Nov. 6, 1962 LE ROY R. BUNNEY 3,062,460

BAMBOO CHIPPER

Filed April 10, 1961

3 Sheets-Sheet 1

Fig. 1.

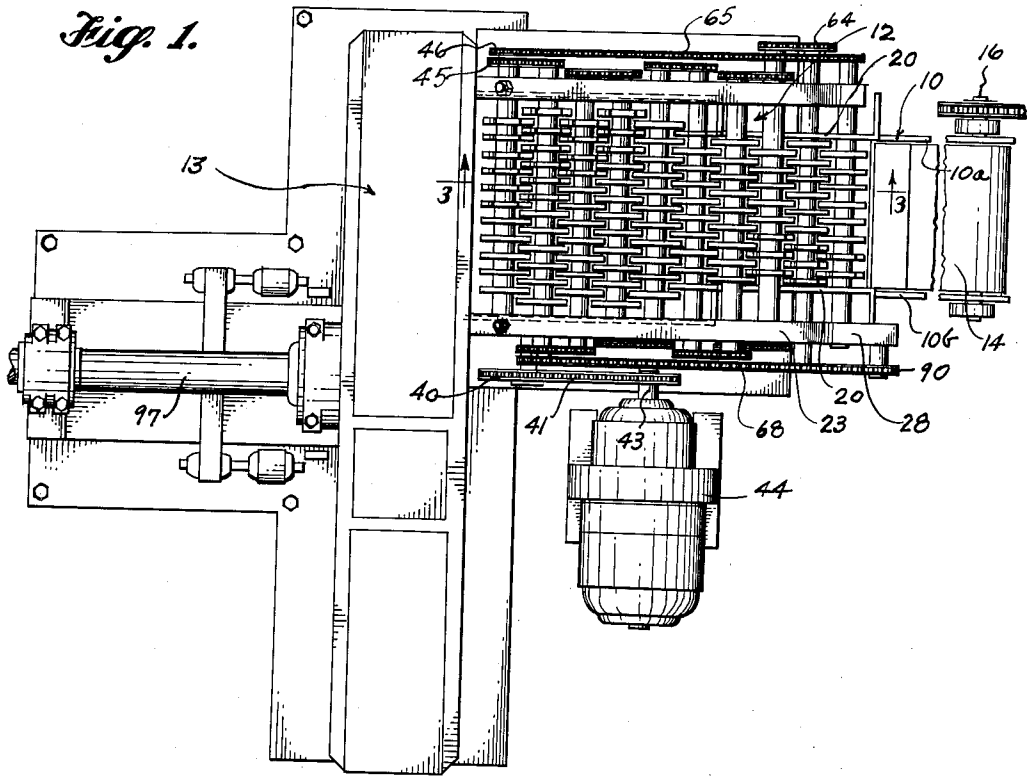


Fig. 2.

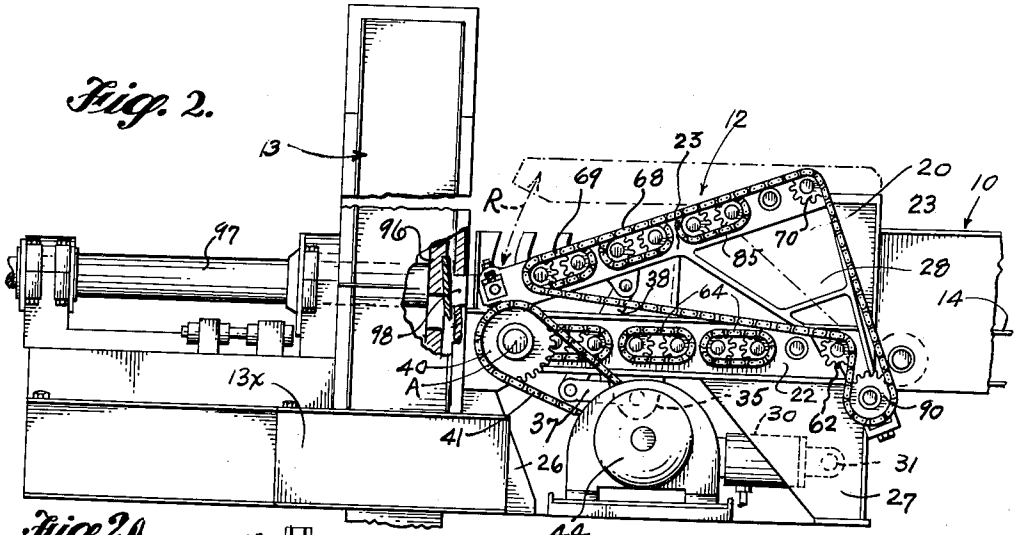
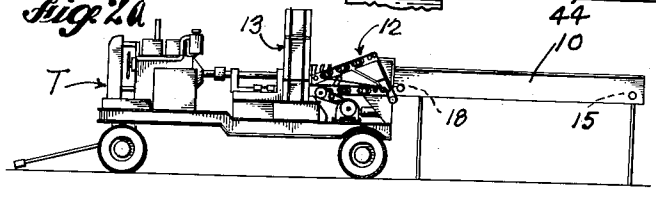


