United States Patent [19]

Voorhes

[11] **3,911,705**

[45] **Oct. 14, 1975**

[54] **EXTRUSION APPARATUS**

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[73] Assignee: **Wanskuck Company,** Providence, R.I.

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[21] Appl. No.: **456,684**

[52] **U.S. Cl.** **72/45;** 72/92; 72/184; 72/270

[51] **Int. Cl.²** **B21B 45/02**

[58] **Field of Search** 72/41–45, 60, 72/270, 92, 184

[56] **References Cited**

UNITED STATES PATENTS

2,602,538	7/1952	Bimba et al.	72/43
3,349,153	10/1967	Beck	72/351
3,740,985	6/1973	Fuchs, Jr.	72/60
3,765,216	10/1973	Green	72/262

FOREIGN PATENTS OR APPLICATIONS

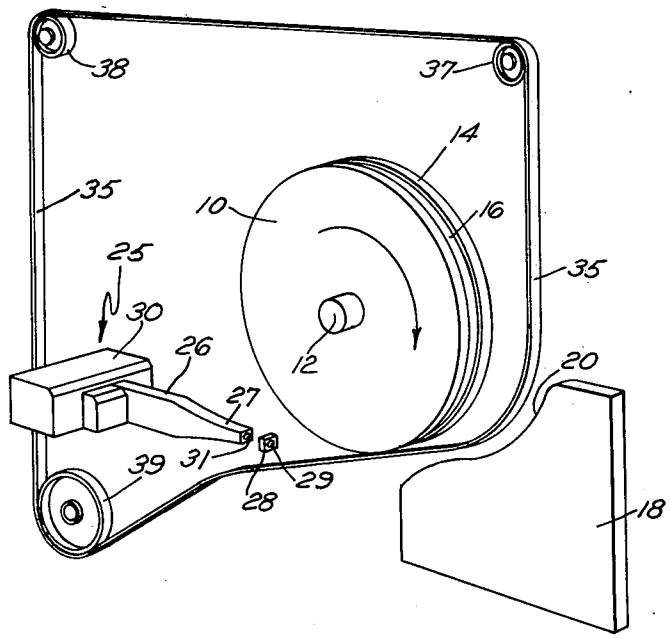
487,791	12/1953	Italy	72/286

Primary Examiner—Victor A. DiPalma
Attorney, Agent, or Firm—Barlow & Barlow

[57] **ABSTRACT**

An extrusion apparatus comprising at least a first and second member forming a passageway, a die being held in position by an abutment closing the end of the passageway and a band means located against one wall of the passageway so as to form an anti-friction device.

