METHOD OF PRODUCING PRINTING PLATES

Original Filed Nov. 10, 1966 3 Sheets-Sheet 1

FIG.1.

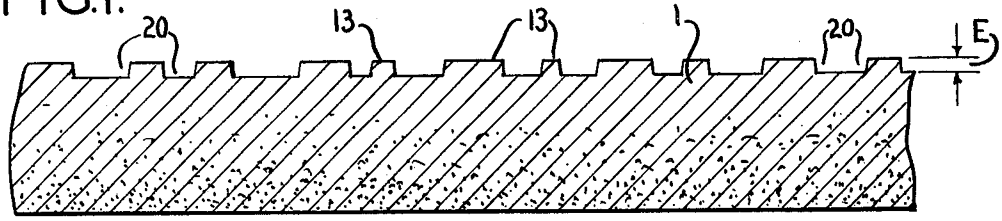


FIG.2.

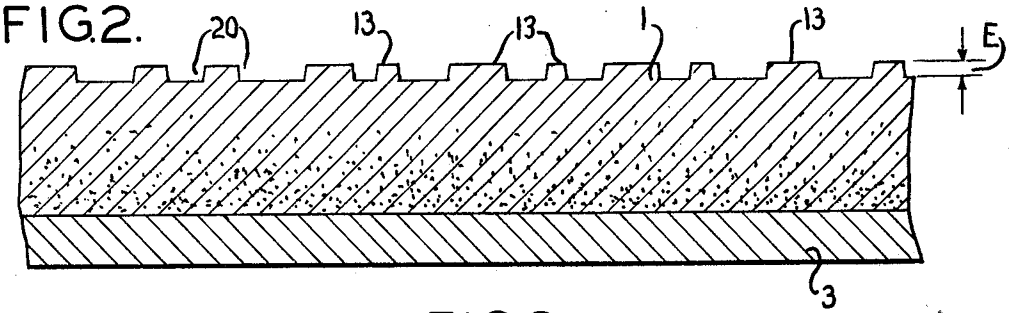
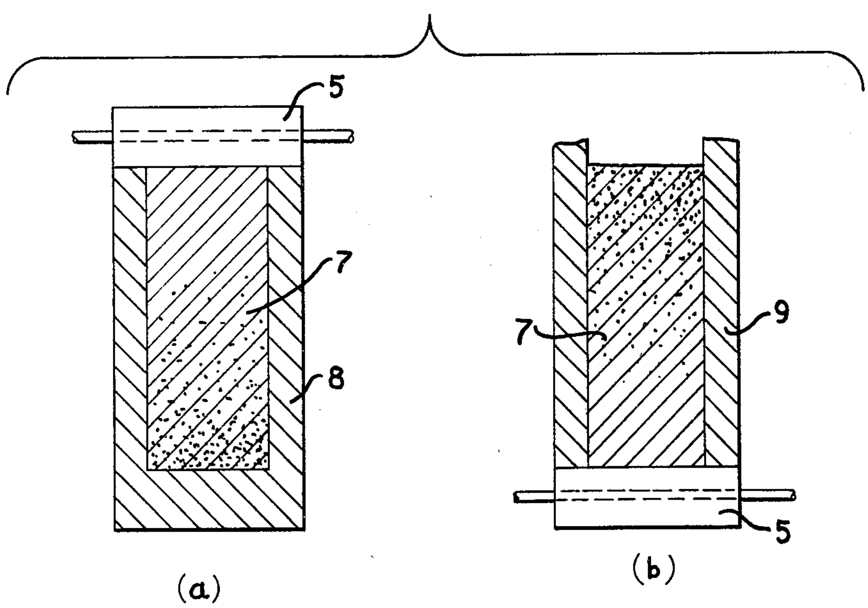


FIG.3.



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METHOD OF PRODUCING PRINTING PLATES

Original Filed Nov. 10, 1966 3 Sheets-Sheet 2

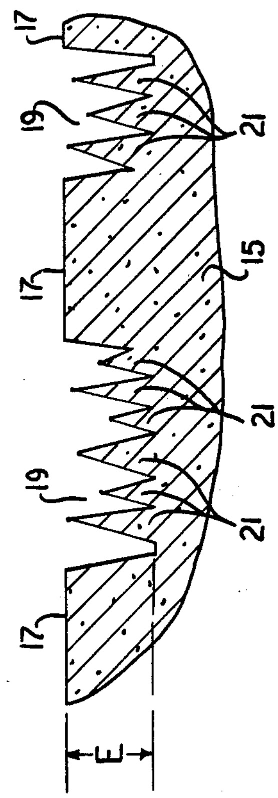

FIG.5.

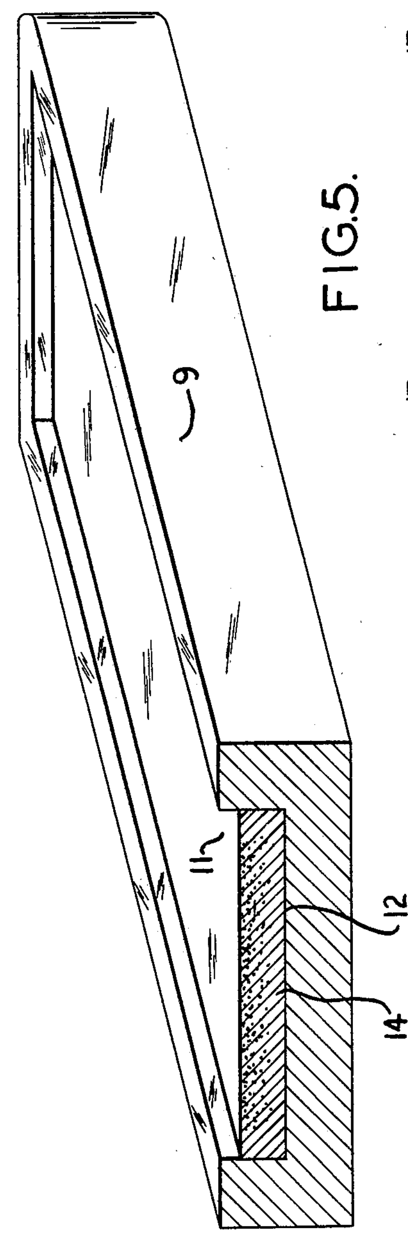

FIG.4.

