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J. N. MOORHEAD

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EXTRUSION

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Fig. 2.

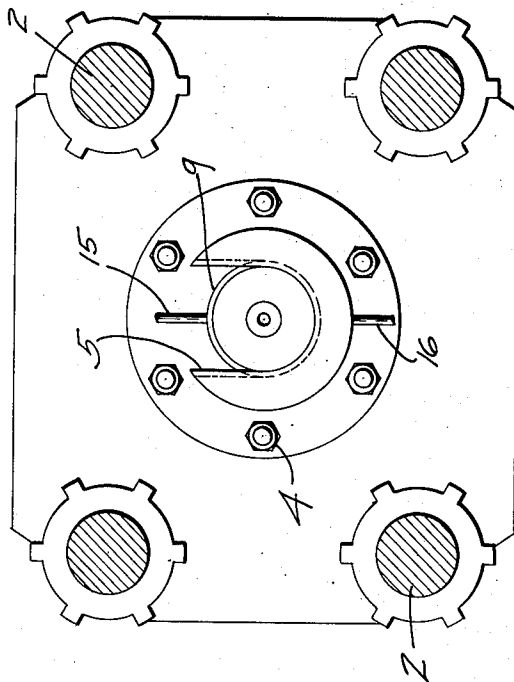


Fig. 3.

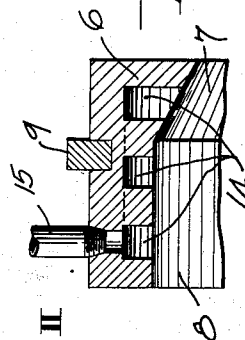
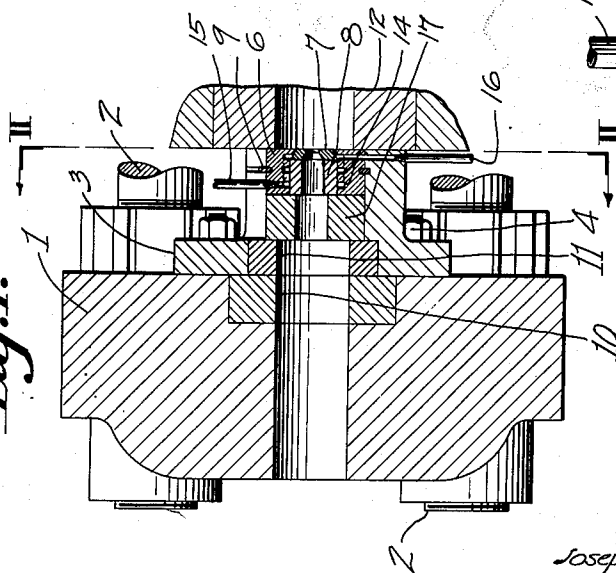


Fig. 1.



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EXTRUSION

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3 Claims. (Cl. 207—10)

This invention relates to improvements in extrusion of metals and is particularly directed towards the extrusion of non-ferrous metals such as aluminum and its alloys.

In the extrusion of metals, wherein a heated metal billet, suitably confined, is expressed in indefinite lengths through a die orifice of desired configuration, there are certain factors which control the speed at which the metal may be extruded. Among these factors, which are numerous, are the friction presented by the bearing surface of a die configuration, the temperature of the particular metal being extruded, and the pressure applied on the billet or charge essential to extrude the same. All of these factors militate against the speed at which any metal may be extruded, in that they are responsible for a phenomenon known as "pick-up", which is defined herein as that metal and/or oxide of the charge being extruded which adheres or bonds, as by a welding or alloying action, to the bearing surface of an extrusion die.

Pick-up varies in amount in accordance with the characteristics of the particular metal being extruded, in that each metal and its alloys requires a definite temperature to which it must be heated prior to its extrusion. Likewise, the die orifice configuration and the pressure essential to extrude a metal also react in the generation of heat by friction. The heat thus generated and the extreme pressures under which metals are extruded react to increase the bonding action between the metal of a billet and an extrusion die, and the pick-up thus formed on the bearing surface of the die greatly impairs the speed at which a metal may be extruded.

