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[54] **EXTRUSION APPARATUS AND METHOD**

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[52] **U.S. Cl.** **72/253,** 72/272, 72/342

[51] **Int. Cl.**.....**B21c 29/04**

[58] **Field of Search**.....72/257, 272, 253, 342, 467, 72/271

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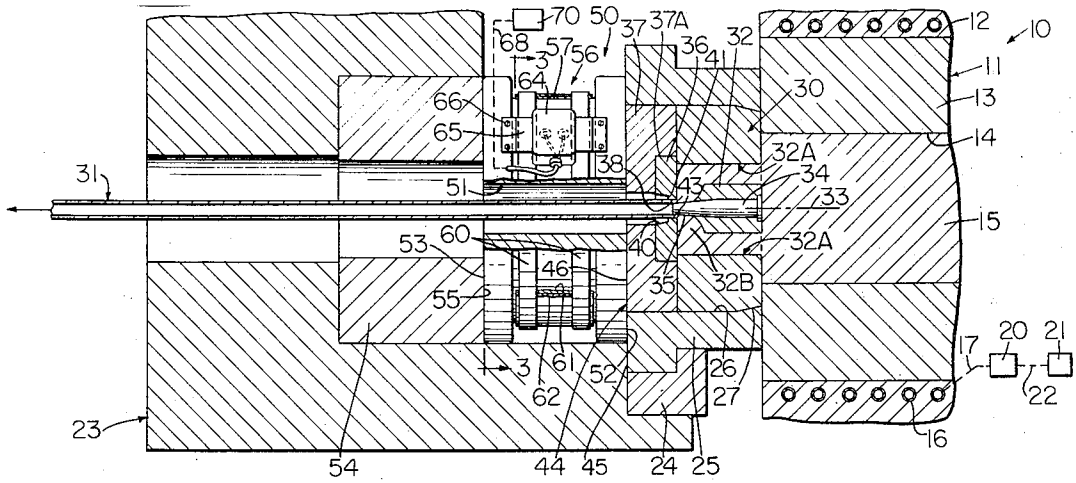
[57] **ABSTRACT**

An apparatus for and method of extruding metal billets is provided and comprises a heated billet container adapted to contain a metal billet adjoined by an extrusion die through which the billet is extruded to define an extruded article. A heated support adjoins the downstream end of the heated die and has an opening therein which is adapted to receive the extruded article therethrough and such support cooperates with the heated billet container to prevent dissipation of heat from opposite ends of the die and thereby provide optimum extrusion efficiency.

