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PROCESS OF MAKING ALUMINUM COATED STEEL OF HIGH REFLECTIVITY

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The invention has to do with the problem of making iron or steel sheet stock which is coated with aluminum by a process involving the wetting of the base stock surface with molten aluminum, in such a way that the aluminum surface of the stock has great smoothness and high reflectivity. These qualities enable the stock to be employed to better advantage in many uses including both decorative uses, uses in the fabrication of articles where an aluminum surface is desired, insulative uses, and uses for the reflection and concentration of heat or infrared radiations, as, for example, in electric wall heaters.

Methods and apparatus for coating iron or steel sheet stock (usually strip stock of sheet width and gauge) with aluminum have hitherto been developed. The present invention is not limited to any specific coating process, although the characteristics of the coated stock should be those hereinafter set forth. By way of example the Sendzimir Patent No. 2,110,893, dated March 15, 1938, and the Oganowski Patent No. 2,437,919, dated March 16, 1948, may be referred to as teaching suitable methods and apparatus for coating.

When iron or steel stock is coated by these and other methods a relatively bright surface is produced; but the surface is not mirror-smooth nor as reflective as, for example, sheet aluminum which has been rolled to gauge in a carefully adjusted mill with smooth rolls, the finishing pass or passes being made by highly polished or burnished rolls. Moreover, the surface is generally characterized by inequalities, principally heavier and lighter areas.

It is an object of the invention to provide a way of improving the reflectivity, smoothness and coating perfection of iron or steel stock hot coated with aluminum.

It is an object of the invention to provide a process of this character which is inexpensive and does not add significantly to the cost of the product.

It is an object of the invention to provide a process of the character outlined which does not operate to change the physical characteristics of the product.

These and other objects of the invention which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, are accomplished by that procedure and in that product of which certain exemplary embodiments will now be described.

The products of this invention are normally coated with aluminum in at least commercially pure form; but it is not intended to exclude from the claims which follow, iron and steel stocks (or other base metal stocks) coated with alloys consisting preponderantly of aluminum but containing other alloying elements such as silicon, magnesium, and the like in minor quantity.

Suitable coated products for the practice of this invention may have coatings of aluminum or aluminum alloy of about one ounce per square foot. In the coating of iron or steel base stock with aluminum by the methods referred to above, there is normally formed between the base stock and the aluminum coating a thin layer of iron-aluminum alloy. Such an alloy layer can be tolerated in the present process; but the coating should be carried on in such a way that there is a definite top layer of aluminum or aluminum alloy which is pure in the sense that it is not substantially alloyed with the metal of the base stock. In a preferable product the overlying

layer of aluminum, as distinguished from the interface alloy, should have a thickness of about .005 to about .0005 inch.

With stock of this character, it is impossible to obtain the bright and reflective surfaces contemplated by this invention through the expedient of rolling the product between bright or burnished rolls. The base stock, treated in accordance with the patents which have been set forth above, is generally softened or annealed in the reducing furnace through which it passes before it enters the molten bath of aluminum or aluminum alloy, and consequently in many instances can be given a certain amount of temper rolling, say up to an elongation of about 2%. But because of the roughnesses and inequalities in the surface, as described above, an attempt to roll the coated stocks between burnished or polished working rolls with an elongation of about 2% or less will result in a streaked or mottled appearance which is unpleasant and makes for low overall reflectivity. This is due to the fact that at such elongations the polished rolls are not able to contact the whole of the coated surface under equal pressure. The mottling can be descreased by increasing the elongation; but in most instances even at 5% or more elongation it is quite impossible to make the whole surface uniform. Further, such elongations, and indeed any elongations above about 2%, tend to harden the base stock and make it unfit for many fabricating operations. Thus, it has been hitherto impossible to treat aluminum coated iron or steel base sheet stock by rolling with polished rolls so as to obtain a uniformly bright surface of high reflectivity; and the art has had no solution for this problem.

In accordance with the present invention, it has been discovered that it is possible to give to the aluminum or aluminum alloy coated base stock a preliminary treatment which changes the character of the light metal coating and unifies and redistributes it, in such a way that a subsequent rolling with bright or burnished rolls will produce a mirror-smooth and highly reflective surface which is uniform and completely free from the mottling effect described above. It has further been found that the preliminary and subsequent treatments can be carried on without undue elongation of the base stock, and well within the limits of normal desirable temper rolling.

Briefly, in the practice of the invention, the coated product is first rolled through rolls having a uniform roughness as will hereinafter be described. This creates a dull but uniform matte finish which has been found to roll flat and bright upon the subsequent treatment. Putting this another way, the coating after the first treatment may be described as characterized by hills and valleys, in the formation of which the coating has been redistributed and unified, with the elimination of surface defects. When such a treated coating is subsequently rolled with bright finished rolls, the tops of the hills are flattened down into a mirror finish. In the successful practice of the invention, it is necessary to produce hill-like formations of a suitable height and distribution.

For the production of the dull but uniform matte finish, a mill is employed with carefully and uniformly roughened rolls. These rolls are preferably shot blasted or so-called "Pangborn" rolls which have been treated with a shot or grit ranging from about number 120 to number 150 as understood in the art of making shot blasted rolls. A roll shot blasted with number 120 shot or grit will have a surface roughness of 50 to 60 micro inches R.M.S. (root mean square), as measured on a standard profilometer. It has been found that with rolls uniformly treated with shot of the sizes set forth, the coating on the iron or steel base stock will be uniformly converted to the desired matte finish in a temper rolling which does not produce more than about 1% elongation.

If rolls are employed treated with a shot or grit substantially smaller than number 150, a matte finish will be formed on only parts of the area of the stock surface, and the effect will be mottled. If the rolls have been treated with a shot or grit substantially larger than number 120, it may be found difficult to avoid a mottling of the surface at an elongtaion of about 1% or less; but in any event, the subsequent treatment with the bright or buffed rolls will not serve to flatten down the hills of the coating, and the resultant finish as observed by reflected light at a relatively high angle will be characterized by a grain which has an appearanec somewhat like the grain of moroccan leather. The reflectivity and brightness of the product will also be impaired.

It will be understood by those skilled in the art that the roughness of shot blasted or Panborn rolls tends to wear away in time, and care should be taken to keep the rolls in good condition, refinishing them as may be required. The need for refinishing can be ascertained by inspection of the rolls; but when the shot blasting indentations have worn away to an appreciable degree, difficulty will be found in obtaining a dull matte finish which is uniform on the product. In other words, the appearance of mottling can be taken as an indication that new rolls should be substituted, or the old rolls retreated.

When a suitable dull matte finish has been produced as set forth above, the second step of the treatment, namely a temper rolling of the product using highly polished or buffed working rolls, will serve to produce a smooth bright finish with high reflectivity, devoid both of mottling, and of any pattern persisting from the roughness which was initially imparted to the coating. Any suitable type of buffed or polished rolls may be employed for this purpose, a suitable type of roll being that known in the trade under the name of "Buffed Rolls," and having typically a profilometer reading of 1.5 micro inches R.M.S. It will be understood that such rolls also tend to wear, and therefore the rolls employed should be new or of equivalent brightness. Wear tends to produce a roughness in the burnishing rolls, and if this occurs a finish of inferior reflectivity will result. The invention is not limited to the use of rolls having any particular degree of polish or burnished character, it being understood that the higher the polish of the rolls the smoother the surface will be.

The production of a uniformly smooth bright finish, devoid of mottling, and possessing high reflectivity can be attained after the initial treatment with an elongation of 1% or less. Thus the total elongation produced in the two treatments can be held to a value of 2% or less which is well within the normal permissible limits of temper rolling for the product.

It may be stated that, given a normal perfection of coating, the thinner the layer of pure aluminum or aluminum alloy (as distinguished from the interface layer of iron-aluminum alloy) the less total elongation will be required in the successive treatments which have been described.

The process has been found to work consistently and to give consistently good results. It will be understood that the specific brightness and reflectivity of the finished product will depend to a certain extent upon the finish of the rolls used in the second step. The brightness of the treated strip may be measured with a reflectance meter. By way of an exemplary but non-limiting illustration, an aluminum-coated iron or steel strip, in the as-coated condition, showed a reflectivity of 16%. When this product was given a dull but uniform matte finish by being rolled with number 120 shot Pangborn rolls with an elongation of 1%, its reflectivity was found to be 19%. When the product thereafter was rolled with about 1% elongation with Buffed Rolls, it exhibited a reflectivity in excess of 90%. Its surface was completely devoid of mottling, and was mirror-smooth and bright. It was found that the coating had been unified; and the surface was devoid of the appearance of inequalities. The product was excellently adapted for fabrication, having been temper rolled with an elongation of not over 2%. Its heat reflectivity was found to be equivalent to or better than bright rolled solid aluminum, buffed chrominum plated stainless steel, buffed copper and buffed 18–8 stainless steel.

It will be understood by the skilled worker in the art that no surface treatment should be applied on the aluminum coating after formation as herein set forth, since such surface treatments tend to produce a foggy film after bright rolling. To the extent that protection for the surface is desired, the product may be covered with paper either by wrapping, interleaving, or with the use of a pressure-sensitive adhesive, until the product is used for fabrication, installation, or the like.

Modifications may be made in the invention without departing from the spirit of it. The invention having been described in an exemplary embodiment, what is claimed as new and desired to be secured by Letters Patent is:

1. A process of producing a base metal sheet stock coated with aluminum or aluminum alloy and having a bright, uniform, mirror-like finish of high reflectivity which comprises associating aluminum or aluminum alloy with a base metal sheet stock by hot coating to a thickness of .005 inch maximum, rolling the coated sheet stock with an elongation not exceeding about 1% between a pair of working rolls having a uniformly rough surface characterized by shot blasting with grit ranging from number 120 to number 150 whereby to produce a dull uniform matte finish on the product, and thereafter temper rolling the product with an elongation not greater than about 1% between a pair of highly polished working rolls having a profilometer reading of about 1.5 micro inches whereby to smooth out the matte finish previously produced.

2. A process of producing an aluminum coated iron or steel strip stock of sheet gauge which comprises hot coating said strip stock with aluminum so as to produce a coating weight not exceeding about one ounce per square foot, thereafter temper rolling said coated stock through a pair of shot blasted working rolls treated with shot ranging from substantially number 120 to substantially number 150, the elongation not exceeding about 1%, and finally temper rolling said strip with an elongation not exceeding substantially 1% between a pair of highly polished working rolls having a profilometer reading of about 1.5 micro inches.

3. The process claimed in claim 2 wherein the aluminum on the surface of said stock, as distinguished from any aluminum-iron interface alloy between said aluminum and said stock, has a thickness of at least about .0005 inch.

4. A process of producing an iron or steel strip stock of sheet width and gauge having a uniform, mirror-like finish of high reflectivity, which comprises an iron or steel stock hot coated with a material chosen from a class consisting of aluminum and aluminum alloys in which aluminum preponderates, the thickness of the said coating being between about .0005 and .005 inch, and in a series of rolling steps the total elongation of which does not exceed about 2%, first redistributing said coating by forming uniform proturberances and depressions therein by rolling between a pair of working rolls having a profilometer reading of about 50 to 60 micro inches to provide a dull matte finish of uniform character throughout the coated area, and then reducing said proturberances and depressions to a uniformly smooth and bright surface by rolling with highly polished rolls.

References Cited in the file of this patent

UNITED STATES PATENTS

1,695,910 Biggert ---------- Dec. 18, 1928

(Other references on following page)

5

UNITED STATES PATENTS

2,084,327	Edwards	June 22, 1937
2,126,578	Roemer	Aug. 9, 1938
2,480,711	Calton	Aug. 30, 1949
2,490,543	Robertson	Dec. 6, 1949
2,539,247	Hensel	Jan. 23, 1951
2,687,565	Schaefer	Aug. 31, 1954
2,708,304	Lundin	May 17, 1955
2,752,305	Turner	June 26, 1956

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2,773,302	Watson	Dec. 11, 1956
2,928,777	Smith	Mar. 15, 1960

OTHER REFERENCES

"Aluminum and Its Application," by Hiram Brown, Pitman Publishing Co., New York, copyright 1948; pages 109–112, 122–124.

"Handbook of Aluminum," published by Aluminum Company of Canada, copyright 1957; pages 26–33, 130-136.