The factors of temperature and pressure, which greatly influence the formation of pick-up, are accentuated by the particular configuration of the extrusion die for any given extruded shape. In simple dies, such as a circular orifice, the amount of pick-up is much less than that which would result in the use of an intricate die orifice having angular faces and otherwise presenting a complicated structure susceptible to increased friction and increased pressure necessary to cause metal to flow therethrough.

The disadvantages above referred to exist in known extrusion practice, although it has been known to lubricate dies with fluids in an attempt to remedy these disadvantages. The lubrication procedures in use, however, have failed to relieve the pick-up condition existing in normal extrusion operations, and the speeds under which met-

als are now being extruded are relatively slow and add greatly to the cost of extruded materials.

It is an object of the present invention to provide a process which will permit speeds of extrusion which have heretofore never been attained. It is also an object of the invention to provide a process which readily adapts itself to known extrusion apparatus and is effective in producing a more economic product than heretofore possible. Other objects and advantages will present themselves on further consideration of the specification.

It has now been discovered that the die temperature is the only factor involved in the formation of pick-up which may be satisfactorily controlled, and means have been provided whereby the die temperature is closely controlled. In obtaining relief from pick-up the speed of extrusion is automatically increased, and the interruptions heretofore necessary for the cleaning, polishing, or otherwise removing pick-up from extrusion dies, have been eliminated, thereby increasing the productive output of extrusion mechanisms.

In the practice of the invention the main desideratum is the substantial elimination of pick-up on extrusion die bearing surfaces. In obtaining this condition it is now found that, if the temperature of an extrusion die is maintained at a temperature lower than that at which the metal being extruded therethrough will bond or otherwise weld to the die bearing surface under the influence of the temperature and pressure employed, substantially no pick-up will accumulate on the die bearing surface. This condition is obtained through the medium of any suitable cooling medium applied adjacent the die bearing surface. In most cases, water, a readily available coolant, has been considered preferable in the application of this invention, but, manifestly, other cooling media may be employed.

In the simplest form of the invention, water is sprayed directly upon the extrusion die adjacent the metal exuding therefrom, the amount of water being so controlled that the heat generated by the extrusion operation, and its related temperature-raising factors, is dissipated to a degree at which the metal of the billet will not bond or otherwise adhere to the bearing surface of the die. More complicated designs of extrusion equipment will manifestly necessitate a particular means for applying the cooling medium, such means usually depending upon the accessibility of the die in a particular apparatus being used, and in such cases it is sometimes necessary to

resort to internal cooling of an extrusion die. However, such instances do not offer any impediment in the practice of the invention, it being the chief requirement for the success of the present invention that the die be maintained below the temperature at which the metal being extruded will bond or otherwise weld to the die bearing surface at any time during the extrusion operation.

Exemplary of actual practice, as applied to the extrusion of an aluminum alloy having the approximate composition, 97.5 per cent aluminum, 0.7 per cent silicon, 1.3 per cent magnesium, 0.25 per cent chromium, and 0.25 per cent maximum impurities, it has been found that, for proper extrusion conditions, the billet should be initially heated to between about 750° to 800° Fahrenheit. Extruding this preheated billet in the usual manner an extrusion speed of 25 to 50 feet per minute was reached before the product commenced to show a roughened surface caused by pick-up. A similar billet preheated to the same temperature and extruded through the same die, cooling water being supplied in sufficient quantity to maintain the die at a temperature lower than that reached by the billet at any time during the extrusion thereof, permitted a speed of 150 feet per minute to be attained without in any way indicating an impaired surface. It was also noted during the extrusion operation above referred to that the temperature of the extruded product reached a maximum of 970° Fahrenheit, which is indicative of the heat generated during an extrusion operation, and the physical properties of the product produced at the higher extrusion speed, with water-cooled die, were appreciably higher than the properties of the product produced in the usual method of extrusion.

It will be manifest, then, that the water cooling step, whereby heat generated at an extrusion die is dissipated, has resulted in an improved process of extrusion, and although the example herein given is confined to a particular alloy composition, the invention is equally adaptable to other metals and their alloys, the main desideratum being maintaining the die temperature lower than that at which the metal being extruded will bond or otherwise adhere to the die bearing surface under the pressures used to extrude the particular metal.

In order that a more thorough understanding of the invention may be had, reference is made to the drawing accompanying this specification and forming a part thereof, in which:

Fig. 1 represents a fragmentary sectional elevation through the forward or die end of an extrusion press;

Fig. 2 represents a view of the mechanism shown in Fig. 1 and taken along the line II—II thereof; and

Fig. 3 represents an enlarged fragmentary view in partial sectional elevation illustrating the cooling system adjacent the die and back-up member.

Referring in particularity to the drawing, wherein the various elements of the apparatus are identified by reference numerals, 1 represents the press head or platen of a horizontal extrusion press, said head being suitably tied into a pressure cylinder supporting member, not shown, by means of suitable horizontal tie bolts or columns 2. Upon the rear face of the press head a tool container bracket 3 is removably secured, as by cap screws 4.

The tool container bracket 3 is provided with an open top bore 5 into which a die and back-up adapter ring 6 concentrically fits, said member 6 being formed with an interior bore to retain a die 7 and back-up member 8, the die and ring being shown in sectional elevation in Fig. 1. A locking ring 9, engaged within concentric keyways in the adapter ring 6 and bracket 3, retains the adapter ring 6 within the bore 5, and filler members or rings 10, 11, 17 complete the tool assembly. An alternative construction for locking ring 9, which has been found satisfactory, comprises forming the ring 9 as a web or rib integral with, and extending inwardly into, the bore 5 of bracket 3.

A fragmentary portion of a billet container cylinder 12 is shown abutting against the tool assembly in operating position, said cylinder being mounted in any suitable manner for reciprocating movement towards and away from the die.

The description of the mechanism thus far is representative of a standard form of extrusion apparatus, and in order that the same may be operated in accordance with the present invention, channels 14 are provided in the interior bore of the adapter ring 6 for the purpose of circulating a suitable cooling medium therethrough. Fig. 3 illustrates, to an enlarged scale, the preferred disposition of the channels 14, wherein they are illustrated as being disposed adjacent the die 7 and back-up member 8. The channels 14 are suitably interconnected and a cooling medium supply pipe 15 and drain pipe 16 complete a continuous system for providing sufficient coolant to maintain the die at a temperature lower than that reached by the metal to be extruded.

In operation, the particular pressure required to extrude a particular metal through a given die orifice is first determined by experiment, the initial temperature of the billet having likewise been determined for proper extrusion characteristics. Knowing the pressure and initial temperature, the temperature to which the die will be raised during the subsequent extrusion operation may be approximated, and sufficient coolant is then supplied to the inlet pipe 15 to insure a die temperature satisfactory to insure against the formation of pick-up. The coolant may be regulated during the extrusion operation, as is usually the preferred practice, since the die temperature increases with the duration of the extrusion operation. Furthermore, it is preferred that the cooling medium be applied or introduced to the die immediately following the actual start of an extrusion operation, the application of the coolant to continue for the duration of the extrusion operation. This method of controlling the coolant insures against any possibility of the cooling medium entering the billet cylinder, through the die, into contact with a heated billet, which action is susceptible of serious consequences resulting from the generation of steam within the billet cylinder.

Although the invention has been described in particularity with respect to a single type of extrusion press and a definite alloy composition, it is to be understood that the invention is in no way limited in these respects, but is applicable broadly as defined in the appended claims.

What is claimed is:

1. The method of eliminating pick-up on an extrusion die in the extrusion of aluminum and

its alloys, comprising heating a solid billet of the metal and expressing the heated solid billet through said die, and cooling said die during the extrusion operation, said cooling being regulated 5 to maintain the die temperature below that reached by the billet during all stages in its extrusion.

2. The method of extruding aluminum and aluminum alloys free from longitudinal surface 10 grooves and other surface defects caused by pick-up, which comprises the steps, heating a solid billet of the metal and expressing it through an extrusion die, and cooling said die during the extrusion operation, said cooling being regu-

lated to maintain the die temperature below that reached by the billet during all stages in its extrusion.

3. The method of extruding aluminum and aluminum alloys free from longitudinal surface 5 grooves and other surface defects caused by pick-up, which comprises the steps, heating a solid billet of the metal and expressing it through an extrusion die, and supplying coolant to said die in sufficient quantity to maintain its tem- 10 perature lower than that reached by the billet during all stages in its extrusion.

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