordinary varnishes and paints are not suitable. Plating with various metals has also been tried and has heretofore been found highly unsuccessful. It appears that the aluminum in the Alnico alloy forms a chemical coating thereon which prevents the adherence of plated metal.

It has been discovered, however, that tin, when used electrolytically in a highly alkaline bath, in the manner described herein, will coat Alnico properly, so as to make it completely resistant to corrosion. The tin appears to adhere well and to fill the crevices and pores which are often present in cast Alnico material. Tests on immersion of such magnets in solutions having different corrosive properties, such as salt water, pure alcohol, and mixtures of alcohol and water, all show that the tin provides an adequate and satisfactory corrosion resistant coating.

A satisfactory plating bath for the Alnico magnet material can be prepared as follows:

To one gallon of water is added 16 ounces of sodium stannate, one ounce of sodium hydroxide, two ounces of sodium acetate, approximately $\frac{1}{8}$ of an ounce of fresh hydrogen peroxide, and about $\frac{1}{8}$ of an ounce of borax. Heat is applied to bring the bath to a temperature of about 150° F. A voltage of about 6 volts is applied, and a current density of about 3.0 amperes per square foot of surface area being plated. The anode should not be of too large area and should be of such area that the current density at the anode is about 3.0 amperes per square foot. It is necessary that the current density figure herewith be utilized, since part of the success of the plating operation depends upon this.

Before plating the Alnico magnet material, it should be ground on some sort of abrasive wheel to remove most of the scale and surface dirt. It is then cleaned with pumice, preferably in a paste made with water. Contrary to the practice usually followed in plating, it has been found best to avoid a chemical cleaning treatment for this material.

The plating technique, namely the cleaning with pumice and water, and the composition and other details concerning the plating bath may also be followed for the plating of brass, bronze, or copper parts to be used in the construction of a compass. For the other parts of the compass described herein, it is understood that the mode of plating will be substantially the same as that described for the plating technique of the Alnico magnet material.

The plating technique described herein may be modified and other means used to obtain the same result. The specific method and composition of the bath disclosed is intended to serve as an example by which successful results may be obtained.

Figure 6 shows a longitudinal cross-sectional view of a cylindrical Alnico magnet 9 covered with an electroplated coating of tin 18.

A precaution desirable in the plating of magnets is that they be plated in the unmagnetized condition. Magnetized material will pick up small pieces of iron and steel, which will project through the plating and subsequently corrode, leaving rust spots. If the magnets must be plated in the magnetized condition, all adhering iron or steel should be removed carefully, and a set of magnets had best be placed in the bath permanently to pick up any particles of magnetic or ferrous material which might fall into the bath.

If the magnets have a very rough surface, it is considered advisable to plate them with tin, work down the coating with a rotary scratch brush or wire brush, and to apply a coating of tin outside the brushed coating. This process may be repeated several times. The brush utilized should preferably have brass wires. The usual type of steel wire brush is too apt to leave small steel particles upon the magnet. These will later cause difficulty when the magnets are plated. The final coating of tin is best made over $\frac{1}{1000}$ of an inch in thickness, and may be made much thicker. An additional advantage of coating the magnet with tin is that soft soldering may be done directly to the coating. The usual Alnico magnet material will not allow such soft soldering.

Although the plating process and products have been disclosed for Alnico magnet material, it is obvious that this technique may be applied to any other permanent magnet material where the same problems appear. It may be applied to any other magnet composition which has a large proportion of aluminum, which aluminum tends to prevent electroplating by usual methods. Alternatively, it may be applied to any of the other ferrous alloys having aluminum as an ingredient.

The possibility of soft soldering mentioned above has particular application to magnetic instrument construction. Thus tin-plated magnets may be soldered to a holder, which is clamped to or otherwise fastened in adjustable relation to a moving system of a compass.

If the composition and current density taught herein are utilized, and if the proper temperature as taught herein is utilized, it will be found that the tin will be deposited in crystalline condition. The moving system will thus have a dull grayish-white appearance, free from glare. This presents a pleasing surface, and one which does not fatigue the eyes in long observation.

The float and card assembly may be made of sheet brass, with the various portions spun or die formed. The coating of tin as disclosed herein, will act as complete protection against corrosion. It will provide a good bond for solder, should repair of the instrument be necessary. It will also facilitate the renewal of the coating. All that need be done is to give the card and float assembly a chemical cleaning treatment, followed by replating in the same type of bath. After this type of plating, the system will have the appearance of an entirely new unit, and will not show the marred surfaces suggestive of a repaired unit.

