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HOT METAL EXTRUSION METHOD

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2 Sheets-Sheet 1

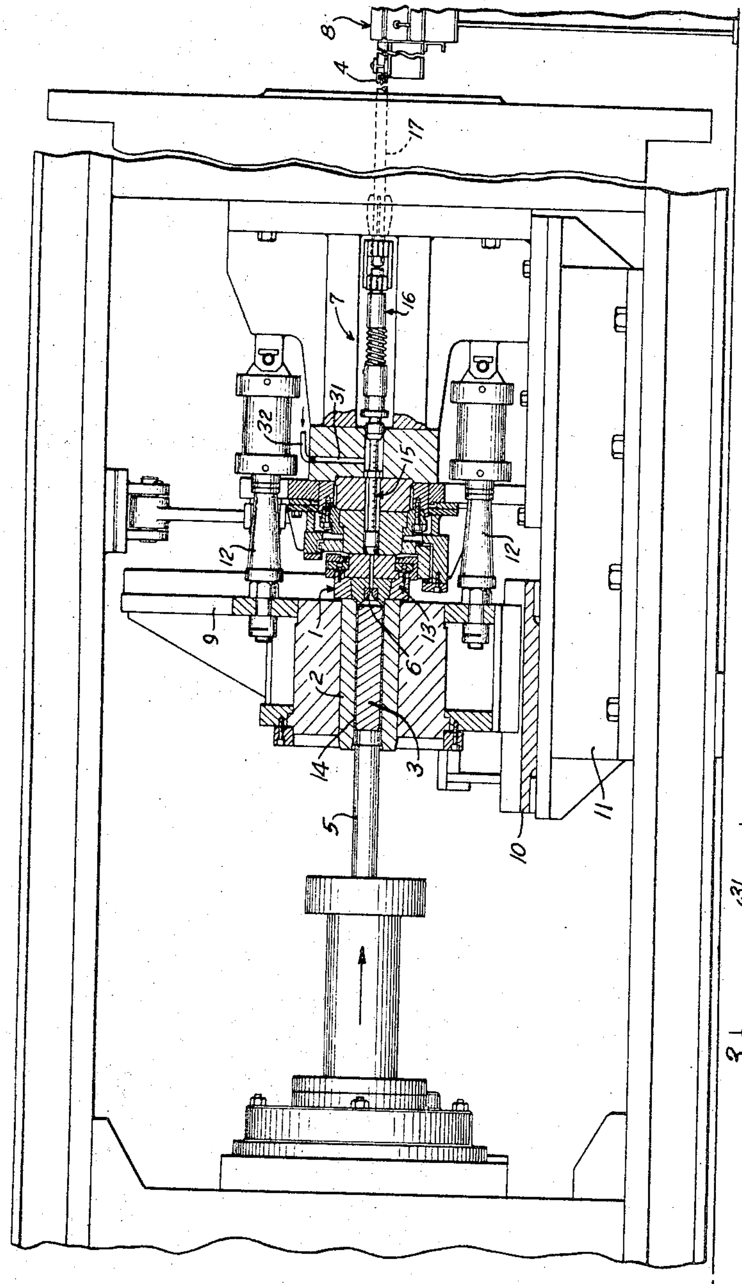

Fig. 1.

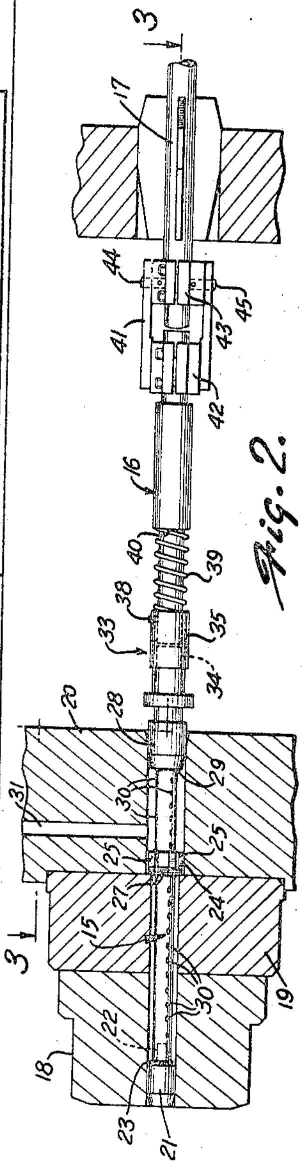

Fig. 2.

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Fig. 3.