Fig. 2a



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Nov. 6, 1962 LE ROY R. BUNNEY 3,062,460

BAMBOO CHIPPER

Filed April 10, 1961 3 Sheets-Sheet 2

Fig. 3.

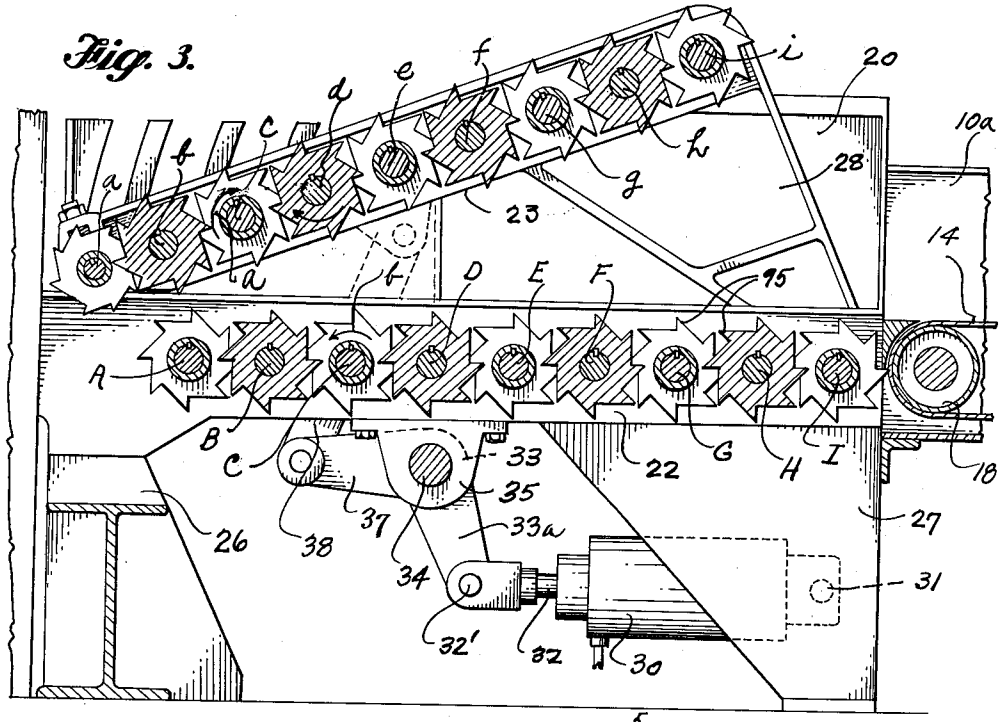
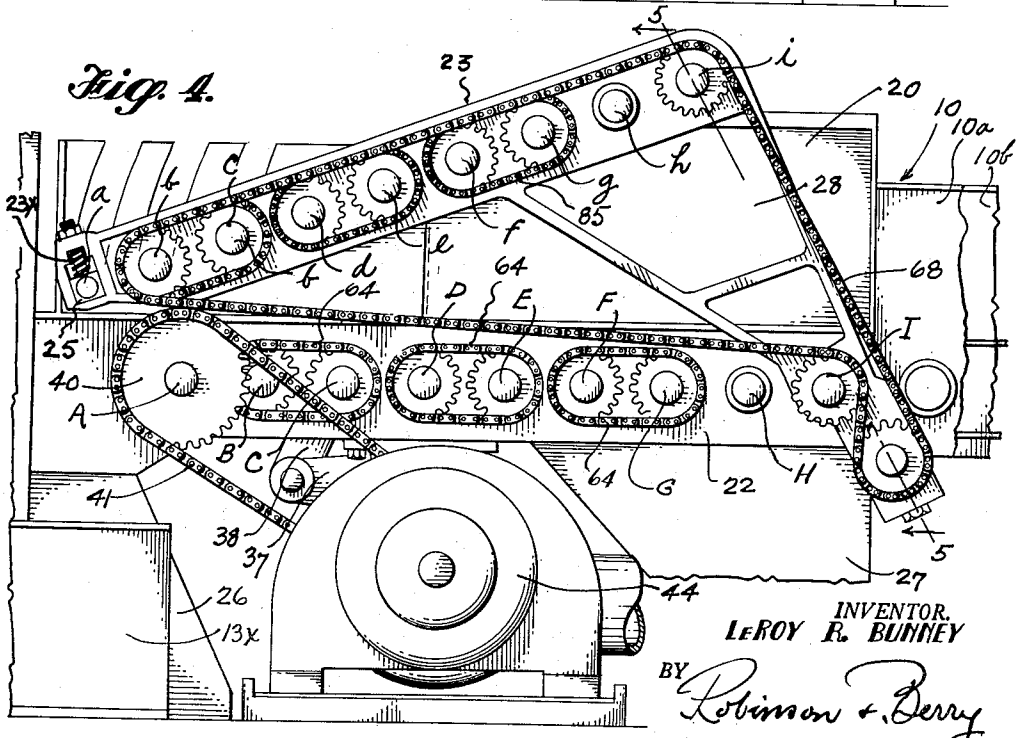


