United States Patent Office 3,236,633
Patented Feb. 22, 1966

3,236,633

EXTRUDED FLINTS AND PROCESS FOR MAKING SAME

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No Drawing. Filed Mar. 28, 1962, Ser. No. 183,066
Claims priority, application Germany, Nov. 30, 1955, G 18,480, G 18,481
12 Claims. (Cl. 75—152)

This is a continuation-in-part of application Serial No. 623,798 filed November 23, 1956, now abandoned.

My invention generally relates to pyrophoric alloys and is more particularly directed to novel pyrophoric alloy compositions suitable for extrusion.

Considered from another aspect, my invention is concerned with an improved and simplified process for the extrusion of flints from pyrophoric alloy compositions and with the flints obtained thereby.

While flints for use in cigarette lighters and the like were originally produced by casting methods, such flints have, in recent years, been manufactured by extrusion, as extrusion, of course, increases the plant output, simplifies the manufacture and may be carried out with considerably less expenditure than casting methods. Further, the general quality of extruded flints including the pyrophoric characteristics compare favorably with and are in many respects superior to that of cast flints. For these reasons, the industry has generally adopted extrusion processes for the production of flints.

Extruded as well as cast flints consist essentially of cerium (misch metal) iron alloys. However, those skilled in the art will readily realize that an alloy which may produce satisfactory flints by casting is not necessarily suitable as a raw material for extruded flints. This is so because the problems and considerations underlying the extrusion of flints are entirely different from those prevailing in casting methods. In fact for many decades it was believed that the extrusion of cerium (misch metal) iron alloys was not feasible and in this connection I refer to my U.S. Patent 2,660,301 wherein I disclosed for the first time a commercially practical extrusion process for flint material and explained the obstacles which have to be overcome.

However, although my basic invention as embodied in said U.S. patent has been considered and proved to be a revolutionary advance in this particular art, the extrusion of flints from cerium (misch metal) iron alloys is still plagued by some serious problems. The most serious difficulty in the manufacture of flints or flint rods by extrusion from pyrophoric cerium (misch metal) iron alloys resides in the extremely high extrusion pressure which in present day processes is necessary for extruding the alloy composition through the extrusion die. Pyrophoric alloys used for the extrusion of flints ordinarily contain about 4.5 to 40% of iron in addition to the cerium (misch metal) and such alloy composition can only be extruded at pressures between 5,000 to 16,000 kg. per square centimeter and at extrusion temperatures between 400–500° C. It is obvious that such high pressures require elaborate and excessively expensive extrusion presses, which moreover are, of course, subjected to considerable wear and tear. As the extrusion tools have to be frequently replaced and/or repaired, the intended gain and advantage by using extrusion instead of casting methods is therefore considerably negated or offset by the expenditure in apparatus. In this connection, I wish to state that attempts have previously been made to reduce the extrusion pressure by alloying the basic alloy composition with additional metals. Thus in my own U.S. Patent 2,792,301 I have disclosed certain metals which under stated conditions facilitate the extrusion.

In the production of flints by casting as distinguished from extrusion it has been suggested to add appreciable

amounts of copper or zinc to the alloy mixture to increase the resistance of the flints to disintegration. Further, it is well known in the art that zinc has a favorable influence and effect on the pyrophoricity of flints, particularly if the zinc content exceeds 0.3%. Thus, U.S. Patents 2,408,400 and 2,389,198, for example, which are concerned with the production of flints by casting, recommend that at least 1.2% of copper are added in addition to silver, nickel and chromium. I have carried out extensive experiments with this and other alloy compositions intended for casting with a view of ascertaining whether or not the teachings relating to the casting of flints could be beneficially made use of for the purpose of reducing the working pressure in the extrusion of flints. The results of my experiments are that these prior art casting compositions containing copper, zinc and other metals cannot in fact be extruded and therefore do not contribute anything of value to the extrusion art and particularly have no bearing on the reduction of the extrusion pressure. For the purpose of substantiating this contention, the following should be considered: The extrusion of pyrophoric alloy compositions is by necessity carried out at temperatures at which the billet or ingot to be extruded is in a plastic state. If the optimum extrusion temperature is above the melting point of one or several of the metals of the alloy composition, this metal or metals liquify and the liquid phase seriously impairs the extrusion proper and in many cases renders extrusion impossible. Thus, for example, I have attempted to extrude the alloy compositions disclosed in U.S. Patents 2,408,400 and 2,389,198 previously referred to, but was not successful although I increased the extrusion pressure to 35 tons. The reason for my failure was that the composition formed a substantial amount of liquid phase which soiled and blocked the extrusion tools of the press.

As previously mentioned zinc has extensively been used in cast flints, as the presence of zinc increases the pyrophoricity. For this reason I have attempted to extrude cerium (misch metal)-iron compositions which were alloyed with varying amounts of zinc. My experiments in this respect, however, failed as the presence of zinc in excess of 0.15% rendered extrusion impossible at the customary extrusion temperatures of about 480° C. In fact, I have ascertained that even at zinc contents below 0.15% the extrusion is difficult to perform. This is so because the zinc forms a liquid phase in the alloy composition as elucidated hereinabove. I have tabulated some of my tests in the following Table I.