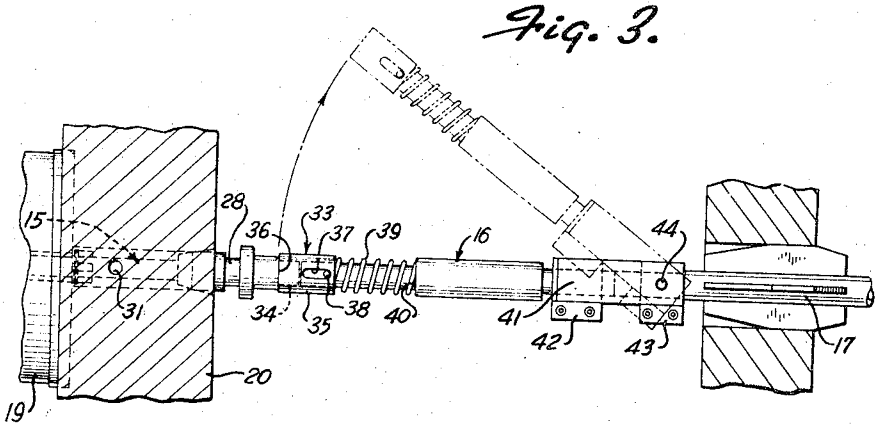
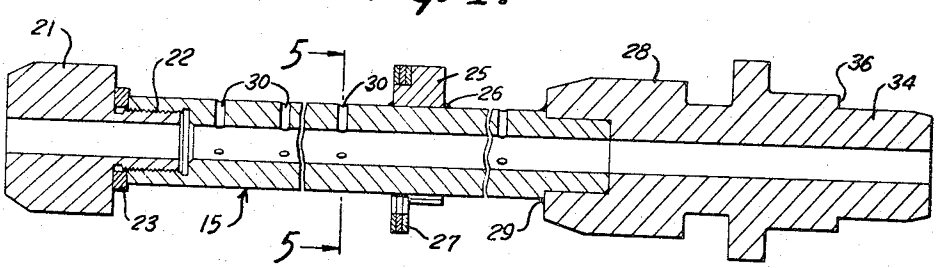


Fig. 4.



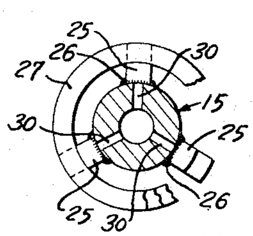


Fig. 5.

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HOT METAL EXTRUSION METHOD

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Original application May 11, 1962, Ser. No. 193,974, now Patent No. 3,210,978, dated Oct. 12, 1965. Divided and this application Apr. 30, 1965, Ser. No. 452,245
6 Claims. (Cl. 72—38)

This invention relates to a hot metal extrusion method and apparatus and particuluarly to the fluid shielding and purging of the extruded metal member.

This is a division of application Ser. No. 193,974, filed May 11, 1962, now Patent No. 3,210,978.

Wire or rod-like members may be formed by disposing a billet in a die and forcing the billet out through a restricted opening. Metals such as carbon and alloy steels, nickel alloys and some of the other carbon metals can all be extruded into wire-like members to provide any particular cross sectional configuration desired.

In order to facilitate extrusion, it has been found desirable to lubricate the die surfaces normally in contact with the hot metal as well as the surfaces of the extrusion cylinder. In the hot extrusion of metals utilizing certain lubricants, the extruded members tend to form coatings which result from the penetration of the members by the volatile constituents which are carried through the die with the wire being extruded therefrom. This is particularly true in the extrusion of carbon and carbon alloy steel billets.

The extruded member tends to develop a carbon rich coating adjacent its exterior surface. This undesirable coating is formed when carbonaceous materials occurring in the extrusion lubricant are gasified by the high extrusion temperatures as the extruded metal leaves the die. At the high temperatures attained as the metal leaves the die, the iron content of the metal is able to absorb quantities of carbon. A carbon-iron solution is formed which initially contains quantities of austenite and cementite. As the carbon concentration increases quantities of ledeburite are formed. As the metal rapidly cools, a two phase solid solution of austenite and cementite forms on the surface of the extruded member, and a quantity of brittle ledeburite fuses to this coating.

The brittle hardness of the high carbon coating, which is primarily due to the presence of ledeburite prevents practical cold drawing of the extruded metal because of wire fracture and excessive wear on the dies.

The present invention is particularly directed to the provision of a means and method of preventing carburization or similar reactions with the surface of the extruded metal following its expulsion from the die. In accordance with the present invention, the extruded metal is supported by a guide tube as it is extruded from the die. Means are provided to continuously flush the guide tube with a gaseous medium to continuously shield the extruded metal and to prevent the volatile carbonaceous constituents occurring in the extrusion process from establishing a carburizing atmosphere adjacent the extruded metal. Applicant has found air to be a satisfactory and inexpensive gaseous medium for preventing carburization of the extruded metal.