15 Claims, 3 Drawing Figures



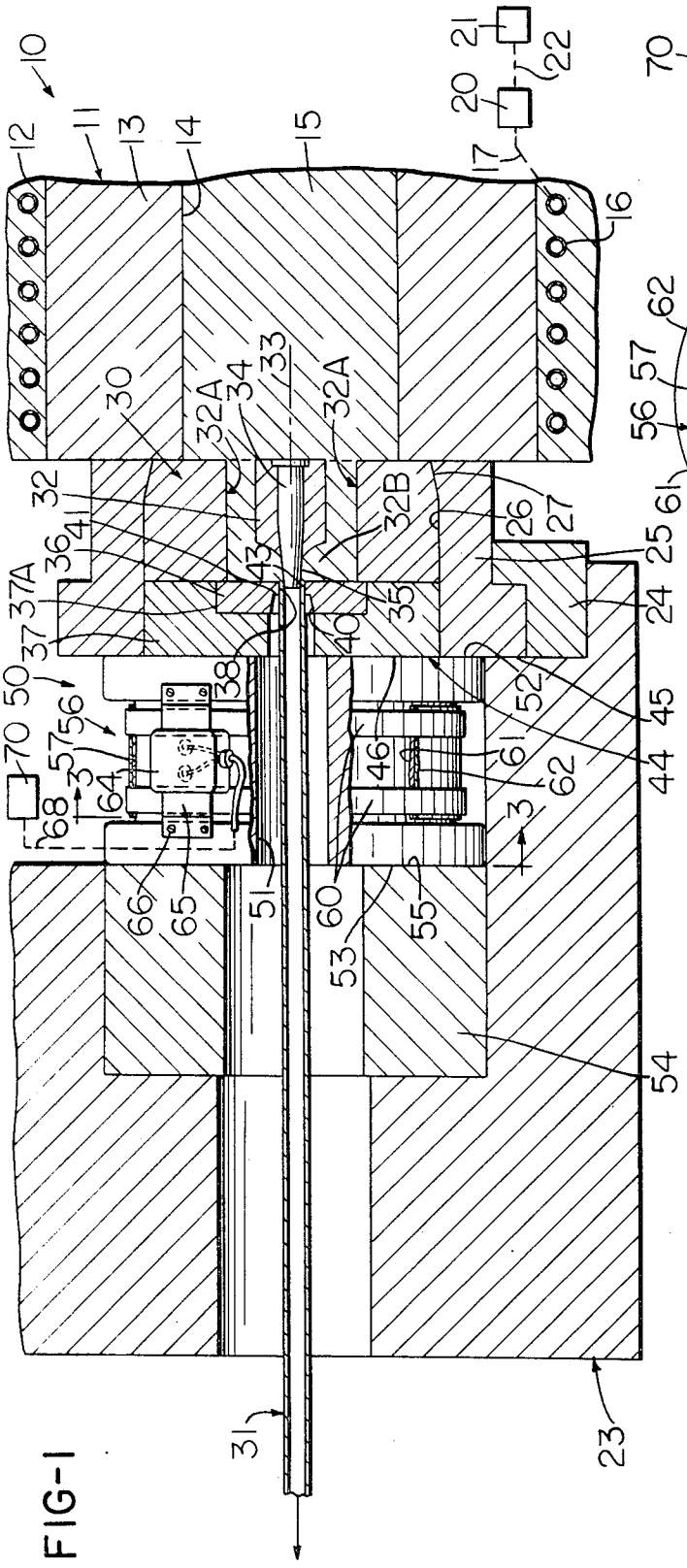


FIG-1

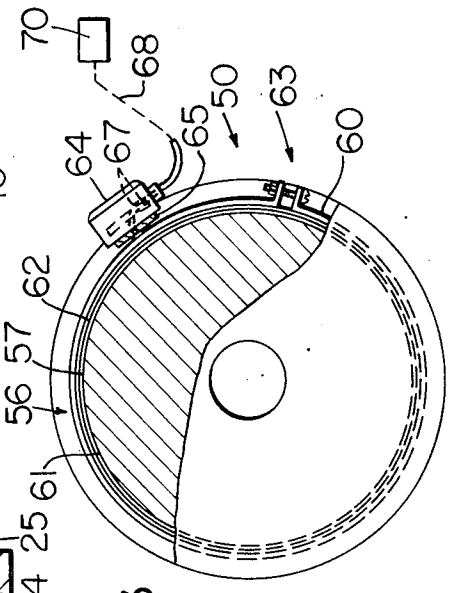


FIG-3

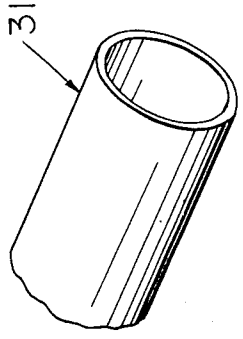


FIG-2

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EXTRUSION APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

During the extrusion of metal articles it is common practice to heat a metal billet to a predetermined temperature and then place the billet in a container of the associated extrusion apparatus and such container is heated and kept at a comparatively high temperature to enable extrusion of the billet through an associated die. A problem with presently used apparatus and methods used to extrude metal articles including, for example, articles having an arcuate cross-sectional configuration, metal tubing, and the like, is that there is usually excessive loss of heat from the hot die to supports arranged downstream of the die because these supports are colder than the die by more than several hundred degrees Fahrenheit whereby there is a tendency to distort the billet as well as a tendency for the billet to seize in the die.

It is also extremely difficult to extrude small diameter metal tubing having a small cross-sectional area when compared to the cross-sectional area of its associated billet. For example, to produce ¼ inch O.D. X 0.035 inch wall thickness tubing by extruding 1,200 aluminum alloy, it is necessary to heat the extrusion die to a temperature in excess of roughly 1,000°F to assure the die will not be cooled excessively by heat transfer to adjoining structures. This high temperature approaches the annealing temperature of most commonly used materials used to make such die whereby the operating life of the die is substantially reduced.

It has also been found that during the routine operation of extrusion apparatus it is necessary to stop to make minor repairs. Also, in many facilities extrusion presses are usually inoperative for a day or more, such as over a week-end. In all of these instances it is necessary to provide a heated extrusion die in the apparatus to enable articles to, once again, be extruded efficiently whereby time delays are incurred with associated production losses.