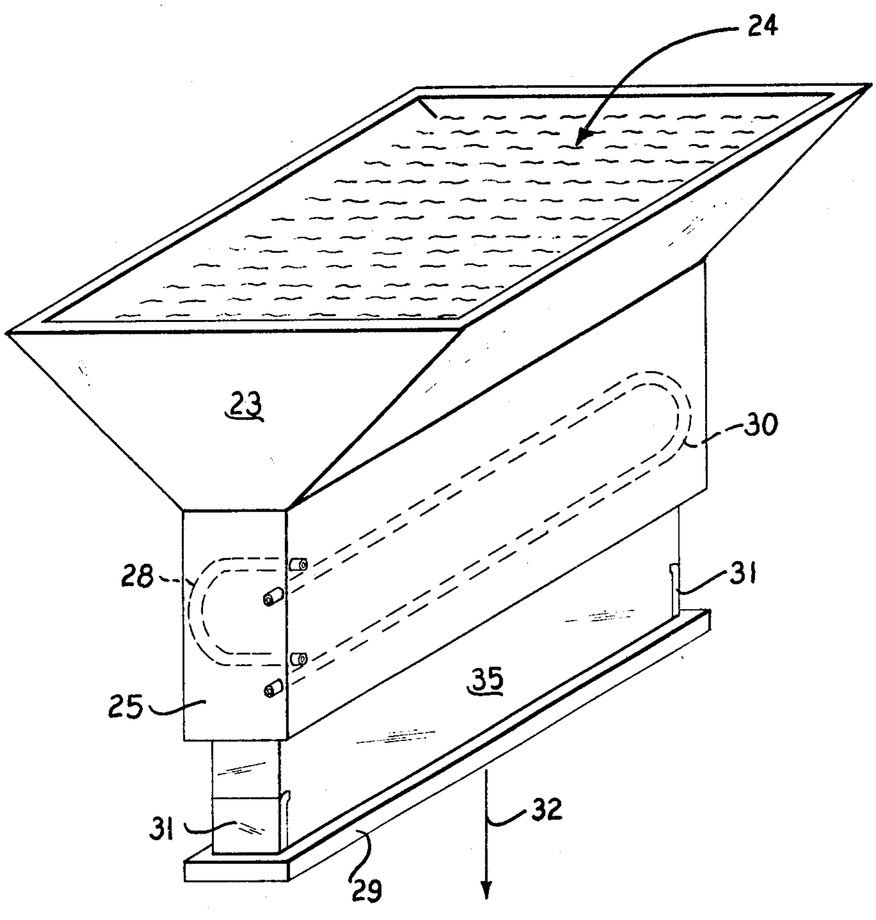

FIG.6.

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3,499,212

METHOD OF PRODUCING PRINTING PLATES

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Continuation of application Ser. No. 593,535, Nov. 10, 1966. This application Apr. 9, 1969, Ser. No. 824,718
Int. Cl. B22d 11/12
U.S. Cl. 29—527.7 9 Claims

ABSTRACT OF THE DISCLOSURE

A method of fabricating etchable printing plates which possess relatively few iron-induced concretions. The printing plates are continuously cast from a zinc alloy which includes traces of iron not exceeding seventy parts per million and heat is abstracted from the poured melt at a rate sufficient to prevent the formation of any substantial number of pimple-forming concretions adjacent at least one surface of the solidified alloy. The rate of heat abstraction is in the range of 0.001–3.00 B.t.u./lb./sec. of weight of the poured melt.

This application is a continuation of Ser. No. 593,535 filed Nov. 10, 1966, now abandoned.

This invention relates to improvements in printing plates, and with regard to certain more specific features to such plates composed of a zinc-base alloy to be etched, preferably but without limitation, by so-called powderless etching.

Among the several objects of the invention may be noted the provision of a process for making zinc alloy printing plates which are comparatively free from undesirable, so-called pimples, i.e., more or less pointed protrusions on their etched surfaces; and the provision of a process which is simple to carry out for eliminating or reducing such pimpling to an acceptable amount. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the products and methods hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated,

FIG. 1 is a fragmentary diagrammatic sectional view of one form of printing plate in etched condition and embodying the invention;

FIG. 2 is similar to FIG. 1 embodying another form of the invention;

FIG. 3 illustrates cross sections of experimental apparatus for demonstrating certain cooling effects on a zinc alloy;

FIG. 4 is a sectioned trimetric view illustrating a step of casting a zinc billet employed in carrying out the invention;

FIG. 5 is a greatly enlarged detail section across part of an etched surface of a prior-art plate, illustrating the pimpling problem with which the invention is concerned; and

FIG. 6 is a diagrammatic trimetric view illustrating a casting step alternative to that shown in FIG. 4.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings. For clarity of illustration, the sizes, thicknesses, etc. are exaggerated in the drawings, which are not to scale.

A major difficulty encountered in the use of engravers' zinc plates, when subjected to etching, and particularly powderless etching, is the random formation of so-called pimples in the etched depressions of the printing surfaces of the plates. These are illustrated in FIG. 5 and will be discussed below in detail. These pimples are small pointed protrusions, which must be mechanically removed by a hand tool or machine before a plate can be used on a printing press. If not removed, the protrusions print unwanted dots on the paper and produce an unattractive mottled appearance. There is considerable cost involved in removing such pimples and there is also a danger of spoiling the plate, requiring that it be scrapped. While the difficulty occurs with engravers' plates in general, it is particularly troublesome in the case of photoengravers' zinc printing plates. By means of the present invention pimple formation is prevented or at least greatly minimized so that the plates consistently produce clear unmottled printing material.