If desired, the guide tube may be heated to maintain the carburizing agents in a volatile state in order to facilitate the flushing and driving off of these agents by the gaseous medium.

The present invention provides a simple and inexpensive method and apparatus for eliminating or substantially reducing the carburization of extruded metal members and the like.

The drawings furnished herewith illustrate the best mode presently contemplated for carrying out the invention.

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FIGURE 1 is a side elevational view of extrusion apparatus incorporating a guide tube constructed in accordance with the present invention;

FIG. 2 is a fragmentary enlarged view of a runout assembly including the guide tube shown in FIGURE 1;

FIG. 3 is a top view of a portion of FIG. 2;

FIG. 4 is an enlarged longitudinal section of the guide tube shown in FIGURES 1–3; and

FIG. 5 is a vertical section taken on line 5—5 of FIG. 4.

Referring to the drawings and particularly to FIGURE 1, a hot metal extrusion apparatus is shown including a die assembly **1** having a cylinder **2** defining a die cavity within which a hot metal billet **3** is disposed for extrusion into a relatively small diameter wire **4** of indefinite length and many times the length of the billet **3**. A ram **5** forms a part of the extrusion apparatus and is aligned with cylinder **2** and is adapted to be moved into the cylinder **2** and force the hot billet **3** outwardly through a small cylindrical die opening provided in a die nib **6**. A runout tube assembly **7** is mounted adjacent the die **6** and supports the hot extruded metal as it is ejected or forced from the die nib **6**. A final runout track **8** is provided extending outwardly adjacent the outer end of the runout tube assembly **7** to support the long extruded wire **4**.

The illustrated die assembly **1** does not form any particular of this invention and may be of any suitable construction. The illustrated die assembly **1** is therefore described only in sufficient detail to fully understand the present invention which is particularly directed to the runout tube assembly **7**.

Generally, the die assembly **1** includes a support structure **9** for the cylinder **2** and is mounted in trackway **10** on a press bed **11**. A pair of upper and lower hydraulic cylinders **12** are fixed to the press bed **11** and connected to structure **9** for limited axial movement with respect to die nib **6**.

A die holder **13** is mounted on the press bed **11** with the die nib **6** suitably disposed within a suitable recess immediately adjacent the discharge end of the cylinder **2** opposite from the ram **5**, An enlarged passageway in the die holder **13** extends outwardly from the small cylindrical die opening in die nib **6** and directs the extruded metal into the runout tube assembly **7**.

A suitable lubricant **14** covers the internal surface of the cylinder **2** and the opening in the die nib **6** to facilitate extrusion of the hot metal billet **3**. The lubricant may be one of the common high temperature varieties which usually contain aluminum powder of flakes, graphite flakes, and a minerol oil vehicle.

A lubricant such as is described in the United States patent to A. Clatot et al. 2,757,138 is a suitable lubricating composition for the hot extrusion of metals. A lubricant containing about 70 percent graphite, 10 percent mineral and 20 percent sodium chloride would be satisfactory. Other lubricants which would be expected to act as satisfactory hot extrusion lubricants are: a combination of about 50 percent flake graphite and about 50 percent potassium iodide; a combination of about 33 percent flake graphite, 33 percent sodium chloride, and 33 percent mineral oil; and a lubricant containing a combination of about 10 percent sawdust, 60 percent flake graphite, 23 percent carbon black, 3 percent MnO_2, and 4 percent linseed oil as is described and used in British Patent 712,007.

As the hot billet **3** is extruded outwardly through the die nib **6**, the working of the metal results in a further increase in the temperature thereof. Further, portions of the lubricant **14** are volatilized or vaporized and are carried along with the extruded wire **4** into the runout tube assembly **7**, These substances react undesirably with the surface of the extruded wire **4** to form a hard brittle multiphase carbon coating. The runout tube assembly **7** of the present invention is constructed to prevent the formation of such coatings.

In the illustrated embodiment of the invention, the runout tube assembly **7** includes a guide tube **15** mounted in axial alignment with the enlarged passageway in the die holder **13** and extending axially outwardly therefrom. A swing tube **16** is releasably secured extending outwardly from the guide tube **15** and is pivotally secured at the outer end to a runout tube **17** which carries the extruded wire and deposits it upon the runout track **8**.

Referring particularly to FIG. 2, the guide tube **15** is a tubular member mounted within an enlarged passageway formed in a die backing and supporting structure including a die backing plate **18**, a die plate **19** and a vertical frame or stool base **20** all of which are carried by the press bed **11**.

