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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :
B29D 30/48, B65H 59/38, B29C 47/02, 47/12

A1

(11) International Publication Number: **WO 00/35667**

(43) International Publication Date: 22 June 2000 (22.06.00)

(21) International Application Number: PCT/US99/06815

(22) International Filing Date: 29 March 1999 (29.03.99)

(30) Priority Data:
09/212,451 16 December 1998 (16.12.98) US

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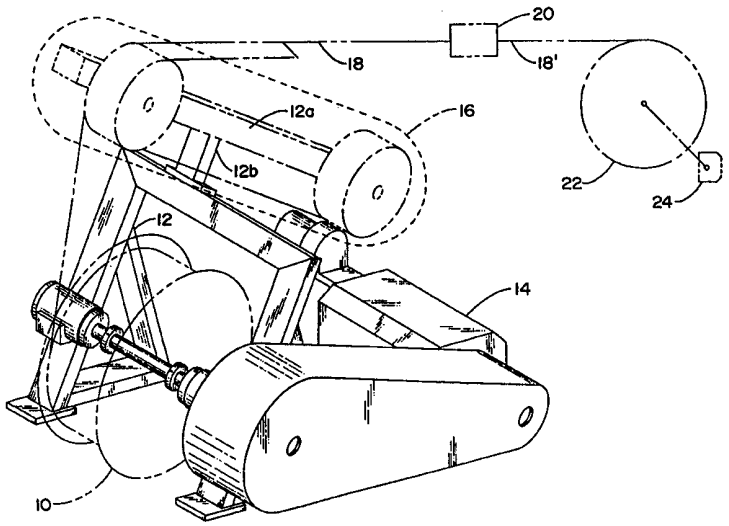
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: FESTOONLESS TIRE BEAD WINDING SYSTEM



(57) Abstract

A tire bead winding system which does not require the usual vertical festoon for storing a varying length of coated wire between the extrusion die and the winding drum is disclosed. The supply reel (10) is rotated to pay off wire (18) by a variable speed electric motor (14). The winding drum (22) is rotated by a second motor (24) to pull wire through the extrusion die (20), and both motors are stopped while the wire is cut, the finished bead removed from the drum and the new leading end of the wire clamped in the drum. Both motors are again started, essentially simultaneously, to begin a new winding cycle. A relatively small accumulator (16) is mounted on the same frame as the supply reel and its drive motor. A pneumatic cylinder (44) applies tension to the wire on the accumulator and the speed of the reel drive motor is varied automatically to pay off wire at a rate tending to maintain the amount of wire on the accumulator constant.

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Festoonless Tire Bead Winding System

Technical Field

The present invention relates to systems for applying a coating to metal wire and winding the coated wire into a tire bead. More specifically, the invention relates to novel and improved bead winding systems which permit alternate starting and stopping of paying off wire from a supply reel during the winding operation, thereby eliminating the need for the usual vertical festoon which accumulates a supply of wire while the winding drum is stopped between the end of one winding cycle and the beginning of the next.

Background Art

In the conventional manner of fabricating tire beads, a supply reel of bare wire is mounted upon a let-off stand for free rotation about a horizontal axis. Wire is pulled from the reel by a motor-driven capstan about which the wire passes after passing through an extruder which applies a rubberized coating to the wire, i.e., the extruder is positioned between the supply reel and the capstan. The capstan operates continuously, at a substantially fixed speed, during the winding operation, although the winding drum which operates to wind the wire into a bead must stop after completion of each winding cycle to permit removal of the completed bead and restarted after preparing for a new cycle. This requires means for accumulating the wire being pulled from the supply reel by the capstan, such means commonly being in the form of a vertical festoon comprising upper and lower pluralities of sheaves, stacked in coaxial, side-by-side relation, about which the wire passes. When the winding drum is in operation, wire is pulled from the festoon by the drum faster than it is supplied by the capstan, thus causing the lower sheave stack to travel upwardly as the accumulated quantity of wire diminishes. Conversely, when the winding drum is stopped, wire accumulates on the festoon and the lower sheave stack travels downwardly.

