United States Patent

Coffman et al.

[15] **3,684,258**

[45] **Aug. 15, 1972**

[54] **APPARATUS AND METHOD FOR BILLET HEATING AND SOLID STRETCH FORMING**

[72] Inventors: **Paul M. Coffman,** 1124 Kitty Hawk Rd., Cherry Hill, N.J. 08034; **Herbert G. Johnson,** 17 N. Drexel Ave., Havertown, Pa. 19083

[22] Filed: **Oct. 8, 1970**

[21] Appl. No.: **79,163**

[52] **U.S. Cl.** .....**263/6 R**

[51] **Int. Cl.**.....**F27b 9/14**

[58] **Field of Search** .....263/6 R, 8 R; 34/DIG. 3

[56] **References Cited**

UNITED STATES PATENTS

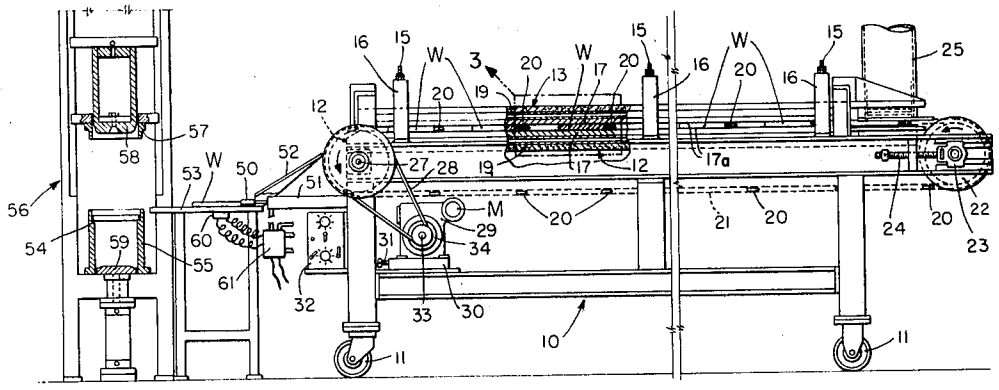
3,502,310	3/1970	Coffman	263/6 R
3,491,989	1/1970	Fritz et al.	263/6 R
2,892,263	3/1959	Hornbostel	34/DIG. 3

Primary Examiner—Charles J. Myhre
Attorney—John H. Colvin and Martin S. Baer

[57] **ABSTRACT**

This application discloses heating apparatus and method of heating employing longitudinally extending heating plates which maintain contact proximity with both surfaces of a line of billets at all times, i.e., actual surface contact with both sides of the billets or full surface contact with the lower side and close proximity at the upper side for engaging projecting portions if warped or burred, the plates being provided with a coating of a material having a low coefficient of friction, such as a fluorocarbon polymer, and means for advancing the line of billets along between the heating plates while the space between plates is maintained constant.