SUMMARY

This invention provides an improved apparatus for and method of extruding metal articles, such as metal tubing, which overcomes the deficiencies of presently used apparatus and methods and enables the production of extruded articles with a minimum loss of production time. In particular, a heated billet container which is adapted to contain a heated metal billet is provided and such container is adjoined by an extrusion die through which the billet is extruded to define an extruded article. A heated support adjoins the downstream end of the heated die and has an opening therein which is adapted to receive the extruded article therethrough and such support cooperates with the heated billet container to prevent or counteract dissipation of heat from opposite ends of the die and thereby provide optimum extrusion efficiency.

Other details, uses, and advantages of this invention will become apparent as the following description of the embodiment thereof presented in the accompanying drawing proceeds.

BRIEF DESCRIPTION OF THE DRAWING

The accompanying drawing shows a present preferred embodiment of this invention, in which

FIG. 1 is a fragmentary view with parts in cross-section and parts in elevation illustrating an exemplary apparatus and method of this invention particularly adapted for extruding metal tubing;

FIG. 2 is a fragmentary perspective view of tubing made utilizing the apparatus and method of FIG. 1; and

FIG. 3 is a view taken on the line 3—3 of FIG. 1.

DESCRIPTION OF ILLUSTRATED EMBODIMENT

Reference is now made to FIG. 1 of the drawing, which illustrates an exemplary embodiment of an apparatus and method of this invention which is designated generally by the reference numeral **10**. The apparatus **10** may be used in an extrusion press of known construction and in this example is used to provide extrusion by the so-called direct method.

The apparatus **10** comprises a billet container **11** which is comprised of an outer jacket or housing **12** which has a liner **13**. The liner **13** and, hence, container **11** has an opening or chamber **14** extending axially therethrough which is adapted to receive a metal billet **15**. The container **11** is provided with heaters which in this example are shown as electrical heating elements **16** provided in the housing **12** and such elements are connected by a line **17** to an electrical control assembly **20** which is in turn connected to a source **21** of electrical power by an electrical line **22**. Thus, through the use of the heating elements **16** and the electrical control assembly **20**, the container **11** may be heated and controlled in temperature so that upon placing the billet **15** within the chamber **14** if will not be cooled excessively during extrusion thereof.

The apparatus **10** comprises a tool container **23** which supports a ring **24** and the ring **24** in turn supports a die holder **25** which has an inside supporting surface **26** which has a tapered or frustoconical portion **27** defining one end portion thereof. The die holder **25** supports die means or a die assembly which is designated generally by the reference numeral **30** and such die means in this example of the invention is adapted to define an extruded article in the form of an extruded metal tube **31**, also see FIG. **2**.

The die assembly **30** is comprised of an upstream member **32** which has a plurality of axial passages **32A** arranged in spaced relation concentrically around a central longitudinal axis **33** which is common to the die assembly **30** and the entire apparatus **10**. The terms upstream and downstream are used in this specification with reference to the direction of flow of extruded metal. The spaced passages **32A** communicate with a converging chamber **32B** provided in the downstream end of member **32** which serves as a combining or welding chamber **32B** for the metal extruded through passages **32A**. The member **32** also has a mandrel **34** fixed thereto and such mandrel has a tapered downstream portion **35** which extends into the welding chamber **32B** for reasons which will be apparent from the following description.

The die assembly **30** also includes a die plate **36** which is supported within a cylindrical recess **37A** of a die plate holder **37** and the plate **36** has a precisely controlled right circular cylindrical passage **38** in the forward end thereof. The passage **38** communicates with a larger diverging passage **40** downstream thereof. The passage **40** is arranged concentrically with passage **38** and an annular shoulder **41** extends between the

downstream end of passage **38** and the upstream end of passage **40**.

During normal operation of the apparatus **10**, metal is extruded through the passages **32A**, combined in the combining or welding chamber **32B**, and then forced through an annular passage **43** defined by the outside surface of downstream portion **35** of mandrel **34** and the inside cylindrical surface of the die plate **32** defining passage **38** to define the tube **31**. The tube **31** then proceeds through passage **40** in the die plate **36** and through adjoining aligned passages, which will be described subsequently, out of the apparatus **10**.

The die means or assembly **30** has a downstream planar bearing surface which is designated generally by the reference numeral **44** and surface **44** is arranged in a vertical plane. The bearing surface **44** is comprised of a cooperating portion of an annular planar surface **45** of the die holder **25** and an annular planar surface **46** of the die plate holder **37**.

The apparatus **10** comprises a heated metal support designated generally by the reference numeral **50** and in this example the support **50** has a substantially cylindrical configuration. The support **50** has a cylindrical opening **51** extending longitudinally therethrough and has a pair of opposed planar bearing surfaces **52** and **53** defining its opposite ends.

The apparatus **10** includes an adapter block **54** which is supported in the tool container **23**. The block **54** has an outer annular planar bearing surface **55** and the assembly of components in the tool container **23** is such that surface **55** is normally held urged tightly against surface **53** of the support **50** with surface **52** held tightly against bearing surface **44**.

The support **50** is in the form of a heated support and in this example such support is heated electrically and for reasons which will now be presented. In particular, during normal operation of the apparatus **10**, the die assembly **30** is kept at an adequate temperature by the heat generated, i.e., the heating action produced, by the extrusion process. The die assembly **30** is also assured of being kept in a heated condition by the cooperating action of the heated billet container **11** and the heated support **50** thereby assuring that heat is not dissipated from the die through its opposite ends by conduction to thus provide optimum extrusion efficiency. Thus, a plurality of billets similar to the billet **15** may be serially extruded merely by removing each hot billet **15** from its associated heated oven while keeping the billet container **11** and the heated support **50** at a predetermined temperature and without the necessity of heating the die assembly, and in particular the die plate **36** in a separate oven, even after a prolonged shut down, such as might occur over a week-end of inoperation.

The support **50** has an annular cutout **56** which defines a reduced diameter right circular cylindrical surface **57** and heating means in the form of a plurality of electrical heater straps **60** are provided and received within the cutout **56**. An electrical insulating material such as a sheet of mica **61** is wrapped concentrically around and against cylindrical surface **57** and the mica **61** may have a layer **62** of asbestos, fiberglass, or the like wrapped thereagainst. Each heater strap **60** is fastened tightly against the layer **62** by a suitable fastening assembly **63** comprised of cooperating brackets and a nut and bolt.

An electrical power control device **64** is also provided and fixed in electrically insulating relation to a plate **65** which is in turn suitably fixed to the support **50** by a plurality of threaded metal bolts **66**. The heater straps **60** are mechanically and electrically connected by leads **67** to the device **64** which is in turn operatively connected by an electrical line **68** to a source of electrical power **70**. The device **64** preferably has electrical controls which precisely control the heating of the support **50**.

The apparatus and method of this invention has been especially effective in extruding aluminum tubing. For example, in one application a billet **15** of 1,200 aluminum alloy is heated in an associated heating oven to a temperature of 950° F. The heated billet **15** is then placed in the heated container **11** and such container is controlled so that its temperature is kept at approximately 820° F.

With the die assembly **30** moved in to operating position, the ram of the press with which the apparatus **10** is associated is urged against the billet to commence the extrusion operation. During extrusion, it will be appreciated that there is no need to heat the die assembly **30** per se because of the heat generated by the extrusion of metal through the die. To prevent heat from dissipating from the downstream end portion of the die assembly **30**, the support **50** is heated and kept at a temperature of approximately 820° F and the heated support **50** cooperates with the heated billet container **11** to provide an accurately controlled heated environment at opposite ends of the die whereby optimum extrusion efficiency is provided.

It has been found that with the apparatus and method of this invention it is possible to extrude a billet of 1,200 aluminum alloy 6¼ inches in diameter and 24⅝ inches long through a standard die to define ¼ inch and another O.D. tubing having a wall thickness of 0.035 inch and even less without requiring that the die assembly **30** be heated to excessive temperatures as is required using present apparatus and methods.

The heater straps **60** of this example are resistive heater straps; however, it will be appreciated that other electrical heating devices as well as other heating techniques may be used to heat support **50**.

The use of the heated container at one end of a die means or assembly **30** and a heated support or bolster at the opposite end thereof provides numerous advantages. In particular, the die assembly **30** has a lower and more uniform temperature throughout which improves die life. Further, this invention enables the provision of tubing having a more accurate diameter and a more uniform wall thickness.

The use of controlled heating of both ends of the billet also enables decreasing the initial pressure required to start the extrusion of a billet to define a tube. Also, with this controlled heating the overall temperature level of components associated with the die assembly is also reduced, together with the oil temperature requirements of the extrusion press associated with the apparatus **10** which tends to reduce the maintenance requirements of the apparatus **10** and its associated press.

In this disclosure of the invention the means used to support and move the tool container and its associated components, the ram used to extrude the billet **15**, etc., have not been shown. However, it will be appreciated

that any suitable moving and supporting means, ram, etc., may be used in accordance with standard practice.

The apparatus and method **10** disclosed herein has been presented in connection with a direct extrusion process by way of example; however, it should be understood that such apparatus and method may be applied to an indirect extrusion process, if desired.

While present exemplary embodiments of this invention, and methods of practicing the same, have been illustrated and described, it will be recognized that this invention may be otherwise variously embodied and practiced within the scope of the following claims.

What is claimed is:

1. A metal extrusion apparatus comprising, a heated billet container adapted to contain a metal billet, extrusion die means adjoining said container and being adapted to define an extruded article upon extruding said metal billet therethrough, said die means having a downstream bearing surface, and a heated support engaging said bearing surface and heating said die means, said heated support having an opening therein which is adapted to receive said extruded article therethrough, said die means being kept at an adequate temperature by the heating action produced by the extrusion of metal therethrough and said heated support and heated billet container providing a controlled heated environment at opposite ends of said die means and thereby counteracting dissipation of heat from said opposite ends to assure optimum extrusion efficiency.

2. An apparatus as set forth in claim **1** in which said heated support comprises a substantially cylindrical support having said opening extending longitudinally therethrough.

3. An apparatus as set forth in claim **1** and further comprising electrical means for heating said support and a control device for precisely controlling the heating of said support.

4. An apparatus as set forth in claim **1** and further comprising electrical resistance heaters for heating said support.

5. An apparatus as set forth in claim **1** in which said bearing surface comprises a substantially planar bearing surface arranged in a plane which is perpendicular to the direction of movement of said extruded article, said heated support comprises a substantially cylindrical support having a central opening extending longitudinally therethrough and having opposed substantially planar bearing surfaces with one of said opposed surfaces being held against said bearing surface of said die.

6. An apparatus as set forth in claim **5** in which said cylindrical support has an annular cutout provided therein with said cutout defining a reduced diameter cylindrical surface and further comprising electrical insulating means supported against said reduced diameter surface, said apparatus further comprising at least one electrical heating element supported against said insulating means and an electrical control device operatively connected between said electrical heating element and a source of electrical power.

7. An apparatus as set forth in claim **6** in which said electrical heating element comprises an electrical resistive heater strap.

8. A metal tube extrusion apparatus comprising, a heated billet container adapted to contain a metal billet, extrusion die means adjoining said container and being adapted to define an extruded metal tube upon extruding said billet therethrough, said die means having a downstream bearing surface, and a heated support engaging said bearing surface and heating said die means, said heated support having an opening therein which is adapted to receive said extruded tube therethrough, said die means being kept at an adequate temperature by the heating action produced by extrusion of metal therethrough and said heated support and heated billet container providing a controlled heated environment at opposite ends of said die means and thereby counteracting dissipation of heat from said opposite ends to assure optimum extrusion efficiency.

9. An apparatus as set forth in claim **8** and further comprising electrical means for heating said support and a control device for controlling said heating means.

10. A method of extruding a metal billet to form an extruded article, said method comprising the steps of, placing a hot metal billet in a heated billet container with an end of said billet adjoining an upstream end of extrusion die means, said die means having an upstream end adjoining said heated container and having a downstream bearing surface, providing a heated support against said downstream bearing surface of said die means with said support having an opening therein which is adapted to receive said article therethrough, and extruding said billet through said die means, said die means being kept at an adequate temperature by the heating action produced by the extrusion of metal therethrough and said heated support and heated billet container providing a controlled heated environment at opposite ends of said die means and thereby counteracting dissipation of heat from said opposite ends to assure optimum extrusion efficiency.

11. A method as set forth in claim **10** in which said providing step comprises heating said support to a controlled temperature roughly equal to the temperature of said billet container.

12. A method as set forth in claim **10** in which said providing step comprises electrically heating said support to a controlled temperature.

13. A method as set forth in claim **10** for extruding said billet to form an extruded article having a tubular portion wherein said providing step comprises heating said support with electrical resistive heating elements supported concentrically therearound.

14. A method as set forth in claim **10** for extruding said billet to form of an aluminum billet to form an extruded article in the form of an aluminum tube in which said providing step comprises heating said support to a controlled temperature.

15. A method as set forth in claim **14** for extruding said billet in the form of 1,200 aluminum alloy wherein said providing step comprises heating said support to a temperature of roughly 800° F and comprising the further step of controlling the heat of said billet container to a temperature close to the temperature of said support.

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