It is a principal object of the present invention to provide a tire bead winding system, and method of operation thereof, which is both less expensive and requires less physical space than typical prior art winding systems of comparable capacity.

A further object is to provide a tire bead winding system which eliminates the need for a festoon or other wire accumulating means between the extruder and the winding drum.

Another object is to provide a tire bead winding system including novel extruder means for applying a coating to the bead wire in a manner permitting alternate stopping and starting of wire travel through the extruder.

Other objects will in part be obvious and will in part appear hereinafter.

Summary Of The Invention

Rather than mounting the wire supply reel for free rotation as wire is pulled off, the winding system of the present invention includes an electric motor for rotating the supply reel to pay off wire. A pair of sheave tacks are mounted on the same frame structure as the supply reel to provide a compact accumulator for a relatively small amount of wire. A line through the axes of the two sheave stacks is at an acute angle to the horizontal, placing one stack at a higher vertical position than the other, although the stacks are not arranged in vertically aligned relation, as in typical prior art festoon apparatus.

The axis of rotation of the sheave stack at the higher elevation is stationary, the axis of the lower sheave stack being linearly movable toward and away from the axis of the other stack. The lower sheave stack is connected to the cable of an air motor, i.e., to opposite sides of the piston of a pneumatic cylinder. A manually operable throttle valve between the source of compressed air and the piston is set so that the air motor exerts a substantially constant force urging the lower sheave stack away from the upper stack, thereby providing a desired wire tension. A potentiometer formed by a stationary strip of conducting metal on the frame

contacted by a wiper arm movable with the lower sheave stack provides a feedback signal which varies the speed of the motor driving the supply reel, paying off wire at a rate tending to keep the lower sheave stack at or near a desired position, such as the center of its range of movement.

From the sheave stacks, the wire travels through extrusion apparatus which applies a uniform thickness of coating material to the wire, and thence directly to the winding drum. The wire is pulled from the extruder by the motor-driven drum, the structure and operation of which are entirely conventional. When the winding drum drive motor is stopped at the conclusion of a winding cycle to permit withdrawal of the finished bead and clamping the new leading end of the wire within the drum, the supply roll drive motor is also stopped. Thus, all wire travel is stopped, including the portion of the wire passing through the extruder. In order to avoid the deposit of excess coating material on this portion of the wire, a unique venting system, forming an aspect of the present invention, is provided for diverting any excess material away from the wire. The respective drive motors for the supply reel and the winding drum are then actuated simultaneously to begin another winding cycle.

The foregoing and other features of construction and operation of the various aspects of the invention will be or are readily understood and fully appreciated from the following detailed description, taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

Figure 1 is a partly diagrammatic illustration of the bead winding system of the invention;

Figure 2 is a plan view of certain elements seen in phantom lines in Figure 1, i.e., those elements surrounded by the dashed lines indicated by reference numeral 16;

Figure 3 is an exploded, perspective view of the elements of Figure 2; and

Figures 4 and 5 are elevational views, in section, of

portions of extruder apparatus of the prior art and the present invention, respectively, used in bead winding operations.

Modes For Carrying Out The Invention

Referring now to the drawings, the components of the bead winding system of the invention, and their relative relationship to one another, are illustrated in Figure 1. Supply reel 10 of metal wire of a type suitable for use in tire beads is mounted upon frame means 12. Electric motor 14 is operable to rotate reel 10 in a direction paying off wire from the reel. Also mounted upon frame means 12, in a position generally above reel 10, is accumulator means 16 which receives wire directly from the reel, holding a variable quantity of wire and applying a desired tension thereto, as explained later. From the accumulator means, bare wire 18 passes through extrusion means 20 which applies a layer of rubber, or similar coating materials used in bead-forming operations.