8 Claims, 6 Drawing Figures



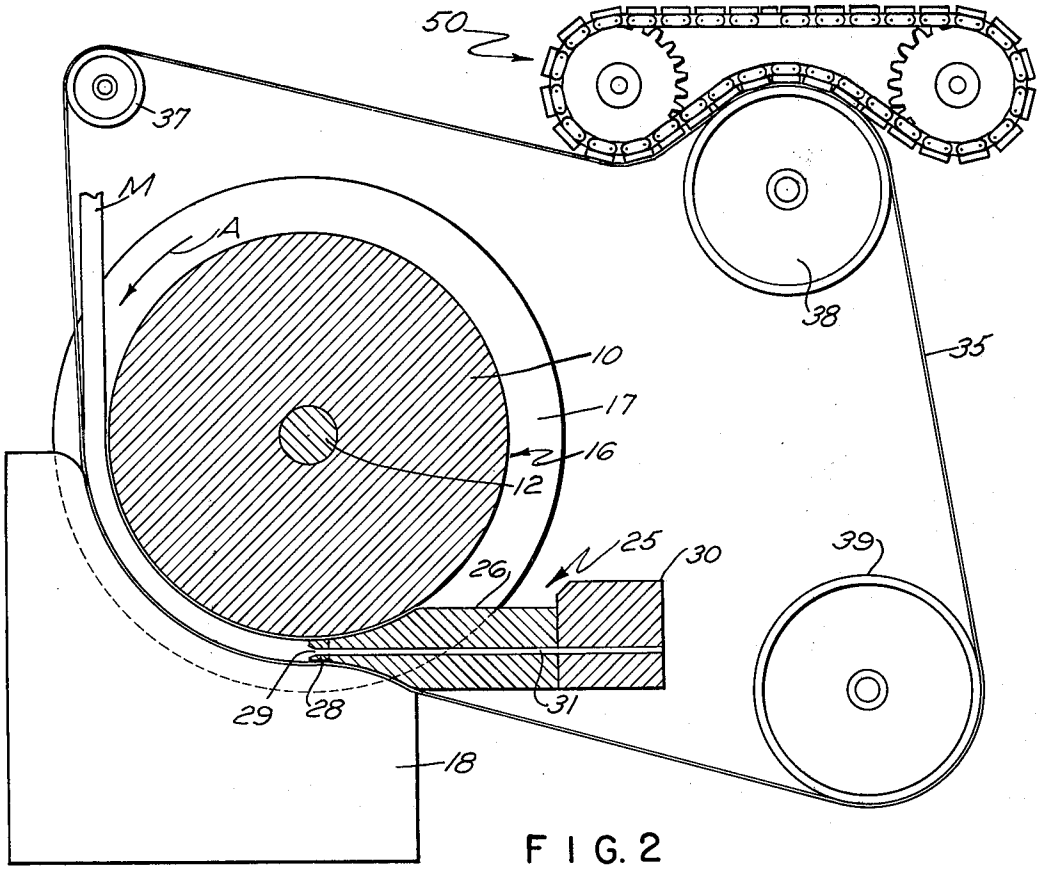


FIG. 2

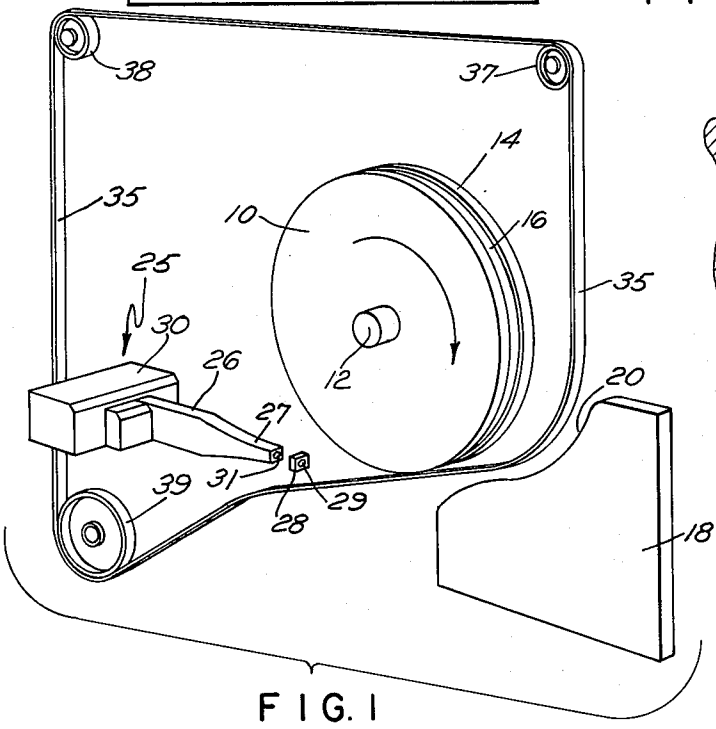


FIG. 1

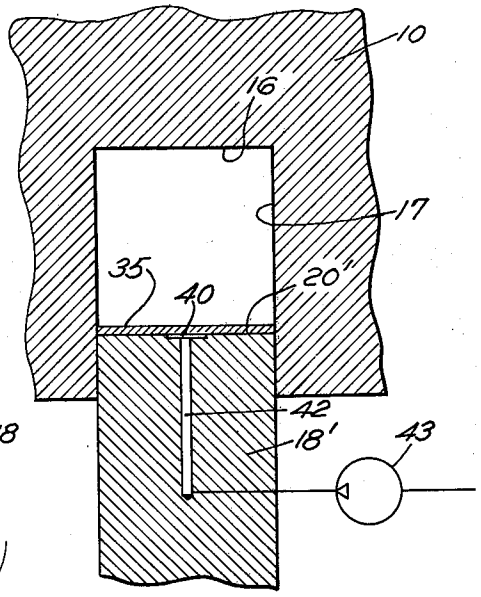


FIG. 3

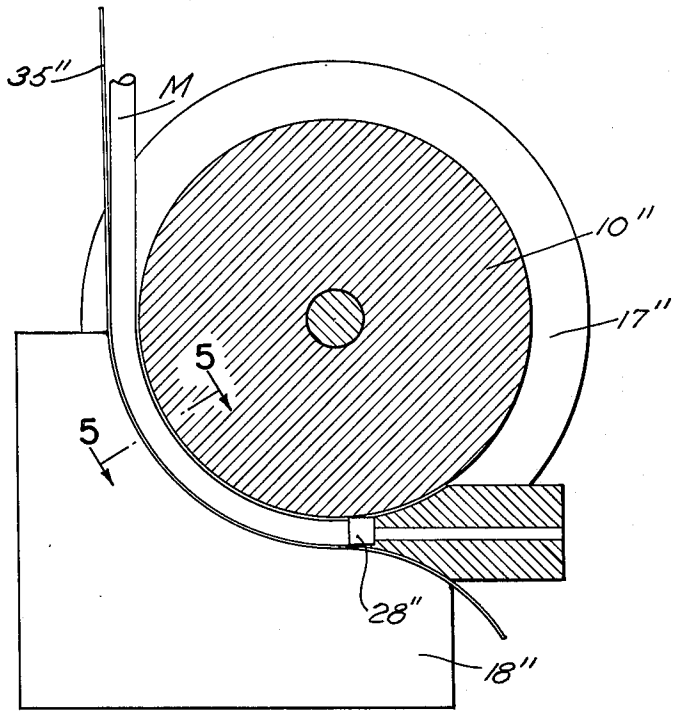


FIG. 4

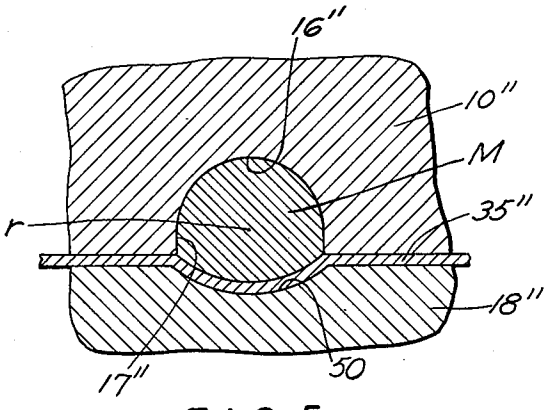


FIG. 5

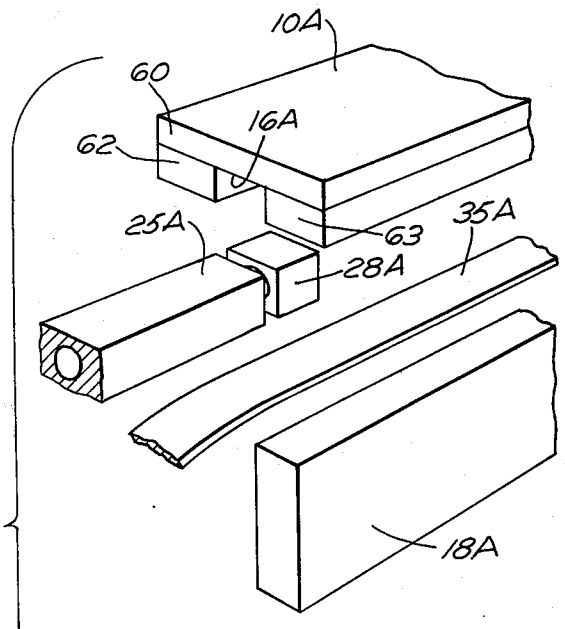


FIG. 6

EXTRUSION APPARATUS

BACKGROUND OF THE INVENTION

Extrusion broadly is the process in which a piece of solid material is converted into a continuous length of uniform cross section by forcing the material to flow under high pressure through a die orifice which is so shaped as to impart the required form to the product. Until relatively recently the main form of extruding material in this general pattern has been to do it as a hot operation, the material being heated to a suitable degree of softness and plasticity to permit it to be forced through the orifice. More recently hydrostatic extrusion has come into our technology as represented by the Fuchs U.S. Pat. No. 3,740,985 and a different approach has been described in ASME paper No. 73-WA/PT-2 and the Green U.S. Pat. No. 3,765,216. In the Green patent, a feed grip is utilized between a wheel and a shoe and the material is progressively squeezed into a groove of the wheel against a die orifice. In processing material using the Green patent, heat is generated within the feed stock because of the sliding contact with the shoe member. It is apparent that excessive temperatures may be achieved such as to anneal the material being extruded and turn out an inferior product. It is therefore an object of the present invention to control the amount of heat that is developed in this type of continuous extrusion apparatus and to reduce the power requirement.

SUMMARY OF THE INVENTION