The guide tube **15** includes a shear tip **21** secured to the forwardmost end of the guide tube **15** by a threaded neck **22** which threads into a correspondingly threaded portion of the innermost end of the tube **15**. A lock washer **23** is threaded onto the neck **22** immediately adjacent the end of the tube **15** to securely lock the shear tip **21** in place. The diameter of the shear tip **21** is substantially the same as the passageway in the die backing plate **18** and serves to seal the inner surface of the guide tube **15** and to concentrically support the corresponding end of the guide tube **15** within the passageway. The guide tube passageway in stool base **20** is enlarged and defines a locating shoulder **24** with the immediately adjacent face of the die plate **19**. Three locating bars **25** are equicircumferentially spaced about and welded or otherwise secured to the guide tube **15** as by welds **26** and the outer ends are joined by locating rings **27**, as most clearly shown in FIG. 5. The locating bars **25** and rings **27** are positioned axially on the guide tube **15** to abut the locating shoulder **24** and locate the end of the sheartip **21** in the plane of the face of the die backing plate **18** immediately adjacent the die holder **13**. A tubular coupling member **28** is telescoped over the outer end of the tube **15** and secured thereto as by a circumferential weld **29** at the junction of the tube and the end face of the coupling member. The outer diameter of the coupling member **28** corresponds to the diameter of the passageway in the stool base **20** and the coupling member **28** projects into this passageway to simultaneously seal the corresponding ends of the passageway and coaxially support the corresponding end of the guide tube **15**.

The guide tube **15** is provided with a plurality of longitudinally spaced sets of three equicircumferentially distributed radial passages **30** which establish fluid communication between the interior of the guide tube **15** and the passageways in the plates **18** and **19** and stool base **20**. A gas inlet opening **31** is provided in the stool base **20** and connected by gas conduit **32** to a source of a suitable gas, such as air, under a selected pressure.

As the billet is extruded through the die nib **6**, the wire product **4** often reaches a temperature near 2400° F. At this temperature, the iron content of the billet may absorb about 5% of carbon. Therefore, if carbon in a combinable form occurs in guide tube **15**, it may penetrate the surface of wire **4**. The carbon penetrating the wire will initially establish a saturated solution with the iron. As the wire containing a saturated iron-carbon solution cools to a temperature of about 2065 to 2085° F., cementite begins to crystallize and separate from the solution. Ledeburite, a eutectic containing about 4.3% of carbon, begins to form as the wire cools through this temperature range. As the cooling of the wire rather rapidly progresses, the carbon is retained by the wire in the combined form of austenite, cementite and ledeburite and results in a hard brittle wire product which is subject to transverse cracking and is commercially unsuitable, particularly for cold drawing.

By continuously introducing a gas, such as air, into the guide tube **15** under a selected pressure and adjacent the downstream end of the extrusion die **6**, the carbonaceous constituents of the vaporized portion of the lubricant, which pass into the guide tube with the extruded metal, may be rapidly and continuously purged from the guide tube and the zone where the temperature of the wire is at a level which permits the penetration of carbon into the surface thereof. While, for economic reasons, the gaseous medium generally employed is air, it is believed that the oxidizing constituents of air augment the flushing and diluting effect of the air being injected into the guide tube. These oxidizing constituents serve to oxidize the carbonaceous elements occurring in guide tube **15** thereby preventing their penetration into the extruded member where they may combine with the iron found therein. Therefore, gaseous media, other than air, which include oxidizers would be expected to render satisfactory non-carburizing results when injected into the guide tube.

The guide tube **15** is of a length which allows all or substantially all of the carburizing constituents present in guide tube **15** to be rendered ineffective by being driven off and diluted by the air flow within the guide tube. The extruded wire **4** leaving the guide tube **15** is generally reduced in temperature to a point below which carbon is insoluble in iron and is therefore not subject to further carburization. The balance of the runout tube assembly **7** and the runout track **8**, therefore, need not be provided with any special air flushing or decarburizing gaseous medium.

The guide tube **15** is releasably clamped in place by the swing tube **16** which is releasably connected to the outer end of the coupling member **28** of the guide tube **15** by a spring loaded coupling assembly **33**.