Coated wire 18' is wound upon drum 22, of entirely conventional construction, as the drum is rotated by electric motor 24, pulling wire from accumulator means 16 and through extruder 20. Upon completion of the winding of a complete bead, rotation of both reel 10 and drum 22 by motors 14 and 24, respectively, is stopped while the wire is severed and the completed bead is removed from drum 22, normally by automatic means (not shown). When the new leading end of wire 18' has been clamped in drum 22, rotation of reel 10 and drum 22 is resumed and another bead is wound. Thus, rotation of both reel 10 and drum 22 is started and stopped once during each winding cycle, as opposed to typical prior art systems where rotation of the winding drum is stopped and started during each cycle but wire continues to be drawn from the supply reel and stored on a festoon between the extruder and the winding drum.

The elements of accumulator means 16 are shown in more detail in Figures 2 and 3. A first plurality of pulleys or

sheaves 26 are stacked adjacent one another for rotation about the axis of rod 28 and secured by nut 30. Rod 28 is supported upon, with its axis perpendicular and fixed with respect to, frame member 12a, and is fixedly supported by frame member 12b (Figure 1) upon the other, rigidly interconnected members of frame 12. A second plurality of sheaves 32 are likewise stacked together and mounted upon, for rotation about the axis of, rod 34 and secured by bolt 36. Rod 34 is fixedly connected to channel member 38 which slidingly engages track member 40 which is affixed to frame member 12a by screws 42, the longitudinal axes of elongated track member 40 and frame member 12a being parallel. Thus, the axis of rotation of sheave stack 32 is linearly movable toward and away from the axis of rotation of sheave stack 26 as channel member 38 slides along track member 40.

Pneumatic cylinder 44 is mounted upon frame member 12a, and connected, through manually operable throttle valve 46, to compressed air source 48. Cable 50 passes around pulleys 52, 52' at opposite ends of cylinder 44 and enters the cylinder through suitable seals with opposite ends of the cable affixed to opposite sides of the piston. A portion of cable 50 externally of cylinder 44 is affixed to bracket 54, mounted on rod 34 and connected to channel member 38. Thus, the elements operate in the manner of a so-called air motor, with the air pressure applied to one side of the piston urging it cable 50 and bracket 54, and thus sheave stack 32, in a direction away from sheave stack 26. Electrically conducting bar 56 is supported on frame member 12a, and conducting slide member or wiper 58 is connected to bracket 54 for sliding, electrical contact with bar 56 in response to movement of sheave stack 32, for purposes explained later.

Wire 18 is led from supply reel 10 to sheave 26a, at one end of sheave stack 26, and thence to sheave 32a of sheave stack 32. Wire 18 passes around successive sheaves of the two stacks, and is led from sheave 26b to extruder 20. Thus, the amount of wire 18 held upon accumulator means 16, i.e., the wire passing around sheave stacks 26 and 32, varies with the

accumulator means 16, i.e, the wire passing around sheave stacks 26 and 32, varies with the distance between the two sheave stacks. That is, the amount of wire held or stored on the accumulator means is increasingly greater as sheave stack 32 moves away from sheave stack 26, and vice versa. The wire passing around the sheave stacks is maintained under tension to some extent by gravity and to some extent by the biasing force of the air motor. In other words, by mounting sheave stack 32 for sliding movement at an acute angle to the vertical, the weight of the sheaves and associated, movable elements tend to move sheave stack 32 away from sheave stack 26. Also, the biasing force provided by the air pressure on one side of the piston tends to move stack 32 away from stack 26, this force being selectively variable by operator adjustment of valve 46.

Electrically conducting bar 56 and wiper 58 provide the fixed and movable contacts of a potentiometer, connected in a conventional speed control circuit for motor 14. Operation of the circuit is such that, as sheave stack 32 moves closer to sheave stack 26, thereby varying the resistance of the potentiometer, the speed of motor 14 is increased. This increases the rate at which wire is paid off from reel 10 and, with motor 24 operating at a substantially constant speed, increases the amount of wire held on accumulator means 16, moving sheave stack 32 away from sheave stack 26. This movement, of course, slows the speed of motor 14, eventually moving sheave stack 32 back toward stack 26. Thus, an electrical-mechanical feedback loop tends to maintain sheave stack 32 near the center of its range of movement while accommodating differences in speed and actuation times of the two motors, and other system variables.