7 Claims, 4 Drawing Figures



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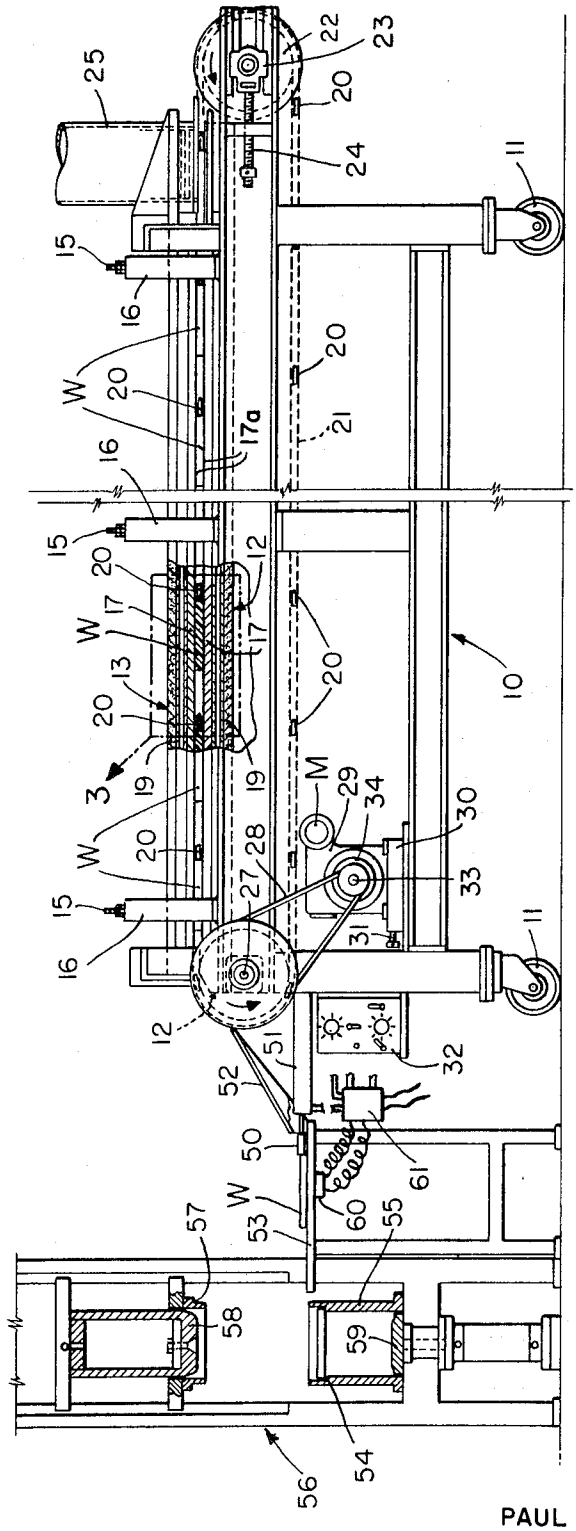

Fig. 1

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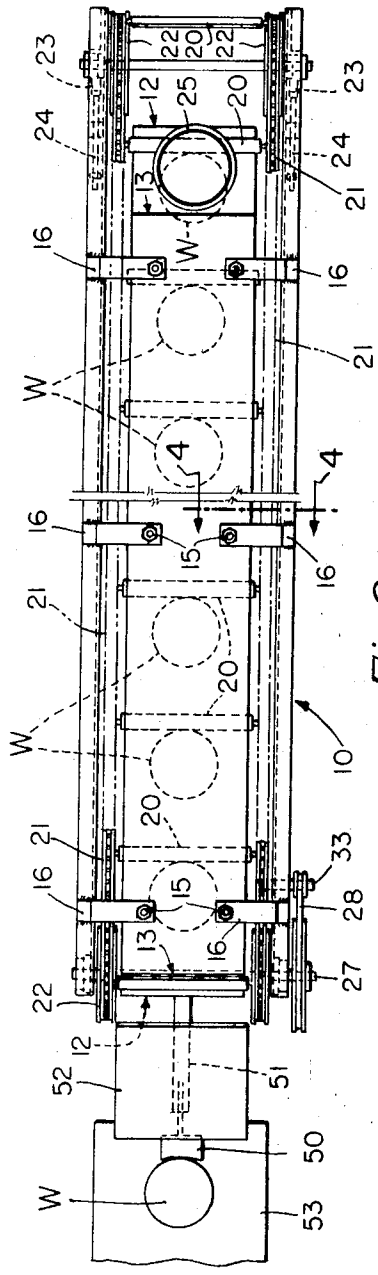

