Oct. 2, 1956 T. C. BEECH ET AL 2,765,248

METHOD OF FORMING COMBINED METAL AND PLASTIC ARTICLE

Filed June 13, 1955

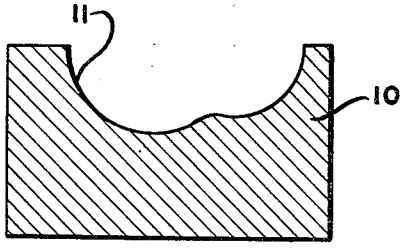

Fig. 1

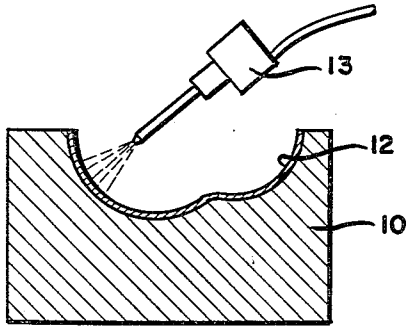

Fig. 2

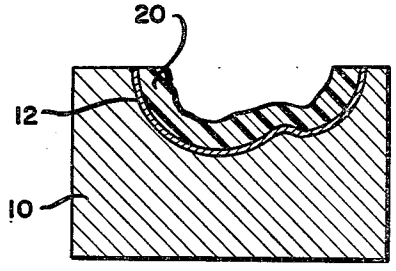

Fig. 3

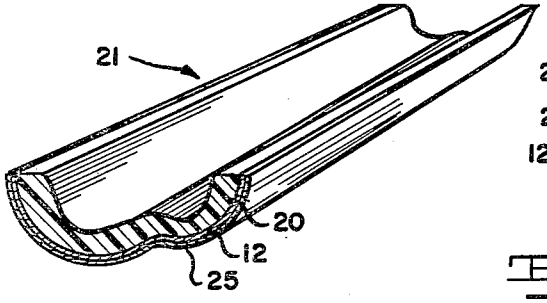

Fig. 4

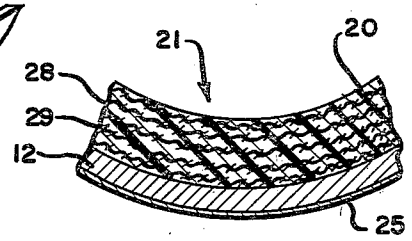

Fig. 5

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2,765,248

Patented Oct. 2, 1956

2,765,248

METHOD OF FORMING COMBINED METAL AND PLASTIC ARTICLE

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Application June 13, 1955, Serial No. 515,092

3 Claims. (Cl. 154—110)

This invention relates to a combined metal and plastic article and a method for forming said article and more particularly relates to articles such as models and prototypes having intricate shapes and which are produced in small numbers for engineering design and for display purposes.

Metal parts of intricate shape which have heretofore been required in the manufacture of prototypes for engineering developments and for display purposes, such as in the formation of automotive body moldings and other parts, have been extremely expensive to fabricate and have required extremely long periods of time to make the initial production. In the field of automotive body moldings, for example, a number of the body parts such as bumpers, headlight rings, door moldings, etc., have been required for engineering and display purposes and these parts had to be made by means of standard casting or stamping methods. These methods are unusually expensive where only one or two or three or four or other small numbers of parts are required.

An object of our invention is, therefore, to cheaply produce parts which are suitable for the above purposes and provide a method for making these parts which require only a nominal amount of time and low production cost.

Another object of our invention is to make small intricately shaped parts in dies which are inexpensive to make and which may be disposed of after use without loss of time or money and to provide a method for treating these dies so that the metallic parts may be easily made therein and more important may be easily removed therefrom.

In order to achieve our objectives, we prepare a die or mold out of some easily worked material such as wood, plaster of Paris, gypsum based plaster, and such similar type material. Thereafter, the mold or die is treated to first seal the pores of the mold and then with a parting agent which prevents the mold from sticking to the metal which will be cast therein. Thereafter, an adhesive coating is provided in the mold so that metal will stick to the mold until such time that it is decided to remove the metal from the mold.

Following the treatment of the mold or die, we then spray molten metal into the mold to deposit a relatively thin shell of metal. The metal sheet, which is quite weak and which will not bear any load, is reinforced by a heavy layer of inexpensive plastic or in the alternative successive sheets of glass fiber cloth and a resin binder.

After the formation of the article within the mold, the article may be removed and then chrome plated by either covering the exposed metal with first a thin coating of copper, then a thin coating of nickel and finally a thin coating of chrome or in the alternative by other suitable means.

It is thus apparent that the article when completed will give the appearance desired for a prototype or display model and will serve its function adequately for engineering design purposes, but nevertheless the cost of the article will be quite low. This reduction in cost is accomplished by means of the inexpensive dies required and by means of the use of only a thin metallic shell which is reinforced by relatively inexpensive plastic materials.

These and other objects of my invention will become apparent upon reading the following description of which the attached drawing forms a part.

Referring to the drawing in which:

Fig. 1 is a cross-sectional view of a mold or die in which our article is to be formed.

Fig. 2 illustrates the formation of the metallic shell within the die or mold by means of a conventional spraying technique.

Fig. 3 is a cross-sectional view of the mold containing the metallic shell after the application of the plastic backing layer.

Fig. 4 illustrates a perspective view of an automobile type molding which may be formed by our process.

Fig. 5 is a cross-sectional view of a portion of the molding illustrated in Fig. 4 and is enlarged to illustrate the glass fiber cloth sheets and the resin binder which may be used to reinforce and back up the thin metallic shell.

As previously mentioned, the object of this invention is to form intricately shaped metal parts inexpensively and quickly. To this end, our invention contemplates forming a die or mold within which the article may be molded. Referring to Fig. 1, a suitable mold **10** is provided with female cavities **11** which are complementary to the exterior surface of the molded article. This mold or die may be made of any suitable material such as plaster of Paris, a gypsum based plaster, wood, or other easily workable material. The mold itself may be hollowed out or cut out to form the cavities **11** by any known and suitable shop technique.

Treatment of the mold

Once the cavities are formed in the die, and prior to depositing the metallic shell therein, it is desirable to treat the cavity surfaces in order to first seal off the pores of the mold or die material to prevent moisture seepage which may harm the metal shell, and to thereafter apply a parting agent to insure that the metal deposited will not stick to the mold when it is desired to remove the metal from the mold. Moreover, in the spraying of thin walled metallic shells, when the metal is sprayed into contact with the mold walls, the metal has a tendency to shrink away from or move away from the cavity walls. This results in a finished product which is not truly correct in dimension. To solve this problem and insure contact between the metal and mold cavity during the time of spraying and cooling of the metal, we apply a suitable adhesive over the parting agent which adhesive adheres to and holds the metal, as it is sprayed, in its proper relationship to the cavity walls.

Although a number of materials are suitable to accomplish the above functions, we have found at least one material which is suitable for each function and therefore will give an example of each one of these materials below.

Where the mold is made of a gypsum based plaster or some such similar plaster material, we have found that a coating of cellulose base lacquer first applied to the mold and then allowed to dry thoroughly will tend to seal the pores of the mold and seal in the moisture. Thereafter, we treat the mold with a carnauba base emulsion in a mineral spirit solvent. This material is commonly known as wax and is of a specific type of wax. The wax film is applied and polished once or twice or

more as the case may be to provide a smooth surface for the reception of the metal deposits.

An example of one type of wax which is suitable for this purpose is as follows:

Carnauba base 11.25%
Soap 0.75% (emulsifying agent)
Mineral spirits solvent remainder

It should be understood however, that we do not limit ourselves to the particular wax described above but only give this description by way of an example to suggest one type of wax which is suitable for this function.

Also, by way of example, one type of compound which has been found suitable for sealing in the moisture in the mold is as follows:

A polymerized vinyl alcohol in an ethyl alcohol, water, nonyl alcohol solution which is then sprayed on the mold. This material may be compounded in the following parts:

Polyvinyl alcohol 100 parts
Ethyl alcohol 100–150 parts/100 PVA
Water 20–30 parts/100 PVA
Nonyl alcohol 3–5 parts/100 PVA

The above compound functions as a sealing agent so that the metal sprayed can be easily removed from the mold when it is so desired.

Thereafter, after the above polymerized vinyl alcohol etc., is dried thoroughly, a neoprene phenolic type adhesive with a suitable solvent, such as toluene, to act as a vehicle, is sprayed over the entire mold surface and this adhesive functions to keep the sprayed metal in contact with the mold wall.

One example of the chemical compositions of such an adhesive is as follows:

Neoprene phenolic type adhesive in which there is present 65 to 85 parts by weight of pheno aldehyde resin to 100 parts of polychloropene with, 185–225 parts of toluene as a vehicle. This type of adhesive is set forth in United States Patent No. 2,610,910.

Once again it is to be understood that our desire is to provide first a sealing compound to seal the pores of the mold, second a wax base which may be polished to complete the sealing and also to provide a smooth wall surface; then a parting agent, and finally an adhesive which will hold the sprayed metal in place until removal is desired.

The metal spraying

The metal shell of the article to be made is deposited within the treated mold by means of a suitable spray process, such as the well-known Schoop process, in which a spray gun deposits molten metal by means of compressed air or other air pressure. Thus referring to Fig. 2, it can be seen that the shell **12** is being deposited by means of a standard and conventional spray gun **13**. The actual spraying of the metal is well-known in this art and therefore no detailed description of either the spray gun or the exact method of spraying is necessary.

However, in our process, we make it a point to provide a dense surface of the metal which is exposed. The reason for this dense surface is to permit chrome plating to later be accomplished. In order to properly chrome plate an article, it is important that the outer surface of the article be as dense as possible. Therefore, we spray the first one-third of the metal shell at approximately 80 p. s. i., the next one-third at 70 p. s. i. and the last one-third at approximately 50 p. s. i.

The lower the pressure, the faster the spray process may proceed. The reason for this is that the high pressure air tends to blow the molten metal out of the mold and out of proper place. Therefore, the first one-third of the mold is sprayed at a high p. s. i. despite the fact that it takes much longer to do so in order to achieve a very dense outer surface. Thereafter the next one-third is sprayed at a lower pressure whereby although the density of the metal is reduced, the process is speeded up. Finally, the last one-third or the inside one-third of the metal shell is sprayed at a relatively low pressure in order to quickly finish the job and particularly so since it is not important whether the inside surface be of high density or low density.

Any metal which may be sprayed into this mold is suitable for our purposes and such metal may be zinc, copper, iron, etc. The temperature of spraying is normally prebuilt into the spraying gun and therefore forms no part of this invention. However, it is only important that the temperature be sufficient to melt the metal and to permit its ejection from the gun into the mold.

The metal shell when completed is quite thin and in many of the articles desired, for example, in the automotive parts industry, need only be in the range of approximately 3/16". Obviously, the thickness of the metal can be considerably less than 3/16" or in the alternative can be somewhat more. However, it is an object of our invention to reduce the thickness of the metal to speed up the process and make the job less expensive.

The plastic backing

The metal shell because of its thinness is extremely brittle and weak and may be easily broken or damaged in removal from the mold. Moreover, it would serve no useful function once removed from the mold because it would lack the strength necessary for use in engineering and design tests. Therefore, we provide a relative thick layer of plastic material **20** inside the shell **12** in order to reinforce the shell and give it adequate strength for ordinary use.

With reference to Fig. 5, we have found that we can obtain an extremely strong plastic backing for the metal shell **12** by means of the use of glass fiber cloth sheets. Thus, one way of reinforcing the shell would be to use successive sheets of open weave glass cloth. Preferably, for our purposes, we use a chrome-complex open weave glass fiber cloth. Along with this cloth, we use a low pressure laminate using an epoxy resin compound such as bisphenol in combination with epichlorohydrin cured with 25–30 parts of an amine type hardener to each 100 parts resin. The resin backing is cured at room temperature.

Fig. 5 shows a portion of sample molded article, in this case, an automobile molding strip **21**, wherein the plastic backing **20** comprises the fibrous glass sheets **28** and the resin **29**. In addition, the chrome and other metal coatings which are placed on the outside of the shell **12** are generally designated as **25**, for simplification purposes.

It is desirable to form the plastic backing in the shell while the shell is still hot so that the resin tends to fill the open pores of the low density inner surface of the shell and thereby coact therewith to form a tight bond between the plastic and the shell. Moreover, once the plastic hardens, it prevents the shell from losing its desired form.

Chrome plating the article

After the metal shell cools and the plastic backing is cured at air temperature, the article is removed from the mold. This removal is accomplished quite easily due to the action of the parting agent.

Thereafter, it is normally necessary to chrome plate the article where it is to be used for display purposes or as a part of a prototype which is chrome decorated. The chrome plating process may be done either by dip coating or by electro-plating.

The surface of the shell is prepared for the chrome plating by first copper plating the dense outer surface to form a completely non-porous coat of copper. This plating may be accomplished by the dip process which is conventional, and forms a coating which is approximately .003 to .007 thick. The dimension of this coating is not critical and actually may vary considerably without any

undesirable effects. It is only to be noted that the thicker the coating, the more expensive the article.

Thereafter, the copper coating is nickel plated, also by any conventional process, such as by dip coating the copper with a few thousandths of an inch of nickel or a nickel bearing alloy. The function of the nickel is to give the bright shiny color to the article which is desirable as mentioned above.

Thereafter, the part is chrome plated again either by dipping or in some cases by electro-plating to get approximately 1/10 of a thousandth of an inch thickness of chrome, more or less, to thereby complete the article for use.

The thicknesses of the above metallic coatings are not critical by any means and therefore may be varied considerably. Moreover, as mentioned before, the thickness of the metal shell is likewise not critical but is normally kept quite thin for economy reasons. Finally, the thickness of the plastic layer within the shell is dictated only by the required strength. In an article such as a bumper, which should be fairly sturdy in order to hold up in display purposes and under engineering explorations on an automobile, should be relatively thick.

Conclusion

It can be seen that by means of our process, we can produce inexpensive molded articles comprising plastic and metal which articles are strong and relatively durable and which are well suited for use in engineering tests, prototype constructions and display purposes. Our process obviates the necessity of expensive dies and expensive tools to form the article. Moreover, we utilize conventional spraying equipment to spray metal to form the article and therefore require no special tooling for that purpose.

In addition, the article which is formed of only a thin shell of metal, because of its plastic backing and because of, where desired, the successive sheets of glass fiber, is extremely strong and will take the normal wear and tear upon such models. Further, our model can be easily chromed in order to give a finished appearance.

By means of the use of the treating steps which include sealing, we are able to use such sheet mold materials as plaster of Paris or gypsum plaster. In addition, by means of first waxing the interior of the mold so as to form an extremely smooth surface, and then spraying the metal at a high pressure to form a high density outer surface, we obtain not only a surface which can be easily chrome plated but which also is smooth and finished looking. Thereafter, we are able to reduce costs and at the same time provide a porous inner surface to which the plastic backing may adhere, merely by the use of a lower spraying pressure.

Further, our process eliminates the possibility of the metal shell springing away from or drawing away from or shrinking away from the mold cavity walls by means of the use of a parting agent which permits the separation of the metal from the mold and by the use of an adhesive

which effectively glues or adheres the metal to the parting agent.

The various materials mentioned in conjunction with each one of the functions required are not critical and it is necessary only that these materials suitably perform the functions. The examples given in the above description are merely each examples of a material which performs the function and are by no means a limitation on our invention.

This invention may be further developed within the scope of the following claims. Accordingly, it is desired, that the foregoing description be read as being merely illustrative of one method of carrying out our inventions and not in a strictly limiting sense.

Now having described one operative embodiment of our invention and one operative method for carrying forth our process, we now claim:

1. A method of die forming, in an inexpensive easily worked mold, articles having a relatively thin metallic shell with a dense outer surface and formed into various curves and backed by a thick layer of plastic bonded to the shell to rigidify and strengthen the shell, comprising the steps of: forming a die with an open die cavity from an easily worked porous material; sealing the pores of the die material within the cavity with a sealing material; forming a metallic outer shell by spraying molten metal into the die cavity against the cavity walls under high pressure to form a thin, high density surface in contact with the die walls, and continuing the molten metal spray under low pressure to quickly form a less dense and porous metallic backing for the outer metallic surface; immediately thereafter, while the shell is still hot, depositing under ordinary atmospheric conditions of pressure and temperature a thick backing layer of a non-metallic thermoplastic material within the shell to thereby bond the plastic material and the shell together; and finally, removing the article from the die.

2. A method as defined in claim 1 and including the step of coating the cavity walls with an adhesive material before forming the shell to cause the shell material to adhere to the cavity walls at all places during the formation of the article and before removal thereof from the die.

3. A method as defined in claim 1, and said layer of thermoplastic material being formed by successively placing sheets of glass fiber cloth and a thermoplastic resin binder into the shell and against the shell inner walls to build up a thick backing layer.

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