As previously indicated, when winding of a tire bead on drum 22 is completed, both motors 14 and 24 are stopped, thereby stopping all wire travel, while the wire is severed, the completed bead is removed, and the new leading end of the wire is clamped in the drum in preparation for a new winding cycle. This would present a problem in the coating operation

using conventional extruding apparatus. As seen in Figure 4, prior art extrusion die 60 has passageway 62 with entry and exit ends 64 and 66, respectively, through which wire 18 is moved, with the coating material deposited thereon. If movement of wire 18 is stopped, the high pressure applied to the coating material within the extruder pushes the material through passageway 62 and excess material, indicated by reference numeral 68, accumulates on the portion of the wire immediately forward of passageway exit end 66, rendering the wire unsuitable for use in the beadmaking process.

This potential problem is overcome by the extrusion die of the present invention, seen in Figure 5 and denoted by reference numeral 70. Die 70 includes passageway 72, of the same cross-sectional configuration as passageway 62. In addition, die 70 has second passageway 74 with first end 76 communicating with passageway 72 between its entry and exit ends 78 and 80, respectively, and second end 82 communicating with the exterior of the extrusion apparatus. Passageway 74 has a cross-sectional area which is constant throughout its length and larger than the maximum cross-sectional area of passageway 72. The central, linear axes of passageways 72 and 74 form an acute angle, preferably about 45 degrees, and the two passageways communicate at a position preferably between about 40% and 60% of the distance between entry and exit ends 78 and 80. With this arrangement, coating material is pushed out through passageway 74 and does not accumulate on wire 18 during periods when the wire is not moving.

From the foregoing, it will be seen that the bead winding system of the invention provides significant economies of occupied space and cost over prior art systems of comparable capacity. In practice, two or more winding lines, sharing a common extrusion apparatus with a plurality of dies, are commonly placed in side-by-side relation and operated in tandem. Motor 14 is preferably capable of accelerating the rate of wire payoff from reel 10 (weighing about 1,000 pounds when full) from 0 to full speed in less than 2 seconds. For example, motor 14 may be 500V DC, 15 horsepower for wire speed

of 750 feet per minute, or 20 horsepower for speeds of 1,500 feet per minute.

What Is Claimed Is:

1. A tire bead winding system operable to form at least one bead in each of a succession of winding cycles, said system comprising:

a) frame means for rotatably supporting a reel of bare bead wire;

b) first motive means for imparting rotation of said reel in a direction paying off wire from said reel;

c) extrusion means for applying a coating material to wire passing therethrough;

d) a bead-winding drum receiving coated wire from said extrusion means;

e) second motive means for imparting rotation to said drum to wind coated wire thereon to form a tire bead; and

f) means for starting and stopping rotation of both said reel and said drum following each of said winding cycles.

2. The bead winding system of claim 1 wherein said first motive means comprises a variable speed electric motor.

3. The bead winding system of claim 2 and further including control means for varying the speed of said electric motor during operation thereof.

4. The bead winding system of claim 3 wherein said control means includes a potentiometer.

5. The bead winding system of claim 1 and further comprising accumulator means to which bare wire is supplied directly from said reel and upon which a variable length of bare wire is held.

6. The bead winding system of claim 5 wherein said accumulator means are mounted upon said frame means.

7. The bead winding system of claim 5 wherein said accumulator means comprises a pair of sheave stacks each including a plurality of sheaves about which the bare wire passes, said sheave stacks being mounted for rotation about parallel axes, and means for effecting relative movement of the respective axes of said sheave stacks to vary the spacing of said axes.