Fig. 4.



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Filed April 10, 1961 3 Sheets-Sheet 3

Fig. 5.

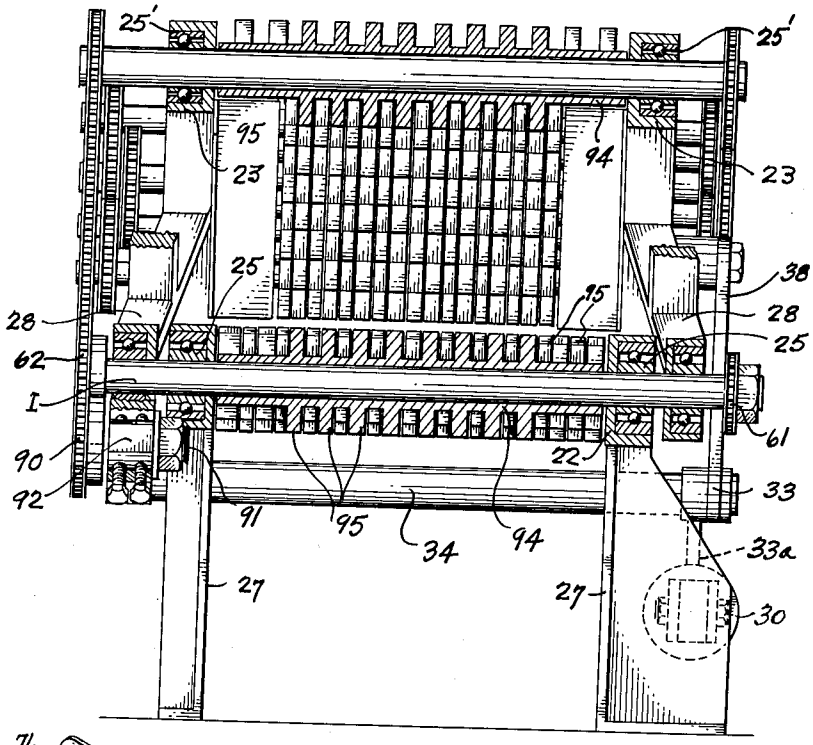


Fig. 6.

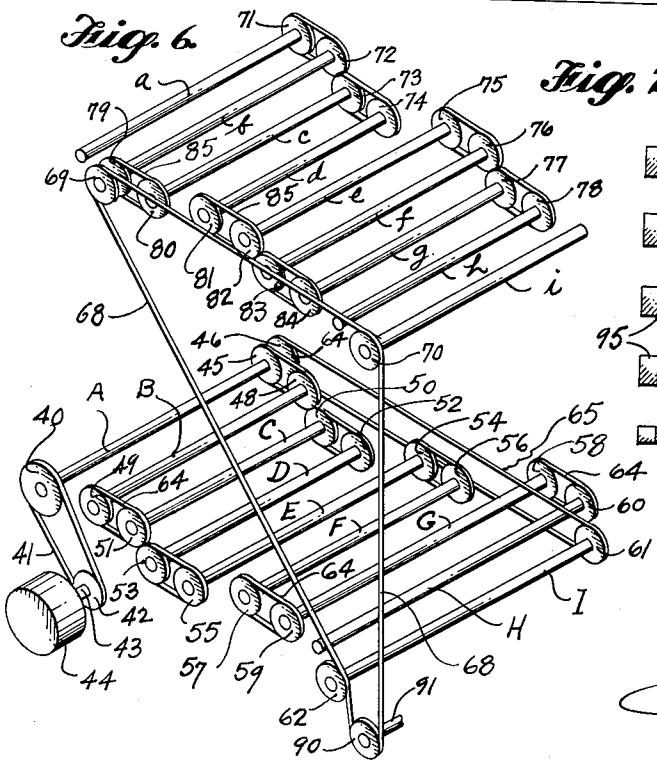
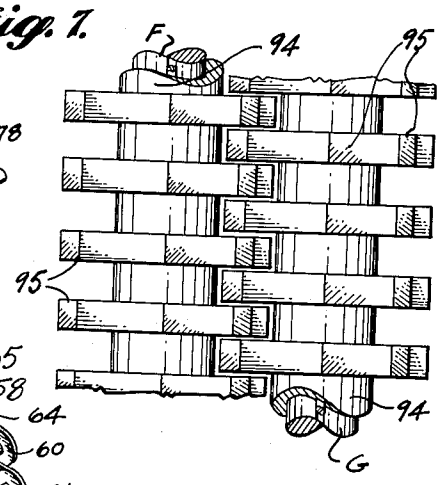


Fig. 7.



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BAMBOO CHIPPER

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5 Claims. (Cl. 241—92)

This invention relates to a mechanism for crushing bamboo stocks or stems preparatory to their being advanced to a chipper and chipped for use in the making of pulp for paper manufacture or other uses.

It is the principal object of this invention to provide a machine whereby bamboo stocks or stems may be fed endwise between upper and lower gangs or banks of coacting feed rollers of novel formation and with a novel mode of operation whereby the bamboo stocks, as progressively advanced to said rollers may be crushed to a condition that renders them best suited for chipping and the uses to which the chips are to be put.

A further object of the invention resides in the provision of means for automatically adjusting the jaw-like crushing action and relationship of the coacting gangs or banks of stock feeding and crushing rollers to establish a yieldable crushing pressure that best suits the character or condition of the bamboo stocks being advanced between them.

Another object of the invention resides in the use of a series of crushing rollers in each of the two coacting gangs or banks of rollers that rotate in unison in the same direction and which coact in their rotative action to prevent crushed material dropping between, clogging or interfering with the rotation of the rollers.

Yet another object of the invention resides in the provision of a bamboo stock crusher mechanism having laterally spaced opposite side plates defining a throat or feed passage for crushed stocks moving to the chipper; said plates having outwardly offset portions widening the passage as it approaches the entrance into the chipper housing.

Still further objects and advantages of the invention reside in the details of construction of the crushing rollers; in their combination and in their mode of operation, as will hereinafter be described:

In accomplishing the above mentioned and other objects of the invention, I have provided the improved details of construction, the preferred forms of which are illustrated in the accompanying drawings, wherein:

FIG. 1 is a top, or plan view of a combined bamboo stock crushing and chipping machine embodied by the present invention, with feed conveyor partially broken away to shorten the view.

FIG. 2 is a side view of the same.

FIG. 2*a* is a side view of the present crusher and a chipper shown in reduced scale, as mounted in use on a mobile truck.

FIG. 3 is an enlarged longitudinal section taken on line 3—3 in FIG. 1, showing the relationship of the upper and lower banks of stock crushing and feeding roller units and the bell crank and linkage connection with the air cylinder for the yieldable closing movement of the upper gang of stock crushing rollers to accommodate the character of the stocks being crushed.

FIG. 4 is an enlarged side view of the mechanism as shown in FIG. 3.

FIG. 5 is a cross-section taken through the stock crushing mechanism on line 5—5 in FIG. 4.

FIG. 6 is a schematic illustration of the arrangement and relationship of the mounting and driving shafts for the upper and lower banks of stock crushing rollers, particularly showing the sprocket chain belting connections for driving the shafts of each of the roller units in unison and the shafts of upper and lower units in opposite directions.

FIG. 7 is a fragmental plan view of parts of two adjacent feeding and crushing rollers, showing the intermeshing relationship of toothed portions thereof.

Referring more in detail to the drawings:

It is shown in FIGS. 1, 2 and 2*a*, that the machine of this invention comprises an elongated feed trough, designated in its entirety by numeral 10, designed for the endwise reception conveyance, guidance and progressive feeding of bamboo stocks or stems placed therein to the stock crusher and chipper. In these views, the stock crusher is designated in its entirety by numeral 12 and the chipper is designated in its entirety by reference numeral 13.

The various parts of this combination, aside from the feed trough 10 are so designed that they may be closely assembled and functionally connected in their intended operating relationship, upon the bed of an automobile truck, T, as indicated in FIG. 2*a*, for the quick and easy transportation of the mechanism from place to place. However, a mobile mounting for the mechanism is not necessarily required.

The feed trough 10 has such dimensions that the bamboo stocks that are to be crushed may be bunched and the bunches laid lengthwise therein. It comprises laterally spaced, opposite sidewalls and a bottom that is provided by the horizontal top run of a continuous feed belt 14 that operates, at the outer end of the trough, about a transverse roller 15 for rotation between the lower edges of the opposite sidewalls of the trough, and operating at its discharge end about a belt driving roller 18, mounted by and extending across the receiving end of the frame structure of the crusher, as best shown in FIG. 3.

In the operation of this machine, the belt 14 is driven in such direction that the bamboo stocks or stems as placed thereon, lengthwise of and within the trough, will be advanced endwise and fed by the belt between the upper and lower banks or units of stock crushing and feed rollers which coact in such manner as to apply crushing pressure diametrically to the stocks advanced between them to thereby effect their being broken into elongated strips that are fed directly from the crusher to the chipper 13.

The feed trough 10 may be and preferably is detachably secured to the receiving end of the frame structure of the crusher by any suitable means, not herein shown or described in detail, and likewise it is supported at its outer end by any suitable form of support. Its length may be varied as desired or as required.

The crusher herein designated in its entirety by reference numeral 12, comprises vertically disposed laterally spaced opposite side plates 20—20, supported on a base structure shown in FIGS. 1 and 2 to be in close association with the base structure 13*x* of the chipper 13. Adjacent the opposite side plates 20—20, but not necessarily attached thereto are the mounting frames 22 and

23 that, respectively, mount therein the lower and upper banks of stock or stem crushing and feed rollers embodied in this invention.

It is to be noted by reference to FIG. 3 that the lower succession of rollers constituting the lower roller bank, as herein shown, comprises nine rollers, arranged horizontally in parallel relationship and extending between the opposite, longitudinal side members of frame 22; each roller being mounted coaxially on and keyed to an individual supporting and driving cross-shaft. These shafts, from the inner or left hand end of the frame, as shown in FIGS. 3 and 6 outwardly are designated, respectively, by reference numerals A, B, C, D, E, F, G, H and I. Each shaft in this lower unit is revolubly mounted near its opposite ends in bearings 25 that are fixed in seats or pockets provided therefor in the opposite side members of frame 22. It is understood, however, that more or less rollers may be employed in the two units, in accordance with desires or requirements for machines of various capacities.

Likewise, the upper roller unit comprises a succession of nine rollers mounted by cross-shafts, *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h* and *i* that are rotatably mounted at their ends in bearings 25 applied to the opposite side members of the upper frame 23.

The rollers of each of the two units are all of the same diameter. All rollers of the upper unit are rotated in unison clockwise and all of the lower units are rotated in unison counterclockwise, in reference to their showing in FIG. 3.

It is shown in FIG. 3 that the lower roller unit as mounted by cross-shafts A, B, C, D, E, F, G, H and I is horizontally disposed and that the frame unit 22 is supported rigidly against movement upon front and rear end leg-like supports designated in FIGS. 3 and 4 by the numerals 26 and 27. It is also shown in FIG. 3 that the rigid frame 23 that carries the upper rollers unit has a single pair of supporting legs 28—28 located at opposite sides at the receiving end of the crusher, and these legs are pivoted near their lower ends on the extended opposite end positions of the roller mounting shaft I of the lower unit of rollers as shown in FIG. 5. The left hand end of the frame 23 may swing from and toward the lower gang of rollers, as indicated by arrow R in FIG. 2. As so mounted, the two crushing roller units act as a pair of jaws between which the advancing bamboo stocks or stems may be received directly from the trough 10 and may be crushed as progressively advanced by the action of the normally converging banks of rollers.

The crushing pressure of the coacting banks of rollers is yieldingly applied and is sustained by means that is best shown in FIG. 3 to comprise an air cylinder 30 that is mounted pivotally at one end, as at 31 in FIG. 3, by one of the paired frame supporting legs 27—27 at the receiving or right hand end of the crusher, and which cylinder has its extended piston rod 32 pivotally connected, as at 32', to the lower end of one arm 33*a* of a bell crank 33 that is keyed on one end of a horizontal cross-shaft 34 mounted in bearings 35–35 fixed to the frame structure. This shaft is extended beneath the lower gang of rollers as shown in FIGS. 3 and 5 and is provided with lever arms 37 at one or both of its ends pivotally connected by links 38 with the opposite side members of the upper roller mounting frame 23.

Air applied under pressure within the rod end of cylinder 30 acts through this linkage to pull the top frame 23 downwardly toward its position of FIG. 3, but in the event that the condition of the stocks require it, the rollers of this upper unit will yield to maintain only the required stock crushing pressure which may be varied by varying the pressure of air applied to cylinder 30 to force its piston inwardly and thereby apply a yieldable downward pulling force to the upper roller unit.

The bamboo stock or stem feeding operation is effected by the rotating coaction of the rollers of the two roller units; all of which rollers rotate in unison as has been

indicated by the arrows *a* and *b* placed on the rollers C and *c* in FIG. 3. The driving of the rollers of the two units is through their roller mounting shafts, and will be best understood by reference to the schematic showing of the shaft assemblies in FIG. 6.

It will be observed in FIG. 6 that the shaft A is equipped at one end with a driving sprocket wheel 40 about which a driving sprocket chain belt 41 operates. Chain belt 41, in turn operates about a driving sprocket wheel 42 on the drive shaft 43 of an electric motor 44, this being mounted on the supporting structure as shown in FIGS. 1 and 2. At its opposite end, shaft A has sprocket wheels 45 and 46 keyed thereon. These sprocket wheels are of the same diameter, as are all driving sprocket of the lower and upper shafts for driving the two roller units. Shafts of the lower roller unit extend at their ends to the outside of the side members of the mounting frame 22. Shaft B is equipped at its opposite ends with sprocket wheels 50 and 51; shaft D with sprockets 52 and 53; shaft E with sprockets 54 and 55; shaft F with sprockets 56 and 57; shaft G with sprockets 58 and 59; shaft H with sprocket 60 at one end only and shaft I with sprocket wheels 61 and 62 at its opposite ends. Sprocket chain belts 64 operate about each of the paired sprocket wheels 45 and 48; 49 and 51; 50 and 52, 53 and 55; 54 and 56; 57 and 59; 58 and 60. Shaft I is driven by a chain belt 65 that is shown in FIG. 6 to operate about the sprocket wheel 46 on shaft A and a sprocket wheel 61 on the corresponding end of shaft I.

The rollers of the upper unit, as shown in FIG. 6 are all driven in unison by a sprocket chain belt 68 which operates over sprocket 62 on shaft I and about sprocket wheels 69 and 70 fixed, respectively, on shafts *b* and *i*. It is also shown in FIG. 6 that shafts *a* and *b* are equipped at one side of frame 23 with sprocket wheels 71 and 72; shafts *c* and *d* are likewise equipped at that side of the frame with sprockets 73 and 74; shafts *e* and *f* with sprockets 75 and 76 and shafts *g* and *h* with sprockets 77 and 78. At the other side of the upper frame 23, shafts *b* and *c* are equipped with sprocket wheels 79 and 80; shafts *d* and *e* with sprockets 81 and 82; and shafts *f* and *g* with sprockets 83 and 84. All of these shafts are driven in unison by sprocket chain belts 85 that operate about paired sprockets 79 and 80; 81 and 82; 83 and 84; 71 and 72; 73 and 74; 75 and 76 and 77 and 78. Thus, the driving of shaft *b* through chain belt 68 effects the driving of all shafts of the upper unit in unison with each other and with all shafts of the lower unit as driven by shaft A but in the opposite direction.

It is to be observed and understood more particularly by reference to FIGS. 3 and 4 that the supporting legs 28—28 of the upper roller unit are pivoted near their lower ends on the opposite end portions of cross-shaft I. The leg 28 on the near side of the crusher as seen in FIG. 3 extends slightly below the pivot point and mounts a belt tensioning sprocket wheel 90 thereon over which belt 68 operates. This sprocket wheel 90 is mounted on a stub shaft 91 mounted in a bearing 92 that is adjustably contained in the lower end of leg 28.

The rollers of each crushing unit are substantially alike in that each extends the full distance between the side members of their mounting frames 22 and 23, as shown in FIG. 5 and each comprises a sleeve 94 that is fitted over and keyed to its mounting and driving shaft. Formed on each sleeve at regularly spaced intervals therealong are annular bands of teeth 95; these bands of teeth being so located on adjacent rollers of each unit that they alternately overlap as will be understood by their showing in FIG. 7. This overlapped relationship of tooth bands operates to prevent material dropping down between rollers of the lower unit and it is further to be understood that all teeth of said bands are similar in formation to the teeth of a one-way ratchet wheel and are so directed that while all toothed bands operate to effect a forward feeding of stocks, stems and crushed ma-

terial, the upwardly moving teeth of each roller will operate to lift fine material from between the intermeshing spaces. These teeth are so shaped, as shown best in FIG. 3 to advance the crushed stocks toward the chipper entrance.

The chipper, designated in its entirety by reference numeral **13**, may be one like or of the general type of that of U.S. Patent 2,838,248 issued on June 10, 1958, wherein a knife equipped disk **96** is mounted for high speed rotation by a supporting shaft **97**; the disk being at a right angle to the direction of discharge of crushed stems from between the crushing rollers. The crushed bamboo stocks or stems are received from between the upper and lower banks of rollers of the crusher **12** through a sidewall opening **98** of the chipper housing for engagement by the chipping disk knives and the chipped material passes through disk openings and is discharged from the housing under the propelling action of the revolving disk and the blower effect induced by the rotation of the chipper disk.

The incoming stocks or stems as advanced by the conveyor belt **14** enter between the vertically spaced ends of the two roller units and as they move into the throat as defined between the opposite side plates and conveying banks of rollers they will be compressed and crushed, and thereby split into longitudinal strips. These strips will be forcibly advanced from between the roller units, and if the condition of the stocks is such as to require a relieving of crushing purpose, this will be automatically effected by the yielding connection afforded by the air cylinder **30**.

The laterally spaced opposite side walls **20—20** that establish the horizontal width of the throat or feed passage of the crusher have been shown, in FIG. 1, to be spaced a distance that is substantially equal to the width of feed belt **14**. However, at a point that is about half the distance to the discharge end, the throat is widened by outwardly offsetting opposite side portions of the sidewalls as has been indicated by the dash line showing of the parts **20'—20'** in that view.

It is further to be explained that the strips of bamboo as provided by the crushing action of the co-acting rolls enter the chipper horizontally and are cut into chips by cuts that are straight across and at right angles to the grain of the strips.

It is also to be understood by the showing of parts in FIGS. 3 and 4, that the roller mounted on the cross-shaft of the upper roller unit is not primarily designed for crushing of the bamboo strips or stock but rather is employed as a feeding and holding assembly whereby the short final end portions of the infeeding stocks, will be retained for uniform cutting by the chipper blades. This roller operates to hold the short final end pieces against canting or slipping sideways on entering the chipper. This roller assembly is yieldingly urged against the advancing stocks by coiled springs **23***x* that are mounted in the side frame members **23—23** to bear downwardly against the shaft mounting bearings **25** to urge them against limiting stops, from which they are upwardly yieldable.

It is further to be understood, more particularly that the upper feed unit is self opening by means of the climbing of its toothed rollers on the bamboo strips as they are advanced. If this unit does not properly crush the advancing stocks, it will automatically rise against the resilient or yielding force supplied by air cylinder **30**.

What I claim as new is:

1. A machine for crushing and feeding bamboo stocks to a chipper which is immediately adjacent thereto; said machine comprising a supporting frame, laterally spaced opposite side plates secured in fixed position on said supporting frame and defining a throat between them having a receiving end for incoming stocks and having a discharge end for discharging them into the chipper; said discharge end of the throat being of greater width than the receiving end, a horizontal lower bank of evenly spaced crushing and feeding rollers rotatably mounted in parallel relationship and extending between said opposite side plates, a rigid mounting frame comprising two laterally spaced arms disposed, respectively, outwardly from said laterally spaced side plates, an upper bank of crushing and feeding rollers extended in parallel and evenly spaced relationship between said arms; said rigid mounting frame being pivotably mounted at the receiving end of the throat and supporting that end the upper bank of rollers above and substantially spaced from said lower bank and inclined toward the discharge end of the lower bank and terminating adjacent the chipper thereby providing a uniformly converging space between said upper and lower banks of rollers extending from the receiving end to the discharge end of said throat; each of said rollers of the upper and lower banks of rollers having a succession of laterally spaced relatively narrow annular bands of teeth formed thereon, with the bands of adjacent rollers staggered and alternately overlapped to substantially fill the entire space between the rollers of the bank, said upper bank of rollers extending at its discharge end beyond the lower bank at least the diameter of one roller, driving means connecting all rollers of the upper bank for causing them to rotate in unison clockwise, driving means connecting all rollers of the lower bank for causing them to rotate in unison anti-clockwise and a power means for driving both banks of rollers in unison, to coact in the advancement of material between them for crushing and discharge from the throat.

2. A machine for crushing and feeding bamboo stocks to a chipper which is immediately adjacent thereto, said machine comprising a supporting frame, laterally spaced opposite side plates secured in fixed position on said supporting frame and defining a throat between them having a receiving end for incoming stocks and having a discharge end for discharging into the chipper; said discharge end of the throat being of greater width than the receiving end, a horizontal lower bank of evenly spaced crushing and feeding rollers rotatably mounted in parallel relationship and extending between said opposite side plates, a rigid mounting frame comprising two laterally spaced arms disposed, respectively, outwardly from said laterally spaced side plates, an upper bank of crushing and feeding rollers extended horizontally in parallel and evenly spaced relationship between and supported by said arms; said rigid mounting frame being pivotably mounted at the receiving end of the throat and supporting that end of the upper bank of rollers above and substantially spaced from said lower bank and inclined toward the discharge end of the lower bank and terminating adjacent the chipper, thereby providing a uniformly converging passage between said upper and lower banks of rollers extending from the receiving end to the discharge end of said throat; each of said rollers of the upper and lower banks of rollers having a succession of laterally spaced relatively narrow annular bands of teeth formed thereon, with the bands on adjacent rollers staggered and alternately overlapped with those of the adjacent rollers to substantially fill all spaces between the rollers of each bank, said upper bank of rollers extending at its discharge end beyond the lower bank at least the diameter of one roller, sprocket wheels mounted on the ends of said rollers outwardly of said side plates, sprocket chains interconnecting said sprocket wheels for driving rollers of each bank in unison, a power means and a sprocket chain interconnecting said power means and said rollers whereby said banks of rollers will be driven in opposite directions, a plurality of arcuate slots in said side plates at the discharge end of said throat opening to the top edges thereof, for passing rollers of the upper bank therethrough for movement incident to the pivotal swinging movement of said mounting frame and means exerting yieldable downward pressure on the free end of said mounting frame.

3. A machine according to claim 2 wherein said means

for exerting yieldable pressure on said mounting frame comprises an air cylinder equipped with a piston that is yieldingly restrained against movement therein by air confined under an adjustable pressure within the cylinder, a rod extending from said piston and cylinder and operatively connected to the mounting frame.

4. A machine as in claim 1 wherein the teeth of the annular bands as applied to rollers of the lower and upper banks are shaped like the teeth of a one way ratchet wheel with their radial surfaces faced to apply forwardly moving force against the material compressed between the banks.

5. A machine as in claim 1 wherein roller of the upper bank closest to the chipper is yieldably mounted.

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