After the card assembly has been plated and after the various small parts, such as screws, magnets, and other removable elements entering into the assembly of the card have been placed in their proper position, and the card completely assembled, it may be put into the plating bath for a short time to receive a final coat of tin. Thus, any spot which has been left open by error or from which the tin has been abraded in handling will be coated and thus protected from corrosion.

When the card assembly has been completely assembled, with the magnets, clips, screws, and other parts, the entire assembly may be placed in the plating bath for a final thin coat of tin.

The exceptionally high "throwing" power of tin will allow it to reach deep into the crevices.

Likewise any very small hole in the bowl or expansion chamber will be filled with tin. The coating will also allow easy soldering, should repair be required, since tin forms a very good foundation for soft solder. The same dull finish above referred to will be deposited on the inside of the bowl. This will provide a satisfactory grayish-white surface, which will make for easy reading and the reflection of light within the bowl, without the development of any metallic glare. The surface can be renewed easily, should it be injured, in the same manner as indicated in the discussion of the plating of the card assembly above. However, should it be desired to paint the interior with white paint, the crystalline, or roughened surface will provide a far better foundation for the paint than the smooth surface usually left by hot tinning. In the past, an albumin paint, usually made of egg white and white lead has been used. This has been found to adhere very well to the tin foundation. A better coating is a paint made up of some white pigment such as titanium white in a vehicle such as vinyl resin. Such a coating is impervious to alcohol, is easier to apply than the albumin paint indicated above, and will adhere exceptionally well to the tin undercoating. However, if the paint is omitted, a perfectly satisfactory surface will result.

It has been found that the plated coating of tin for the interior of the bowl and for the moving system have great advantages in the operation of the compass. Since in the movement of the moving system within the bowl, the liquid is set in motion, the material having least adhesion to the liquid will be best as a coating. The parts will then adhere less strongly to and be less retarded by the liquid. Although the plated coating has a type of roughness, it is of a microscopic degree, as compared with that which will be noted in paint. The moving system will therefore move with less hindrance through the liquid and the response of the compass will be superior to that of a system in which other materials are employed. Similarly, the liquid moving inside the bowl will move with least hindrance if the bowl is made relatively smooth. The plated coating is smoother than the paint customarily used and there will therefore be less of the type of error known as "swirl."

Although the above method has been shown as applied to a compass which employs liquid contained therein, it may obviously be applied to a similar instrument which operates without liquid. The corrosive fluid in this case would be air, such as salt air, or air containing various corrosive gases, as well as oxygen.

While the plating of metal pieces has been disclosed herein, it will be seen that it is possible to plate non-metallic pieces by the same technique, by coating them with some conducting material. Thus, non-conducting pieces may be coated with graphite or with chemically deposited or "sputtered" deposits of metals. The electrolytic tin coating may then be applied over these preliminary coats.

The scope of the invention is indicated by the appended claims.

We claim:

1. As an article of manufacture, the bowl of a magnetic compass which is normally filled with liquid when in use, the said bowl having an interior surface exposed to liquid and exposed to view when in normal use, the said bowl being covered with a crystalline deposit of tin, the said tin serving the function of sealing porous portions of the bowl, protecting the said bowl against corrosion and providing a dull surface resembling white paint.

2. A bowl as in claim 1, with the addition of a metallic expansion chamber, the said chamber being fastened together with solder and being coated after soldering with a plated deposit of tin.

3. In a magnetic compass, a moving system adapted to point in the direction of the magnetic meridian, the said moving system being made of metal and forming a float portion adapted to be immersed in liquid, the said float portion being coated with a crystalline deposit of tin, thereby protecting the said member against corrosion, sealing any porous or open portions, and furnishing a non-glaring surface resembling white paint.

4. In a magnetic instrument, an indicating dial, the said dial having graduations and characters cut completely therethrough, the said dial being immersed in liquid when in normal use, a coating of crystalline tin on the said dial, the said coating serving to protect the cut and uncut portions against corrosion, further serving to provide a dull surface of non-glaring properties, resembling white paint.

5. As an article of manufacture, a permanent magnet composed of material having an appreciable aluminum content, the said magnet being covered with an electrodeposited coating of tin.

6. A painted metal surface adapted to be exposed to corrosive fluids, the said painted surface being applied upon an undercoating of metal which is subject to corrosion, the said metal having upon it a crystalline deposit of tin, the paint being applied over the said crystalline deposit of tin, the said deposit providing a corrosion resisting coating for the metal and further providing a firm foundation for the paint.

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