United States Patent [19]

Fuchs, Jr.

[11] **3,767,368**

[45] **Oct. 23, 1973**

[54] **METHOD OF AND MEANS FOR COMMENCING A DEFORMING OPERATION, E. G., HYDROSTATIC EXTRUSION OF A BILLET**

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[73] Assignee: **Western Electric Company, Incorporated**, New York, N.Y.

[22] Filed: **June 22, 1972**

[21] Appl. No.: **265,219**

[52] **U.S. Cl.** **29/187.5**, 72/60, 72/253

[51] **Int. Cl.** **B21c 23/04**

[58] **Field of Search** 72/60, 253, 256; 29/187.5, 187, 183, 183.5

[56] **References Cited**

UNITED STATES PATENTS

3,150,936	9/1964	Hunt	29/187.5
3,391,448	7/1968	Lanphier	29/187.5
3,440,853	4/1969	Tombaugh	29/253
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Primary Examiner—Richard J. Herbst

Attorney—Jack Schuman

[57] **ABSTRACT**

The forward end of the billet to be deformed, e.g., hydrostatically extruded, is provided with a shaped nose of material softer than the billet material. In another embodiment, a series of progressively softer noses is mounted to the forward end of the billet to be extruded. In yet another embodiment, the forward end of the billet is zone refined to provide a hardness gradient in the billet decreasing from a point spaced behind the forward end of the billet toward the said forward end.

1 Claim, 5 Drawing Figures

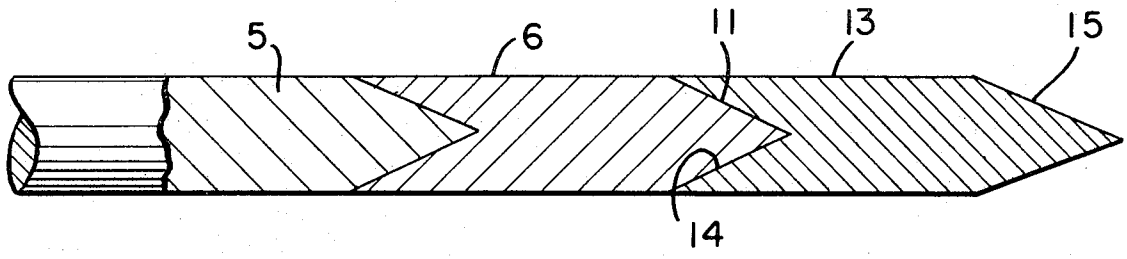


FIG 1

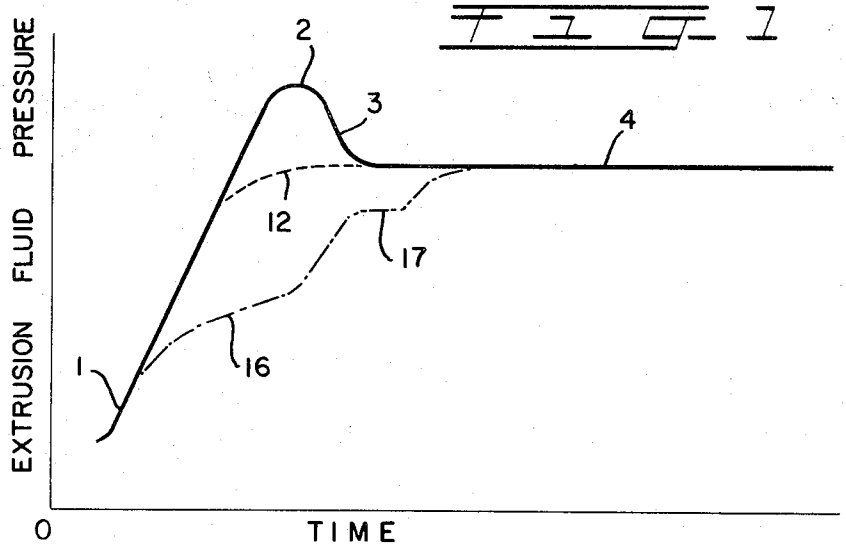
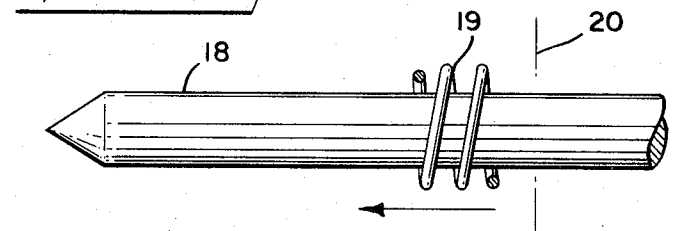


FIG 4



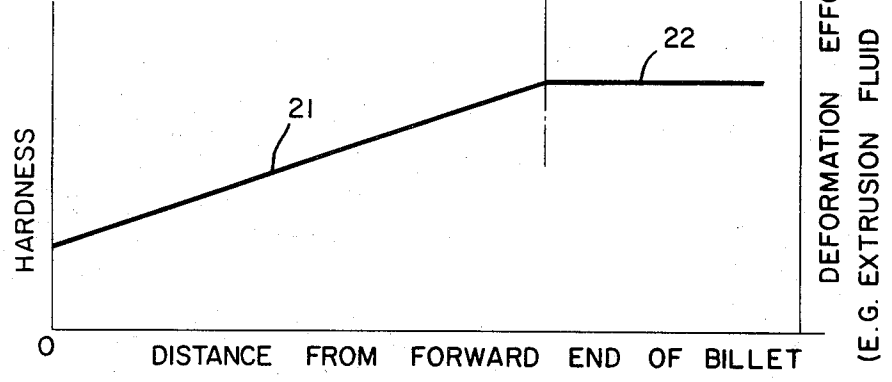


FIG 5

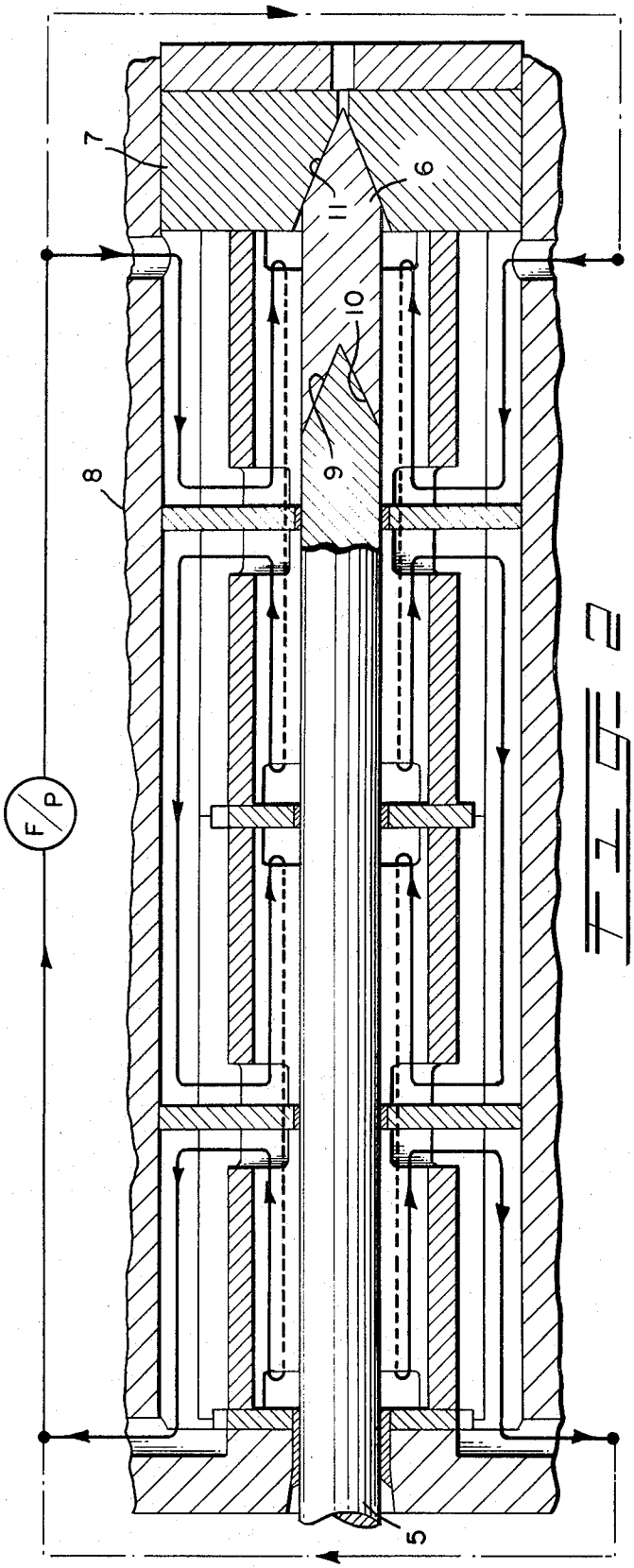


FIG 2

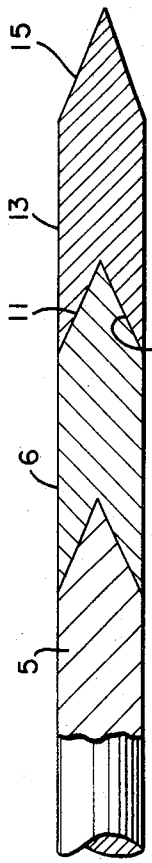


FIG 3

METHOD OF AND MEANS FOR COMMENCING A DEFORMING OPERATION, E. G., HYDROSTATIC EXTRUSION OF A BILLET

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates, generally speaking, to improved method of and means for commencing an extrusion or drawing operation. Specifically, this invention relates to method and means for eliminating or substantially reducing peak effort ordinarily required to initiate an extrusion or drawing operation. More specifically, this invention relates to method of and means for eliminating or substantially reducing peak pressure heretofore encountered in commencing hydrostatic extrusion.

2. Description of the Prior Art

Various methods and means for drawing or extrusion, including hydrostatic extrusion, are now well known. See, for example, U.S. Pat. No. 3,667,267 which teaches method and apparatus for continuously hydrostatically extruding an elongated billet of indefinite length to produce wire of indefinite length.

In commencing hydrostatic extrusion of certain materials to obtain certain ratios of reduction, it has been noted that, when the nose of the billet enters and initially contacts the zone of deformation of the die, the pressure of the extrusion fluid rises to a peak value until extrusion commences. After extrusion commences, the pressure of the extrusion fluid falls to a lower, substantially constant, level known as the "run-out" pressure.

Although the peak pressure occurs only at the commencement of an extrusion operation, the pressure vessel for containing the extrusion operation, the die, die stem and related components must be designed to withstand this peak pressure which may, in some instances, be as much as 25 percent or more above run-out pressure, even though virtually the entire extrusion operation is performed at the lower run-out pressure. Thus, for virtually the entire extrusion operation, the pressure vessel, die, die stem and related components are overdesigned by as much as 25 percent or more.

From another point of view, the phenomenon of peak pressure may inhibit the degree of reduction obtainable by equipment of a given design. Elimination or substantial reduction of peak pressure permits much higher (e.g., by an order of magnitude or so) ratios of reduction in equipment of a given design and pressure capability. Indeed, for certain materials, ratios of reduction are now attainable which heretofore were not attainable because of design limits on maximum pressure of equipment.

An example of the relationship between peak pressure and run-out pressure can be seen in the hydrostatic extrusion of a 0.300 inch diameter copper billet to produce 0.013 inch diameter wire, representing a reduction ratio of 500, wherein the peak pressure in the extrusion fluid is 370,000 psi and the run-out pressure in the extrusion fluid is 280,000 psi.

Moreover, as peak pressure is reached, extrusion commences with a burst of speed, which may be undesirable.

In non-hydrostatic extrusion operations, and also in drawing operations, it has been noted that, for certain materials and for certain ratios of reduction, the initial effort required to commence the extrusion or drawing operation is substantially in excess of the effort required to maintain the extrusion or drawing operation, and, further, with conventional billets, the extrusion or drawing operation may commence with an un-desirable burst of speed.

Efforts have been made in the past to facilitate the extrusion of billets. In U.S. Pat. No. 2,630,220 (1953) to Sejournet, extrusion of a hot billet or ingot of steel is commenced by interposing between the front end of the hot billet and the die a packet of glass fibers and glass plate, the glass melting under the heat of the billet and lubricating the die. In U.S. Pat. No. 3,345,842 (1967) to Richards, a hot billet is coated with a plurality of layers of glass of different viscosity-temperature characteristics (e.g., by sequentially dipping the entire hot billet into tanks of the various molten glasses) and is then extruded through a die.

In each of the above instances, the molten glass acts as a lubricant.

SUMMARY OF THE INVENTION

One of the objects of this invention is to provide improved method of and means for commencing an extrusion or a drawing operation.

Another of the objects of this invention is to provide improved method of and means for eliminating or substantially reducing peak effort ordinarily required to initiate an extrusion or drawing operation.

Still another of the objects of this invention is to provide improved method of and means for commencing a hydrostatic extrusion operation.

Yet another of the objects of this invention is to provide method of and means for eliminating or substantially reducing peak pressure in hydrostatic extrusion.

A further object of this invention is to provide method of and means for smoothly commencing hydrostatic extrusion.

Still other and further objects of this invention will become apparent during the course of the following description and by reference to he accompanying drawings and appended claims.

Briefly, I have discovered that the foregoing objects may be attained, in one embodiment, by mounting to the forward end of the billet to be extruded a nose of material which is softer than the billet materials. In another embodiment, a series of noses of progressively softer materials is mounted to the forward end of the billet, starting with a leading nose of very soft material, one or more intermediate noses of less soft material, and followed by the billet itself. In yet another embodiment, the forward portion of a billet of refinable materials is refined, e.g., by zone refining, from a point behind the forward end of the billet toward the said forward end thereby to progressively decrease the hardness of said billet from said point toward said forward end. In all embodiments the billet is drawn or extruded in the conventional manner.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings, in which like numerals represent like parts in the several views:

FIG. 1 represents an idealized plot of extrusion fluid pressure vs. time for three conditions, viz., extrusion with an ordinary billet, extrusion with a billet provided with a softer nose, and extrusion with a billet provided with a series of two progressively softer noses.

FIG. 2 represents a medial longitudinal section of hydrostatic extrusion apparatus as disclosed in U.S. Pat.

No. 3,667,267 and shows a billet which has just engaged the zone of deformation of the die and which has not yet commenced to extrude, the billet being shown partially in medial longitudinal section as constructed according to the present invention with a nose of material softer than the billet material mounted to the forward end of the billet.

FIG. 3 represents a view, partially in medial longitudinal section, of another embodiment of billet constructed according to the present invention with a series of noses of progressively softer materials mounted to the forward end of the billet, starting with a leading nose of very soft material, followed by an intermediate nose of less soft material, and followed finally by the billet itself.

FIG. 4 represents a longitudinal view of a billet of refinable material, that portion of the said billet adjacent the forward end thereof being zone refined by an induction coil, the direction of movement of the induction coil in effecting the zone refining being indicated by an arrow.

FIG. 5 represents an idealized plot of hardness vs. distance from the forward end of the billet of FIG. 4 and alos represents an idealized plot of deformation effort (e.g., extrusion fluid pressure) vs. distance from forward end of the said billet.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In commencing the hydrostatic extrusion of conventional billets (e.g., rods of indefinite length) of certain materials to achieve certain ratios of reduction, when the nose of the billet enters and initially contacts the zone of deformation of the die, and until extrusion of the billet through the die commences, the pressure of the extrusion fluid rises generally along curve 1 of FIG. 1 and reaches a maximum value 2. When the billet begins to extrude through the die, the pressure of the extrusion fluid decreases, generally along curve 3, to a lower substantially constant level 4 known as the "run-out" pressure.

The difference between the maximum or peak pressure 2 and the run-out pressure 4 requires that the pressure vessel for containing the extrusion operation, the die, die stem and related components be overdesigned for this high transitory condition.

The present invention eliminates or substantially reduces this peak or maximum pressure 2, and permits the extrusion apparatus to be designed to operate substantially under the conditions of run-out pressure.

An extrusion billet 5 having a nose 6 fastened thereto, according to one embodiment of the present invention, is shown in FIG. 2, prior to the actual commencement of extrusion and at the point of initial contact with the zone of deformation of die 7 of extrusion apparatus 8 of the type described in U.S. Pat. No. 3,667,267. Extrusion apparatus 8 forms no part of the present invention and reference to U.S. Pat. No. 3,667,267 should be made if a detailed description of the construction and operation of the said extrusion apparatus 8 is desired.

The forward end 9 of billet 5 is conically shaped. The rearward end of nose 6 is provided with a female conical opening 10 which mates with the conical forward end 9 of billet 5. The forward end 11 of nose 6 is conically shaped, preferably to match the profile of the opening in die 7. To assemble nose 6 and billet 5, the conically shaped forward end 9 of billet 5 is inserted into the female conical opening 10 of nose 6, and billet 5 and nose 6 are secured to each other as by pressure welding.

Nose 6 is constructed from material which is softer than the material of billet 5. Thus, nose 6 may, under appropriate circumstances, be constructed of soft metals or plastic (i.e., polymeric) materials such as Teflon.

More specifically, when hydrostatically extruding a copper billet having an initial diameter or 0.300 inch to produce a wire having a diameter of 0.013 inch, nose 6 may advantageously be constructed of material having a shear strength of 80 percent of the shear strength of copper. Such a material is 5086 aluminum (which designation follows the well-known Aluminum Association alloy designation system). With such a nose 6, the pressure of the extrusion fluid rises generally along curve 1 of FIG. 1 until extrusion of nose 6 commences and thence along curve 12 until extrusion of the billet 5 commences and thence along curve 4. There is a complete elimination of pressure peak in the extrusion fluid as represented by point 2 in FIG. 1, and the extrusion of billet 5 commences smoothly. Consequently, the vessel for containing the extrusion operation, the die, die stem and related components need be designed only to withstand the run-out pressure 4 and not a transitory maximum or peak pressure 2.

In another embodiment of the present invention as shown in FIG. 3, the extrusion billet 5 with nose 6 of FIG. 2, is provided with yet another nose 13 of material (metallic or polymeric) which is softer than the material of nose 6. The rearward end of nose 13 is provided with a female conical opening 14 which mates with the conical forward end 11 of nose 6. The forward end 15 of nose 13 is conically shaped, preferably to match the profile of the opening in die 7. Nose 13 is assembled to nose 6 by inserting the conically shaped forward end 11 of nose 6 into the female conical opening 14 of nose 13 and then securing nose 13 to nose 6 as by pressure welding.

When hydrostatically extruding the billet 5 with noses 6 and 13, the pressure of the extrusion fluid rises generally along curve 1 of FIG. 1 until extrusion of nose 13 commences and thence along curve 16 until extrusion of nose 6 commences and thence along curve 17 until extrusion of billet 5 commences and thence along curve 4.

It will be understood that a series of more than the two progressively softer noses shown in FIG. 3 may be mounted to the forward end 9 of billet 5.

It will be seen from the foregoing that a composite billet is provided having a hardness which descreases by steps from a point behind the forward end of the billet toward the said forward end. This stepwise variation in hardness is achieved by proper selection of materials for the noses 6 and 13 and not by heating billet 5 and the said noses 6 and 13; in other words, initiation of deformation of noses 6 and 13 and billet 5 is not dependent on heating noses 6 and 13 and billet 5 but preferably is performed at ambient or substantially ambient temperature. The number of such steps and the difference in hardness from step to step may be chosen as required, by selecting suitable materials for noses 6 and 13 and a suitable member of and lengths of said noses, thereby to avoid excessive sudden changes in hardness from the forward end of the billet on back.

Under some circumstances, it may be desirable to avoid step-wise changes in hardness and to maintain essentially a homogeneous billet (e.g., avoiding the use of dissimilar materials such as aluminum noses on a copper billet). FIG. 4 shows how this may be done with a billet 18 of refinable material.

The principles of zone refining, involving the application of heat to an elongated member in a narrow band or zone, and moving the said band or zone of heat along the member, the intensity of the heat being sufficient to melt the material of the member within said heated band or zone, which melted material freezes as the heated band or zone moves on, are well known. In such operations on an elongated member of refinable material (e.g., material containing impurities), the said impurities tend to collect and concentrate in the molten liquid material. Thus, material within the trailing area of the moving heated band or zone will freeze prior to the freezing of the material within the forward area of said band or zone, and impurities in the said material will continually be concentrated in the said forward area and will remain there after the said forward area freezes.

By application of the principles of zone refining to a billet of refinable material containing impurities initially uniformly distributed in the said billet, a concentration gradient of the said impurities along the billet can be obtained.

In FIG. 4, billet 18 of refinable material (e.g., copper) is zone refined by induction coil 19, the said induction coil 19 being moved from a point 20 toward the forward end of billet 18 in the direction indicated by the arrow. In this manner, the purity of the material is increased from point 20 spaced behind the forward end of the billet toward the forward end of the billet. For materials in which softness is a function of purity, it will be apparent that the billet 18 is provided with a softness gradient which increases from said point 20 toward the said forward end, and conversely with a hardness gradient which increases from the forward end of the billet backwardly to the point 20 at which point zone refining began. In FIG. 5, the hardness gradient is represented generally by curve 21 which increases until it reaches line 22 which represents the hardness of the billet behind point 20. FIG. 5 also represents deformation effort vs. distance from the forward end of billet 18. It will be seen that, as the billet is extruded from the forward end thereof back, deformation effort (e.g., extrusion fluid pressure in hydrostatic extrusion) increases gradually along curve 21 until point 20 is reached, and then levels off smoothly and without peaks to run-out pressure 22.

It will be apparent that means other induction coil 19 may be employed to effect zone refining of billet 18. Further, the shape of curve 21 may be controlled as desired by the rate of movement of the heated zone or band along billet 18.

Billet 18 may be provided with a male conical forward end before zone refining, or the male conical forward end may be formed on billet 18 after the latter has been zone refined.

The forward portion of a billet 18 of indefinite length may be zone refined as above described. Alternatively, a short length of billet 18 may be zone refined as above described to provide therein a hardness gradient, and this billet 18 may be secured as by pressure welding to the forward end of a main billet of indefinite length.

In the foregoing description of the preferred embodiments, the value of the present inVention has been illustrated in a hydrostatic extrusion environment. The present invention is capable of reducing the effort required to initiate non-hydrostatic extrusion and drawing operations smoothly and without initial peaks in the effort required for such operations.

What I claim is:

1. A billed nose for facilitating the commencement of deformation against a deforming agency of a billet of first material having a forward end, said billet nose comprising:

a. first material having impurities therein, said billet nose having a forward end and a rearward end, said billet nose being adapted to be mounted at its rearward end to the forward end of said billet;

b. the concentration of impurities in said first material of said billet nose having a gradient decreasing from the rearward end to the forward end of said billet nose;

the softness of said billet nose increasing from the rearward end to the forward end of aid billet nose.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,767,368 Dated October 23, 1973

Inventor(s) FRANCIS JOSEPH FUCHS, JR. Case-95

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 1, "operation," should read --operation--; line 3, "un-desirable" should read --undesirable--; line 39, "to he" should read --to the--.

Column 3, line 24, "alos" should read --also--.

Column 4, line 10, "or" should read --of--.

Column 6, line 8, "other induction" should read --other than induction--; line 24, "inVention" should read --invention--; claim 1, line 43, before "the softness" insert --(c)--; claim 1, line 44, "aid" should read --said--.

Signed and sealed this 5th day of March 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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