A usual zinc alloy for making zinc plates nominally consists of approximately 0.06 to 0.14% aluminum (Al), 0.00 to 0.20% magnesium (Mg), the balance zinc (Zn). Ordinarily, certain trace amounts of impurities such as iron, cadmium, copper and lead are included. A billet, which may be several inches thick, is first cast in slab form from a melt of such an alloy. The billet after solidification by cooling is rolled down to printing plate thickness, as for example 0.032 inch or .064 inch. These are the usual gauges employed for an etch depth in the plate of approximately .010 inch to 0.040 inch. A greatly enlarged cross section of a rolled-down and etched plate made according to the invention is illustrated at numeral **1** in FIG. 1. If desired, such a plate **1** may be provided with a bonded backing layer **3** such as illustrated in FIG. 2. This layer may be composed of aluminum. The layers are preferably bonded by solid-phase bonding but other bonding methods may be employed.

The impurities, and more particularly traces of iron, we believe to be a major cause of pimpling. We believe that the iron particles distributed throughout the alloy melt induce concretions which are distributed throughout the mass of the billet as it slowly cools. After the billet is rolled down, a large number of these concretions appear on and near the surface of the plate where it is to be etched. Upon etching they cause pimpling. These concretions are very small, i.e., about 0.1 to 10 microns in mean diameter. It has been difficult to determine of what these concretions consist but there are indications that they might be iron (Fe) per se, iron oxide (Fe_2O_3), or possibly some intermetallic compound such as $FeAl_2$, Fe_2Al_3 or $FeAl_5$. Such concretions appear to be formed by or in connection with the trace iron content when the molten zinc alloy after pouring slowly solidifies to the solid billet form.

We have discovered that, by controlling the amount of the trace iron content as an impurity in the zinc alloy and the rate of the heat removal during cooling of the cast billet, the number of pimples at or near the printing surface of the zinc plate, as rolled out from the billet, can be reduced to such an extent as to be harmless. Thus we minimize the amount of trace iron in connection with which the concretions may form, and by appropriate fast cooling minimize the ability of the trace iron to form concretions. In the following table are displayed some results of our experiments in arriving at the invention. It shows the effects of iron content and rate of heat removal from the solidifying billet upon the formation of concretions which cause pimpling.

TABLE.—NUMBER OF CONCRETIONS PER BILLET [1] AREA [2] OF ABOUT 2.8 SQ. IN.

Alloy iron content (parts per million)	Rate of heat removal from billet casting, B.t.u./lb./sec.		
	0.036 or less	0.144 to 0.482	1.44 or more
5 or less	10–15	0–10	0–10
30–70	21,000–27,000	500–1,000	0–10
120 or more	30,000–40,000	11,000–17,000	[3] 10,000–15,000

[1] This is the cast billet as reduced to 0.080 inches in thickness as for example by rolling and annealing.
[2] This is an area on that face of the billet which after rolling becomes the printing face of the printing plate.
[3] Estimated.

The heat removal at the rates indicated may be accomplished by casting the alloy melt against a cool or chilled surface. This cool surface forms the face on the billet which after rolling is to become the printing face of the printing plate. If a given rate of cooling is obtained at a cool surface, the rate of cooling at a distance away from such a surface may be less. This is shown by the experimental apparatus illustrated in FIG. 3. At (*a*) in FIG. 3, a water-cooled copper chill block **5** is shown at the upper end of a mass **7** of solidifying zinc which is being cooled in a container **8** of low heat conductance. At (*b*) in FIG. 3 the water-cooled chill plate **5** is shown at the bottom of a container **9** of low heat conductance. It will be noted that in both cases (*a*) and (*b*) the concretions responsible for pimple formation (as indicated by the dots) are absent or at least fewer in number in the material closest to the chill block. While a fluid-cooled chill block may be used, it will be understood that an ordaniary mold **9** for melt **11** may have its bottom surface **12** provide the temperature gradient for the rate of cooling desired (see FIG. 4). A typical billet obtained from melt **11** when cooled may be 8 feet long, 22 inches wide and 2½ inches thick.