8. The bead winding system of claim 7 wherein the axis of rotation of one of said sheave stacks is stationary and the axis of rotation of the other of said sheave stacks is linearly movable in the plane of said axes, toward and away from the axis of rotation of said one sheave stack.

9. The bead winding system of claim 8 and further including means biasing said other sheave stack toward movement of its axis of rotation away from the axis of rotation of said one sheave stack.

10. The bead winding system of claim 9 wherein said biasing means include a pneumatic cylinder connected to a source of compressed air.

11. The bead winding system of claim 10 and further including a manually operable valve between said source of compressed air and said pneumatic cylinder for selective control of the biasing force applied to said other sheave stack.

12. The bead winding system of claim 8 and further including means for generating an electrical signal commensurate with the distance between said axes of rotation.

13. The bead winding system of claim 12 wherein the speed of rotation imparted by said first motive means to said reel is variable in response to variations in said electrical signal.

14. The bead winding system of claim 13 wherein said signal generating means comprise a potentiometer having a wiper movable with said other sheave stack.

15. In a tire bead winding system, the improvement comprising:

a) frame means comprising a plurality of rigidly interconnected frame members;

b) first support means on said frame means for mounting a supply reel of bare bead wire for rotation to pay off wire from said reel;

c) accumulator means including first and second rotatable sheave stacks about which said bare wire passes;

d) second support means on said frame means for

mounting said accumulator means with the axes of rotation of said sheave stacks parallel and linearly movable relative to one another to vary the spacing of said axes and thereby the quantity of said bare wire held by said accumulator means;

e) a winding drum for fabricating tire beads from a supply of wire; and

f) extrusion means intermediate of said accumulator means and said drum to apply a layer of coating material to said bare wire, thereby supplying coated wire to said drum.

16. The improvement of claim 15 and further including an electric motor and third support means on said frame means for mounting said motor in a position to rotate said reel.

17. The improvement of claim 16 and further including a potentiometer for controlling the speed of said motor.

18. The improvement of claim 17 wherein said potentiometer includes a fixed elongated conductor and a wiper contacting said conductor and connected to said second sheave stack, and wherein said second sheave stack is movable, with said wiper, relative to said conductor to vary the effective resistance of said potentiometer.

19. The improvement of claim 15 wherein said reel is supported for rotation about a horizontal axis and the axis of rotation of said first sheave stack is positioned substantially vertically above said horizontal axis.

20. The improvement of claim 19 wherein the axis of rotation of said second sheave stack is at a vertical level lower than the axis of rotation of said first sheave stack.

21. The improvement of claim 20 wherein the axis of rotation of said second sheave stacks is at an acute angle to the horizontal.

22. The improvement of claim 21 wherein said first sheave stack is mounted upon an elongated one of said frame members with its axis of rotation fixed, and said second sheave stack is mounted upon said one frame member with its axis of rotation movable along said one frame member, toward and away from the axis of rotation of said first sheave stack.

23. The improvement of claim 22 and further including an elongated conductor affixed to said one frame member and a wiper affixed to said second sheave bundle for movement therewith in sliding contact with said conductor.

24. The improvement of claim 23 and further including an electric motor, third support means for mounting said motor upon said frame means, and drive means connecting said motor to said reel for rotation thereof, said conductor and wiper forming a potentiometer for controlling the speed of said motor.

25. The improvement of claim 22 and further including means for biasing said second sheave stack toward movement of its axis of rotation away from the axis of rotation of said first sheave stack.

26. The improvement of claim 25 and further including means for controlling the biasing force applied to said second sheave stack.

27. The improvement of claim 26 wherein said biasing means comprises a pneumatic cylinder connected to a source of compressed air, and said controlling means comprise a manually operable throttle valve between said source and said cylinder.

28. In a tire bead winding system wherein a bare bead wire from a supply reel passes through an extruding device for application of a uniform layer of coating material to the wire preparatory to winding the coated wire on a drum to fabricate the bead, the improvement comprising a die member having:

a) a first passageway elongated along a linear axis between an entry end and an exit end for passage of said bead wire surrounded by said coating material; and

b) a second passageway extending from a first end, communicating with said first passageway intermediate of said entry and exit ends, and a second end, communicating with the exterior of said die member, through which coating material in excess of that required to apply said uniform layer to said wire is vented.

29. The improvement of claim 28 wherein said second passageway is of larger cross-sectional area than the portion

of said first passageway with which it communicates.

30. The improvement of claim 28 wherein said second passageway is of uniform cross-sectional area throughout its length between said first and second ends, and said uniform cross-sectional area is larger than the cross-sectional area of said first passageway at any position between said entry and exit ends.

31. The improvement of claim 28 wherein said first and second passageways have first and second, linear axes, respectively, arranged at an acute angle to one another.

32. The improvement of claim 31 wherein said acute angle is formed by said second axis and the portion of said first axis lying between said first end of said second passageway and said exit end of said first passageway.

33. The improvement of claim 32 wherein said acute angle is about 45 degrees.

34. The improvement of claim 33 wherein said first end of said second passageway communicates with said first passageway at a position between about 40% and about 60% of the distance from said entry to said exit end.

35. A method of fabricating tire beads comprising:

a) supporting a supply reel of bare wire for rotation about an axis;

b) rotating said reel by first motive means in a direction paying off wire;

c) applying a coating material to said wire;

d) attaching an end portion of the coated wire to a winding drum;

e) rotating said winding drum by second motive means to wind a plurality of convolutions of said coated wire, constituting a complete bead, on said drum;

f) stopping rotation of both said reel and said drum;

g) severing the coated wire to form a new leading end;

h) removing the completed bead from said drum;

i) attaching said new leading end to said drum preparatory to winding another bead thereon; and

j) resuming rotation of both said reel and said drum by

said first and second motive means, respectively.

36. The method of claim 35 wherein rotation of said reel and said drum is stopped substantially simultaneously.

37. The method of claim 35 where rotation of said reel and said drum is resumed substantially simultaneously.

38. The method of claim 35 and further including holding a variable length of said wire on accumulating means between said reel and application of said coating material.

39. The method of claim 38 and further including varying the speed of rotation of said reel in accordance with the length of wire held on said accumulating means.

40. The method of claim 38 wherein said first motive means in an electric motor, and including the further steps of generating a signal commensurate with the length of wire held on said accumulating means and varying the speed of said motor in response to variations in said signal.