The present invention provides an improvement in the material extrusion process in which the metal is forced through a die means by frictional engagement of the metal in a groove or passageway that is located within a wheel or block, the material being retained in the groove by a shoe member that is held stationary with respect to the wheel. In particular the improvement utilizes a band member that is located between the shoe and the walls of the groove and is held against the shoe by the feedstock. In this preferred embodiment the band member is continuous. The band is normally moved by frictional engagement between the feedstock and the band. In some cases the band is restrained from such free movement. The degree of movement of the band with respect to the feedstock controls essentially the temperature rise in the feedstock due to friction.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a detached perspective view of the main parts of the extrusion apparatus made in accordance with this invention;

FIG. **2** is a part sectional longitudinal elevational view of a modified form of extrusion apparatus made in accordance with the teachings of this invention;

FIG. **3** is a partial sectional view showing a detail of a modified form of shoe that is part diagrammatic indicating the source of fluid being fed thereto by a pump;

FIG. **4** is a partial sectional elevational view of a modified form of the invention;

FIG. **5** is a sectional view taken on lines **5**—**5** of FIG. **4**;

FIG. **6** is a detached perspective view of the elemental form of the extrusion apparatus of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The extrusion apparatus comprises a wheel **10** which is rotatably mounted on a shaft **12** that is suitably driven by a source of power (not shown) The wheel has a circumference **14** containing a passageway or groove **16,** the groove taking a variety of forms of shape depending upon the type of feedstock being