Fig. 2

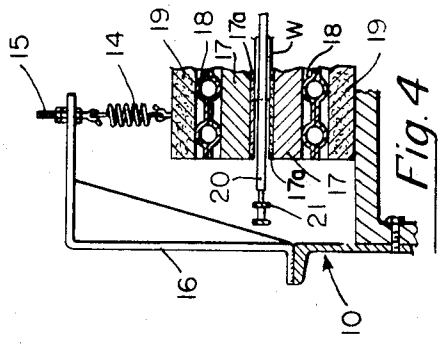

Fig. 4

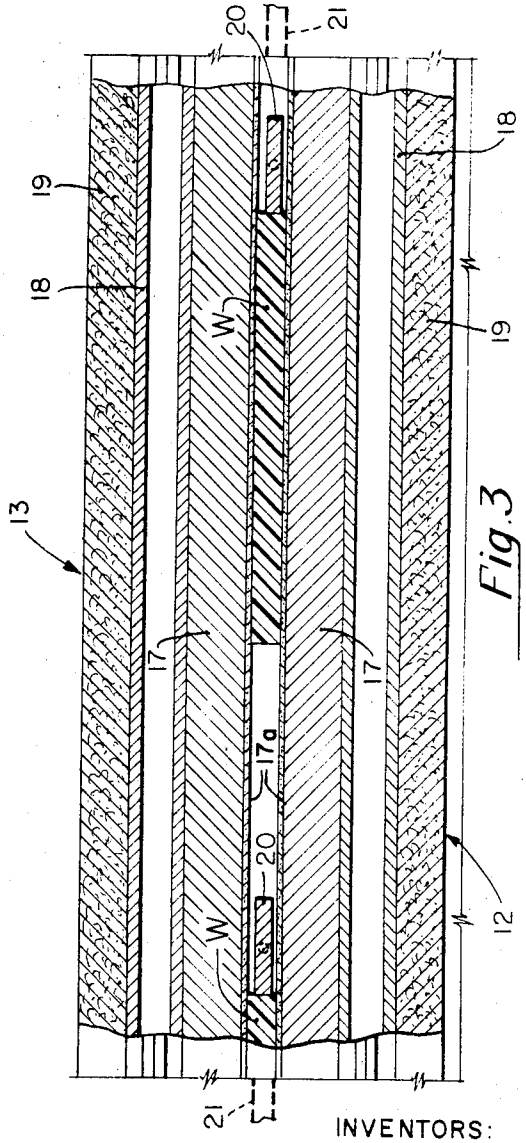

Fig. 3

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APPARATUS AND METHOD FOR BILLET HEATING AND SOLID STRETCH FORMING

BACKGROUND OF THE INVENTION

The invention is particularly applicable for heating plastic polymer materials which are "cold-workable" and work-strengthenable in the solid state, that is between an upper temperature near a so-called melting point at which the material begins to change shape without any applied force except gravity and atmospheric pressure, say up to 15–25 p.s.i., and a lower temperature, referred to as the "glass-transition" point, at which the material becomes brittle and strongly resists flow by applied force unless very great and maintained for a relatively long time.

If the materials are maintained at the elevated temperature for too long a period of time, especially if exposed to air, they tend to assume an objectionable bloom which adversely affects the appearance and quality of the product.

It is very desirable to heat the billets to a temperature as near the melting point as possible for better forming conditions but if heated too high they lose shape and become sticky and if they contact directly with metal heating surfaces while too hot they adhere and form a residue which is very difficult to remove.

Therefore, it is desirable to heat the materials as rapidly and completely as possible and to control the time and temperature of heating as closely as possible; and it is particularly desirable to minimize contact with air while heating.

These plastic polymer materials, polyethylene, polypropylene, and a number of others which are known and need not be named, have very low thermal conductivity so that it is difficult to drive heat into the interior of even relatively thin sections sufficiently to provide the desired substantially uniform temperature throughout the plastic body. The heating temperature must not be above the melting point or the outer surface will be melted before the center has been heated sufficiently.

U.S. Pat. No. 3,502,310, Paul M. Coffman, Mar. 24, 1970, discloses apparatus and method of heating by plates which intermittently separate while billets are moved forward between them.

U.S. Pat. No. 3,499,188, Herbert G. Johnson Mar. 10, 1970, discloses apparatus and method for forming plastic billets into cup-shaped articles.

SUMMARY OF THE INVENTION

According to the present invention, billets are moved along continuously between heating plates which are maintained in a fixed space relationship of contact proximity, either in contact with both faces of the billets or in full contact with one face and so near the other face as to engage any warped or burred surfaces of the billets, the plates being coated with a surfacing material having a low coefficient of friction with the billets. The preferred coating material is a fluorocarbon polymer, specifically polytetrafluoroethylene being used at present.

In this way the maximum temperature short of the melting point can be maintained to heat the billets to within 5° to 20° F. below the melting point and to heat the interior portion of the billets to within about 3° F. of the surface temperature. By keeping the heating plates

in fixed spatial relationship, especially when in full surface engagement with both sides of the billets, the contact with air while heating is reduced to a very low value.

As an example, when heating billets of polypropylene, typically Shell 5520 (M.F. 0.7) which melts at 335° F., having a thickness of about 140 mils and a diameter of about 4 inches, between heating plates about 16 feet long heated by circulating hot oil through ducts, it has been found that the billets can be held to about 1° F. above or below a desired temperature, even if no outer insulation is used on the heating plates. The entire plate area can be heated to a uniform temperature, say 315° F., which establishes the exit temperature of the billets with a dwell time of about 2.5 minutes between the heating plates when there are about 35 to 40 billets in progress between the plates.

DRAWINGS

The invention will be described in connection with one form of heating apparatus shown in the accompanying drawings, in which:

FIG. **1** is a side elevation, partly in section, of billet heating apparatus embodying the invention;

FIG. **2** is a top plan view, some parts being omitted;

FIG. **3** is an enlarged view in the zone **3** shown in section in FIG. **1**;

FIG. **4** is an enlarged local section showing support means for the heating plates.

SPECIFIC EMBODIMENT

The apparatus illustrated herein comprises a main frame **10** which is shown as being mounted on caster wheels **11** for portability.

A lower heating plate unit **12** is mounted on the main frame **10** and an upper heating plate unit **13** is carried (FIG. **4**) by springs **14** adjustable by nuts on threaded rods **15** carried by suitable frame supports **16**.

Each heating unit **12, 13** comprises an inner billet-engaging metal plate **17** of good thermal conductivity, as of aluminum, copper, or steel, heating means indicated by fluid tubes **18** (suitable fluid heating and control means being assumed) and outer cover means **19** which may be a metal plate or insulation or both. The plates are provided on the billet-contacting sides with a coating material **17*a*** of low friction coefficient, such as a fluorocarbon polymer, preferably polytetrafluoroethylene, to ease the travel of billets between the plates under the pressure maintained on them.

Means are provided for feeding billets and moving them along between the heating plate units. The term billets is meant to include sheets from which billets are cut but preferably, and as here shown, the billets are assumed to have been pre-cut in the cold state before being supplied to the heating apparatus.

The billet advancing means herein shown comprises transverse conveyor bars **20**, which are thinner than the thinnest billets to be heated, secured to endless conveyor belt or chain means **21** carried over end pulleys or sprockets **22**. The pulleys for one end are shown to be adjustable for tightening the belts, as by slides **23** and adjusting screws **24**.

Billets W are fed in between adjacent pusher bars **20**, as from billet stack holding means or hopper **25**

mounted above the infeed end of the lower heating plate unit 12, the upper heating plate unit 13 being cut out or shortened to allow the billets to feed down upon the lower plate heating unit.

A shaft 27 carrying the feed conveyor pulleys 22 at the feed-out or delivery end is driven by a belt or sprocket chain 28 from a gear box unit 29 driven by a motor M, the chain passing over suitable sprockets. The gear unit 29 is shown to be mounted on a slide 30 adjustable by a screw 31 to control tension in the belt or chain 28.

A control unit 32 is provided for regulating the speed of the motor drive. The drive shaft 33 of the gear unit may be provided with a magnetic clutch-brake unit 34 for starting and stopping the feed of billets when desired.

The control unit 32 also assists in regulating the means for transferring heated billets from the heating means to associated forming means and controlling the action of the forming means.

Heated billets are delivered to a chute 52 from which they drop upon a table 53 and from this they are fed, as by a power pusher 50 operated by a power device 51 (fluid cylinder-piston) 54 of a die-mold unit 55 of a forming press 56 having a clamping plunger 57 and a forming plunger 58 cooperating with a bottom plunger 59.

The forming press 56 and transfer pusher 50 have a faster operating cycle than the heater delivery to allow ample time for the press to form and discharge an article before another billet blank can be fed out. Preferably the presence of a billet, indicated by heat, weight, or the like, through a power-initiating control switch 60 at the transfer table 53 and power control unit 61 for device 51, serve to initiate transfer and formation of a billet as soon as it falls on the transfer table. If desired, the chute and transfer table may be enclosed to minimize contact with air but in any case the exposure with air would be very brief.

In operation, assuming that the heating plates are at proper temperature and that a stack of billets is in the hopper 25, the conveyor bars 20 feed out a billet each time a bar moves beneath the stack of billets and pushes it forward between the heating plates against such pressure as is adjustably maintained between them. If desired, the lower front edge of the upper heating plate is beveled to assist the entry of billets between the plates. The coating of low-friction material on the heating plates eases the travel of the billets between the plates. It is so thin that it does not substantially reduce the heat transfer although its own heat conductivity is not high. The billets are so closely confined between the heating plates throughout their whole travel between them, since the heating plates are maintained in contact proximity with the billets at all times and never separated, that the exposure of heating billets to air is minimized.

When a billet is delivered down the chute 52 upon the transfer table 53 its presence will be registered by the device 60 and through the controls 61 and 32 the pusher 50 and press 56 will be cycled to move the billet onto the seat 54 of the die-mold unit 55, form it into a flanged cup-shaped article, and deliver it out of the press before another billet is fed out to the transfer table. The unit 60 is illustrated as being of the type responsive to heat, having a location within a cut-out opening in the table if needed; but if a weight-sensitive indicator is used the table will be supported, as on light springs, to make it responsive to the weight of a billet falling upon it. A trip-responsive device activated by the passage of a billet to the table might also be used.

While one embodiment of the invention has been described for purposes of illustration it is to be understood that there may be other embodiments and modifications within the scope of the invention.

We claim:

1. Apparatus for heating billets of plastic polymer material having a low coefficient of heat transfer and having a high coefficient of adhesion and friction at the melting point, comprising in combination, spaced longitudinally extending heating plates arranged one above the other to receive a line of billets in surface contact with at least the lower one of said plates and in very close proximity with at least possible contact with the upper plate, said plates having a coating of material having a low coefficient of friction with the billets, and pushing means, traveling between said heating plates, for insertion between successive billets for advancing the line of billets between said plates while their position is maintained.

2. Apparatus as set forth in claim 1, in which said coating material is a fluorocarbon polymer.

3. Apparatus as set forth in claim 2, in which said coating material is polytetrafluoroethylene.

4. Apparatus as set forth in claim 1, which further includes spring adjusting means for one of said heating plates for adjusting its position relative to the other heating plate and the contact pressure on billets pushed along between the heating plates.

5. The method of heating flat polypropylene billets to within 1° F. of a predetermined surface temperature and an interior temperature within about 3° F. of the surface temperature, which comprises disposing a line of polypropylene billets between longitudinally extending heating plates, having a coating of material having a low coefficient of friction with the billets, maintaining said heating plates in contact proximity engagement with the billets continuously, and moving the line of billets along between said heating plasts while contac proximity is maintained, the transit time being controlled to achieve the predetermined surface temperature of the billets as they reached the end of the heating plates.

6. The method as set forth in claim 5, in which said coating material is a fluorocarbon polymer.

7. The method as set forth in claim 6, in which said coating material is polytetrafluoroethylene.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,684,258 Dated August 15, 1972

Inventor(s) Paul M. Coffman and Herbert G. Johnson

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

Following the inventors' names and addresses in the heading of the patent, reference to the assignment has been omitted, which reference should read:

-- Shell Oil Company, New York, N. Y. -- .

Signed and sealed this 20th day of March 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents