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(54) Agricultural Balers

(57) A round baler having a bale chamber (11, 11') defined in part by expandable bale forming means (8, 9) comprises at least two spaced endless flexible members (17, 48), and a plurality of slats (22) each attached intermediate its ends to the flexible members and each slat comprising a hollow tube of circular cross-section having at least a section (62) at or towards each end which carries a reinforcing insert (66) internally of the tube and which section is deformed to provide two opposed, generally parallel, portions (63, 64) with at least one aperture (67) extending therethrough. One portion (63) abuts a complementary surface (69) on the associated flexible member (17, 48) which is also apertured similarly to the portions (63, 64). The other portion (64) provides an abutment for securing means (68) and extends between two upstanding portions (65). Each insert (66) is located between the associated opposed portions (63, 64) and is also apertured for the through passage of the securing means (68).

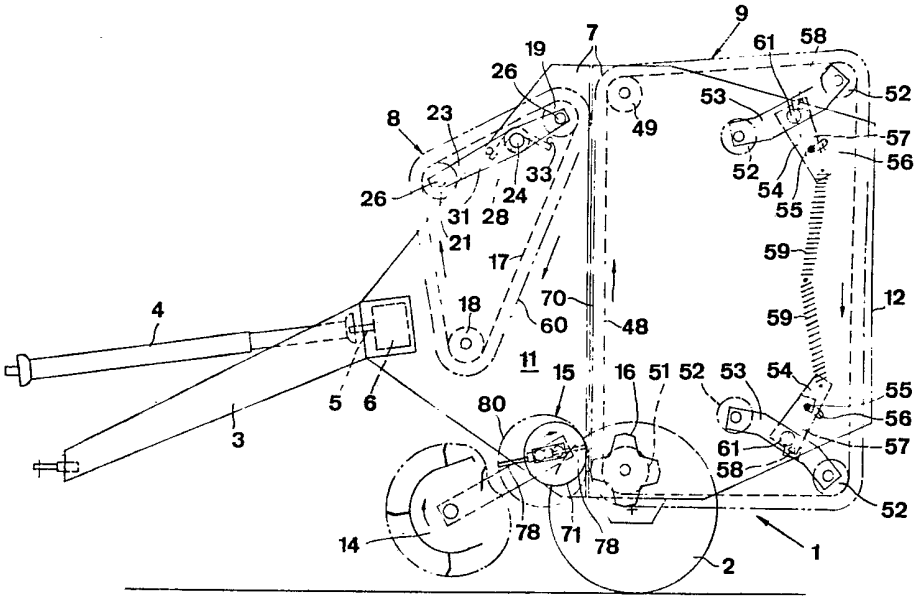

FIG.1

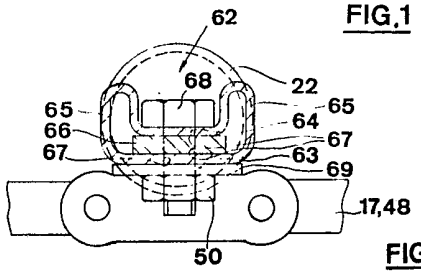

FIG.8

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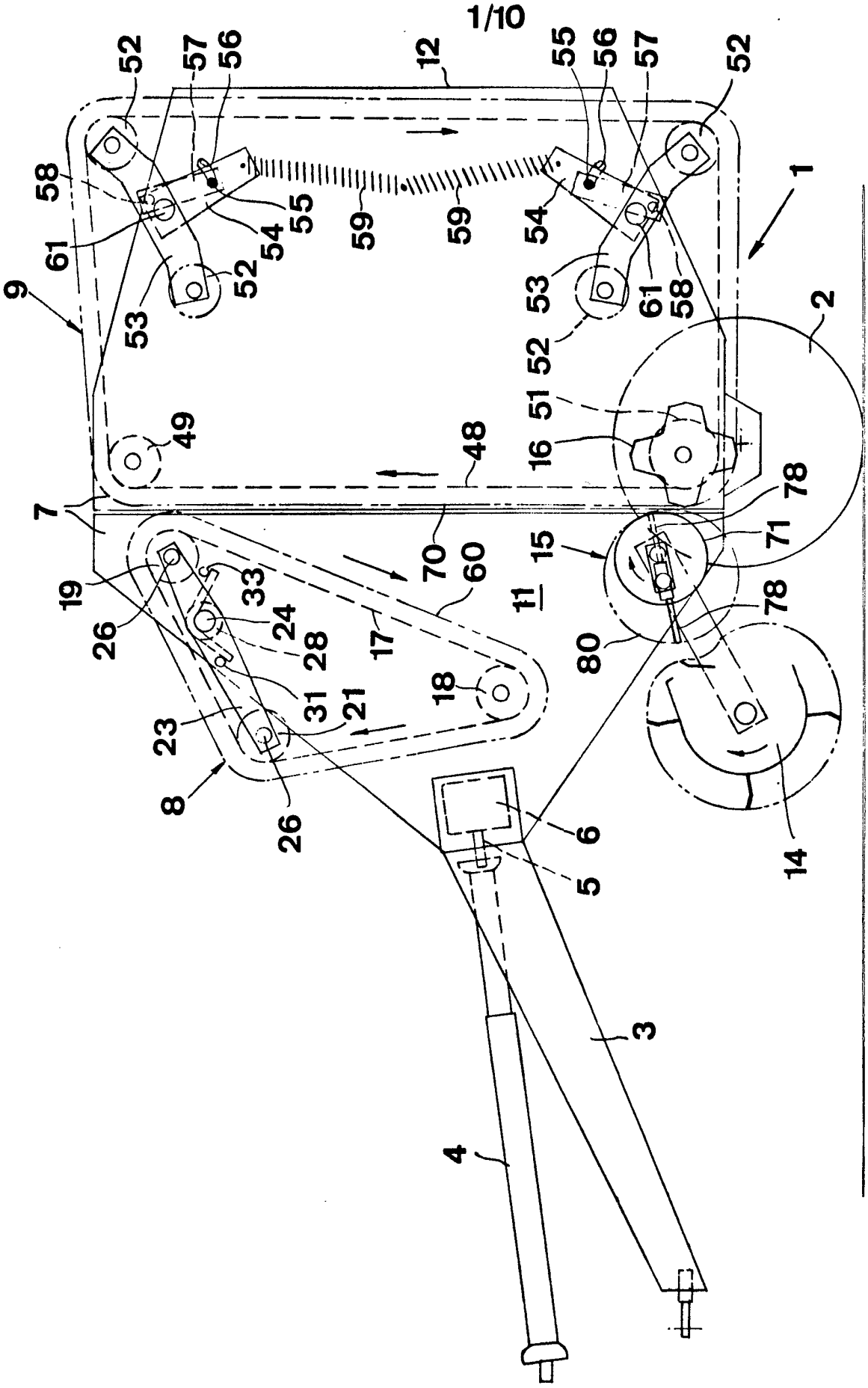
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FIG.1

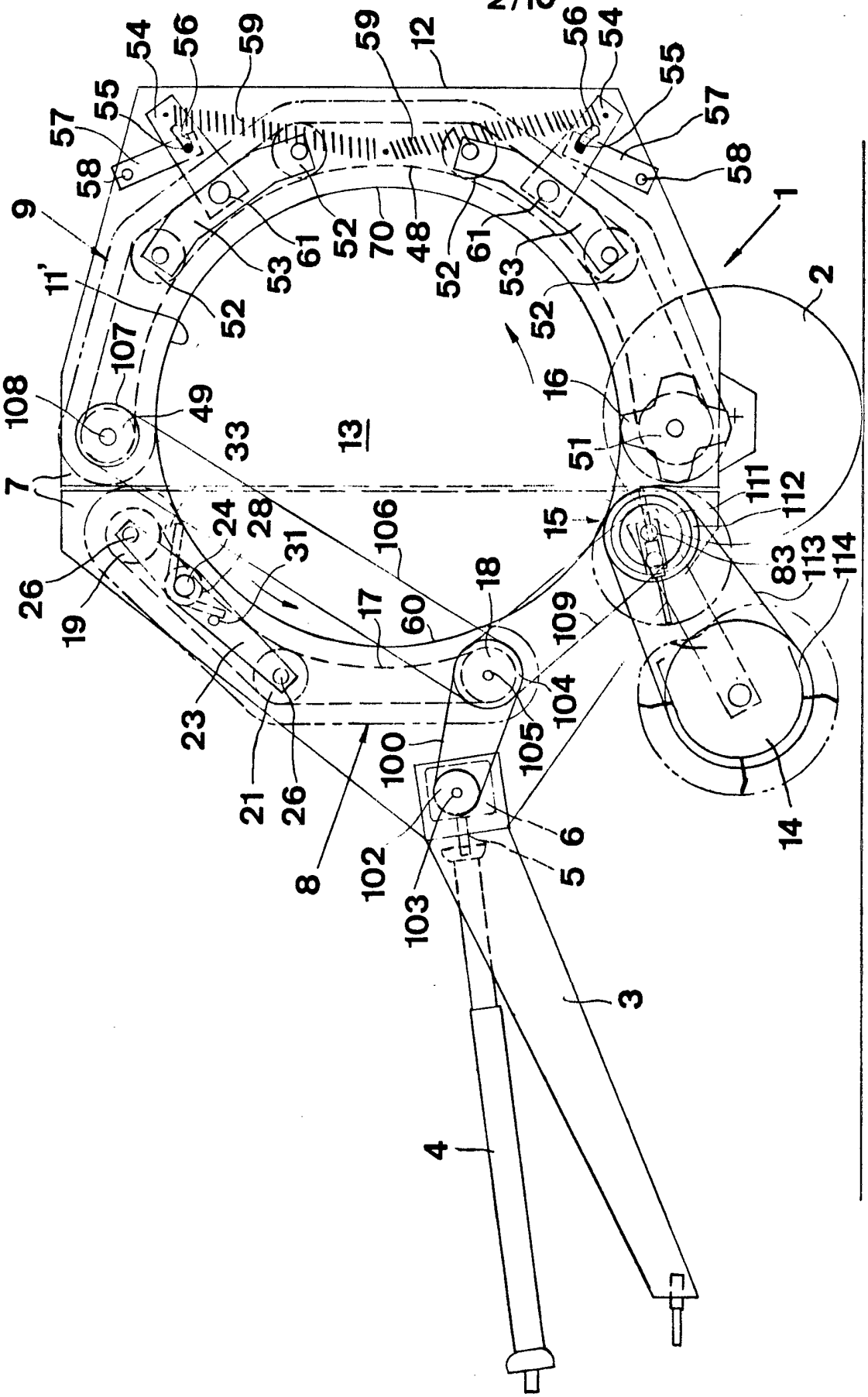
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FIG.2

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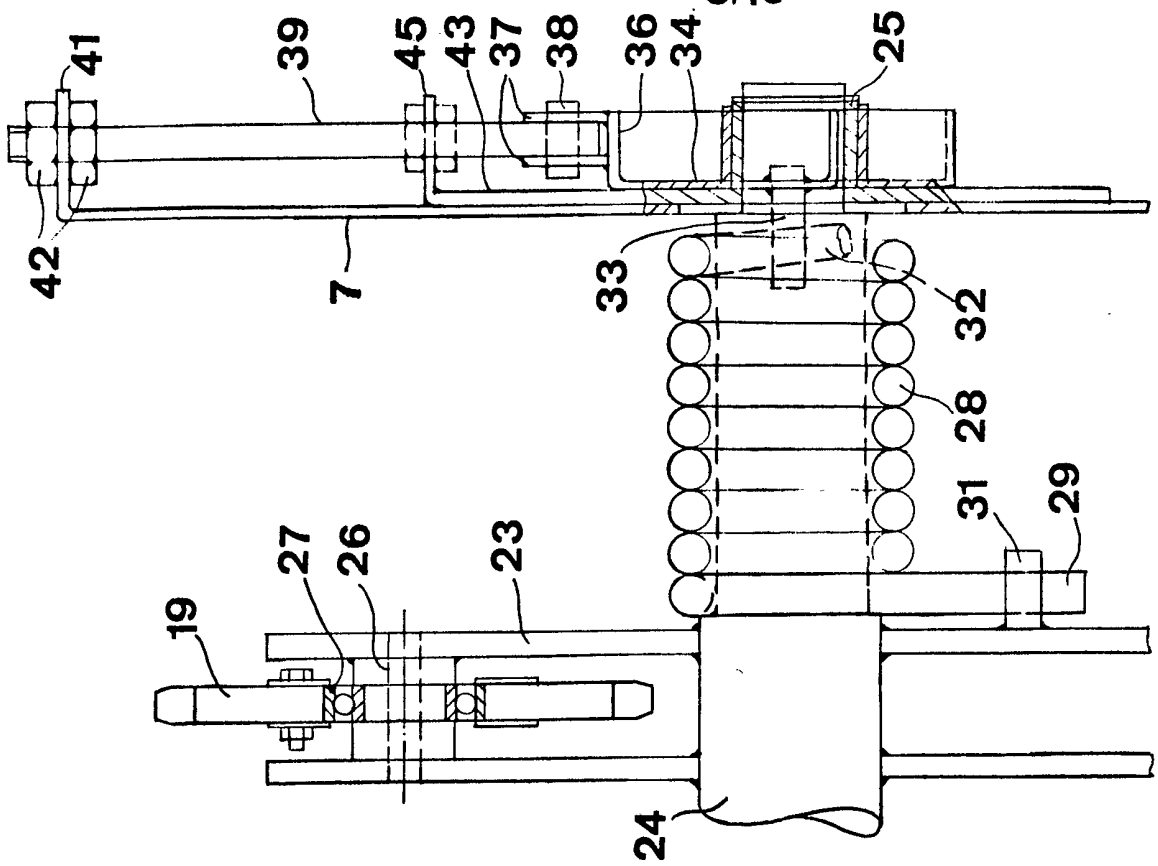

FIG.4

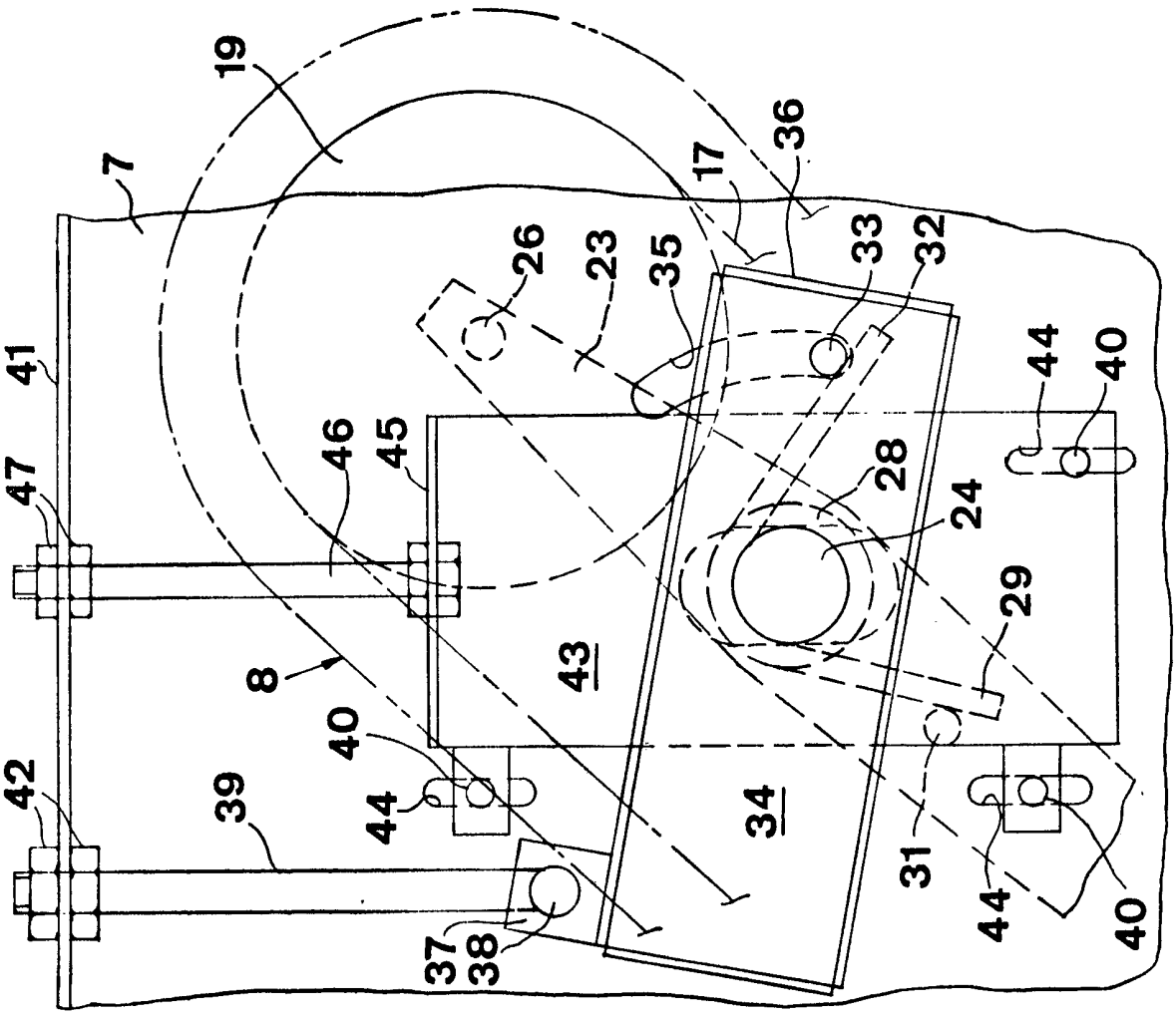

FIG.3

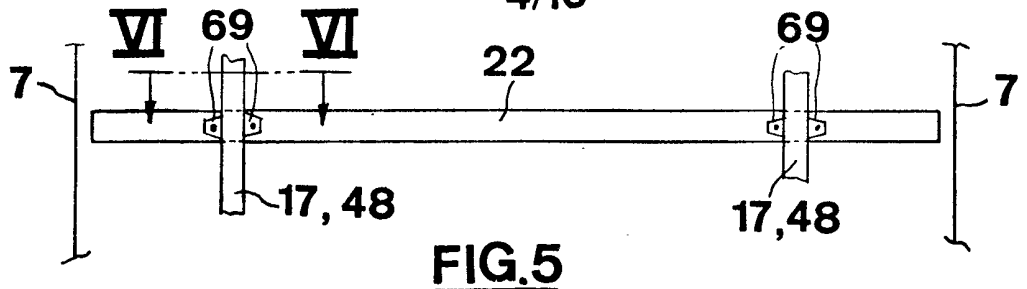

FIG.5

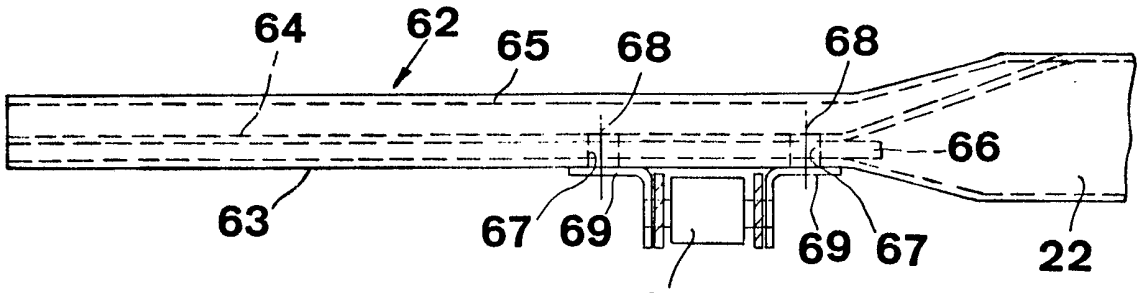

FIG.6

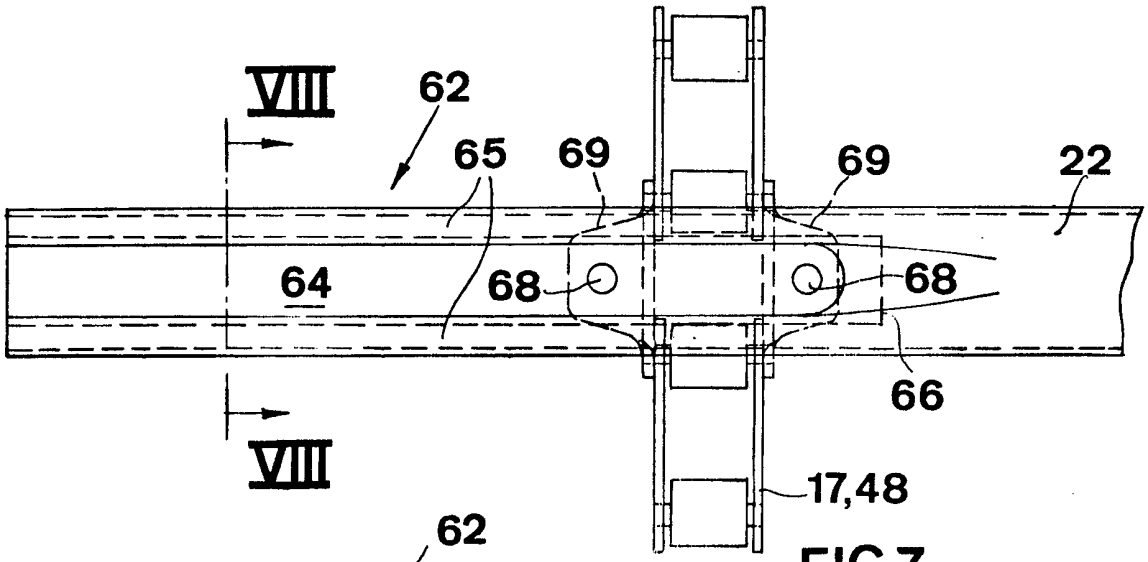

FIG.7

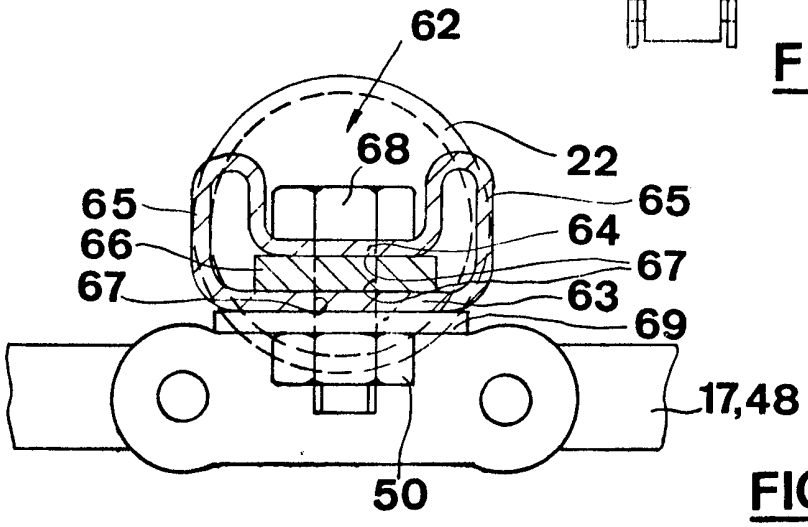

FIG.8

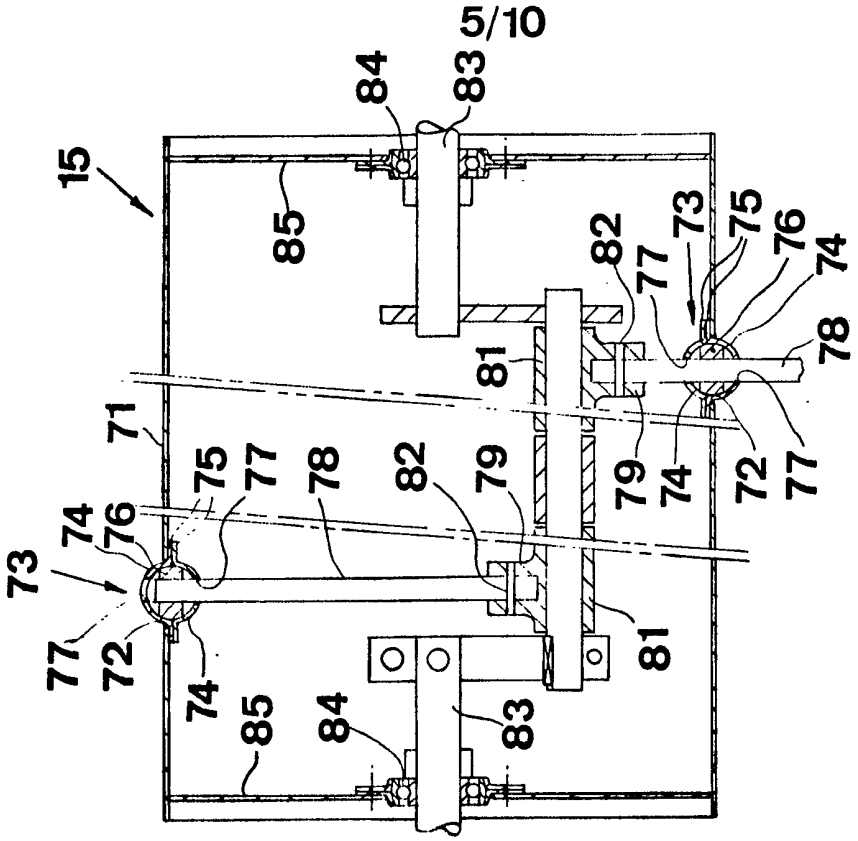
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FIG.10

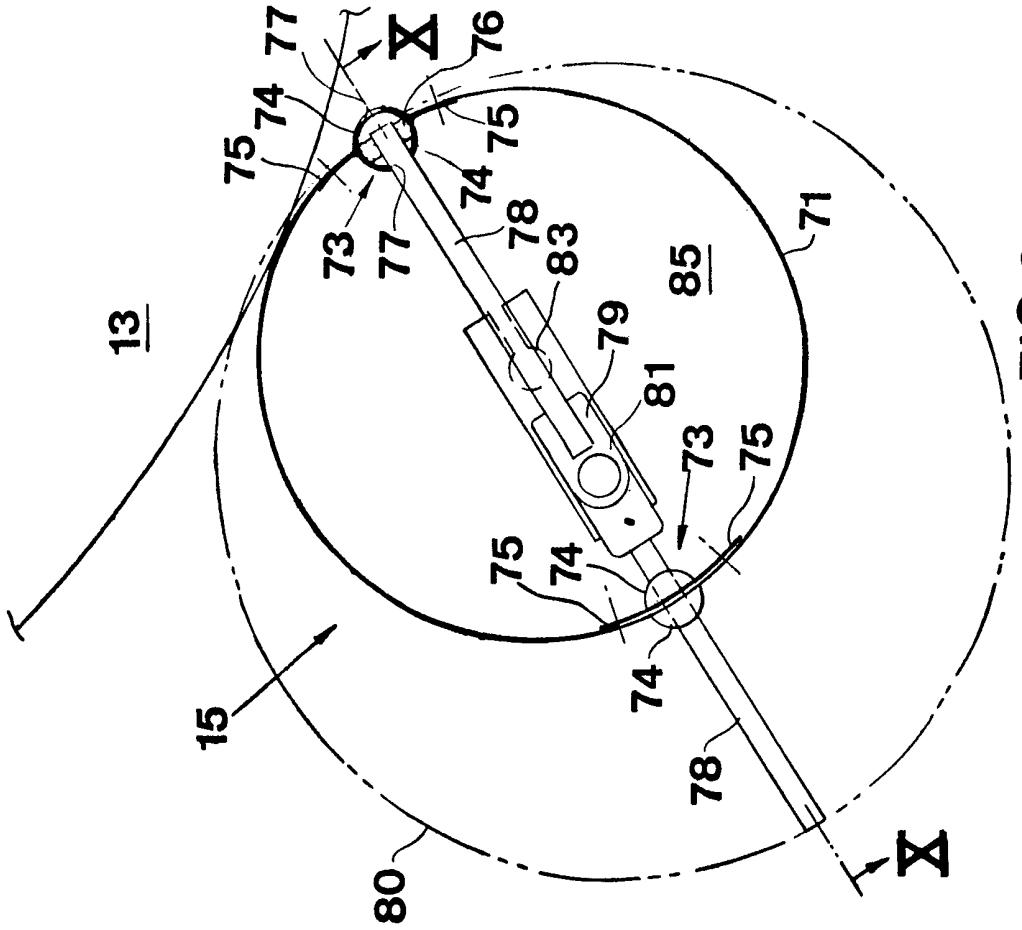
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FIG.9

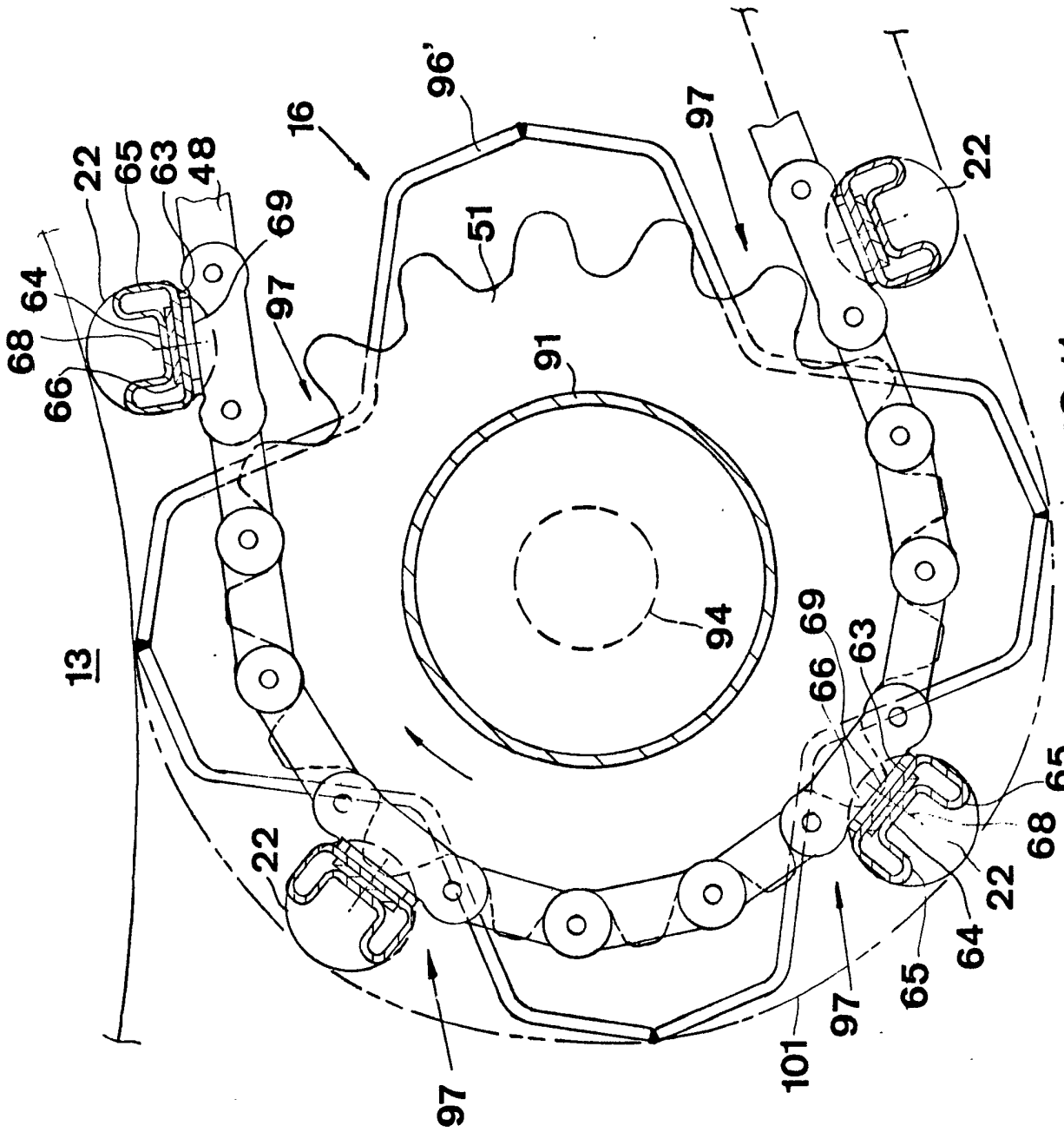

FIG.11

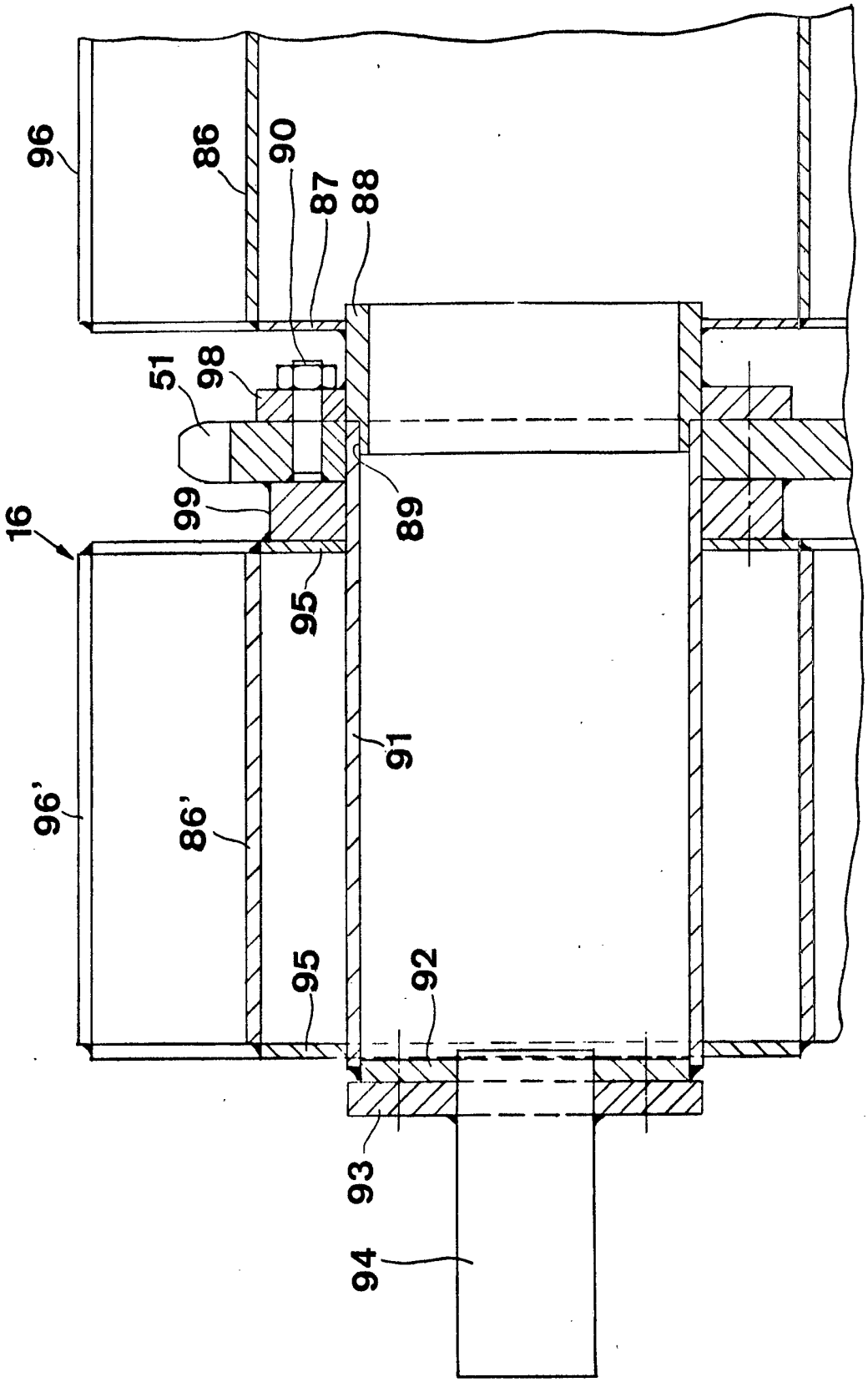

FIG.12

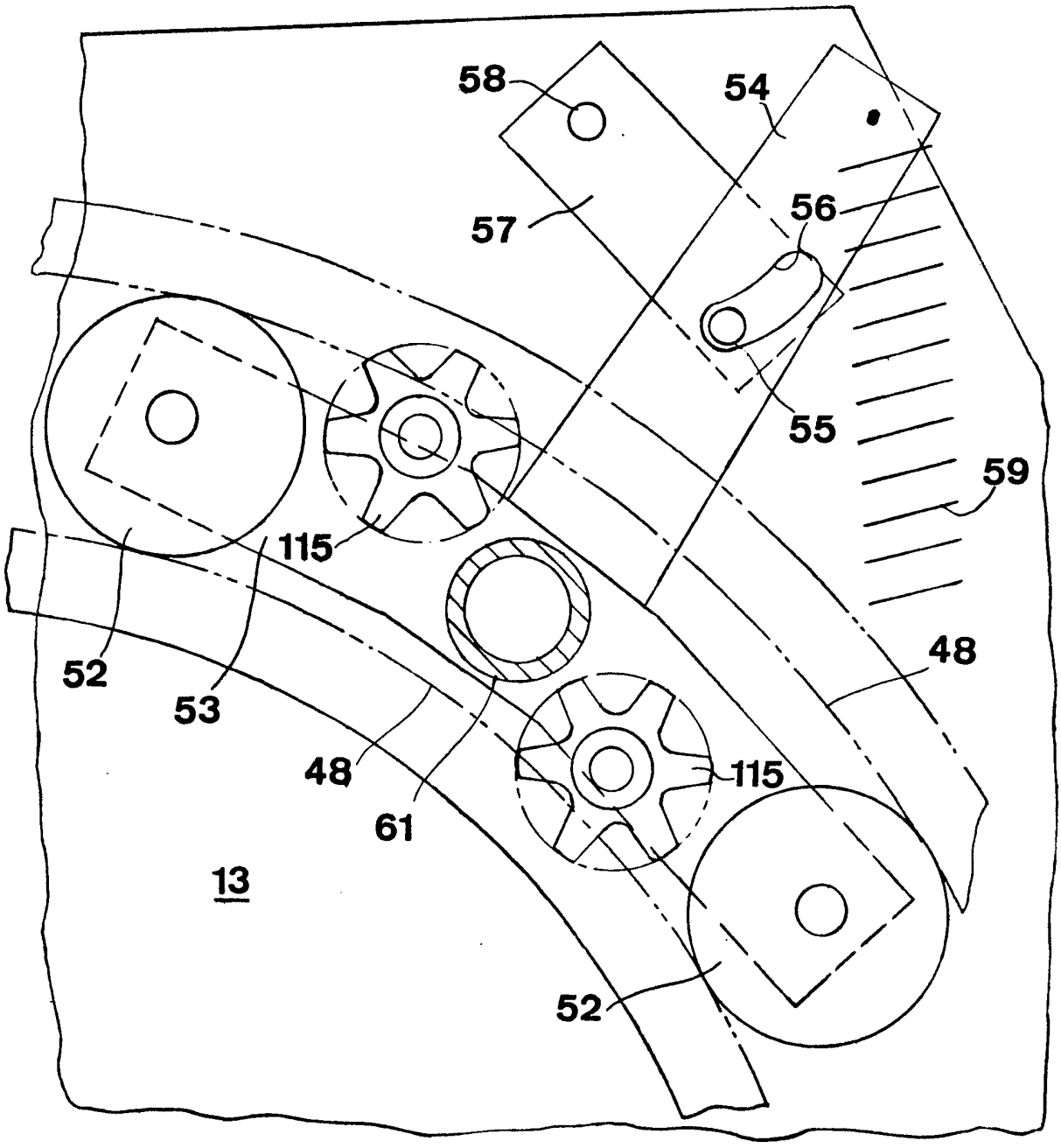

FIG.13

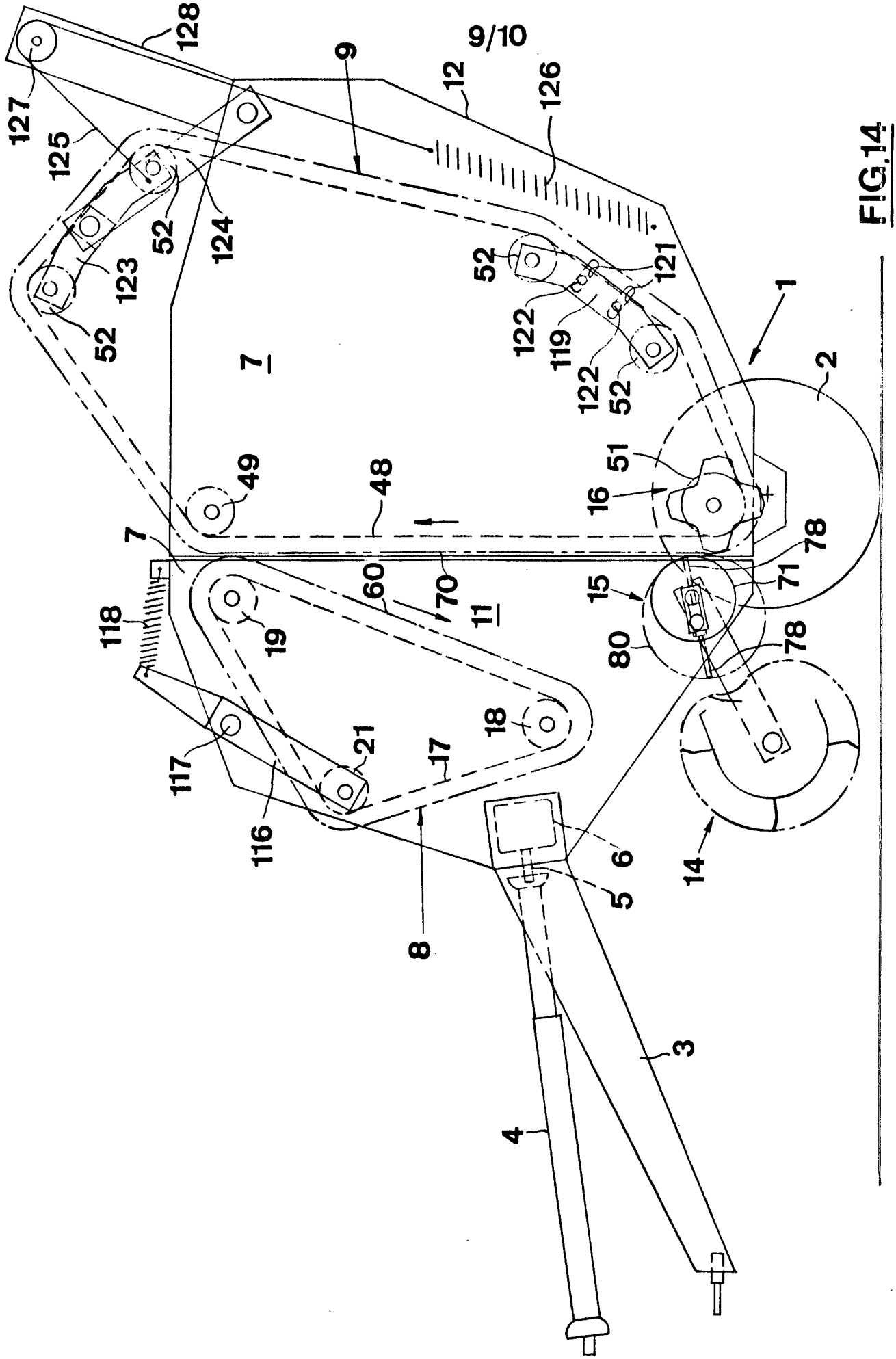
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FIG.14

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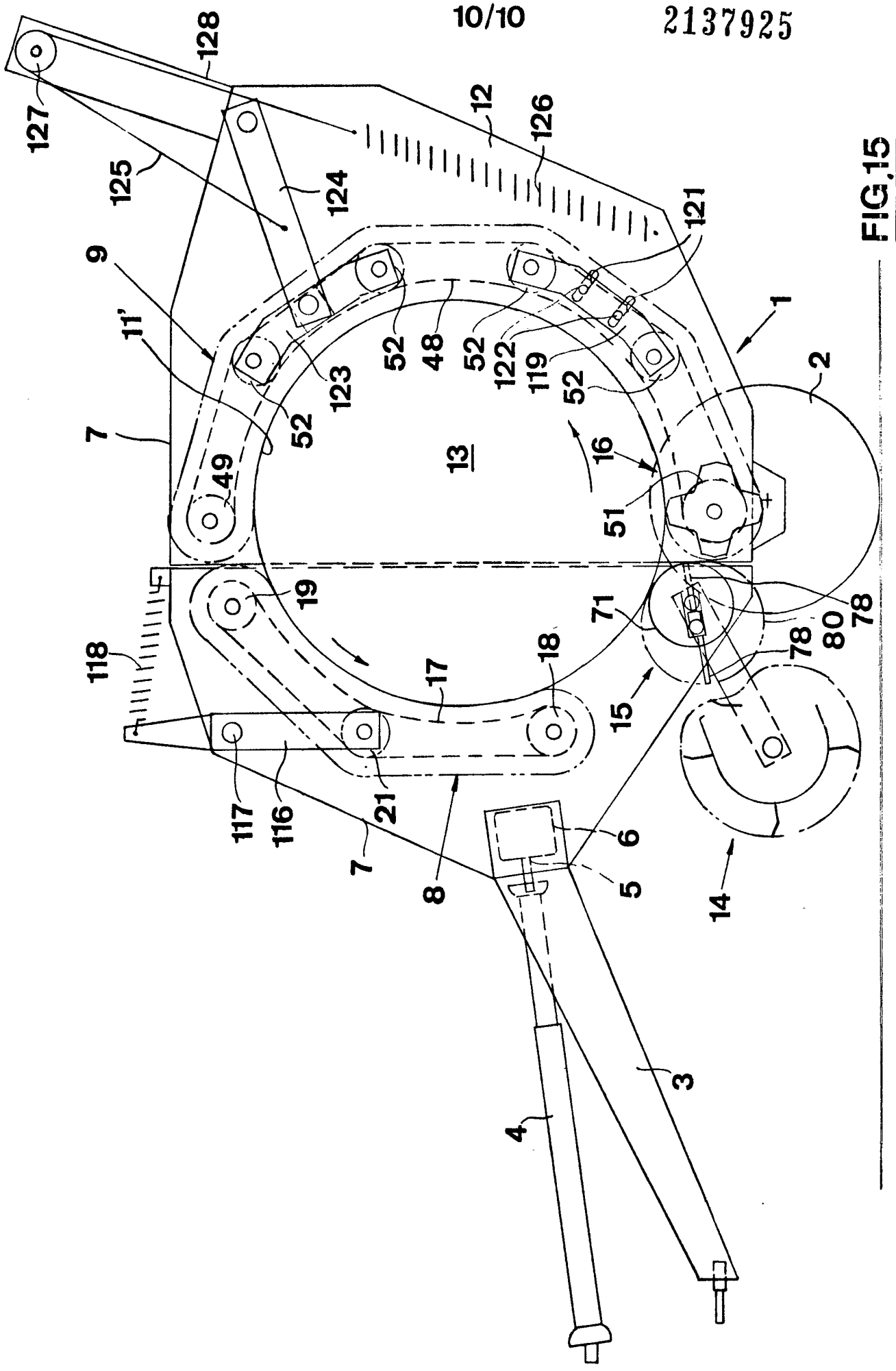

FIG.15

SPECIFICATION

Agricultural Balers

This invention relates to agricultural balers and more particularly to so-called round balers which produce cylindrical bales or rolls of cross material.

In general, round balers are of two types: the expanding chamber type which produces balers with a relatively hard core and a generally high and relatively constant density throughout; and the fixed chamber type which produces bales with a relatively soft core but a relatively compacted or hard outer layer or shell.

The advantages of hard core balers are that they pack more crop material into a bale compared with a similarly sized soft core bale, and they can produce bales of any size up to the maximum which a given machine is capable of producing, with all sizes of bales being in generally good order from the standpoint of being subjected to handling without falling apart. The advantages of soft core balers are that they produce bales with a reduced tendency to moulding if the crop material is baled wet; the bale core present no problems to cattle when feeding from the bale (whereas hard cores can be difficult to tear apart); they produce bales with good weathering characteristics due to the hard shell, and the latter ensures a good looking, "clean" bale which is very stable when being handled; the balers are of relatively simple design; and the balers normally have no difficulty in forming a bale core which can sometimes be a problem with hard core balers when handling short lengths of crop material.

It is an object of the present invention to provide a round baler which affords some of the advantages of both a hard core baler and a soft core baler. One of the problems with achieving this objective is that the bale-forming elements have to be both expandable and yet exert a relatively large force on the bale at completion thereof to produce the hard outer shell. In the case of round balers employing expandable bale-forming members in the form of a pair of endless flexible members, such as chains, interconnected by slats extending transversely of the machine, the strength of the bale forming members has, of course, to be consistent with the force to be exerted on the crop material and the bale forming members normally employed in hard core balers would either not be strong enough, or not suitable even if of sufficient strength. In the latter connection, slats formed from angle iron would have the necessary strength but suffer from the disadvantage of a tendency for crop material to hook therearound. Furthermore, special chains at present have to be used to provide the necessary attachment points for the slats and such chains are more expensive than standard chains.

According to the present invention a round baler is provided having bale-forming means comprising at least two spaced endless flexible members, and a plurality of slats each attached intermediate its ends to said at least two flexible members, each slat comprising a hollow tube having at least a section at or towards each end which carries a reinforcing insert internally of the tube and which section is deformed to provide two opposed, generally parallel, portions with at least one aperture extending therethrough; one portion abutting a complementary surface on the associated flexible member which is also apertured similarly to said portions, and the other portion providing an abutment for securing means and extending between two upstanding portions, each insert being located between the associated opposed portions and also being apertured similarly to said portions for the through passage of the securing means to the respective apertures in the related flexible member.

Preferably, the slats are of circular cross-section. Also, the upstanding portions may extend from the associated other portion by an amount sufficient to be proud of the securing means and thereby, in use, shield the latter from abrasive action by the crop material. Further, it is also preferable for the outer edges of the upstanding portions of each slat to lie generally within the outer periphery of the slat as seen in end view, and for each insert and the opposed portions of each slat to be flat.

Each flexible member may be in the form of a chain and in this case, the complementary surface comprises two lugs attached to respective sides of the chain and apertured to receive respecting securing means. Such chains are standard commercially available chains. Also, the slats of tubular cross-section and the inserts are standard commercially available components. Hence all these components are relatively inexpensive. The particular fixation of the slats to, and the cantilevered mounting of the slats on, the respective chains give increased strength to the bale-forming means, thus permitting lighter components to be used than otherwise would be the case. This again favourable influences the cost of the machine.

Round balers in accordance with the present invention will now be described in greater detail, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a schematic side view of a first embodiment of round baler showing the machine empty,

Figure 2 is a view similar to that of Figure 1 but showing the machine with a completed bale,

Figure 3 is an enlarged view of a portion of Figure 1,

Figure 4 is a side view of Figure 3,

Figure 5 is a schematic view of a component of Figure 1,

Figure 6 is a partial sectional view, on the line VI—VI of Figure 5,

Figure 7 is plan view of Figure 6,

Figure 8 is a sectional view on the line VIII—VIII of Figure 7,

Figure 9 is an enlarged view of a still further component of Figure 1,

Figure 10 is a partial sectional view on the line X—X of Figure 9.

Figure 11 is an enlarged view of yet another position of Figure 1,

Figure 12 is a partial longitudinal section of the component of Figure 11,

Figure 13 is a view of an alternative component for the first embodiment, and

Figures 14 and 15 are views similar to those of Figures 1 and 2, respectively, but showing a second embodiment.

Referring first to Figures 1 and 2, the first embodiment is in the form of a pull-type round baler comprising a base frame 1 carrying a pair of ground-engaging wheels 2 and having attached thereto a drawbar 3 for connection to a tractor (not shown) or other towing vehicle. A drive shaft 4 extends above the drawbar 3 and is connected at one end to an input shaft 5 of a gearbox 6, and connectable at the other end to a power-take-off shaft (also not shown) of the towing vehicle. Side walls 7 of the machine are attached to the base frame 1, the side walls partially defining a bale forming chamber by way of providing the sides therefor. The front and rear of the bale forming chamber are defined by portions of respective expandable members 8 and 9 which, when the machine is empty (Figure 1), form together with the side walls 7 a generally vertically oriented, wedge-shaped (as seen in side view) start chamber 11, and which expand on the formation of a bale to form a cylindrical bale chamber 11' (Figure 2). Each side wall 7 is split, with the expandable member 8 forming a front portion of the bale chamber in conjunction with one portion each side wall, and the expandable member 9 forming a rear portion of the bale chamber in conjunction with the other portion of each side wall.

As seen in Figures 1 and 2, the rear portion of the bale chamber is larger than the front portion and in fact forms a tailgate 12 for the machine which is pivotable upwardly in order to effect discharge of a completed bale 13 (Figure 2) from the machine. With this differential sizing of the two portions of the bale chamber, the centre of gravity of a completed bale lies within the rear portion of the bale chamber, whereby there is a natural tendency for a completed bale to roll from the machine once the tailgate 12 has been raised, which tendency greatly facilitates bale discharge.

Pivotally mounted at the front of the machine is a conventional crop pick-up unit 14 which, in use, picks up crop material from the ground and delivers it to a combined crop feeder and bale support device 15 located at the mouth of the bale start chamber 11. Located within the rear portion of the bale chamber and disposed at the front bottom corner adjacent the feeder and support device 15 is a rotor 16 which extends across the full width of the bale chamber, i.e. extends between the side walls 7. The rotor 16 also serves to support a bale during its formation.

Having described the overall machine in general, certain components will now be described in greater detail with reference to Figures 3 to 12, in addition to Figures 1 and 2, of the drawings. Looking first at the bale chamber, the expandable member 8 partially defining the front surface of the chamber comprises two transversely spaced apart endless chains 17 each extending around, a driven sprocket 18, an idler sprocket 19 and a non-toothed guide roller 21 disposed at respective apices of a triangle, as seen in side view in Figures 1 and 2. The chains 17 are disposed towards, but inset from, respective sides of the machine and are interconnected by a plurality of slats 22 which extend transversely of the machine, with each end of each slat extending past the associated chain and terminating just short of the side walls 7 as seen in Figure 5. The construction of each slat 22 will be described hereinafter.

With specific reference to Figures 3 and 4, the sprocket 19 and guide roller 21 associated with each chain 17 are mounted for rotation on an arm 23 which in turn is pivotally mounted on the frame via a pivot shaft 24 (common to both arms 23) offset from the centre of the arm and carried in a bush 25. It will be seen from Figure 4 that each arm 23 comprises a pair of spaced members between which extends two spigots 26 on which the sprocket 19 and guide roller 21 are respectively mounted via bearings 27, only the sprocket being shown in Figure 4. The pivot shaft 24 has, at each end, a first portion of reduced diameter around which is disposed a torsion spring 28, and a second portion of further reduced diameter which is received by the associated bush 25. Each spring 28 serves to bias the associated arm 23 in a clockwise direction as seen in Figures 1 and 2, whereby tension in the chain 17 is maintained and any slack resulting from wear is automatically taken up. The pivotal mounting of the arms 23 allows the orientation of the latter to change as a bale is being formed as will be described.

This tensioning of each chain 17 is achieved by locating one end 29 of each spring 28 against a stop 31 fixed to the related arm 23, and locating the other end 32 against a stop 33 fixed to one end of an arm 34 located on the outside of the associated side wall 7, the stop 33 extending through an arcuate slot 35 in the latter. Each arm 34 is pivotally mounted on the pivot shaft 24 via the associated bush 25 and has a reinforcing flanges 36 extending around its periphery and away from the side wall 7. A bracket in the form of two spaced plates 37 is attached to the end of each arm 34 opposite to that of which the stop 33 is secured, a pivot pin 38 extending between the plates 37 and being attached to one end of a threaded rod 39, the other end of which is received by a flange 41 provided on the related side wall 7. Nuts 42 adjustably secured each rod 39 to the related flange 41, whereby the arms 34 can be adjusted about the pivot shaft so as to move the stops 33, thereby to set the required torsion in the springs 28 and hence initial tension in the chains 17.

The arms 23 and pivot shaft 24 are vertically adjustably mounted with respect to the related

side wall 7 by virtue of the ends of the pivot shaft 24 and the bushes 25 being carried by respective plates 43 bolted by bolts 40 to the side wall 7 via slots 44 provided in the latter to permit relative sliding movement. Each plate 43 is formed with a flange 45 to which is attached one end of a threaded rod 46, the other end of which is adjustably attached to the related side wall flange 41 by nuts 47. Adjustment of the nuts 47 after loosening the bolts 40 either raises or lowers the plates 43 relative to the side walls 7 so as to move the pivot shaft 24, and hence the arms 23, to the desired position.

After adjustment, the pivot shaft 24 and the arms 23 coupled thereto are firmly held in the selected vertical position, on the one hand, by the nuts 47 and the threaded rod 46, and on the other hand, by the bolts 40 firmly tightened to the side walls 7 through the elongate slots 44 therein. It will be noted that by this adjustment, the vertical position of the sprockets 19 relative to fixed upper sprockets 49 of the rear expandable member 9, when the baler is in its empty condition, can be changed. It will also be noted that, as a bale is being formed in the bale chamber, the sprockets 19 move upwardly and away from the fixed upper sprockets 49 of the rear expandable member 9 by virtue of the arms 23 supporting the sprockets 19 pivoting in an anticlockwise direction as seen in Figures 1 and 2. This displacement, however, has been kept to an acceptable minimum by providing the pivot shaft 24 substantially offset relative to the centre of the arms 23, and such that the sprockets 19 are positioned closer to the pivot shaft 24 than the guide rollers 21. Using the adjustability of the pivot shaft 24 in a generally vertical directions provided by the adjustable plates 43, the forward expandable member 8 is set so that, in the empty condition of the baler, the sprockets 19 are positioned slightly below the fixed sprockets 49 of the rear expandable member 9 and as close as possible to the forward, generally vertical run of the rear expandable member 9 without however the forward and rearward expandable members 8, 9 fouling each other during operation.

It will also be noted that, as a bale is being formed in the bale chamber, the arms 23 pivot anticlockwise, as seen in Figures 1 and 2, until the guide rollers 21 engage the opposed runs of the endless chains 17 forming part of the expandable member 8. At this moment, further pivoting of the arms 23 in the anticlockwise directions, and hence further "expansion" of the expandable member 8, becomes impossible, whereby the inner run of the expandable member 8 assumes a virtually fixed position which is very much the same as the fixed position assumed by the bale forming members in a so-called soft core baler or a baler with a fixed bale chamber.

Turning now to the expandable member 9, this also comprises a pair of spaced endless chains 48 located adjacent, but inset from, the respective side walls 7 and interconnected by a plurality of slats 22, the construction of which has yet to be described. Again, the slats 22 extend beyond the chains 48 and terminate just short of the side walls 7 as shown in Figure 5. Each chain 48 extends around an upper fixed sprocket 49, a lower fixed sprocket 51 associated with the rotor 16, and one or both movable guide rollers 52 of each of an upper and lower pair thereof. When the machine is empty (Figure 1), only one roller 52 of each pair is in engagement with the chains 48, but when a bale nears completion, both rollers of each pair are in engagement with the chains 48. Also, under this condition as a bale nears completion in the bale chamber 11', both the inner and outer runs (as seen with respect to the bale chamber) of the chains 48 engage the rollers 52. The rollers 52 of each pair are rotatably mounted on respective ends of a crosspiece 53 of a generally T-shaped support, the stem 54 of which is provided with a pivot 55 intermediate its ends. Each pivot 55 extends from the stem 54 through an arcuate slot 56 in the associated side wall 7 and is attached to a support arm 57 pivotally mounted at 58 on said side wall at the centre of curvature of the slot 56. The end of each stem 54 of the T-shaped support remote from the crosspiece 53 is connected to one end of a tension spring 59, the other end of which is attached to the associated side wall 7. The two upper crosspieces 53 and the two lower crosspieces 53 are interconnected by respective transverse tubular beams 61 to ensure that the two upper and two lower supports pivot in unison. The springs 59 serve in the empty condition of the baler, to bias the upper T-shaped supports in a clockwise direction, and the lower supports in an anti-clockwise direction, as viewed in Figure 1, whereby one roller 52 of each pair engages the associated chain 48 to maintain tension therein and again take up any slack in the chain resulting from wear. Also, the support arms 57 are pivoted in a direction towards the bale start chamber 11 until the pivot pins 55 engage the forward ends of the arcuate slots 56, under the action of the springs 59. It will also be noted that in this empty condition the rear expandable member 9 assumes a generally rectangular configuration with the run 7 facing the bale start chamber 11 being oriented generally vertically.

As a bale is being formed in the bale chamber 11', the forward run 70 is moved in a rearward direction against the force of the springs 59 and inbetween the top and bottom sprockets 49 and 51, respectively. As the bale nears completion, both guide rollers 52 of each pairs of guide rollers first engage the rear runs of the respective chains 48 and ultimately, the forward runs of the chains 48 engage the "opposite sides" of the guide rollers 52. Any "stretching" of the chains 48 resulting from wear is compensated by the T-shaped supports 53, 54 with the guide rollers 52 thereon moving generally radially outwardly, as seen with respect to the completed bale 13 in the bale chamber 11'. Such radially outward movement is made possible by the provision of the support arms 57 carrying the T-shaped

supports being mounted for pivotal movement about the pivots 58, whereby the pivot pins 55 extending through the elongate slots 56 are moved away from the inner ends thereof.

It will be appreciated that, like the forward expandable member 8, the rear expandable member 9 also cannot expand any further once both runs of the chains 48 engage the "opposite sides" of the guide rollers 52. Thus, again in this condition, the expandable member 9 also acts as the fixed bale forming means of a so-called soft core round baler.

It will also be appreciated that as a result of the guide rollers 21, 52 engaging at times the opposed runs of the respective associated chains 17, 48, these guide rollers 21, 52 need to have smooth outer surfaces, otherwise toothed outer surfaces (such as those of sprockets) would interfere with the proper simultaneous guidance of both runs of the chains.

Returning now to the slats 22 forming part of both the front and rear expandable members 8 and 9, and referring to Figures 6 to 8, these are formed from tubular stock and, as already mentioned, extend essentially the full width of the machines. The chains 17 and 48 are inset from the ends of the slats 22, as already described with reference to Figure 5, in order to reduce the unsupported length of each slat, whereby to lessen the chance of the slats flexing, and indeed being permanently deformed, when a bale is being formed. Also, the offset loading of the chains 17 and 48 is reduced substantially, resulting in an increased life of the chains or, alternatively, enabling lighter, and hence cheaper, chains to be used based on a required life. The use of tubular stock for the slats 22 maximises the inherent strength of the latter but gives rise to a problem in connecting the slats to the respective chains 17, 48.

To overcome this problem, each slat 22 is basically flattened, but in a special manner, at each end, the flattened portion 62 extending from the end of the slat to just beyond the point of connection to the chain 17 or 48. As best seen in Figure 8, the flattened portion 62 of each end of each slat 22 comprises a flat rear portion 63 and an opposed front, working portion having a longitudinally-extending central portion 64 extending parallel to, but spaced from, the rear portion 63 and being flanked by two upstanding portions 65. Thus the front surface of each flattened slat portion 62 is channel-shaped.

The flattening of the ends of the slats 22 destroys the inherent strength of the previous tubular configuration and in order to restore this strength, a fillet or insert 66 cut from flat metal strip is disposed inside each flattened portion 62 in the space between the rear portion 63 and the front central portion 64. Two longitudinally-spaced apertures 67 are provided through each flattened portion 62, including the insert 66, for the reception of bolts 68 by which the slat is attached to lugs 69 carried on either side of the associated chains 17, 48, the lugs being provided with holes to receive the bolts and together forming a surface complementary to the adjacent surface of the portion 63. It will be noted from Figure 8 that the upstanding portions 65 of the flattened end portions 62 extend proud of the heads of the bolts 68, whereby the latter are protected from excessive abrasive wear by the crop material, and the likelihood of crop material getting hooked around the bolt heads reduced. It will also be noted that the upstanding portion 65 lies generally within the outer periphery of the tubular slat as seen in end view.

The threaded ends of the bolts 68 and the nuts 50 cooperating therewith are positioned to the side of the chains 17, 48 facing away from the bale to be formed and hence are also protected from abrasive wear by the crop material. The chains 17, 48 with the lugs 69 thereon are standard commercially available chains which means that the cost thereof is considerably lower than it would if special chains had to be employed.

It will be appreciated that the front and rear surfaces 60, 70 of the start chamber 11 are defined by the slats 22 on the runs of the chains 17 on the longest side of the triangle formed by the sprockets 18, 19 and the guide roller 21 and the slats 22 on the runs of the chains 48 between the upper and lower sprockets 49, 51, respectively. These surfaces 60, 70 change shape as a bale is formed, being transformed from linear to arcuate as has already been mentioned and as will be further described in more detail.

Turning now to the combined crop feeder and bale support device 15, and referring to Figures 9 and 10, this comprises a hollow rotor 71 having a smooth outer surface and provided with two diametrically opposed rows of apertures 72 each of which receives an insert 73 from within the rotor, the insert being bolted to the rotor. Each insert 73 comprises two hemispherical shells 74 formed with flanges 75 by which the insert is bolted to the rotor 72, the sphere formed by the two shells containing a bush 76 of elastomeric synthetic plastics material. Each shell 74 is apertured to provide a through aperture 77 for a rod or finger 78 mounted in a radial extension 79 of a bush 81 of an elastomeric synthetic plastics material. Each rod 78 is retained in the extension 79 by a pin 82, and each bush 81 is rotatably mounted on a stationary crankshaft 83 the ends of which are received in bearings 84 provided in end plates 85 for the rotor 71. The rotor body is driven and rotates around the crankshaft 83, whereby the rods 78 are alternately extended (at the side of the rotor adjacent the pick-up unit 14) and retracted (at the side of the rotor adjacent the other rotor 16) by way of sliding in and out of the apertures 77 and bushes 76, the ends of the rods describing the circle indicated at 80.

The combined crop feeder and bale support device 15, together with the facing runs 60, 70 of the expandable members 8, 9 when in the empty condition of the baler define the generally triangular and upright bale starting chambers 1

with the device 15 being provided at a distance beneath the lower end of the member 8, thus providing therebetween a bale chamber inlet opening. The device 15 is further mounted proximate, and forwardly of the rotor 16 so that, in the empty condition of the baler, the generally vertical run 70 of the rear bale forming member 9 is offset to the rear of the device 15, which in part forms the base of the triangular bale starting chamber 11.

The device 15 is further also positioned relative to the lower sprockets 18 of the front bale forming member 8 and the rotor 16 (which is part of the rear bale forming member 9) so that, as a bale is nearing completion within the bale chamber, the bale is supported at least in part by the cylindrical body 71 of the device 15. Hence the cylindrical body 71 is positioned, together with other components on a circumference defining the cylindrical bale chamber 11′ when at its maximum diameter.

However, the device 15 is also positioned relative to the bale chamber 11′ so that, as a bale is being formed in the bale chamber and is nearing completion, its centre of gravity is moved from generally above the device 15 to the side thereof opposite to the side facing the pick-up device 14.

The retractable fingers 78 are substantially in the retracted position at the point on the cylindrical body 71 of the device 15 where, when a bale is being completed in the bale chamber 11′, the bale is supported on the cylindrical body, thereby avoiding the fingers penetrating into the bale and adversely affecting the surface thereof. The fingers 78 are extended to the maximum at the side of the cylindrical body 71, facing the discharge end of the pick-up device 14 in order to take over crop material therefrom and are retracted gradually from the maximum extension position to said part of contact of the bale on the cylindrical body 71, as the device is rotated.

Referring to Figures 11 and 12, the rotor 16 will now be described. The function of the rotor 16 is to provide a positive support for a bale during formation, which support does not impart any substantial vibration to the bale which might impair the the formation thereof and/or cause unacceptable wear and/or damage to the machine. As already described, the chains 48 extend around sprockets 51 associated with the rotor 16 and if the rotor were not provided, the slats 22 would continuously pass beneath the bale being formed, thereby raising the bale on each occasion and thus subjecting the bale to vibration in the generally vertical plane. The rotor 16 overcomes this problem by providing pockets for the slats 22 to enter as they pass beneath the bale, whereby the rotor, together with the slats received in the pockets thereof, provide a substantially smooth or continuous surface on which the bale is supported.

The rotor 16 comprises a hollow tubular core 86 extending between the two sprockets 51 and closed at each end by a plate 87 formed with a tubular extension 88 of reduced diameter and concentric with the core and formed with an annular recess 89 around its outer end. The recess 89 receives one end of a tube 91 having the same outer diameter as the extension 88 and being closed at its other and outer end by an end plate 92 which is bolted to a flange 93 carried by a stub shaft 94 by which the rotor is mounted for rotation in bearings (not shown) provided in the respective side walls 7. Each tube 91 is surrounded along the majority of its length by a further tube of the same outer diameter as the core 86 and representing an extension 86′ of that core. Each core extension 86′ is supported by two annular discs 95 carried by the tube 91.

On the main core 86 and the two core extensions 86′ of the rotor 16 there are mounted respective outer rotor surfaces 96 and 96′, which are generally star-shaped in cross-section as seen in Figure 11, thus providing four longitudinally extending pockets 97 for the reception of the slats 22 associated with the chains 48. The surfaces 96, 96′ are each formed from four identical sections of sheet metal welded together at the "points" of the star and to the respective end plates 87, 95 of the rotor 16.

The two sprockets 51 associated with the rotor 16 are annular and each is welded to an annular disc 99 attached to the tube 91. On assembly, the two ends of the rotor 16 are mounted on the main rotor body by sliding the tubes 91 into the recesses 89 in the extension 88 and bolting the sprockets 51 to respective discs 98 secured to the extensions 88 via bolts 90 welded to the sprockets 51. Thus the sprockets 51 are inset from the ends of the rotor to match the insetting of the chains 48 from the ends of the slats 22.

As the rotor 16 rotates, the slats 22 move into the pockets 97 as the chains 48 pass around the sprockets 51, whereby a substantially continuous support surface is seen by the bale 13 being formed as presented at any given instant by a slat and a "point" of the star-shaped rotor. In this respect, it will be seen from Figure 11 that when a slat 22 is received in a pocket 97, the radially outer portion of the main body of the slat is located at the circle 101 circumscribed by the "points" of the rotor 16.

From the drawings, and more especially from Figure 2, it will be appreciated that only part of the weight of a bale being formed on the bale chamber is supported on the rotor 16 (and on a slat 22 received in a pocket 97 thereof and on the chains 49), another part of the bale weight being supported, as already mentioned, by the combined feeder and bale supporting device 15.

It should be noted that the number of teeth on each sprocket 51 is N times the number of links in the chains 48 between adjacent slats 22, where N is an integer, although preferably not one. Also, the number of teeth on each sprocket 51 is a multiple of the number of pockets provided in the rotor. It will be seen from Figure 11 that in the first embodiment, each sprocket has sixteen teeth which is multiple of the four pockets 97 and

which makes N=4 since a slat 22 is attached to every fourth link of the chains 48.

The drives for the various driven components of the baler are shown in Figure 2 of the drawings, these being omitted from Figure 1 for clarity. A sprocket 102 on the output shaft 103 of the gearbox 6 drives, via a chain 100, one sprocket of a triple sprocket 104 on a shaft 105 on which the sprocket 18 of the front expandable member 8 is mounted, whereby the chains 17 are driven in a clockwise direction as seen in Figures 1 and 2. Both chains 17 are driven since the shaft 105 is common to both sprockets 18. A further chain 106 extends around a second sprocket of the triple sprocket 104 and around a sprocket 107 on a common shaft 108 for the two sprockets 49 of the rear expandable member 9, whereby the two chains 48 are also driven in a clockwise direction as seen in Figures 1 and 2. Thus the runs of the chains 17 and 48 partially defining the start chamber 11 move in opposite directions so as to impart a rolling motion to the crop material fed to the start chamber.

A chain 109 extends around the third sprocket of the triple sprocket 104 and around a sprocket 111 provided on one end of the cylindrical body 71 of the rotor 15, whereby the latter is driven in a clockwise direction as seen in Figures 1 and 2. A pulley 112 is also coupled to the sprocket 111 and a belt 113 extends from that pulley to a pulley 114 on the pick-up unit 14 so as to drive the latter also in a clockwise direction as seen in Figures 1 and 2. Thus it is seen that the drives to the driven components are effected in a simple manner.

In operation of the embodiment of Figures 1 to 12, the machine is hitched to the tractor or other towing vehicle via the drawbar 3, and the driveshaft 4 connected to the tractor PTO, whereby the chains 17, 48, the rotor 15 and the pick-up 14 are driven as described above. Thus as the machine is towed across a field to previously cut crop material, the latter is picked up by the pick-up 14 and conveyed overcrop and rearwardly towards the rotor 15. The extended fingers or rods 78 of the latter take over the crop material and feed it into the mouth of the start chamber 11 against the rising run of the chains 48 and associated slats 22, the fingers then retracting and thus releasing the crop material. It will be appreciated from the foregoing description that the slats 22 are relatively closely spaced, and they serve to carry the crop material a certain way into the start chamber 11 before the crop tumbles under gravity and falls downwardly, assisted by the generally downwardly moving slats 22 of the front expandable member 8. The relatively gentle tumbling action of the crop material results in a generally soft core for the bale being formed. However, the rolling action imparted to the crop material by the rotor 15, and the slats 22 on the facing runs of the chains 17 and 48 results in a smaller core than would otherwise pertain in a conventional soft core baler. Experience has shown that the core usually starts to roll at a distance above the combined feeder and support device 15 and inbetween the facing runs 60, 70 of the bale forming members 8, 9. As the size of the bale core increases, the start chamber 11 becomes full, whereupon the core presses increasingly harder on the slats 22 of the facing runs of the chains 17 and 48 with the result that runs of chains 17 are urged to the left as seen in Figure 1, and the runs of the chains 48 are urged to the right, the former against the action of the springs 28 and the latter against the action of the springs 59. Accordingly, the layers of crop material surrounding the soft core begin to be more consolidated, the density of the bale in fact increasing to the outer shell thereof since the springs 28 and 59 progressively increase the tension in the chains 17 and 48.

It will be appreciated that the degree of compaction depends on the forces exerted by the springs 28 and 59. With the illustrated arrangement it is easy and convenient to vary these spring forces and thus vary the density of the bale. Therefore, if it is desired to produce soft-core bales pretty much as are conventionally produced with soft core balers, it is sufficient to adjust the springs 28 and 59 accordingly.

It should be noted that as the runs 60, 70 of the bale forming members 8, 9 are deflected as the bale increases in size, the facing runs of the chains 17 and 48, together with the associated slats 22, form complementary portions of a cylinder as seen in Figure 2 to give rise to the cylindrical bale chamber 11'. As already mentioned, this deflection is accompanied by pivotal movements of the arms 23 and the T-shaped supports, 53, 54 to the positions indicated in Figure 2. It should also be noted that the arms 23 are pivoted off centre in order to minimise the relative movements between the sprockets 19 and the sprockets 49 so as not to create any sizeable gap therebetween through which crop material may be lost.

When the arms 23 and supports 53, 54 are in the positions of Figure 2, the chains 17 are in contact with opposite "sides", as it were, of the sprockets 18 and 19 and the rollers 21, whereby the chains are positively supported in fixed positions with no slack therein. Likewise the chains 48 are positively supported in fixed positions by the sprockets 49, 51 and the rollers 52. Thus when the bale size of Figure 2 is reached the slats 22 are moved along a fixed path around the bale being completed. As further crop material is still being fed into the bale chamber 11' and as the bale chamber cannot expand further a hard shell or outer layer is formed on the bale with compaction taking place in an inward direction from the outside. The hardness of this outer shell, and hence its weathering characteristics, depends on the amount of crop material fed into the bale chamber after the bale has reached its maximum diameter. This is comparable to the hard shell which can be produced with soft core balers and is totally independent of the initial setting of the springs 28, 59.

As the bale is nearing completion in the bale chamber 11', it is supported in part on the cylindrical body 71 of the device 15 and on the rotor 16, together with the slats 22 of the rear bale forming member 9 as they pass in the successive pockets 79 of the rotor. This occurs without any undue vibration of the bale in the bale chamber, and hence also of the baler. It will also be appreciated, mainly from Figure 2, that the forward bale forming member 8, together with the sprockets 18, and the rearward bale forming member 9, together with the lower pairs of guide rollers 52 on the T-shaped support members 53, 54, assist in supporting the weight of the bale in the bale chamber.

As already mentioned, the particular mounting of the T-shaped support members 53, 54 provides compensation for any "stretching" of the bale forming member 9 as a result of wear. When the bale 13 has been completed, the tailgate 12 is raised (by means not shown) above the axis 108 of the sprockets 49 and since the centre of gravity of the bale 15 lies within the rear portion of the bale chamber 11', there is a natural tendency for it to roll from the machine on the raising of the tailgate. This tendency is augmented by the action of the rotor 15, which continues to be driven, and thus positive discharge of a completed bale is achieved.

As soon as a completed bale 13 is discharged from the machine, the springs 28 and 59 return the arms 23 and supports 53, 54, respectively, to the positions of Figure 1, whereby the tapered start chamber 11 is re-formed ready for forming the next bale. It will be appreciated that the machine is capable of forming bales of less than the maximum diameter as bale discharge can be effected at any time by raising the tailgate 12. Whilst any bale less than the maximum size will not have the heavily compacted outer layer or shell, the latter nevertheless will be such that the bale will hold together especially when the springs 28, 59 have been set to give an increased density to the bale being formed.

Turning now to Figure 13, this shows a modified arrangement of the guide means for guiding the chains 48 when a bale has reached its maximum diameter in the bale chamber 11'. Figure 13 shows one T-shaped support 53, 54 in the position adopted when a completed bale has been formed. In this arrangement, each support 53, 54 is provided with two sprockets 115, one in engagement with the front run of the associated chain at a location proximate one guide roller 52 and the other in engagement with the rear run, again at a location proximate to the other guide roller 52. As before, the chains 48 engage both "sides" of the rollers 52 when in the position (bale complete) of Figure 13. This arrangement improves the guidance of both runs of the chains 48 on the guide rollers 52 when a bale has reached its maximum size within the bale chamber 11' by positively holding the chains 48 in alignment with the rollers 52.

Figures 14 and 15 show an alternative embodiment of round baler which, in the main, is similar to that of Figures 1 to 12, the differences being in respect of the chain tensioning devices associated with the front and rear expandable members 8 and 9. In this embodiment the arms 23 are replaced by arms 116 which carry at one end the guide rollers 21, with the sprockets 18 and 19 being fixed. Each arm 116 is pivoted intermediate its ends on a pivot 117, with the other end of the arm connected to one end of a tension spring 118 attached at its other end to the machine frame. With this arrangement, the gaps between the sprockets 19 of the front expandable member 8 and the sprockets 49 of the rear expandable member 9 remain constant and small so the likelihood of any loss of crop material therethrough is small. In the embodiment of Figures 1 to 12, the sprockets 19 are movable relative to the sprockets 49 as a bale being formed increases in size so that care has to be taken with the disposition and mounting of the sprockets 19 with the crop loss problem in mind, as already explained.

As regards the rear expandable member 9, tension in the chains 48 is maintained only by the upper member and not the upper and lower members (supports 53, 54) as in the first embodiment. The lower supports 53, 54 are replaced by arms 119 which carry the guide rollers 52, with the lower arms being mounted for limited movement relative to the side walls 7 by virtue of a pair of elongated slots 121 formed in the side walls which slidably receive mounting pins 112 attached to the associated arms 119. This particular mounting, like the provision of the pivot arms 57 in the embodiment of Figures 1 to 12, provides compensation for any "stretching" of the chains 48 as a result of wear. The upper supports 53, 54 are replaced by arms 123 which carry the rollers 52 and are each centrally pivoted on one end of a further arm 124 which is pivoted at its other end to the machine frame. One end of a cable 125 is attached to each arm 124 intermediate its ends, the other end of the cable being secured to one end of a tension spring 126 which in turn has its other end attached to the machine frame, the cable passing over a pulley 127 on an extension 128 on the frame. Thus as the bale forming member 9 gets deflected as the bale grows (as already described with respect to the first embodiment), each arm 124 is pulled anticlockwise about its pivot and takes with it the cable 125 which therefore stretches the spring 126 associated therewith, thereby increasing the tension in the chains. Similarly, the springs 118 increase the tension in the chains 17 as the arms 116 are pivoted anticlockwise and stretch the springs 118. It will be noted that, unlike in the embodiment of Figures 1 to 12, both guide rollers 52 of each pair of guide rollers engage one run of the respective chains 48, when the baler is empty. In all other respects, the operation of the embodiment of Figures 13 and 14 is similar to that described for the embodiment of Figures 1 to 12.

It will be seen that the present invention provides a round baler which can produce bales with a hard outer shell whilst the density of the crop material within the outer shell can be varied greatly at will from a low density comparable to the characteristics of bales produced with conventional soft core bales to a high density as is known from balers having an expandable bale chamber, thus providing greater flexibility to the operator and combining advantages of conventional soft and hard core balers. The slats 22 are of a strength sufficient to exert the required force on the bale as it is being formed and yet are not bulky. Furthermore standard chains can be used. Also, the insetting of the points of connection to the chains from the ends of the slats helps to reduce chain wear as it has been found that chains located at the extreme ends of the slats are subjected to uneven loading and hence relatively fast wear. This insetting also reduces the unsupported length of the slats so that less robust tubing can be used therefor than would otherwise be the case. In the described embodiments, slats of 1.2 metres are employed, with flattened portions of 30cms, and internal and external diameters of 38mm and 42mm. The chains 17 and 48 are inset from the ends of the slats by 21cms.

As already mentioned, the rotor 15 has a dual function in feeding crop material to the bale chamber from the pick-up unit 14, and in helping to support the bale as it is being completed. The rotor 15 thus performs an important part in the formation of a bale and without its presence, the pick-up unit 14 would have to be mounted much closer to the mouth of the bale chamber to an extent that it would inevitably have to support each bale being formed, and conventional pick-up units are not constructed to fulfil this purpose.

The function of the rotor 16 is also important in lending further support to each bale as it is formed and in so doing to present, in conjunction with the slats 22 a substantially smooth surface to the bale. To this end the pockets 97 are formed in the surface of the rotor 16 to accommodate the slats 22 as they pass therearound. As already explained, this prevents the slats from imparting generally vertical vibrations to the bale being formed which would impair formation.

Although the illustrated embodiments employ two expandable bale-forming members 8 and 9, the member defining the smaller portion of the bale chamber 11′ (be it the front or rear member) may be replaced by one or more of a fixed type of bale-forming means employing, for example, fixed rollers, or fixed chain or belt conveyors. Alternatively, the bale-forming members 8 and 9 may be augmented by one or more fixed bale-forming means. Also the chain type bale forming means 8, 9 may be replaced by belt type bale forming members.

The present invention provides a round baler capable of producing a bale with a hard outer shell (soft core bale characteristics), and with either a relatively high density (hard core bale characteristic), or a rather low density of crop material within the outer shell, without giving rise to an over complicated structure. The machine can produce a maximum sized bale (1.2 metres in diameter) in approximately two minutes, provided crop material is fed to the bale chamber at the appropriate rate. Of this bale-forming time, between 1/3 and 1/4 is devoted to forming the hard shell, i.e. this is the period in which the runs of the chains 17 and 48 are positively supported by the "opposed sides" of all the sprockets and guide rollers provided within the envelopes formed by the respective chains. This is a very important aspect because it provides the possibility of producing with a baler of the type having an expanding bale chamber, bale with an extra hard outer shell, such as is obtained with known balers of the type having a fixed chamber and commonly referred to as soft core balers. It will be appreciated that the tension initially set in the chains 17 and 48 determines the hardness of the core as well as influencing the overall density of the bale except for the hardness of the outer shell which basically is determined by the amount of crop material fed into the bale chamber after the latter has expanded to its maximum diameter. In general, a baler in accordance with the present invention provides a core which is smaller than that provided by known soft core machines due to the positive rolling action imparted to the core by the bale-forming members. Thus the baler produces a highly satisfactory bale having qualities of both soft core and hard core bales without, as already mentioned, being of complicated mechanical construction.

CLAIMS

1. A round baler having bale-forming means comprising at least two spaced endless flexible members, and a plurality of slats each attached intermediate its ends to said at least two flexible members, each slat comprising a hollow tube having at least a section at or towards each end which carries a reinforcing insert internally of the tube and which section is deformed to provide two opposed, generally parallel, portions with at least one aperture extending therethrough, one portion abutting a complementary surface on the associated flexible member which is also apertured similarly to said portions, and the other portion providing an abutment for securing means and extending between two upstanding portions, each insert being located between the associated opposed portions and also being apertured similarly to said portions for the through passage of the securing means to the respective apertures, in the related flexible member.

2. A baler according to Claim 1, wherein each slat has a circular cross-section.

3. A baler according to Claim 1 or 2, wherein the upstanding portions extend from the associated other portion by an amount sufficient to be proud of the securing means and thereby, in use, shield the latter from abrasive action by the crop material.

4. A baler according to any of the claims 1 to 3, wherein the outer edges of the upstanding portions lie generally within the outer periphery of the slat as seen in end view.

5. A baler according to any of the preceding Claims, wherein each insert and the opposed portions of each slat are flat.

6. A baler according to any of the preceding claims, wherein each flexible member is in the form of a chain, and wherein each said complementary surface comprises two lugs attached to respective sides of the chain and apertured to receive respective securing means.

7. A baler according to any of the preceding Claims, wherein each slat at one point in its movement at least partially supports the bale as it is being formed and wherein rotor means are provided around which the endess flexible members are guided and which is provided with a plurality of longitudinally-extending pockets equispaced around the periphery thereof and operable to receive the slats as the flexible members are guided therearound, the rotor and the or each slat disposed at any given instant in a rotor pocket presenting a generally continuous, smooth support surface for the bale being formed, whereby the bale is at least partially supported without being subjected by the slats to excessive vibration as a result.

8. A baler according to Claim 7, wherein the rotor has an outer surface in the general shape of a star, as seen in cross-section.

9. A baler according to Claim 8, wherein the outer surface of the rotor is made from a plurality of identically shaped pieces of sheet material jointed together at the "points" of the star.

10. A baler according to any of Claims 7 to 9, wherein the flexible members are inset from the ends of the slats, and hence from the ends of the rotor.

11. A baler according to Claim 10, wherein the flexible members are chains and the rotor comprises a core upon which are mounted a number of spaced annular sprockets corresponding to the number of chains.

12. A baler according to Claim 11, wherein two chains are provided inset from respective ends of the rotor, and wherein the rotor is in three sections releasably connected together.

13. A baler according to Claim 11 or 12, wherein the number of teeth on each sprocket is N times the number of links in each chain between adjacent slats, where N is an integer.

14. A baler according to any of Claims 11 to 13, wherein the number of teeth on each sprocket is a multiple of the number of pockets provided in the rotor.

15. A baler according to any of Claims 7 to 14, wherein the pockets in the rotor are of such a depth that the slats, when engaged therein, lie within the overall periphery of the rotor.

16. A baler according to any of Claims 7 to 15, wherein a portion of the baler is capable of pivoting upwardly about an upper pivot for discharging a completed bale, the bale forming means being guided between upper and lower sections of the pivotable portion, and the rotor being provided adjacent the lower end of the pivotable portion.

17. A baler according to Claim 16, wherein the rotor is mounted on the pivotable portion of the baler at a location proximate the fixed portion of the baler when the pivotable portion is in its lowered position.

18. A baler according to any of Claims 7 to 17, wherein the bale forming means define at least in part a bale chamber positioned generally above the rotor and which, as a bale is being formed therein, expands from a minimum size chamber to a maximum size chamber of generally cylindrical shape, with the centre of the chamber moving, during formation of the bale from one side of the rotor to a position generally vertically above the rotor.

19. A baler according to Claim 18, wherein the centre of the bale chamber, when expanded to its maximum, is located within the pivotable position of the baler.

20. A baler according to any of the preceding Claims having a bale-forming chamber and further comprising pick-up means operable to pick-up crop from the ground for feeding to the bale-forming chamber, and crop feeder means operable to receive crop from the pick-up means and to transfer it to the bale-forming chamber, the crop feeder means being disposed so as to assist in supporting the bale during formation thereof.

21. A baler according to any of Claims 1 to 19 and having a bale-forming chamber defined at least in part by at least one expandable bale-forming means arranged so as to define initially a generally wedge-shaped start chamber for the bale, the start chamber being generally vertically oriented and having a crop inlet at the base thereof, pick-up means operable to pick-up crop from the ground for feeding to the crop inlet of the bale-forming chamber and crop feeder means operable to receive crop from the pick-up means and to transfer it to the bale-forming chamber, the crop feeder means being disposed so as to assist in supporting the bale as it is formed.

22. A baler according to Claim 21, wherein the start chamber is generally triangular in shape with two generally upright sides being defined by bale-forming means and the third side being formed generally by the crop feeder means.

23. A baler according to Claim 21 or 22, wherein the crop feeder means is positioned proximate and forwardly of, the lower end of a rear run of bale forming means defining in part said start chamber, on the one hand, and rearwardly of, and at a distance below, the lower end of a front run of bale forming means also defining in part said start chamber, on the other hand; the crop feeder means and the lower end of said front run of the bale-forming means defining therebetween the crop inlet of the bale chamber.

24. A baler according to any of Claims 21 to 23, wherein at its maximum expansion the bale chamber is generally cylindrical in shape with the

crop feeder means being positioned so as to assist in supporting the bale during formation thereof.

25. A baler according to any of Claims 20 to 24, wherein the crop feeder means is in the form of a driven hollow rotor having a smooth outer surface, and with a plurality of fingers eccentrically mounted within the rotor and being extendable and retractable through respective apertures provided in said outer surface as the hollow rotor is rotated.

26. A baler according to Claim 25, wherein the fingers of the crop feeder means are arranged to be extended in the vicinity of the pick-up means, and retracted at the side thereof facing the bale-forming chamber, whereby the bale is supported by the rotor, during formation, without the fingers fouling the bale.

27. A bale according to any of Claims 20 to 26, wherein a portion of the baler is capable of pivoting upwardly relative to a fixed portion about an upper pivot shaft for discharging a completed bale, the crop feeder means being positioned adjacent the lower end of the fixed portion and proximate the pivotable portion when the latter is in its lowered position; the machine further comprising baler support means provided on the pivotable portion adjacent the lower end thereof and proximate the crop feeder means on the fixed portion, when the pivotable portion is in its lowered position.

28. A baler according to any of the preceding Claims, wherein the bale chamber is arranged to expand from an initial generally vertically oriented wedge-shaped start chamber to a generally cylindrical final chamber, the bale chamber being defined in part by first expandable bale-forming means arranged to define a majority of the final bale chamber, and in part by complementary bale-forming means.

29. A baler according to Claim 28, wherein the complementary bale-forming means comprise second expandable bale-forming means.

30. A baler according to Claim 28, wherein the complementary bale-forming means define a fixed portion of the bale chamber.

31. A baler according to Claim 30, wherein the complementary bale-forming means comprise a plurality of fixed rollers.

32. A baler according to Claim 30, wherein the complementary bale-forming means comprise one or more fixed conveyors.

33. A baler according to Claim 32, wherein the or each fixed conveyor is a chain conveyor.

34. A baler according to Claim 32, wherein the or each fixed conveyor is a belt conveyor.

35. A baler according to Claim 28 or 29, and any chain appended thereto, wherein one expandable member is tensioned by tensioning means comprising at least one arm pivotally mounted intermediate its ends on the machine and carrying at respective ends rotatable members around which the expandable member passes, the arm being urged about its pivot by a torsion spring acting between a stop on the arm and a stop on the machine, whereby the expandable member is tensioned.

36. A baler according to Claim 35, wherein the pivot of the or each arm is offset from the centre thereof.

37. A baler according to Claim 35 or 36, wherein the one expandable member also extends around a third rotatable member, whereby said expandable member follows a triangular path when the machine is empty.

38. A baler according to Claim 28 or 29 wherein the first expandable member is tensioned by tensioning means comprising at least one upper and lower tensioning device each in the form of a T-shaped member with the crosspiece thereof carrying a rotatable member at each end, and the stem thereof being pivotally mounted on one end of a support arm pivotally attached to the machine, a tension spring being connected between said stem and the machine and operable to pivot the T-shaped member such that only one rotatable member thereof is in engagement with the expandable member when the machine is empty.

39. A baler according to Claim 38, wherein the pivot of each T-shaped member extends through an arcuate slot in an adjacent side wall of the machine, and the pivot of the associated support arm is located at the centre of curvature of the arcuate slot.

40. A baler according to Claim 38 or 39, wherein at least two upper and at least two lower T-shaped members are provided, and wherein the upper T-shaped members have a common pivot and the lower T-shaped members have a common pivot.

41. A baler according to Claim 40, wherein a transverse beam is provided for coupling to each other the at least two upper T-shaped members, and a further transverse beam is provided for coupling to each other the at least two lower T-shaped members.

42. A baler according to Claim 28 or 29, wherein one expandable member is tensioned by tensioning means comprising at least one arm pivotally mounted on the machine intermediate its ends and carrying at one end a rotatable member and being connected at the other end to the machine via a tension spring, the latter urging the rotatable member into engagement with the expandable member to tension the latter.

43. A baler according to Claim 28 or 29, wherein the first expandable member is tensioned by tensioning means comprising at least one upper and lower tensioning device of which the or each upper device comprises a first arm pivotably mounted on one end of a second arm and carrying at each end a rotatable member each arranged in engagement with the associated expandable member; the second arm being pivotally attached at its other end to the machine and having one end of cable attached intermediate its ends, the cable extending from the second arm, over a pulley to one end of a tension spring, the other end of which is attached to the machine.

44. A baler according to Claim 43, wherein the or each lower tensioning device comprises an arm mounted for sliding movement relative to the machine and carrying at each end a rotatable member arranged in engagement with the expandable member.

45. A baler according to Claim 44, wherein each lower tensioning arm is provided with two spaced apart pins which are slidably engaged in respective elongate and parallel slots provided in at least one machine side wall whereby the arm is slidable relative to the machine.

46. A baler according to any of Claims 38 to 41 and 43 to 45, wherein the one expandable member also extends around an upper rotatable member mounted forwardly of the upper tensioning device, and a lower rotatable member mounted forwardly of the lower tensioning device, the upper and lower rotatable members being disposed in a generally vertical plane, whereby the associated run of the expandable member is also generally vertical when the machine is empty.

47. A baler according to any of Claims 38 to 41 and 43 to 46, wherein the expandable members each comprise two and less chains interconnected by a plurality of slats extending transversely of the machine, upper and lower tensioning devices being associated with each chain and having the rotatable members thereof arranged for engagement with opposed runs of the respective chains; the upper and lower tensioning devices and further comprising two guide sprockets disposed within the chain envelope and operable to align the associated chain with the rotatable members, one sprocket being arranged to engage one run of the chain and the other sprocket being arranged to engage an opposed run when a bale has reached the maximum size.

48. A baler according to Claim 37 or 46, wherein all rotatable members of all tensioning means and all further rotatable members are disposed within the envelope of the respective associated expandable members.

49. A baler according to any of the preceding claims and operable to form bales up to a maximum diameter, the baler further comprising drive and guide members all disposed within the envelope defined by the or each endless flexible member, the arrangement being such that, in use, at least when a bale has reached substantially said maximum diameter, the run of the or each endless flexible member defining the bale chamber is in contact with all of the associated drive and guide members so as to be supported thereby.

50. A baler according to Claim 49, wherein the run of the or each flexible member not defining the bale chamber is also in contact with all of the associated drive and guide members at least when a bale has reached substantially said maximum diameter.

51. A baler according to any of Claims 1 to 48 and having an expandable bale chamber for forming bales up to a maximum diameter and comprising at least one endless flexible bale-forming member provided with an excess length around a pair of spaced apart rotatable members; the endless bale-forming member defining, at least in part, between the spaced apart rotatable members, and by means of said excess length, a final bale chamber of cylindrical shape corresponding to said maximum size bale to be formed; and floating guide members provided within the envelope defined by the opposed runs of the bale-forming member and engaging, and holding apart, both said runs to prevent said runs fouling each other during operation and when a bale has reached substantially said maximum diameter within the bale chamber.

52. A round baler substantially as herein particularly described with reference to Figures 1 to 12, or Figures 14 and 15, or as modified by Figure 13, of the accompanying drawings.

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