Since the bottom **12** of the mold **9** acts as a cooling member (and may be fluid-cooled if need be) the bottom surface of the melt will be comparatively rapidly cooled. Therefore it is this surface in the finally solidified billet that will have in it or adjacent to it the smallest population of pimple-inducing concretions such as indicated in the above table. It is the side **14** of the billet having the low population of concretions which after rolling out becomes the printing surface **13** of the plate, whether the plate be unbacked as shown in FIG. 1 or backed as shown at **3** in FIG. 2.

As the billet is rolled down, it increases in area. Thus the area of its side face **14** having the low population of concretions becomes larger. As a result the number of concretions per unit area of the printing face **13** of the resulting plate will be even lower. The thickness of the billet is selected so that when the thickness of the desired plate is reached the population of concretions in and near to the printing face of the printing plate reaches about two concretions or less per square inch of the printing area. By the phrase "in and near to the printing face of the printing plate" is meant the population at the printing face to a depth equal to or slightly greater than the usual depth of etching.

From the above table it will be apparent that for a low content of iron impurity in the zinc alloy a low population of pimples at the cooled face of the billet does not require as large a rate of heat removal as do larger iron contents. Thus according to the table, for an iron content of not more than 5 p.p.m. a rate of heat removal from the billet of 0.036 B.t.u./lb./sec. or less is satisfactory, and a rate of removal of 0.144 B.t.u./lb./sec. or more results in about as low a population (0–10) of pimples as can be obtained as the surface of the billet; provided that the iron content is not greater than 70 p.p.m. For an iron content greater than 30–70 p.p.m., in order to obtain an equally low number (0–10) of pimples, it is required that 1.44 or more B.t.u./lb./sec. must be removed. For an iron content greater than 120 p.p.m, no practicable rate of heat removal is effective enough to obtain a sufficiently pimple-free surface. It is preferable that for the lowest pimple population the alloy melt should have an iron content of less than about 70 p.p.m. and that for best economy the rate of heat removal upon casting should be in the range of 0.144 to 0.482 B.t.u./lb./sec. On the other hand, for consistently obtaining optimum high quality of zinc plate having a substantially pimple-free surface, the iron content should be less than 5 p.p.m. with a rate of heat removal of 1.44 or more B.t.u./lb./sec.

Following are various relationships which we have found practical between the parameters of iron content and the rate of heat removal:

Iron content, p.p.m.:	Rate of heat removal from billet B.t.u./lb./sec.
1–70	.001–3.00
1–5	.001–0.035
6–20	0.035–1.44
30–70	1.44 or more

FIG. 5 illustrates a much-enlarged etched art of a typical printing face of a prior-art printing plate **15** made from engravers' zinc without regard to the proper relationship to the parameters of iron content of the zinc melt and rate of heat removal during solidification. Printing surfaces are indicated at **17** and the etched depressions at **19**. Before etching, a dense population of concretions extended throughout the plate to the unetched printing surface and through the etch depth E. The drawing shows how concretions which were in the areas **19** before etching have interfered with proper etching at **19**, causing pimples, diagramatically illustrated at **21**. As a result, upon inking the unetched printing areas **17**, some of the ink reached the tops of many of the higher pimples **21**. Thus upon printing, an unattractive mottled area occurred within the print made by the printing faces **17**. Ink caught on the tips of pimples **21** reached the paper because the latter has some tendency to bulge into the etched depressions **19**.

As shown in FIGS. 1 and 2, the number of concretions within the etch depth E of our plates is so low that in the etched depressions **20** very few, if any, pimples are formed. The ideal case of no pimples within the etched depressions **20** is illustrated in FIGS. 1 and 2. In practice, it is acceptable to have in the depressions **20** about two or less pimples per square inch measured on the printing face **13**. In such case the cost of removal of the pimples is not prohibitive. Theories of operation as set forth herein are to be considered only as possible explanations of the invention and not as limitations.

Instead of employing known batch casting to form a billet, such as illustrated in FIG. 4, known continuous casting may be employed as illustrated in FIG. 6, wherein numeral **23** designates a refractory hopper for receiving molten zinc as indicated by dart **24**. The hopper **23** leads to a hollow rectangular solidification section **25**, all four walls of which may be cored to form liquid cooling passages. Two of such passages for two walls are shown diagrammatically at **28** and **30**, it being understood that like passages are provided in the other two walls. At numeral **29** is shown a downwardly rectractible table **29** which when raised closes the lower open end of the unit **25**. The direction of retraction is shown by dart **32**. The table **29** includes upstanding cleats **31** which fit into the lower end when closed by the table **29** in elevated position of the latter. These cleats become anchored in the first portion **33** of zinc to solidify in the unit **25** when closed by table **29**. Then the table **29** is continuously retracted to withdraw this portion **29** and succeeding portions of zinc as such portions pass through and solidify in the unit **25**. Thus a solid billet **35** of idenfinite length is continuously formed which may later be segmented into plate lengths. Cooling and solidification occur substantially uniformly and simultaneously on all surfaces of the resulting billet. Hence all of these surfaces after the billet has been rolled to plate thickness are characterized by the absence of any substantial number of pimple-forming concretions. Therefore, either extended face of the rolled-out plate may be used for etching. This is of practical advantage in that no means is necessary to indicate which surface of a plate has the characteristics imparted by the invention.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above methods and products without departing from the scope of the invention, it is intended that all matter contained in the above descripion or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. A method of producing etchable printing plate material comprising forming a melt of a photo engravers zinc alloy which embodies not more than 70 parts per million iron, continuously feeding the alloy melt into a hollow-mold solidification section of selected length, cooling the alloy in said solidification section for abstracting heat from the alloy at a rate sufficient to solidify said alloy in said section and to prevent the formation of any substantial number of pimple-forming concretions adjacent at least one surface of said solidified alloy, and continuously withdrawing said solidified alloy from said solidification section to form a billet of a length greater than the length of said solidification section.

2. The method as set forth in claim **1** wherein said alloy melt is fed into a hollow-mold solidification section having four sides disposed in rectangular configuration.

3. The method as set forth in claim **1** wherein said alloy comprises 0.06 to 0.14% aluminum 0.00 to 0.20% magnesium, not more than 70 parts per million iron, and the balance zinc.

4. The method as set forth in claim **2** wherein said alloy is cooled in said solidification section for withdrawing heat from said alloy contacting said four sides of said solidification section at a substantial uniform rate for preventing the formation of any substantial number of pimple-forming concretions adjacent any surface of said solidified alloy.

5. The method as set forth in claim **1** wherein said alloy embodies not more than 5 parts per million iron and said cooling removes heat from said alloy at a rate of at least 0.001 B.t.u./lb./sec.

6. The method as set forth in claim **1** wherein said alloy embodies between 6 and 20 parts per million iron and said cooling removes heat from said alloy at a rate of about 0.035 to 1.44 B.t.u./lb./sec.

7. The method as set forth in claim **1** wherein said alloy embodies not more than 7 parts per million iron and said cooling removes heat from said alloy at a rate of at least 1.44 B.t.u./lb./sec.

8. The method as set forth in claim **1** wherein said billet is rolled for forming printing plate material of a selected thickness smaller than the thickness of said billet.

9. The method as set forth in claim **8** wherein said sheet material is metallurgically bonded to a metallic supporting member.

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U.S. Cl. X.R.

75—86; 101—395, 401.1; 164—2, 76, 82; 29—526.2