TABLE I

Test No.	Composition in percentage by weight			Working pressure in kg./cm.² at 480° C. and after 30 minutes of preheating treatment
	Misch metal	Fe	Zn	
327a	18.75	18.1	0.15	4,950.
327b	81.39	18.3	0.31	Not extrudable, as partly liquid.
258	79.60	19.3	1.1	Same.
213	80.00	18.0	2.0	Same.
213b	76.00	18.1	5.9	Same.

This table clearly shows that the required extrusion pressure at a zinc content of 0.15% is exceedingly high, i.e. 490 kg./cm.² while at higher zinc contents extrusion could no longer be performed.

With a view to extruding cerium (misch metal)-iron alloys with higher zinc contents, I tried to lower the extrusion temperature, as the liquefaction of the zinc is, of course, reduced at lower temperatures. My experiments in this direction were, however, equally unsuccessful, as the reduction of the temperature resulted, in turn,

in a significant increase in the required extrusion pressure. In fact, the required high pressure rendered extrusion impractical if not impossible, as available extrusion presses cannot withstand the resulting stresses. Thus, for example, I ascertained that a cerium (misch metal)-iron alloy containing 18% of iron and 1% of zinc could be extruded at 440° C. at a prohibitive working pressure of 7000 kg./cm.^{2} only.

It is, accordingly, a primary object of this invention to provide for a zinc-containing alloy composition which may be extruded at considerably lower pressures than was hitherto possible.

It is also an object of this invention to provide an extrusion process for the extrusion of zinc-containing flint material which may be carried out at lower pressure values than heretofore.

Another object of the invention is to provide extruded flints of excellent quality having superior pyrophoric characteristics.

It is also an object of this invention to increase the storage durability of flints.

Generally, it is an object of this invention to improve on the art of extruding flints as hitherto practiced.

Briefly, and in accordance with this invention, I have ascertained that cerium (misch metal)-iron alloy compositions containing between about 0.3–5% of zinc may be extruded within the desired temperature range of about 400–500° C. at relatively low working pressure if the alloy also contains between about 0.1 to 4.2% of magnesium and the ratio of zinc:magnesium in the alloy is at the most 1.2.

The addition of magnesium completely eliminates the otherwise disturbing influence of zinc and extrusion is readily effected. The presence of magnesium, however, does not affect the pyrophoricity-inducing properties of zinc, so that the zinc-containing flints have excellent pyrophoric characteristics.

In this connection it should be stressed that the indicated zinc:magnesium ratio of at the most 1.2 is critical for a successful extrusion. If the ratio increases, the required extrusion pressure reaches prohibitive values and extrusion is no longer possible.

My observations and experiments relating to the admixture of zinc and magnesium with cerium (misch metal)-iron alloys are tabulated in the following Table II.

TABLE II

Test No.	Composition in percent by weight				Ratio between Zn and Mg	Working pressure in kg./cm.^{2} at 480° C. after 30 minutes of preheating
	Cerium (misch metal)	Fe	Zn	Mg		
I						
336*a*	81.2	18	0.5	0.3	1.66	Not extrudable.
336*b*	81.0	18	0.5	0.5	1.0	3,680.
336	80.5	18	0.5	1.0	0.5	3,260.
302	79.9	18	0.5	1.6	0.31	2,050.
II						
337*a*	80.35	18	1.0	0.65	1.5	Not extrudable.
337	80.00	18	1.0	1.0	1.0	1,850.
338	79.1	18	1.0	1.9	0.53	3,050.
274	76.2	20	1.1	2.7	0.41	3,050.
251	77.2	19	0.9	2.9	0.31	2,450.
III						
339	79.1	18	1.7	1.2	1.42	Not extrudable.
340	77.8	18	2.1	2.1	1.00	2,250.
232	75.2	19.8	2.1	2.9	0.73	3,050.
252	75.8	18.9	2.0	3.3	0.61	3,050.
IV						
341	78.0	18	3.0	1.0	3.00	Not extrudable.
342	76.9	18	2.8	2.3	1.21	1,650.

It will be noted that extrusion could not be performed in tests 336*a*, 337*a*, 339 and 341 as the ratio zinc:magnesium was above 1.2. The tests as tabulated in Table II cover varying percentages of zinc and magnesium,

while the iron content has been maintained substantially constant.

The table clearly supports my surprising discovery that the extrusion obstructing properties of zinc are completely negated by the simultaneous presence of magnesium, provided the zinc:magnesium ratio does not exceed 1.2.

In further developing my invention, I ascertained that the extrusion pressure can be still further reduced without affecting the pyrophoric properties of zinc, if the zinc-magnesium containing cerium (misch metal)-iron alloy is further enriched by the addition of small amounts of copper. The presence of copper in flints is desirable as copper increases the corrosion resistance, shelf life and durability of pyrophoric materials. I have ascertained that the copper has a most beneficial effect in the alloy composition referred to provided it does not exceed 0.35%. If amounts of copper in excess of 0.35% are employed, the formation of liquid phase impedes the extrusion. The lower limit value for the copper is 0.5%, as lesser amounts do not exert any influence on the extrusion. The following Table III lists some of the test results concerning the additional admixture of copper to the basic alloy.

TABLE III

Test No.	Composition in percent by weight					Working pressure (kg./cm.^{2}) at 480° C. after preheating of 30 minutes
	Cerium (misch metal)	Fe	Mg	Zn	Cu	
458	76.2	20.8	2.0	1.0	------	3,500.
460	76.6	20.9	1.7	0.7	0.1	1,850.
461	76.1	20.9	1.8	0.9	0.23	1,450.
462	76.0	20.8	1.9	1.0	0.30	1,250.
462*a*	75.75	20.9	2.0	0.09	0.35	Not extrudable any more.

If, for example, test 338 of Table II is compared with Test 462 of Table III, it will be noted that the zinc and magnesium contents are the same while in test 462 the alloy additionally contained 0.30% of copper. Although the iron contents of the two alloys are slightly different, it is obvious that the significant pressure reduction in test 462 was caused by the presence of the copper.

My tests have also indicated that the presence of the copper within the stated range considerably increases the corrosion resistance, shelf life and durability of the extruded flints. In fact, a copper content of 0.3% doubles the corrosion resistance and shelf life if compared with flints devoid of copper.

The invention will now be described in connection with a specific example, it being understood, however, that this example is given by way of illustration and not by way of limitation, and that many changes may be performed without departing in any way from the scope and spirit of this invention as recited in the appended claims.

Example 1

This example illustrates test 337 of Table II above.

An alloy composition comprising 80.00% by weight of cerium (misch metal), 18% of iron, 1.0% of magnesium and 1.0% of zinc was prepared in known manner and cast into billet or ingot form. The alloy billet was thereafter heated to about 480° C. for 30 minutes and the billet was inserted into an extrusion press and was extruded into thin rods of 2 to 6 mm. diameter at an extrusion pressure of 1850 kg. per square centimeter. The extruded rods were thereafter cut down into individual flints of suitable length.

Similar tests were carried out to arrive at the other test results of Tables II and III.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What I claim is:

1. A pyrophoric alloy composition suitable for extrusion essentially consisting of about between 4.5 to 40% of iron, between 0.3 to 5% of zinc and between 0.1 to 4.2% of magnesium, the remainder being cerium (misch metal), the ratio zinc:magnesium being at the most 1.2.

2. An extruded flint essentially consisting of about between 4.5 to 40% of iron, between 0.3 to 5% of zinc and between 0.1 to 4.2% of magnesium, the remainder being cerium (misch metal), the ratio zinc:magnesium being at the most 1.2.

3. An extruded flint essentially consisting of between about 18 to 22% of iron, about 0.3 to 5% of zinc and between 0.1 to 4.2% of magnesium, the remainder being cerium (misch metal), the ratio zinc:magnesium being at the most 1.2.

4. A pyrophoric alloy composition suitable for extrusion essentially consisting of about between 4.5 to 40% of iron, between 0.3 to 5% of zinc, between 0.1 to 4.2% of magnesium and between 0.05 to 0.35% of copper, the remainder being cerium (misch metal), the ratio zinc:magnesium being at the most 1.2.

5. An extruded flint essentially consisting of about between 4.5 to 40% of iron, between 0.3 to 5% of zinc, between 0.1 to 4.2% of magnesium and between 0.05 to 0.35% of copper, the remainder being cerium (misch metal), the ratio zinc:magnesium being at the most 1.2.

6. An extruded flint essentially consisting of between about 18 to 22% of iron, between 0.3 to 5% of zinc, between 0.1 to 4.2% of magnesium and between 0.05 to 0.35% of copper, the remainder being cerium (misch metal), the ratio zinc:magnesium being at the most 1.2.

7. A process of producing flint rods by extrusion which comprises extruding a pyrophoric alloy in ingot form and essentially consisting of about between 4.5 to 40% of iron, between 0.3 to 5% of zinc, about between 0.1 to 4.2% of magnesium, the ratio zinc:magnesium being at the most 1.2, the balance being cerium (misch metal), at a temperature of between about 400 to 500° C. and at the lowest working pressure at which extrusion is possible.

8. The process as claimed in claim 7, wherein the alloy is preheated before being extruded.

9. The process as claimed in claim 7, wherein the extrusion pressure is between about 1600 and 3700 kg./cm.^{2}.

10. The process of claim 7, wherein the alloy additionally contains 0.05 to 0.3% of copper.

11. In a process of extruding flints from alloy compositions in ingot form, wherein the alloy composition essentially consists of between about 4.5 to 40% of iron, the remainder being cerium (misch metal) and the alloy composition is extruded at a temperature of between about 400–500° C., the improvement which comprises incorporating into the alloy composition, prior to extrusion, between 0.3 to 5% of zinc and between 0.1 to 4.2% of magnesium, the ratio zinc:magnesium being at the most 1.2.

12. The improvement of claim 11, wherein between 0.05 to 0.35% of copper are additionally incorporated into the alloy composition prior to extrusion.

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