United States Patent [19]

Fuchs, Jr. et al.

[11] **3,766,768**

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

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

[75] Inventors: **Francis Joseph Fuchs, Jr.**, Princeton Junction; **Peruvemba Swaminatha Venkatesan**, Princeton, both of N.J.

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

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

[21] Appl. No.: **265,245**

[52] **U.S. Cl.** **72/256**, 29/187.5

[51] **Int. Cl.** **B21c 5/00**

[58] **Field of Search** 72/60, 253, 256; 29/187, 187.5, 480

[56] **References Cited**

UNITED STATES PATENTS

2,781,903	2/1957	Buffet et al.	72/256
3,360,348	12/1967	Schreiner	29/182.2
3,620,059	11/1971	Nilsson	29/187.5

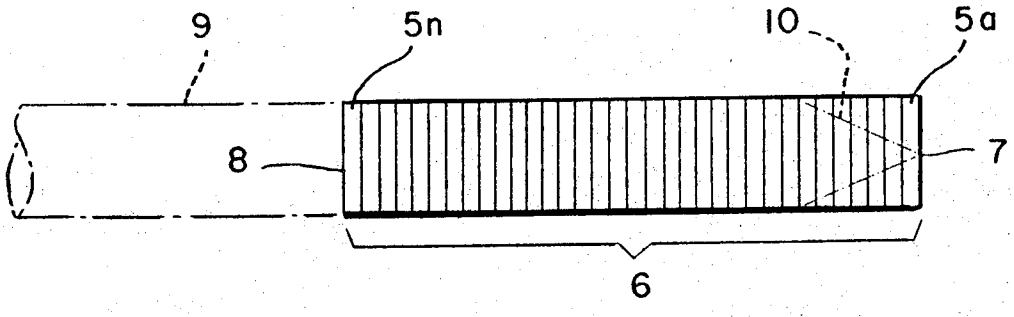
Primary Examiner—Richard J. Herbst

Attorney—W. M. Kain et al.

[57] **ABSTRACT**

The forward end of the billet to be deformed, e.g., hydrostatically extruded, is provided with a billet nose prepared by securing in order of hardness a plurality of metallic wafers of varying hardnesses to provide the billet nose with a hardness gradient increasing from the forward end thereof toward the rearward end thereof. The wafers are secured to each other by brazing, diffusion bonding, explosive bonding, friction welding or pressure welding techniques.