extruded. Fitting closely within the groove **16** of the wheel is a shoe member **18** which is suitably anchored in position relative to the axis of rotation of the shaft **12** and this shoe member has an arcuate mating edge **20** which substantially conforms to the curvature of the bottom wall of the groove. An abutment member **25** is suitably anchored in position relative to the axis of rotation of the shaft **12** and has a projecting portion **26** with a nose **27** that is shaped to fit within a groove **16** of the wheel **10.** On the end of the nose **27** is a die insert **28** which has an orifice **29** therein of a shape of the product to be extruded and the projecting portion **26** and **27** together with the anchor means in the form of a block **30** are formed with a thru bore **31** so that the material extruded through the orifice **29** may pass through the abutment block **30.** Against the arcuate surface **20** of the shoe **18** is a band **35** which effectively closes the groove **16** so as to provide the closure wall thereof and this band **35** passes between the side walls **17** of the groove **16** of the wheel **10** and bears against the arcuate surface **20** of the shoe **18.** Band **35** may be made continuous as shown in which case it is fed around guide pulleys **37, 38, 39.** Since the band forms the closure for the groove **16** it will be apparent that the material M as seen in FIG. **2** will bear against this band and create a frictional drag thereon normally moving the band in the direction of rotation of the wheel **10** as seen by the arrow A. It is desirable that the band be provided with some lubricant on the surface thereof that faces the arcuate surface **20** of the shoe **18** and this lubricant can take the form of a number of greases such as the sodium series of greases or the EP greases.