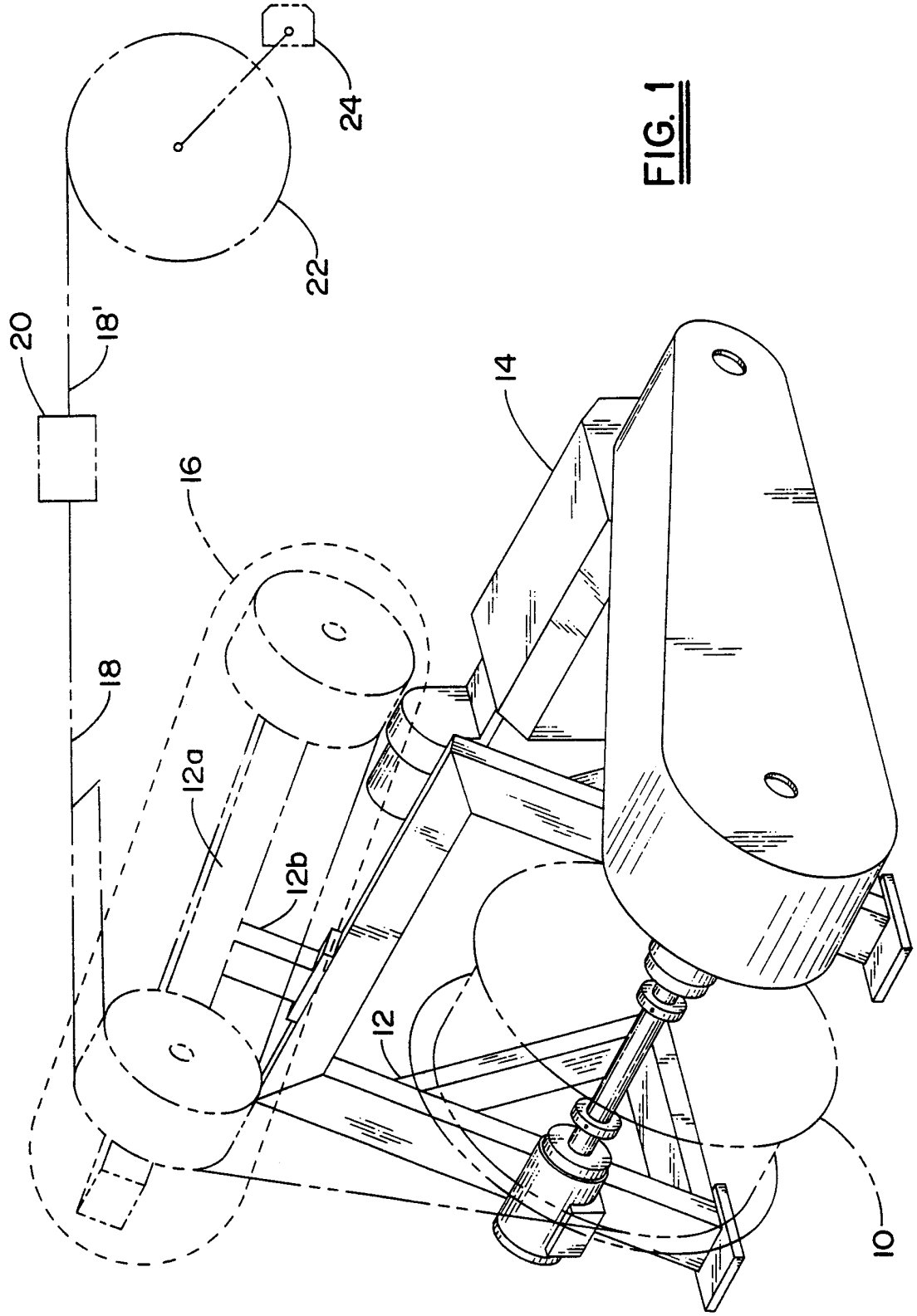

FIG. 1

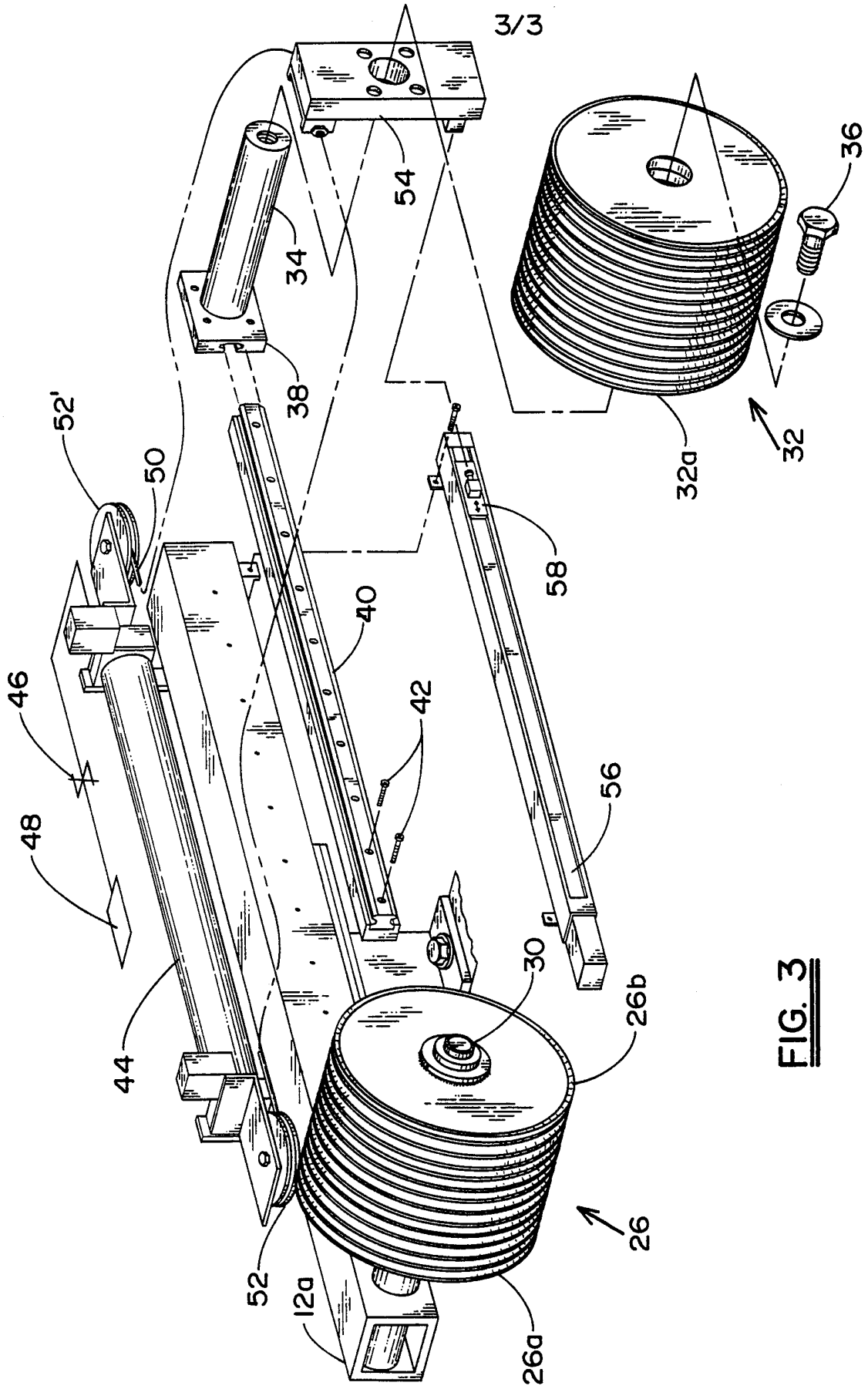

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/06815

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B29D30/48 B65H59/38 B29C47/02 B29C47/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B29D B65H B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 049 308 A (E. U. LANG) 14 August 1962 (1962-08-14) the whole document ---	1-9, 12-17, 19,20, 22,25, 35,38-40
Y	WO 97 48548 A (VACCARO MICHAEL P ;KOLB ROBERT W (US); BARTELL MACHINERY SYSTEMS C) 24 December 1997 (1997-12-24) the whole document ---	1-20, 23-27, 35-40
Y	US 3 718 289 A (ALAIMO B) 27 February 1973 (1973-02-27) the whole document --- -/--	1-20, 23-27, 35-40

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
13 August 1999	17. 02. 2000

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 994 445 A (TARULLI LUIGI) 30 November 1976 (1976-11-30) the whole document ---	1-3,5, 7-10,12, 13,15, 16,24-27
A	US 3 612 430 A (FREEMAN REGINALD E) 12 October 1971 (1971-10-12) column 1, line 50 - line 65; figure 1 ---	2-5,14, 17,18, 23,24
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1

INTERNATIONAL SEARCH REPORT

Inte...ational application No.
PCT/US 99/06815

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-27, 35-40

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

1. Claims: 1-27, 35-40

An apparatus and a method of delivering a tyre bead wire from a storage reel to a bead manufacturing drum.

2. Claims: 28-34

An apparatus for winding a tyre bead wire, comprising an extruding device for coating the wire.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 99/06815

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