

Sept. 11, 1956

N. V. GATES

2,762,115

PROTECTING HOT EXTRUDED METAL

Filed Jan. 29, 1952

FIG. 1

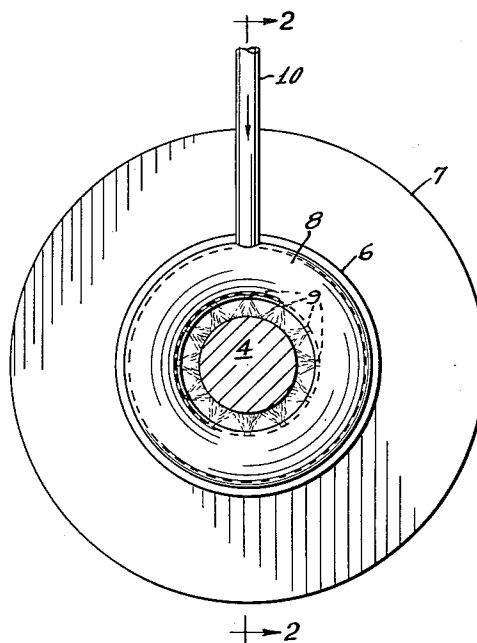
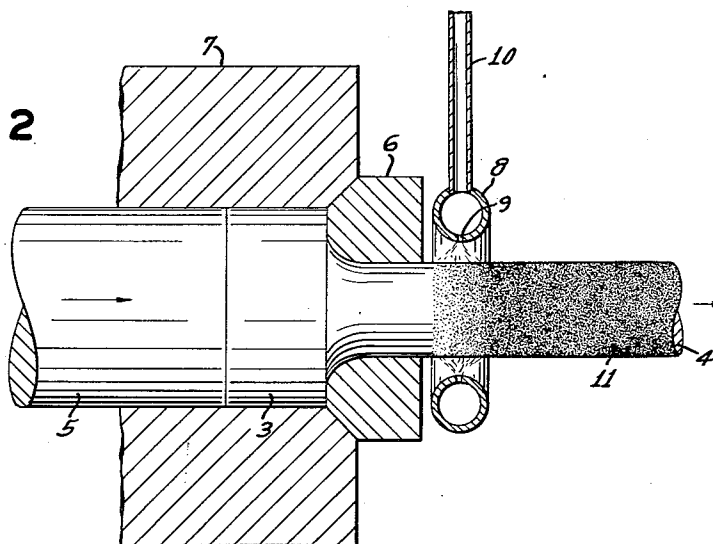


FIG. 2



INVENTOR

Newman V. Gates

BY

Reinhold & Walter Baumgardner & Taylor

ATTORNEYS

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PROTECTING HOT EXTRUDED METAL

Newman V. Gates, Stratford, Conn., assignor to The American Brass Company, Waterbury, Conn., a corporation of Connecticut

Application January 29, 1952, Serial No. 268,755

4 Claims. (Cl. 29—424)

This invention relates to the protection of freshly extruded hot metallic surfaces from oxidation by contact with the air while they are still at the elevated temperature necessary for extrusion. Such protection is provided in accordance with the invention by passing the freshly extruded metal shape through a protective vapor flux atmosphere immediately upon its emergence from the extrusion die.

The extrusion of metals such as copper and its alloys requires heating the metal to a hot-working temperature above the recrystallization temperature and then forcing the hot metal under high pressure to flow out through a die of the desired cross-sectional shape. The temperature of the metal as it emerges from the die is high enough so that extensive air oxidation ordinarily occurs promptly upon its contact with the atmosphere. The resulting surface oxidation products are generally removed by pickling in an acid-chromate bath. In the case of copper or copper alloy extrusions, such pickling removes the black cupric oxide scale from the metal surface, but does not completely remove the red cuprous oxide. Surface residues of cuprous oxide may cause trouble upon further working of the extruded product.

The present invention avoids the necessity of specially treating extruded metal shapes to remove surface oxidation products, by protecting such shapes from oxidation as they emerge from the extrusion die. The method of the invention comprises establishing an alkyl borate vapor atmosphere, passing a hot extruded shape into said vapor immediately upon emergence from an extrusion die, and maintaining the hot extruded shape in said atmosphere until its surface is substantially covered with a film of flux resulting from thermal decomposition of said vapor by contact thereof with the hot shape, whereby the surface of the shape is protected from oxidation. Only after such flux coating has been deposited on the shape is it passed into an ordinary air atmosphere. The flux coating serves to protect the extruded metal in two ways—it minimizes the extent to which oxidation thereof occurs, and it dissolves such oxidation products as form despite its presence.

The alkyl borate employed in the method of the invention is commonly known as a "vapor flux," i. e. a fluxing agent which is readily convertible to a vaporous, gaseous or mechanically finely divided form so that it may be entrained in a gas stream and may be dispersed in a gas atmosphere. Typical alkyl borate vapor fluxes are those composed essentially of methyl, butyl, propyl, isopropyl, tributyl, amyl, and hexyl borates. They may be used as such or in solution in alcohol or other organic solvent. These volatile borate compounds are liquid at room temperature but vaporize quite completely at slightly elevated temperatures. Ethyl borate, for example, boils at 120° C. The vaporized alkyl borate decomposes in a flame or upon striking a hot metal surface to form a boron oxide, which of course is a well-known flux capable of combining with many metallic oxides to form a light slag. The lower alkyl borates, such

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as methyl, ethyl, and isopropyl borates are best adapted for use as vapor fluxes since they are easily volatilized from the liquid form by bubbling a gas through them or passing it over the surface of a body of liquid. However, in addition to the alkyl borates, various other compounds such as alkyl silicates, azeotropic and other mixtures of alkyl borates and alkyl silicates, and boron trichloride, all can be and on occasion are used in the same way as alkyl borates to serve as vapor fluxes. These other compounds are the full equivalents of the alkyl borates for purposes of the present invention. Throughout this specification and in the appended claims particular reference is made to alkyl borates because they constitute the preferred vapor fluxes for general use, but it is to be understood that the other compounds previously referred to could be used in like manner and are the full equivalents, for purposes of this invention, of the alkyl borates specifically mentioned.

An advantageous form of apparatus to employ in carrying out the method of this invention is shown in the accompanying drawings, in which—

Fig. 1 is a view of the exit side of an extrusion die, showing a perforated tubular ring assembly used to apply a vapor flux to a rod being extruded, and

Fig. 2 is a sectional view of the die and tubular ring assembly taken substantially along the line 2—2 of Fig. 1.

As shown in the drawings, a billet 3 of copper alloy is being extruded into the form of a rod 4 by a ram 5 through the opening of a die 6 that is held tightly against the cylinder 7 of an extrusion press. The extruded metal is at an elevated temperature of perhaps 1400° F. A tubular ring 8 is positioned closely adjacent and in a plane parallel to the exit side of the die 6. It extends completely around the die opening and thus surrounds the emerging extruded copper alloy rod. Small perforations 9 are cut at regular intervals in the wall of tubular ring 8, about its inner periphery. The tubular ring 8 is connected with a source of alkyl borate vapor through a delivery tube 10. Such vapor can be generated, for example, by bubbling compressed air through a reservoir of liquid alkyl borate, or by passing it over the surface of a body of heated alkyl borate. Instead of compressed air, it may sometimes be desirable to use compressed nitrogen or some other inert gas.

In utilizing the above-described apparatus, alkyl borate vapor either alone or carried in a current of air or other gas is delivered through the tube 10 into the interior of the tubular ring 8, whence it issues from the perforations 9 and is thereby directed against the surface of the rod being extruded. Thus an atmosphere of alkyl borate vapor is established about the exit side of the die 6; and the hot extruded rod 4, immediately upon emerging from the die, enters this atmosphere. The alkyl borate undergoes thermal decomposition upon contact with the hot extruded metal to form a boron oxide flux coating 11 on the rod 4. This coating provides excellent protection for the underlying metal against oxidation. Such oxidation products as do happen to form dissolve in the flux with the formation of a protective slag covering which freezes on the surface of the metal as the latter cools.

As the rod or other extruded shape cools to room temperature, the slag and flux coating cracks owing to the difference between its thermal coefficient of contraction and that of the metal itself, and hence it is easily removed from the extruded rod when the latter is cold and no longer readily susceptible to air oxidation.

If the rod or other shape is to be cold-finished, no effort need be expended to remove the residual coating of protective flux or slag. The latter breaks off completely in subjecting the extruded shape to the plastic deforma-

tion incident to cold-drawing or cold-rolling operations.

It has been found that extruded shapes of copper alloy protected from oxidation in accordance with the method of this invention are essentially free from any objectionable oxide scale when the metal has cooled to room temperature. Further, extrusions thus protected and thereafter cold-drawn or cold-rolled without being subjected to any intermediate pickling operation, do not develop slivers or display other defects which result from oxide inclusions forced into the metal in the course of plastically deforming it.

I claim:

1. The method of protecting hot extruded metal shapes which comprises establishing an alkyl borate vapor atmosphere, passing a hot extruded shape into said atmosphere immediately upon its emergence from an extrusion die, and maintaining the hot extruded shape in said atmosphere until its surface is substantially completely covered with an adhering film of the product resulting from thermal decomposition of said vapor by contact thereof with the hot shape, whereby the surface of the freshly extruded shape is protected from oxidation.

2. The method of protecting hot extruded metal shapes which comprises directing a stream of alkyl borate vapor against the surface of a hot extruded metal shape as it emerges from an extrusion die, whereby a protective film resulting from thermal decomposition of said vapor by contact thereof with the hot shape is deposited on the surface of said shape.

3. In a process of the character described, the improvement which comprises establishing an alkyl borate vapor atmosphere, extruding a metal shape at a temperature high enough for such shape readily to acquire an oxide scale in air directly into said atmosphere, maintaining the extruded shape in said atmosphere until it is substantially completely coated by an adhering film of the product re-

sulting from thermal decomposition of said vapor by contact thereof with the hot shape, and only thereafter passing the extruded shape into an ordinary air atmosphere.

4. In a process of the character described, the steps which comprise establishing an alkyl borate vapor atmosphere, extruding a metal shape at a temperature high enough for such shape readily to acquire an oxide scale in air directly into said atmosphere, maintaining the extruded shape in said atmosphere until its surface is substantially completely covered by an adhering film of the product resulting from thermal decomposition of said vapor by contact thereof with the hot shape, then withdrawing the flux-coated shape from said atmosphere and allowing it to cool substantially to room temperature, and thereafter subjecting the extruded shape with the flux coating remaining thereon to a cold-working operation, whereby the flux coating is separated from the shape and a cold-finished metal shape substantially free of oxide inclusions or surface scale is produced.

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