26 Claims, 3 Drawing Figures



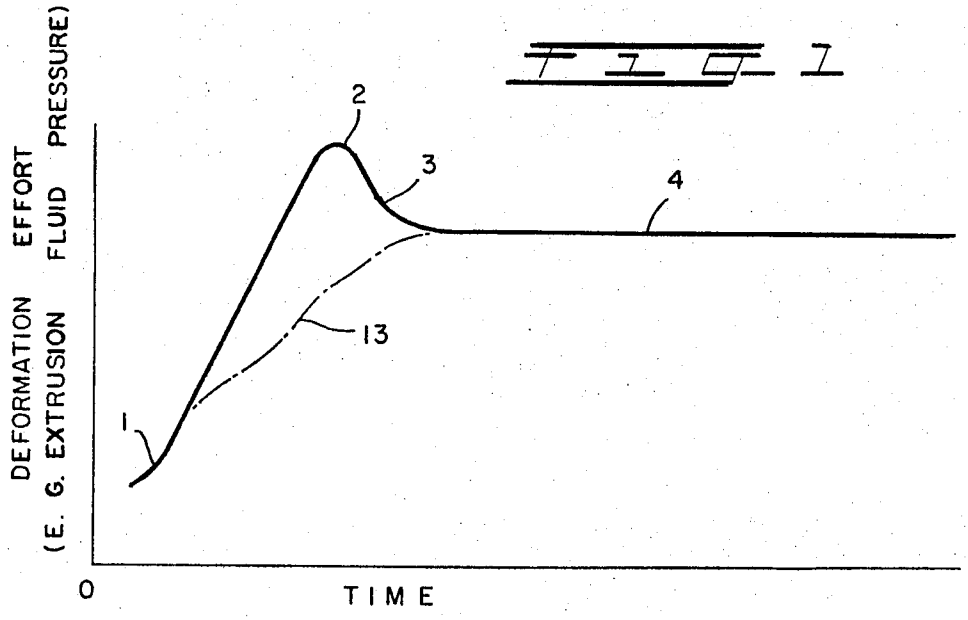

DEFORMATION EFFORT
(E. G. EXTRUSION FLUID PRESSURE)
0
TIME
1
2
3
4
13

FIG 1

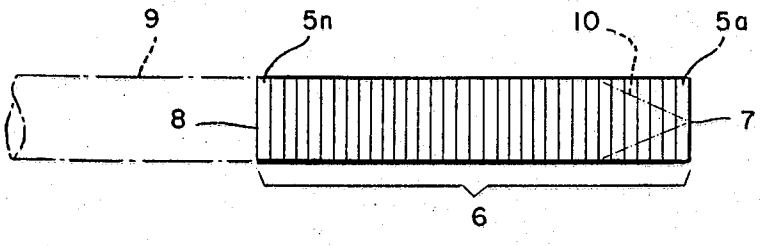

9
5n
10
5a
8
7
6

FIG 2

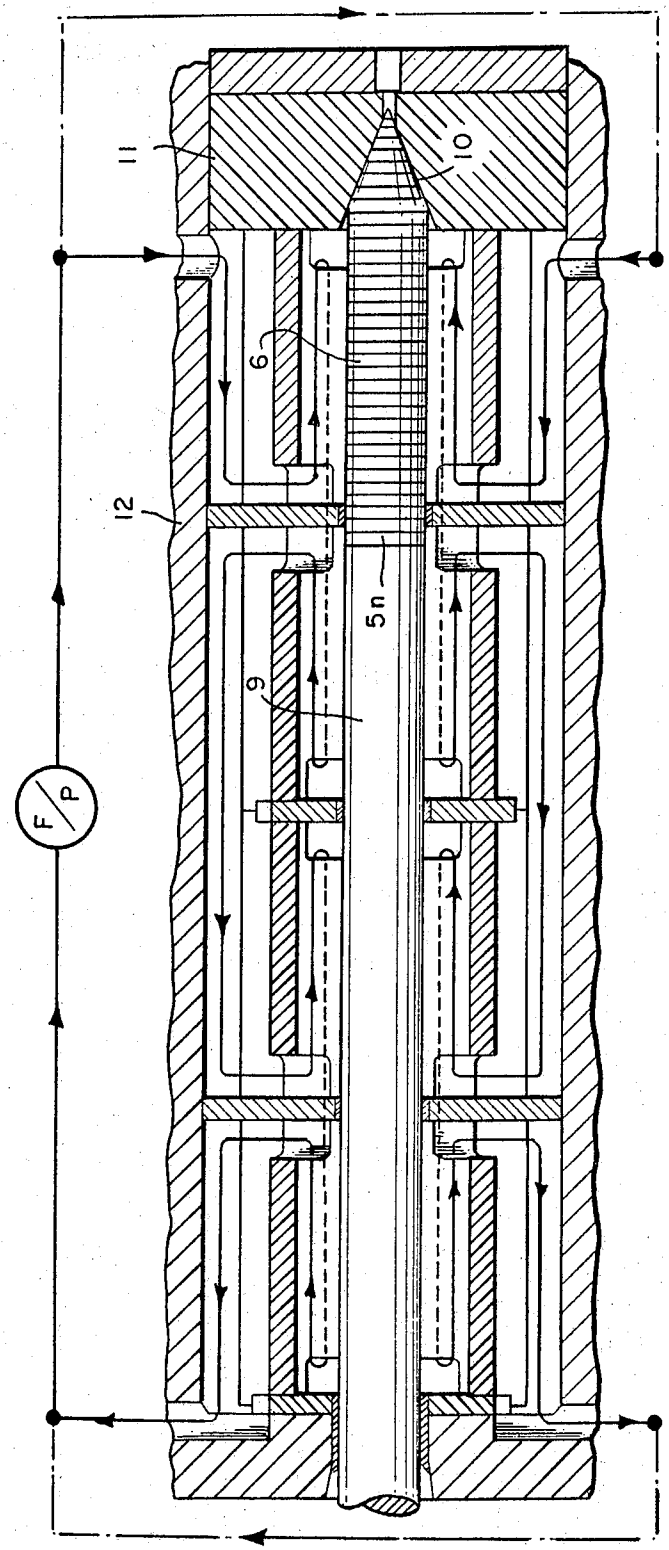


FIG. 3

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 undesirable 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 the accompanying drawings and appended claims.

Briefly, we have discovered that the foregoing objects may be attained by fastening together (e.g., brazing, diffusion bonding, explosive bonding, friction welding or pressure welding) a plurality of wafers to form a billet nose, the wafers having different hardnesses and being arranged in order of hardness to provide the billet nose with a hardness gradient increasing from the forward end thereof toward the rearward end thereof, the hardness of the rearward end of the billet nose not exceeding the hardness of the billet to be deformed. The rearward end of the billet nose is mounted to the forward end of the billet and deformation thereof is commenced.

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 deformation effort (e.g., extrusion fluid pressure) vs. time for two conditions, viz., deformation with an ordinary billet and deformation with a billet provided with a billet nose prepared according to the present invention.

FIG. 2 represents a view in side elevation of the plurality of wafers constituting the billet nose prior to forming a male conical forward end thereon.

FIG. 3 represents a medial longitudinal section of hydrostatic extrusion apparatus as disclosed in U.S. Pat. No. 3,667,267 and shows a billet having a billet nose which has just engaged the zone of deformation of the die and which has not yet commenced to extrude.

DESCRIPTION OF THE PREFERRED EMBODIMENT

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.

A plurality of wafers **5***a* . . . . **5***n* of metallic materials of different hardnesses are secured together as shown in FIG. **2** by brazing, diffusion bonding, friction welding, pressure welding, or explosive bonding or like methods, thereby to form billet nose **6.** Wafers **5***a* . . . . **5***n* are arranged in order of hardness so as to provide billet nose **6** with a hardness gradient increasing from the forward end **7** thereof toward the rearward end **8** thereof. The hardness, or shear strength of wafer **5***n* is no greater than the hardness, or shear strength of billet **9**; preferably, the hardness or shear strength of wafer **5***n* is approximately 80 percent of the hardness of shear strength of billet **9.** Advantageously, the peripheral contour of wafers **5***a* . . . . **5***n* are the same as the peripheral contour (i.e., transverse cross section) of billet nose **6** which, in turn, is the same as that of billet **9.** Thus, where billet **9** is a rod with a circular transverse cross section, billet nose **6** will have the same transverse cross section, and wafers **5***a* . . . . **5***n* will be circular and of the same diameter as billet nose **6,** with a thickness considerably less than the diameter thereof. Alternatively, wafers **5***a* . . . . **5***n* can be larger in peripheral contour than the desired billet nose **6** and after assembly as hereinabove described, the billet nose **6** can be machined down to the desired transverse cross section (e.g., turned down on a lathe). The forward end **7** of billet nose **6** is provided (e.g., by turning on a lathe) with a male conical profile **10.**

As hereinabove mentioned, the object of the foregoing method of fabricating billet nose **6** is to provide such billet nose **6** with a hardness gradient increasing from the forward end **7** thereof toward the rearward end **8** thereof. Care should be taken in securing wafers **5***a* . . . . **5***n* to each other to avoid using techniques and materials which would cause a local peak in hardness at the interfaces between adjacent wafers **5***a* . . . . **5***n.* Thus, in brazing two adjacent wafers together, it is desirable to avoid the use of certain metallic materials which are different from the two adjacent wafers **5***a* . . . . **5***n* and which might result in the formation at the interface therebetween of an alloy having a hardness greater than that of the adjacent wafers **5***a* . . . . **5***n.*

Billet nose **6,** prepared in the manner hereinabove described, is mounted in a suitable manner, keeping in mind the foregoing injunction, to the forward end of billet **9,** e.g., by pressure welding or the like.

Billet **9,** having billet nose **6** mounted thereto, is shown in FIG. **3,** prior to the actual commencement of extrusion and at the point of initial contact with the zone of deformation of die **11** of extrusion apparatus **12** of the type described in U.S. Pat. No. 3,667,267. The male conical profile **10** of the forward end **7** of billet nose **6** corresponds with the profile of die **11,** as shown. Extrusion apparatus **12** 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 **12** is desired.

When hydrostatically extruding billet **9** with billet nose **6,** the pressure of the extrusion fluid rises generally along curve **1** of FIG. **1** until extrusion of billet nose **6** commences and thence along curve **13** until extrusion of billet **9** commences and thence along curve **4.**

In the foregoing description, 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 is claimed is:

1. A billet comprising:

a. a main body portion having a forward end;

b. a billet nose having a rearward end and a forward end, the rearward end of said billet nose being mounted to the forward end of said main body portion;

c. said billet nose comprising a plurality of wafers of materials of different hardnesses, the said wafers being arranged in order of said hardnesses so as to provide said billet nose with a hardness gradient increasing from the forward end toward the rearward end thereof, the hardness of the rearward end of the said billet nose not exceeding the hardness of said main body portion;

d. adjacent wafers of said billet nose being secured to each other.

2. A billet as in claim **1** wherein said materials are metallic.

3. A billet as in claim **1** wherein adjacent wafers are brazed to each other.

4. A billet as in claim **1** wherein adjacent wafers are diffusion bonded to each other.

5. A billet as in claim **1** wherein adjacent wafers are explosively bonded to each other.

6. A billet as in claim **1** wherein adjacent wafers are friction welded to each other.

7. A billet as in claim **1** wherein adjacent wafers are pressure welded to each other.

8. Means for facilitating the commencement of deformation against a deforming agency of a billet having a forward end, said means comprising:

a. a billet nose having a rearward end and a forward end;

b. the rearward end of said billet nose being adapted to be mounted to the forward end of said billet;

c. said billet nose comprising a plurality of wafers of materials of different hardnesses, the said wafers being arranged in order of said hardnesses so as to provide said billet nose with a hardness gradient increasing from the forward end toward the rearward end thereof, the hardness of the rearward end of said billet nose not exceeding the hardness of the said billet;

d. adjacent wafers of said billet nose being secured to each other.

9. Means as in claim **8** wherein said materials are metallic.

10. Means as in claim **8** wherein adjacent wafers are brazed to each other.

11. Means as in claim **8** wherein adjacent wafers are diffusion bonded to each other.

12. Means as in claim **8** wherein adjacent wafers are explosively bonded to each other.

13. Means as in claim **8** wherein adjacent wafers are friction welded to each other.

14. Means as in claim **8** wherein adjacent wafers are pressure welded to each other.

15. Method of commencing deformation against a deforming agency of a billet having a forward end, said method comprising:

a. arranging a plurality of wafers of materials having different hardnesses ranging up to a hardness not in excess of the hardness of said billet in order of said hardnesses and securing adjacent wafers together to form a billet nose having a forward end and a rearward end with a hardness gradient increasing from said forward end toward said rearward end;

b. securing the rearward end of said billet nose to the forward end of said billet;

c. advancing said billet and said billet nose against the deforming agency to deform the billet nose and then the billet.

16. Method as in claim **15** wherein adjacent wafers are brazed to each other.

17. Method as in claim **15** wherein adjacent wafers are diffusion bonded to each other.

18. Method as in claim **15** wherein adjacent wafers are explosively bonded to each other.

19. Method as in claim **15** wherein adjacent wafers are friction welded to each other.

20. Method as in claim **15** wherein adjacent wafers are pressure welded to each other.

21. Method of preparing a billet nose adapted to be mounted to the forward end of a billet to facilitate deformation thereof, said method comprising:

a. arranging a plurality of wafers of materials having different hardnesses ranging up to a hardness not in excess of the hardness of said billet in order of said hardnesses and securing adjacent wafers together to form a billet nose having a forward end and a rearward end with a hardness gradient increasing from said forward end toward said rearward end.

22. Method as in claim **21** wherein adjacent wafers are brazed to each other.

23. Method as in claim **21** wherein adjacent wafers are diffusion bonded to each other.

24. Method as in claim **21** wherein adjacent wafers are explosively bonded to each other.

25. Method as in claim **21** wherein adjacent wafers are friction welded to each other.

26. Method as in claim **21** wherein adjacent wafers are pressure welded to each other.

* * * * *