Referring particularly to FIGS. 2–4, the coupling member **28** is provided with an outwardly extending reduced tubular portion **34**. A tubular coupling **35** is slidably disposed on the reduced tubular portion **34** and abuts a shoulder **36** defined by the reduced portion **34**. The opposite end of the tubular coupling **35** is slidably disposed on the adjacent end of the swing tube **16**. An axial slot **37** is provided in the coupling **35** and mates with a radial pin **38** secured to the outer wall of the swing tube **16**. The slot **37** and pin **38** allows limited axial movement of the coupling **35** on swing tube **16** while interconnecting the two members. A coil spring **39** encircles the swing tube **16** between the end of the coupling **35** and a shoulder **40** formed on the tube **16**. The coil spring **39** continuously biases the coupling **35** onto the coupling member **28** to releasably interconnect the swing tube **16** to the guide tube **15**. To disconnect the swing tube **16** from the coupling member **28** of the guide tube **15**, it is merely necessary to slide the coupling **35** axially onto the swing tube **16** until the end of the coupling **35** clears the corresponding end of the coupling member **28**.

The opposite end of the swing tube **16** is pivotally secured to the runout tube **17** in the following manner. A clamp member **41** includes a split clamp portion **42** rigidly secured to the outer end of the swing tube **16** and a similar split clamp portion **43** releasably secured to the adjacent end of the runout tube **17**. Small pivot pins **44** and **45** are secured to the split clamp portion **43** on opposite sides of a runout tube **17**. The inner ends of the pivot pins **44** and **45** bear on the adjacent portion of the runout tube **17**, as shown in FIG. 2, for swinging movement of the member **41** and the attached swing tube **16** about the vertical axis through pins **44** and **45**.

To remove the guide tube **15**, the coupling **35** is axially slid onto the swing tube **16** against the bias of spring **39** until the outer end of the coupling **35** clears the coupling member **28**. The swing tube **16** is then pivoted about the axis of pins **44** and **45** to the dotted line position of FIG. 3. The guide tube **15** can then be withdrawn from the corresponding passageways.

The runout tube **17** and runout track **8** may be any desired or suitable construction and no further description thereof is deemed necessary to the complete understanding of the invention.

The operation of the present invention is summarized as follows.

The ram **5** is withdrawn from the cylinder **2**. The surfaces of the cylinder **2** and die nib **6** subject to contact with a billet are provided with a lubricant **14**. A heated billet **3** of low carbon steel or any other suitable metal is disposed within the cylinder **2**.

Ram **5** is then moved into cylinder **2** to force the billet **3** through the die nib **6** and by extrusion form an elongated wire **4** having a continuous length many times that of the billet **3**.

In accordance with the present invention, simultaneously with the initiating of the extrusion process, air is fed into guide tube **15** from line **32**. The air enters the guide **15** through the many radial passages **30** and moves outwardly through the guide tube **15** and swing tube **16** to maintain a non-carburizing atmosphere about the hot extruded wire **4**. The air in the tube **15**, which is heated during operation, prevents the formation of appreciable high carbon coatings on the surface of the wire **4**.

The present invention thus provides a method and apparatus of extruding metal members without the formation of undesirable carbide coatings thereupon and is particularly adapted for extrusion of carbon and carbon alloy steel into wire-like elements which are to be subsequently cold drawn.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. In a process of extruding material from a die opening in a heated condition, the improvement comprising the steps of extruding the heated material through a lubricated die and saturating the zone adjacent the die opening with an oxidizing agent to prevent carburization of the extruded material.

2. A method of extruding a heated material subject to carburization comprising expressing the material from a die, establishing a higher material temperature adjacent the downstream side of the die than the upstream side of the die, and introducing an oxidizing agent into the zone adjacent the downstream side of the die as a continuously flowing gas to prevent carburization of the extruded material.

3. In a method of extruding a material from a group comprising carbon steel, alloy steel, carbon metals and nickel alloy, the steps of heating the material, extruding the heated material from a die orifice, heating the zone adjacent the die orifice and flushing the heated zone with an oxidizing agent to prevent carburization of the heated material.

4. A method of hot extruding a billet of material subject to carburization comprising heating the billet, lubricating the billet with a carbon-bearing lubricant, expressing the billet from an extrusion die, and flushing the zone adjacent the downstream side of the die with an oxidizing gas to prevent carburization of the extruded material.

5. A method of hot extruding a billet of material subject to carburization comprising heating the billet, lubricating the billet with a carbon-bearing lubricant, expressing the billet from an extrusion die, and flushing the zone adjacent the downstream side of the die with air to prevent carburization of the extruded material.

6. The method of hot extruding a billet of material subject to carburization comprising the steps of heating the billet, lubricating the billet with a carbon bearing lubricant, expressing the billet from an extrusion die, heating the zone immediately adjacent the discharge side of the extrusion die to maintain the carbon constituents of the lubricant in a volatile condition, and flushing the zone adjacent the downstream side of the die with an oxidizing gas to prevent carburization of the extruded material.

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