Reference should now be made to FIG. **3** where a modified form of shoe **18'** is disclosed, this shoe having a recess in its arcuate surface **20'** which recess is designated **40.** The recess **40** comprises a central longitudinal groove of a length substantially the length of the contacting surface **20'** which communicates with a number of bores **42** that lead to a pump **43** that is connected to a source of fluid such as air or oil. In effect fluid which is fed under pressure to the groove provides a bearing for the band **35,** such fluid being used as a lubricant so as to maintain the band **35** and the arcuate surface of shoe out of direct contact by developing a film of fluid under compression underneath the band **35.** In effect, the film of fluid operates in the same fashion that a hydrostatic bearing operates, the fluid escaping out under the edge of the band **35** whre the same is guided between the side walls of the groove.

It is also desirable in some cases to control the temperature of the stock that is being extruded. If the speed of the band **35** is the same as the speed of the feedstock, then there will be substantially no friction forces to increase the temperature of the stock being extruded. On the other hand if it is desired to raise the temperature of the stock being extruded, then the speed of the band **35** may be varied with respect to the feedstock and to this end a caterpillar drive generally

designated **50** may be provided, the caterpillar drive being made similar to the caterpillar drives used widely in wire handling field and may be made substantially in accordance with U.S. Pat. No. 2,776,832. It will be understood that a separate drive means for the caterpillar may be provided or a variable speed coupling provided to the main shaft **12.**

Referring now to FIGS. **4** and **5,** there is shown a modification of the invention in which there will be less distortion of round feedstock than in the square-grooved version represented in FIGS. **1–3.** The wheel **10''**is provided with a groove **16''** which is of substantially circular section with the center radius thereof as at r positioned radially inward of the circumferential surface of the wheel **10''** so as to yield for a partial distance side walls **17''** that are tangent to the circle cross section. The shoe **18''** has a groove **50** therein which complements the circular cross section of the groove **16''** of the wheel so as to provide a grip thereon, the feedstock yielding and upsetting to fill the cross section. The band **35''** that is utilized between the feedstock and the show **18''** is such that it will conform to the shape of the groove **50** due to its inherent flexibility and will reduce the friction of the feedstock by virtually eliminating the frictional drag on the shoe. In all other respects this modification is similar to that previously described in connection with FIG. **1.**

Refer now to FIG. **6.** Essentially the use of a wheel is a practical form of a continuous process device which in its elemental form comprises a block **10A** having a groove or passageway **16A,** an abutment **25A** and shoe **18A** upon which band **35A** rests. Stated in other terms, the passageway **16A** may be defined by the walls of a pair of first members **62, 63,** a second shoe member **18A** and a third plate member **60.** Such a device is useful for discontinuous extrusions and it will immediately be apparent that the first and third members are coupled together for movement while the second member and the abutment are stationary.

It will be understood that this apparatus operates substantially in the same manner as that disclosed in U.S. Pat. No. 3,765,216. The difference between the operation of the instant device and the Green patent lies in the fact that the feedstock does not press directly against the arcuate surface **20** of the shoe member **18** but against the band **35** that bears against the arcuate surface **20** of the shoe member and the groove **16.** The material M is carried toward the die member **28** by frictional drag of the side walls **17** and the bottom wall of groove **16.** It will be apparent that there are frictional forces set up on each of the four contacting sides of the material M. Three of the sides are aiding motion of the material and only one is resisting, that is the side which now contains the band **35.** It is this fourth side of the member in the Green patent which creates considerable friction and resulting power loss and gives rise to a significant temperature increase in the feedstock. Additionally, by eliminating the fourth side drag, various groove configurations are possible. As explained by Green in his U.S. Pat. No. 3,765,216 and the article in Journal of the Institute of Metals 1972, Vol. 100, p. 295, the compressive stress on the feedstock does not exceed the yield strength of the feedstock where the feedstock enters the passageway. However, the compressive stress on the feedstock in the die region will exceed the yield strength of the feedstock, causing the feedstock to yield and upset completely filling the groove over a portion of its length immediately preceding the die. The relationship between this upset length *l*, the groove width W, the extrusion pressure P and the yield strength Y can be expressed $l/W = P/Y$. It has been demonstrated that the pressure profile along the feedstock decreases exponentially. The average pressure along length *l* can be expressed approximately as:

$$P_{AVG} = \frac{P + 2Y}{3}$$

Since the force to overcome friction along length *l* can be expressed

$$F_{FRICTION} = P_{AVG} \cdot l \cdot W \cdot \mu$$

where μ is the coefficient of friction between the feedstock and the shoe therefore

$$F_{FRICTION} = PW^2 \quad \frac{P}{Y} + 2 \quad \frac{\mu}{3}$$

The total force required both to extrude and to overcome shoe friction can be expressed:

$$F_{TOTAL} = F_{EXTRUSION} + F_{FRICTION}$$

If the groove/shoe cross section is square, then

$$F_{TOTAL} = PW^2 + PW^2 (P/Y + 2) \mu/3$$

I claim:

1. Extrusion apparatus comprising a passageway formed between two opposing walls in a first member, the bottom of the passageway being closed by a surface of a second member, said surface having lubricant thereon, the top of the passageway being closed by a third member, an abutment extending into the passageway and closing an end thereof, a die insert positioned against the abutment, a continuous band being guided for movement on the lubricated surface of the second member about the apparatus, the surface wall area of the first member being greater than the surface area of the band lying against the third member, means for feeding material to be extruded to said passageway, said material bearing against said band and moving the same toward said abutment.

2. Extrusion apparatus comprising first and second members forming a passageway therein, said first member providing means forming a groove, said second member closing the groove, by means defining a surface, lubricant on said surface, an abutment at one end of the passageway, a die insert held by the abutment, and a continuous band being guided by the first member about the apparatus and bearing on a lubricated surface of the second member facing the passageway, means for feeding material to be extruded to said passageway, said material bearing against said band and moving the same toward said abutment.

3. Extrusion apparatus as in claim **2** wherein said first member is a wheel and the second member is a shoe facing the bottom wall of the groove.

4. Extrusion apparatus as in claim **2** wherein the arcuate surface of the shoe member is concave in cross section.

5. Extrusion apparatus comprising first and second members forming a passageway, said first member being a wheel with a groove therein, said groove having side and bottom walls, the second member having a

surface closing the groove of the first member, an abutment extending into the passageway and closing an end thereof, a die insert positioned against the abutment and a continuous band being guided for movement on the lubricated surface of the second member about the apparatus, the surface wall area of the first member being greater than the surface area of the band lying against the third member, means for feeding material to be extruded to said passageway, said material bearing against said band and moving the same toward said abutment.

6. Extrusion apparatus as in claim **5** wherein said first member is a wheel and the second member is a shoe facing the bottom wall of the groove.

7. Extrusion apparatus as in claim **5** wherein the arcuate surface of the shoe member is concave in cross section.

8. A process of extruding material comprising feeding solid stock material into a passageway formed between a band and a groove in another member, moving the other member, providing die means closing one end of said passageway, providing means to support the band , moving the band at the input feed speed of the solid stock and providing continuous lubrication between the band and the support means therefor.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,911,705 Dated October 14, 1975

Inventor(s) William G. Voorhes

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

In the specification line 21 of column 4, please correct the formula to read as follows:

$$F_{FRICTION} = PW^2 \left(\frac{P}{Y} + 2\right) \frac{\mu}{3}$$

Signed and Sealed this

second Day of March 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks