Oct. 10, 1944. H. E. KORUM 2,359,995

ROUGHAGE AND HAMMER MILL

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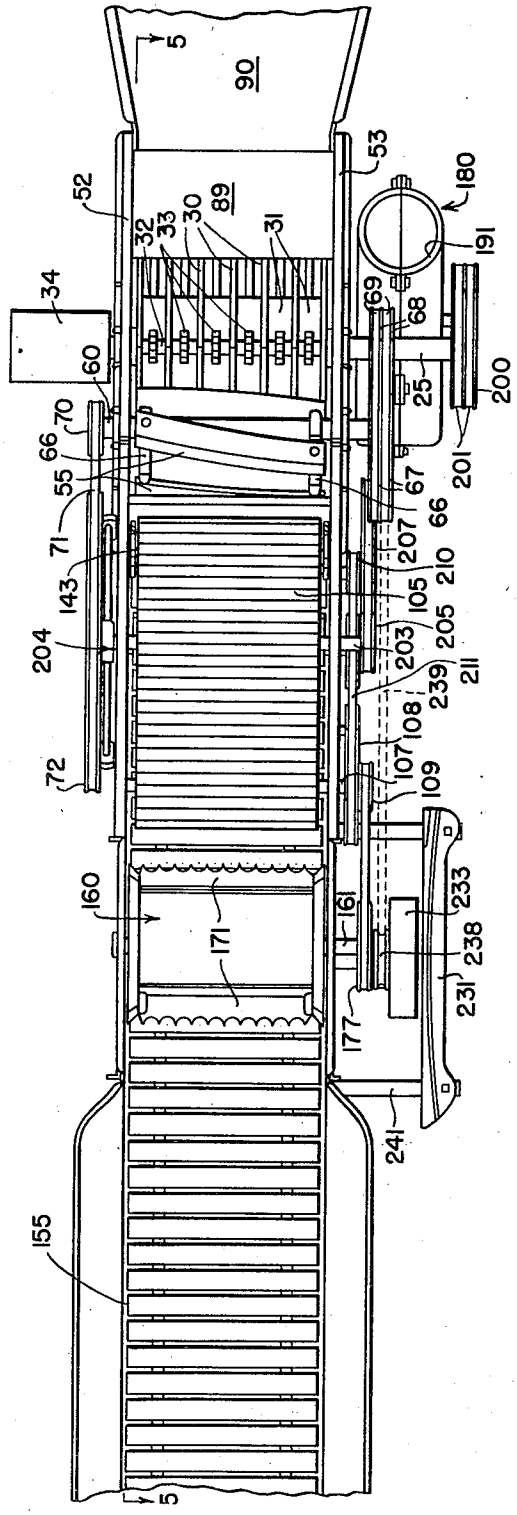


FIG. 1

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ROUGHAGE AND HAMMER MILL

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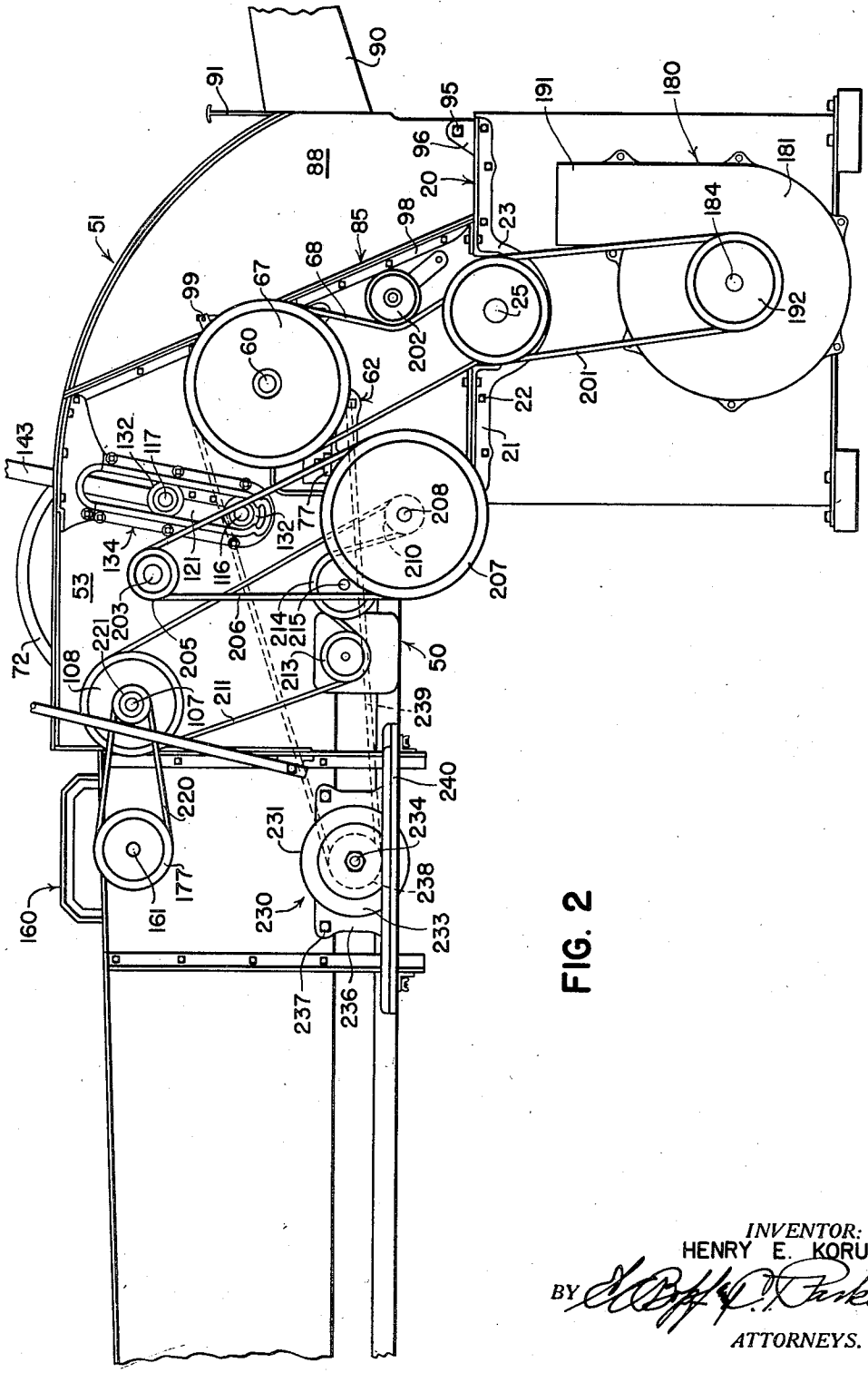


FIG. 2

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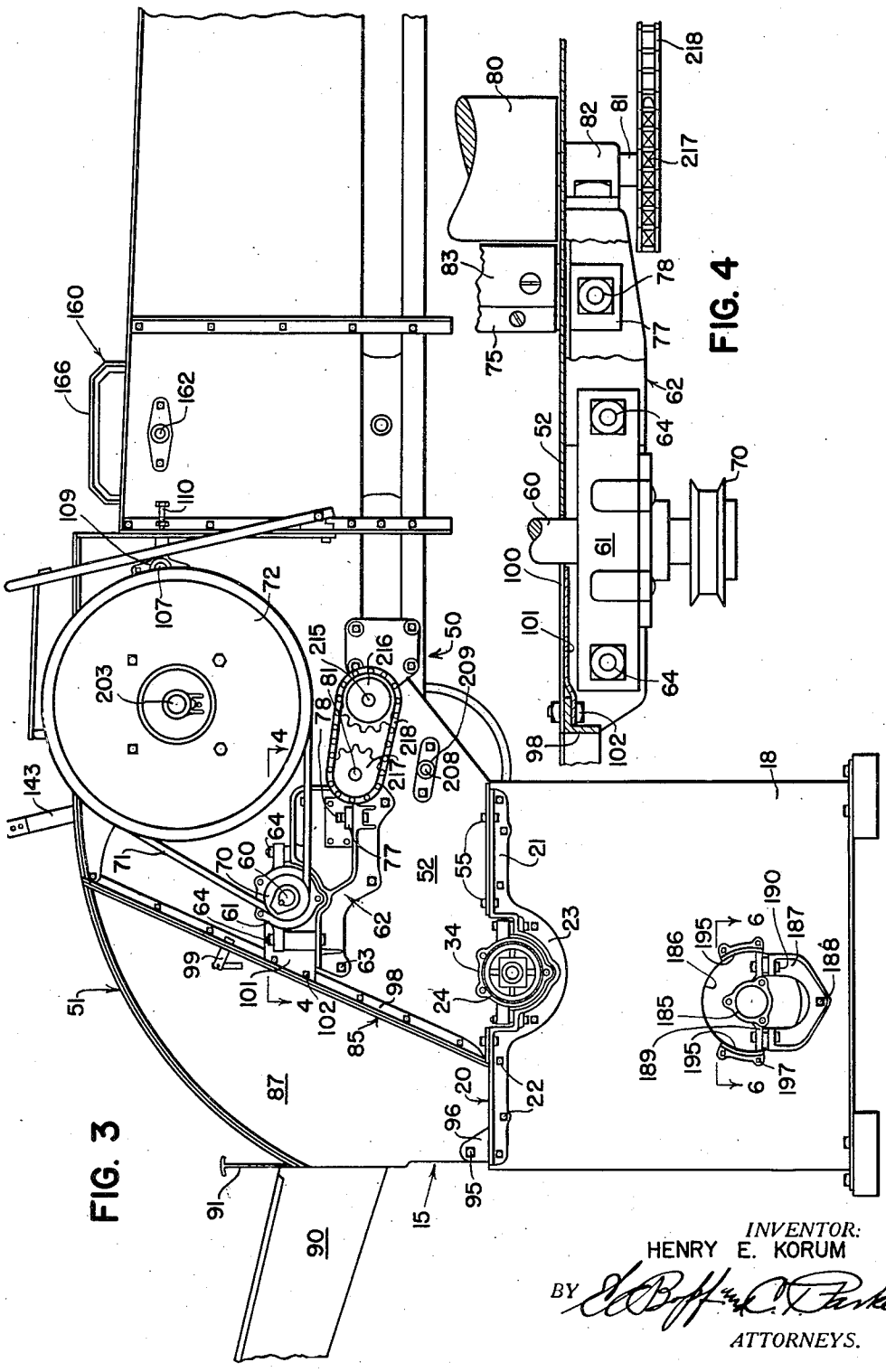


FIG. 3

FIG. 4

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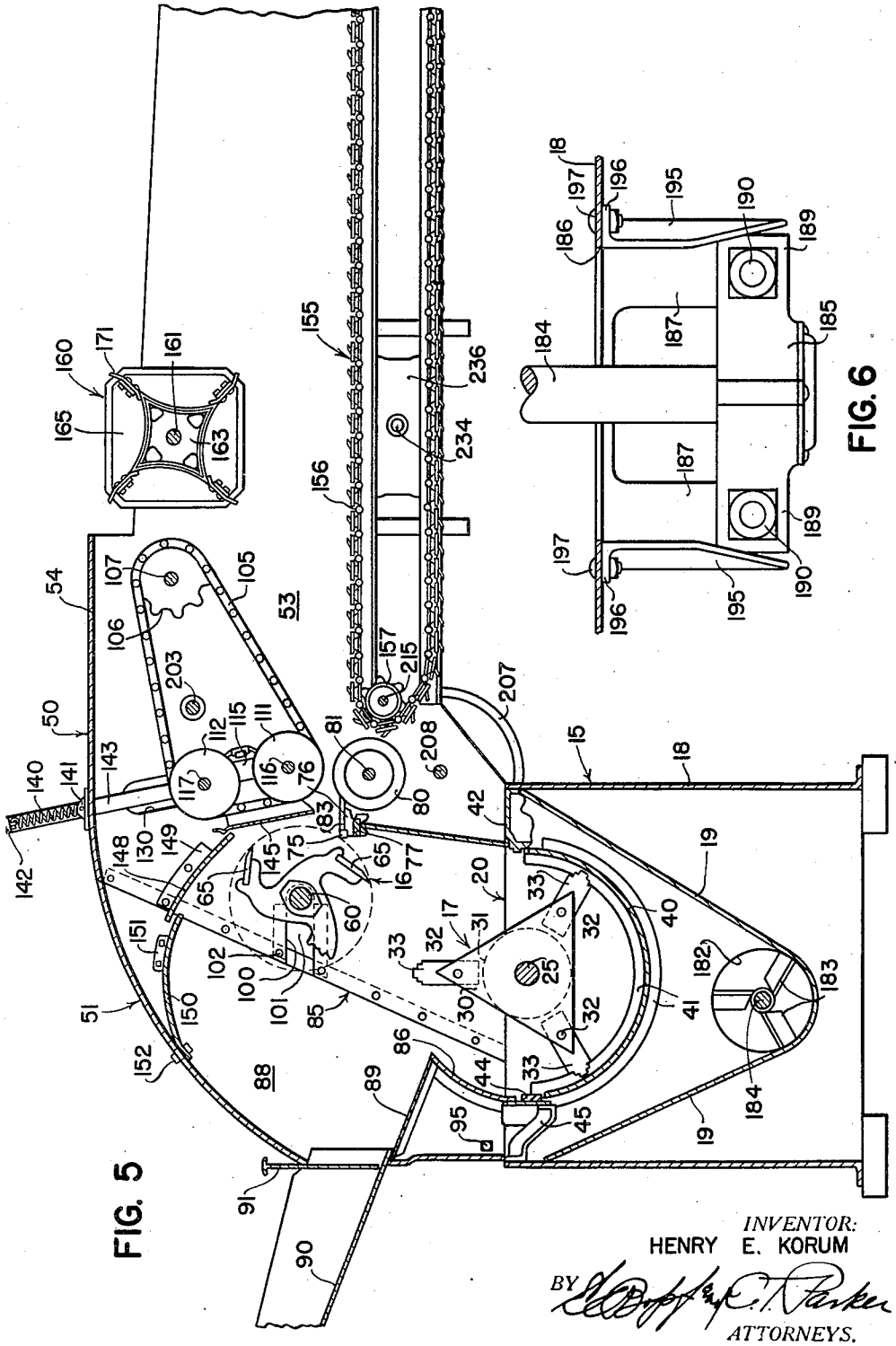


FIG. 5

FIG. 6

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ROUGHAGE AND HAMMER MILL

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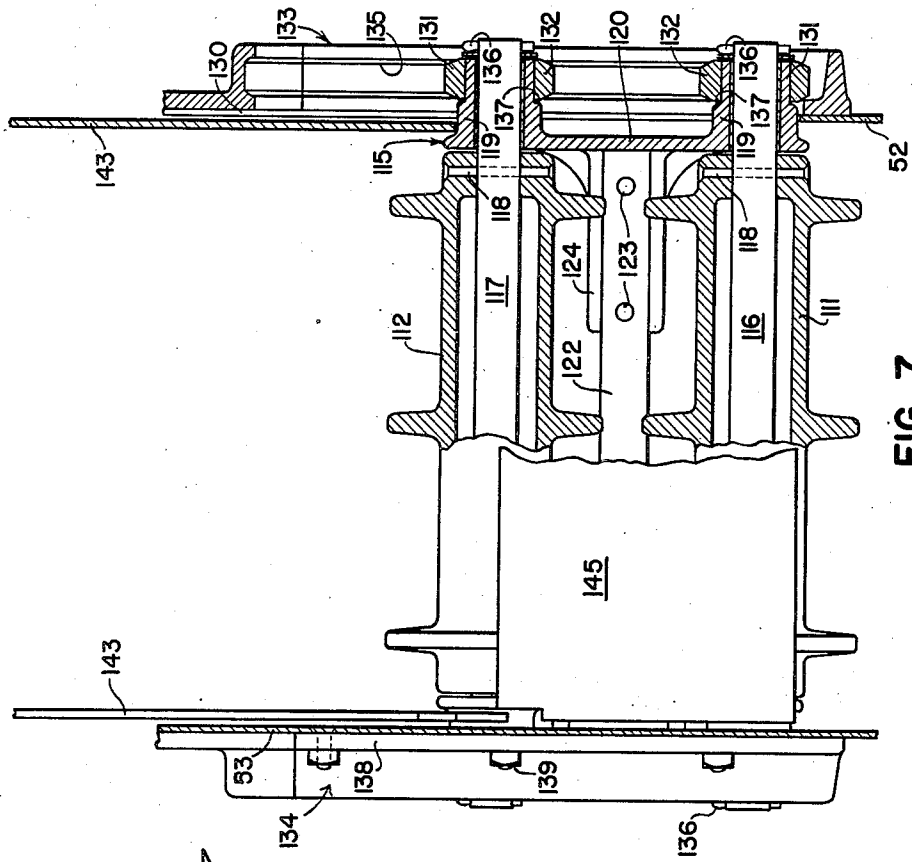


FIG. 7

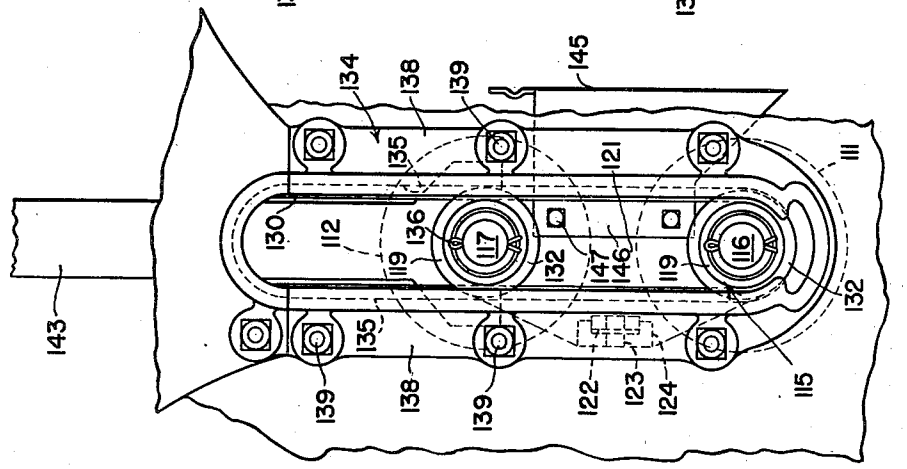


FIG. 8

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ROUGHAGE AND HAMMER MILL

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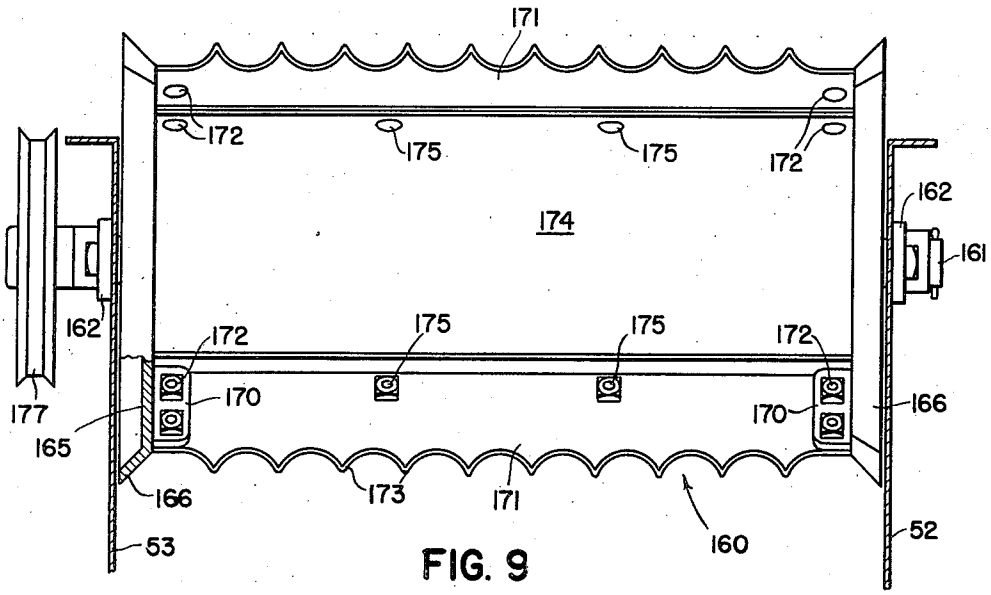


FIG. 9

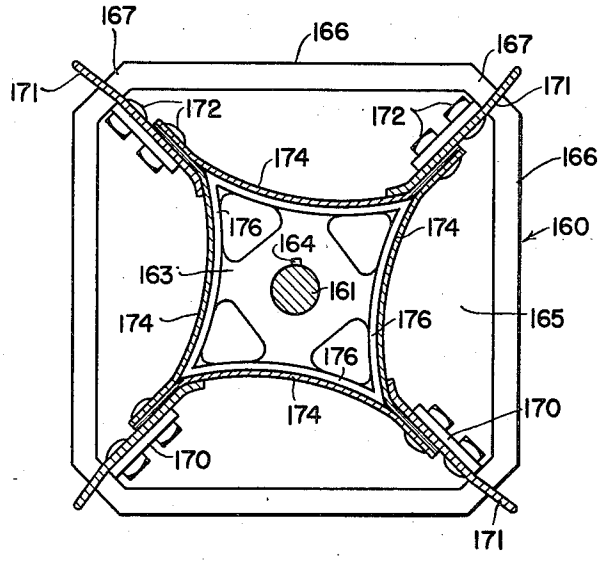


FIG. 10

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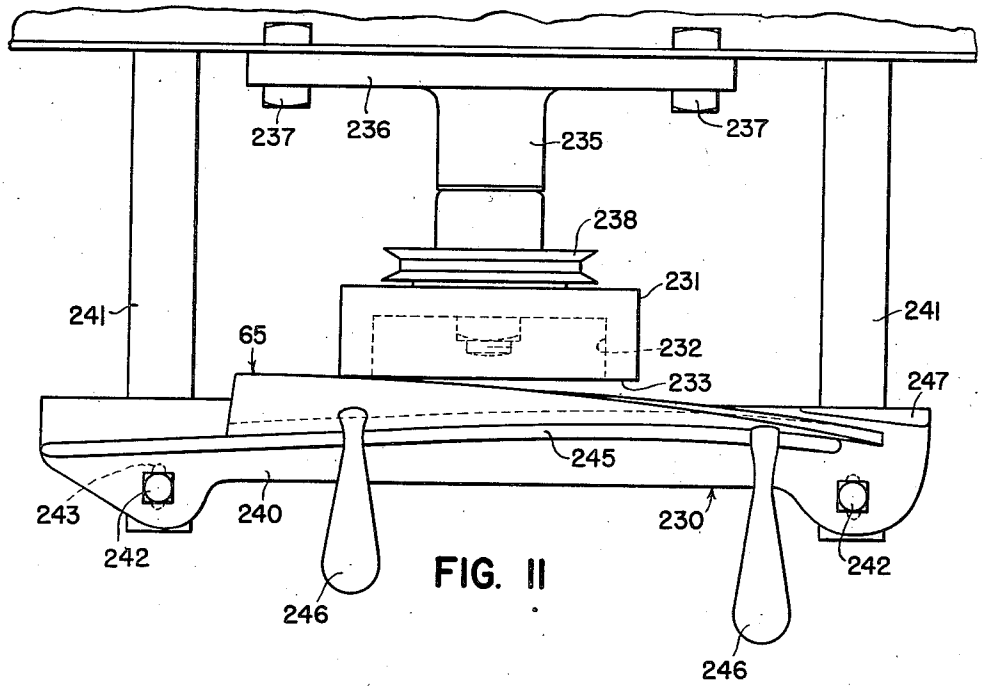


FIG. 11

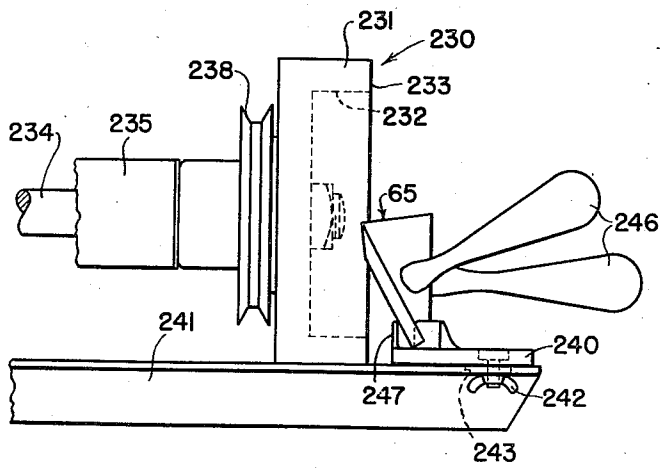


FIG. 12

INVENTOR:
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BY Dodge & Parker

ATTORNEYS.

Patented Oct. 10, 1944

2,359,995

UNITED STATES PATENT OFFICE

2,359,995

ROUGHAGE AND HAMMER MILL

Henry E. Korum, East Moline, Ill., assignor to Deere & Company, Moline, Ill., a corporation of Illinois

Application January 2, 1941, Serial No. 372,724

6 Claims. (Cl. 146—79)

The present invention relates generally to crop comminuting machines and more particularly to a combination roughage and hammer mill which is provided with both a cutter head and a hammer mill rotor, with provision for feeding crop material either to the cutter head or to the hammer mill rotor. The principal object of this invention relates to the provision of a mill of this class of improved design, which is stronger, more durable, more efficient, and is easy to maintain and repair whenever necessary.

A further object of this invention relates more specifically to the provision of a housing for a machine of the class described, which is separable along a line of division which provides for maximum accessibility of all the working parts for the purpose of adjustments and of replacement of the parts which receive the most wear.

Another object of this invention has to do specifically with an improved means for mounting the cutter head in the housing, providing for quickly installing and removing the cutter head with a minimum disturbance of the other parts of the machine.

Still another object of the present invention relates to the provision of a feeding means for introducing the crop material to be chopped in the rotary cutter head, with additional provision for feeding crop material directly to the hammer mill rotor. A further object has to do with the provision of directional vanes or louvers in the air intake to the housing of the machine for controlling the direction of the air flow into and through the housing.

A still further object relates to the provision of a novel and improved feed mechanism in the form of a floating compression web for feeding material to the cutter head. More specifically, it is an object of the present invention to provide a floating roller device for the compression belt, in which the friction is reduced to provide for reduced power losses in the belt and also to maintain a more even pressure of the feed rolls upon the material being fed to the cutter head.

Still a further object of the present invention relates to the provision of a new and improved hay roll or feeder for packing hay under the compression web, and in which the tendency for hay to wrap or cling to the hay roll is appreciably reduced.

Another object of the present invention relates to the provision of a knife grinder built into the roughage and hammer mill, having a novel guide for facilitating the grinding of the helical blades of the cutter head.

These and other objects and advantages of the present invention will be made apparent by a consideration of the following description in which reference is had to the drawings appended hereto, in which

Figure 1 is a plan view of a roughage and hammer mill embodying the principles of the present invention, shown with the detachable housing section removed and also with the top wall of the main housing section removed;

Figure 2 is a side elevational view of one side of the mill;

Figure 3 is a side elevational view of the other side of the mill;

Figure 4 is a detailed plan view drawn to an enlarged scale of the casting which supports the bearing for one end of the cutter head and other parts of the comminuting mechanism;

Figure 5 is a sectional elevational view taken along a line 5—5 in Figure 1;

Figure 6 is a fragmentary plan view drawn to an enlarged scale, showing the air intake opening and fan bearing, as indicated by a line 6—6 in Figure 3;

Figure 7 is an elevational view drawn to an enlarged scale and shown partially in section, of the double roller carriage for the compression feed belt and the track mounting therefor;

Figure 8 is an end elevational view of the carriage and mounting shown in Figure 7;

Figure 9 is a side elevational view of the hay roll;

Figure 10 is an end elevational view of the same;

Figure 11 is a plan view, drawn to an enlarged scale, of the knife grinder and guide therefor; and

Figure 12 is a side elevational view of the knife grinder, showing the position of a knife being ground thereby.

Referring now to the drawings and more particularly to Figures 1 to 5, inclusive, the comminuting machine comprises generally a housing 15 in which are enclosed a rotary chopping member in the form of a cutter head 16 and a rotary grinding member in the form of a hammer mill rotor 17, as best seen in Figure 5.

The housing 15 includes a lower upright box portion 18 including four vertical walls within which is a hopper 19 having inclined walls. The upper edges of the walls 18 terminate in a substantially horizontal plane 20 and are braced along opposite longitudinal sides thereof by

means of a pair of structural frame members 21, fixed to the side walls of the housing by bolts or rivets 22 and having a downwardly curved central portion 23 serving as supporting cradles for the bearings 24 at opposite ends of the shaft 25 of the hammer mill rotor 17.

The rotor 17 comprises a plurality of triangular plates 30 supported on the rotor shaft 25, which extends through aligned central openings in the plates 30, and between the plates 30 are disposed a plurality of spacing rings 31, best shown in Figure 1. The corners of the equilateral triangular plates 30 are disposed in alignment and are interconnected each by a rod 32. Each of the rods 32 extends through aligned openings in the corners of the triangular plates 30 and supports a number of stepped hammers 33, all of the inner ends of which terminate adjacent the outer circumferences of the rings 31 and permit a limited amount of swinging movement about the axes of the rods 32. For further details of construction of the hammer mill rotor 17, reference is hereby made to my co-pending application, Serial No. 355,977, filed September 9, 1940.

The hammer mill rotor 17 is driven through a suitable belt pulley 34 fixed on the end of the rotor shaft 25 which is extended outside of one of the walls of the housing 18 for this purpose, as best shown in Figures 1 and 3.

Beneath the rotor 17 is disposed an arcuate screen 40 through which the crop material passes after it is ground by the hammers 33 and falls to the hopper 19 in the housing 18. The screen 40 is supported between a pair of arcuate guides 41 fixed to the longitudinal housing walls at opposite edges of the arcuate screen 40. One end of the screen abuts against a casting member 42 which is fixed to the lower housing section 18 and serves not only as a stop for the screen 40 but also to close the upper end of the housing portion 18 between the screen and the end wall thereof. The opposite end of the screen 40 is held by means of a transversely disposed breaker bar 44 which is supported by suitable brackets 45 on the walls of the lower housing section 18.

Above the lower housing section 18 are disposed a pair of detachable cooperative upper housing sections 50, 51. One of the upper housing sections 50 supports the cutter head 16 and the majority of the mechanism for feeding crop material to the comminuting rotors, as will be later described. This housing section 50 comprises a pair of longitudinally extending vertical side walls 52, 53 and a top wall 54. The lower edges of the side walls 52, 53 terminate in a generally horizontal plane and are adapted to register with the upper edges of the walls of the lower section 18, to form a unitary housing 15. The upper section 50 is connected to the lower section 18 by means of bolts 55 which interconnect a pair of flanges on the side walls 52, 53 and the frame members 21, respectively.

The cutter head 16 comprises a supporting shaft 60 journaled at opposite ends thereof, respectively, in a pair of bearings 61, which are fixed to a pair of supporting brackets 62 which are fixedly supported on the opposite side walls 52, 53, respectively, by means of bolts 63. The bearings 61 are rigidly bolted to the bracket 62 by means of bolts 64. The chopping rotor 16 comprises a plurality (three, in the illustration shown and described herein) of helical knives or cutting blades 65 of the lawn mower type, which are supported on a pair of laterally spaced spiders 66 fixed to the shaft 60 at opposite ends thereof, respectively, within the housing section 50.

One end of the cutter head shaft 60 extends through the wall 53 of the housing and supports a driving pulley 67 driven by a pair of V-belts 68 which are trained around a driving pulley 69 on the hammer mill shaft 25 which is extended beyond the housing wall on the side opposite the driving pulley 34. The other end of the cutter head shaft 60 extends through the housing wall 52 and carries a driving pulley 70 connected by a suitable belt 71 to a large diameter pulley 72 which is used for driving the various parts of the feeding mechanism in a manner which will be described more fully at a later time.

The cutter head 16 cooperates with a shear bar 75 which is carried on a transversely extending bed plate 76 having extensions 77 at opposite ends thereof and which extend outwardly through the sides 52, 53 of the upper housing section 50. The bed plate extensions 77 serve to support the bed plate on the side brackets 62. The bed plate 76 is fixed to each of the brackets 62 by means of a bolt 78. Behind the bed plate 76 is disposed a feed roller 80 supported on a shaft 81 which is journaled at opposite ends thereof in bearings 82 disposed outside the side walls 52, 53 of the housing section 50. Each of the bearings 82 is mounted on the unitary bracket member 62. Between the roller 80 and the shear bar 75 is a stripper plate 83 which has one edge disposed closely adjacent the surface of the feed roller 80 for the purpose of stripping crop material therefrom and preventing it from wrapping thereon. The plate 83 also serves as a feed table over which the material is fed to the chopping action of the knives 65 against the shear bar 75.

It is now evident that the purpose of the side bracket members 62 is to support the cutter head, shear bar, stripper plate, and feed roller in a rigidly fixed position relative to each other, inasmuch as these elements cannot move out of adjustment with respect to each other without seriously impairing the operation of the mill. By thus mounting the various aforesaid members on a unitary bracket, it is possible to construct the remainder of the housing section 50 of a lighter material such as sheet metal.

It will be noted that the cutter head 16 is disposed above the hammer mill rotor 17 and is rotatable about an axis substantially parallel to the axis of the hammer mill rotor and offset slightly to one side of the latter. As crop material is chopped by the knives 65 and shear bar 75, it falls into the hammer mill rotor by means of which it is further reduced until it is in a condition to pass through the screen 40. In order to gain access to the cutter head 16 and the hammer mill rotor 17, the upper housing sections 50, 51 are divided along a plane indicated by reference numeral 85. This plane of division is generally vertical but is inclined slightly toward the cutter head rotor and thus passes closely adjacent to each of the rotors to provide easy access thereto. It is to be noted that the plane of division passes through the paths of rotation of both the cutter head and the hammer mill rotor, so that when the cover section 51 of the housing is detached, the knives 65 and hammers 33 pass outside of the housing section 50 when they are rotated and thus permitting the knives and hammers to be adjusted and sharpened, if desired, without removing them from the housing. The plane of division 85 intersects the horizontal plane of division 20 within the diameter of the path of

rotation of the hammer mill rotor, so that when the detachable housing section 51 is removed, the breaker bar 44 and the end of the screen 40 are also exposed for easy access thereto, and thus providing for quickly and easily changing the screen to obtain a finer or coarser grind. The breaker bar 44 rests upon the end of the screen 40 to hold the latter in place, and is in turn retained by means of a curved baffle 86 which is rigidly fixed to the side walls 87, 88 of the housing section 51, respectively, and extends therebetween. The upper end of the baffle 86 connects with the lower end of an inclined feed table 89 within the housing 51, and which also extends between the two side walls 87, 88 and forms a continuation of a feed chute 90, which is provided for the purpose of feeding certain kinds of small grain by hand to the hammer mill rotor when it is not desired to first chop them in the cutter head 16. It is possible to obtain a mixture of roughage and grain by feeding roughage to the cutter head and at the same time feeding grain through the grain chute 90, whereby both the grain and roughage enter the hammer mill together and are mixed by the action of the hammer mill rotor. When the grain chute 90 is not in use, it can be blocked off by means of a closure plate 91 which is slidable vertically against the end of the housing 51.

To facilitate dismounting the detachable housing section 51, the latter is pivotally supported on a transverse axis at the end of the housing by means of a pair of axially aligned bolts 95 which are supported in a pair of upstanding ears 96 at the end of each of the frame members 21. The housing member 51 is provided with a suitable flange along the plane of division 85, which abuts a flanged supporting frame member 98, which is fixed along the edge of the housing section 50 at the plane of division 85. The housing sections 50, 51 are secured together by means of a pair of suitable fasteners 99 which secure the flange of the cover portion 51 to the flanged frame member 98, and is quickly detachable to provide for swinging the cover portion 51 outwardly about the pivot bolts 95.

One of the features of the present invention relates to the means by which the cutter head can be quickly and easily removed from the housing. As best indicated in Figure 5, each of the side walls 52, 53 of the upper housing section 50 is provided with a generally horizontal slot 100 extending inwardly from the edge of the wall at the plane of division 85. This slot is wide enough to accommodate the shaft 60 of the cutter head 16. The outer ends of the slots 100 are closed by means of the frame members 98 and the slots are sealed to prevent leakage of comminuted crop material, by means of detachable plates 101 which lie over the slots and overlap the same, as best indicated in Figure 5. The plates 101 are secured by bolts 102 to the frame members 98, as shown in Figures 3 and 4. The cutter head can easily be removed from the housing by detaching the frame members 98 from the edge of the housing walls 52, 53 and then removing the plates 101 from the slots 100, after which the cutter head can be slid outwardly through the slots.

Cooperative with the feed roll 80 is a compression web 105, which comprises a flexible endless belt made up of a plurality of transversely disposed steel slats attached to a suitable connecting chain. The compression web 105 is trained around a driving roll or pulley 106, mounted on a supporting shaft 107 within the housing section 50. The shaft 107 is supported in bearings suitably mounted in the side walls 52, 53 of the housing and extends out of the housing in one direction to support a driving pulley 108 through which the web is driven. The bearings 109 of the shaft 107 are provided with suitable adjusting means 110 for the purpose of adjusting the tension in the compression web 105 by shifting the bearings 109 and hence the pulley 106 horizontally on the walls 52, 53. The compression web is trained over a pair of generally vertically spaced rolls 111, 112 and thus defining a substantially triangular path of travel for the compression web or feeder belt 105. Thus, the feeder belt is adapted to travel downwardly on an incline from the driving pulley 106 to the lower roll 111 which is normally directly above the feeder roll 80 and serves to compress the crop material and feed the latter to the cutter head over the stripper plate 83 and shear bar 75. The feeder belt makes an abrupt bend over the roll 111 and travels generally vertically away from the feed roll 80 from which it returns to the driving pulley 106 over the upper roll 112.

In order to accommodate a variable amount of crop material fed to the cutter head, the rolls 111, 112 are mounted on a carriage, indicated generally by reference numeral 115 and shown in detail in Figures 7 and 8. The carriage 115 is mounted in the housing 50 by means which will be described presently, adapted to permit the carriage to rise and fall to exert a substantially constant pressure against the material being fed to the cutter head.

Each of the rolls 111, 112 is fixedly mounted on a shaft 116, 117, respectively, and pinned thereto by a pin 118 which extends through suitably aligned apertures in the rolls and shafts. The ends of the shafts 116, 117 are journaled in hubs 119, the two hubs at each end being supported in an end frame 120, 121, respectively. The two end frames 120, 121 are interconnected rigidly by means of a transverse frame member 122, which is securely fastened by bolts or rivets 123 to a pair of bosses 124 extending inwardly from the end frames 120, 121, respectively. Thus it is evident that the carriage 115 rigidly supports the rotatable rolls 111, 112 and by preventing twisting of one roll relative to the other, insures that the latter rotate freely in their bearings.

The carriage 115 is disposed within the housing section 50 with the two hub members 119 at each side of the carriage extending out through a generally vertical slot 130. Each of the hubs 119 has a cylindrical outer surface 131 on which is journaled a supporting wheel 132. The wheels 132 engage a pair of track members 133, 134 disposed on opposite sides of the housing section 50. Each of the track members 133, 134 comprises a pair of oppositely disposed channel-shaped tracks 135 adapted to engage the opposite sides of each of the wheels 132, guiding the latter for vertical rolling movement but preventing lateral axial movement of the wheels, and thus preventing the carriage from moving axially within the housing 50. The tracks 135 on each of the track members 133, 134 are spaced apart a distance slightly greater than the diameter of the wheels 132, so that the latter may freely roll on either track, depending upon the direction of pressure of the carriage upon the wheel.

The portions 131 of the hubs 119 on which the wheels 132 are journaled are reduced in diameter to provide shoulders 137 against which the wheels bear to resist the end thrust of the

frame. The hubs 119 are secured on the shafts 116, 117 by cotter pins 136 inserted through apertures in the ends of the shafts outside of the hubs 119.

The tracks 135 are formed integral with supporting flanges 138 which are secured by bolts 139 to the side walls 52, 53, respectively.

The web 105 is urged downwardly against the crop material not only by the weight of the carriage 115 but also by pressure exerted by springs 140, which are connected between a boss 141 on top of the housing section 50 and a transverse bar 142 which is supported at opposite ends upon a pair of generally vertically disposed bars 143 extending downwardly through apertures in the top 54 of the housing 50 and which are bifurcated at their lower ends to fit over the upper hubs 119 to transmit the pressure of the springs 140 upon the latter.

In order to prevent the crop material from being thrown by the cutter head into engagement with the vertical portion of the feeder belt 105, a baffle 145 extends transversely between the cutter head and the vertical portion of the belt. The baffle 145 comprises a plate, the ends 146 of which are bent toward the carriage 115 and are rigidly fixed thereto by bolts 147. A stationary baffle 148 is flanged at 149 at opposite ends thereof, and is supported within the housing section 50 with its lower end substantially in contact with the baffle 145. Another stationary baffle 150 is supported by flanges 151 on opposite side walls 87, 88 of the housing section 51 and extends from the upper end of the stationary baffle 148 to the top wall of the housing portion 51 to which it is fixed by bolt means 152. It is obvious that as the carriage rises in the slot 130 the movable baffle 145 maintains a position close to the stationary baffle 148 to prevent material from being thrown therebetween. By making the carriage travel in a straight line instead of on an arc about the axis of the pulley 106, it is possible to position the roller 111 at a minimum distance from the shear bar 75 and thus to maintain control of the material being fed to the cutter head. Obviously, if the carriage moved on an arc about the pulley shaft 107, the baffle 145 would have to be curved instead of straight, which would require the lower feed roller 111 to be moved farther away from the cutter head and the shear bar.

A traveling feed table 155 is provided for feeding crop material to the feed roll 80, and comprises an endless conveyor belt 156 trained over a roller 157 adjacent the feed roll 80, and another feed roll (not shown) at the outer end of the conveyor. The sides 52, 53 are extended along the sides of the conveyor 155.

When hay is fed to the machine to be chopped and ground, it is desirable to compress it and feed it under the compression web 105. This is accomplished by means of a hay roll 160 of novel design, shown in detail in Figures 9 and 10. The hay roll 160 comprises a shaft 161 journaled in a pair of bearings 162 mounted on the side walls 52, 53 of the housing 50, respectively, on which are mounted a pair of laterally spaced spiders 163 fixed to the shaft 161 by suitable keys 164. Preferably formed integrally with each of the spiders 163 is an end plate 165 having a plurality of straight sides 166, preferably four, as shown in the drawings, the edges of the sides 166 being turned outwardly to form obtuse angles with the side plates 165. Each of the corners 167 is beveled off to avoid having any sharp corners on the end plates which might catch the hay. On the inner face of each of the side plates 165 is formed a plurality of radially extending lugs 170 disposed in diagonal alignment adjacent the corners of the plates and preferably formed integral therewith. Fixed to each of the lugs 170 is a laterally extending blade 171, supported at its opposite ends by bolts 172 extending through suitable apertures in the blades 171 and lugs 170. The outer edges of the blades 171 are scalloped, as indicated at 173, to provide a plurality of hay engaging points which act to urge the hay toward the cutter head as the hay roll revolves. The inner edges of the blades 171 terminate at an appreciable distance from the shaft 161, however, and the spaces between each pair of adjacent blades 171 is occupied by a concave filler plate 174. The filler plates 174 are also supported on the bolts 172 and are also bolted together and to the blades 171 intermediate the plates by means of bolts 175, extending through aligned holes in the plates 174 and blades 171, respectively. Each end of each of the concave plates 174 is braced by a raised rib 176 on the inner surface of the spider 163, to prevent the plates from bending inwardly under pressure of the hay during operation. The purpose of the end plates 165, in addition to serving as supports for the blades 171, is to prevent hay from wrapping on the shaft 161 at each end of the hay roll. The plates are made square rather than circular to provide a slightly aggressive action against the hay to prevent the latter from bridging over the edges 166 of the plates. Thus it is evident that a hay roll of this design is very effective in preventing any hay from catching upon the shaft or sides of the roll and the concave plates 174 enclosing the shaft, prevent the hay from packing into the center of the member. The hay roll is driven by means of a pulley 177 fixed to the shaft 161 outside of the housing wall 53.

The ground crop material is drawn from the bottom housing section 18 by means of a fan 180 comprising a circular housing 181 fixed to the side wall 18 and having an intake opening in register with an aperture 182 in the side wall 18, as best indicated in Figure 5. Within the fan housing 181 is a three-bladed impeller or rotor 183 mounted on a shaft 184 which is journaled at one end in the housing 181. The shaft 184 extends through the opening 182 and across the housing 15 to a journal bearing 185, mounted outside the opposite wall of the housing substantially in the center of a circular intake opening 186. The bearing 185 is supported on a bracket 187, the latter being U-shaped in form and fixed to the housing wall 18 by bolt means 188. The bearing 185 is provided with laterally outwardly extending ears 189 which are secured by bolts 190 to the upper ends of the U-shaped bracket 187. The fan has a tangentially disposed exhaust duct 191 which is directed upwardly and can be attached to any suitable discharge pipe for the purpose of blowing the comminuted crop material either into a silo or into a suitable centrifugal separator for the purpose of placing the material into sacks, as well known to those skilled in the art.

The fan is driven by means of a pulley 192 fixed to the shaft 184 outside of the fan housing 181, and draws air through the intake opening 186 across the housing, in which the air sweeps the crop material into the fan.

I have found by experiment that the action of the air in sweeping material across the bottom of the trough formed by the downwardly con-

verging bottom walls 19, is greatly improved by providing a pair of vanes 195 disposed on opposite sides of the air intake opening 186, as best indicated in Figure 6. The vanes are slightly curved to conform with the edge of the opening 186 and extend outwardly from the wall 18 substantially perpendicular thereto. The vanes are provided with supporting flanges 196 which are fixed to the walls 18 by bolts 197. The vanes tend to prevent the formation of eddy currents in the flow of air and thus avoid "dead spots" and reduces the possibility of the material clogging in the fan intake opening 182.

The means for driving the various elements of the comminuting machine will now be described. The mill is driven by a power transmitting belt (not shown) engaging the main pulley 34 on the shaft 25 of the hammer mill rotor. The fan rotor shaft 184 is driven from a sheave 200 fixed to the opposite end of the hammer mill rotor shaft 25 and connected to the fan pulley 192 by a pair of belts 201. A second pair of belts 68 engages the sheave 69 on the shaft 25 spaced inwardly from the sheave 200, and drives the sheave 67 on the shaft 60 of the cutter head 16. The belts 68 are maintained tight by a suitable belt tightener 202. At the opposite end of the cutter head shaft 60 is the pulley 70 which drives the large sheave 72 through the belt 71. The sheave 72 is disengageably connected to a shaft 203 by means of a governor mechanism, indicated generally by reference numeral 204 and which need not be described in detail here inasmuch as it does not constitute any essential part of the present invention. The governor shaft 203 extends transversely through the housing section 53 within the compression web 195 and projects out of the opposite wall 53. The driving pulley 205 is mounted on the end of the shaft 203 and is connected by a suitable belt or chain 206 to a comparatively large diameter pulley 207 mounted on a shaft 208 which extends transversely of the housing portion 50 and is supported in a bearing 209 at the opposite side thereof. A comparatively small pulley 210 is mounted on the shaft 208 adjacent the large pulley 207 and drives the various elements of the crop feeding mechanism through a belt 211, which is trained over a pulley 198 mounted on the shaft 197 of the drive pulley 196 through which the compressor web or feeder belt 105 is driven. The belt 211 passes under an idler pulley and over a drive pulley 214 for driving the travelling feed table 156 in the opposite direction of rotation to that of the hammer mill rotor shaft 25. The pulley 214 is mounted on the outer end of the shaft 215 which supports the drive pulley 157 for the feed table 156. A sprocket 216 on the opposite end of the shaft 215 drives a sprocket 217 on the shaft 81 of the feed roll 80, through a chain 218. Thus, every rotating member rotates in a clockwise direction as viewed in Figure 5, with the exception of the travelling feed table 156 and the feed roll 80 which turn clockwise. The pulley 177 for driving the hay roll 160 is driven by means of a belt 220 trained over a pulley 221 which is disposed on the shaft 107 adjacent the drive pulley 108.

During operation, the roughage crops are placed on the travelling feed table 156 which delivers them to the feeder belt 105 and the feed roll 89 between which they are compressed and fed to the shear bar 75. The cutter head 16 chops the crops into short lengths, from which they drop to the hammer mill rotor 17 which further reduces the size of the pieces until they can pass through the mesh of the screen 40. Small grain may be fed at the same time if desired, through the gate 91 over the table 89. The comminuted material falls to the bottom of the trough 19 and is drawn therefrom by the fan 180 and delivered to the silo or to the separator. The carriage 115 of the compressor web rises and falls to maintain a pressure on the crops being fed into the cutter head. The governor 204 functions to disconnect the large diameter sheave 72 from the governor shaft 203 in the event of a decrease in speed of the hammer mill rotor shaft as occurs when the power plant driving the mill is overloaded. This action of the governor prevents any more material being fed to the cutter head or hammer mill until the latter clear themselves. It frequently occurs that the crop material is placed on the feed table unevenly, resulting in bunches of excessive size of material entering the cutter head and overloading the same, making it desirable to interrupt the flow of crop material until the cutter head has a chance to dispose of the slug. Also, when the machine is being started or stopped, the governor serves to prevent the material from being fed into the cutter head before the latter has come up to speed or after it has begun to decelerate.

Referring now more particularly to Figures 11 and 12, I have provided a knife grinder built into the frame of the mill and forming a permanent part of the roughage and hammer mill, for the purpose of sharpening the helical knives 65 of the cutter head 16. The knife grinder, indicated generally by reference numeral 230, comprises a cylindrical emery wheel 231, the central outer portion of which is recessed at 232 to provide an annular cutting edge 233 on the outer face thereof. The wheel 231 is supported on a shaft 234 which is carried in a journal bearing 235 having an integrally formed flange 236 which is bolted to the frame of the mill by bolts 237. A pulley 238 is fixed on the shaft 234 adjacent the wheel 231 and is adapted to receive a V-belt 239, indicated in dotted lines to show that the latter is not normally connected to the driving mechanism. When it is desired to use the knife grinder, one of the belts 68 is removed from the large diameter pulley 67 and the belt 239 is slipped over the latter in its place. A supporting table 240 is provided for the knife 65 and is disposed in front of the wheel 231 on a pair of frame members 241 which are attached to the frame of the mill and extend outwardly therefrom. The table 240 is attached to the frame members 241 by bolts 242 which extend through slots 243 in the frame members 241 to provide for adjustably shifting the table 240 toward and away from the wheel 231. The top of the table 240 is disposed in a horizontal plane and on the surface of the table is a raised guide ridge 245 which is curved to fit the back of the helical blade 65. The knives 65 are removed from the cutter head 16 and a pair of temporary handles 246 are provided for holding the knife with its back against the top of the table 240 in contact with the face of the guide 245, and the knife blade is tilted until the edge engages the grinding edge 233 of the stone 231. A short section of guiding ridge 247 is provided at one end of the table on the opposite side of the knife blade. The knife is ground by moving the frame laterally along the guide 245. Due to the fact that the knife blade is helical in form, the beveled edge is maintained at a uniform angle to the opposite side by holding the edge against the wheel and the back against the guide as the

knife is moved laterally in engagement with the wheel.

I claim:

1. A combination chopper and hammer mill comprising, in combination, a chopping rotor, a cooperative cutter bar disposed on one side thereof, means for feeding crops to said cutter bar, a hammer mill rotor disposed below said chopping rotor to receive chopped material therefrom and offset therefrom on the side opposite said cutter bar, a housing for supporting said feeding means, said cutter bar, and said rotors, said housing comprising a single enclosure formed by a pair of cooperative sections divided along an inclined plane passing adjacent both rotors opposite said cutter bar and feeding means, and means supported on the housing section opposite that section which supports said rotors and substantially coextensive with said chopping and hammer mill rotors, for feeding crops into said enclosure directly to said hammer mill rotor.

2. A combination chopper and hammer mill comprising, in combination, a chopping rotor, a cooperative cutter bar disposed on one side thereof, means for feeding crops to said cutter bar, a hammer mill rotor disposed below said chopping rotor for receiving and grinding chopped crops from said chopping rotor and rotatable about an axis generally parallel thereto, a housing comprising a single enclosure formed by a pair of cooperative detachable sections, one of said sections supporting said rotors, said cutter bar, and said feeding means, and means supported on the other housing section and substantially coextensive with said chopping and hammer mill rotors for feeding crops into said enclosure directly to said hammer mill rotor.

3. A combination chopper and hammer mill comprising, in combination, a chopping rotor, a cooperative cutter bar disposed on one side thereof, means for feeding crops to said cutter bar, a hammer mill rotor disposed below said chopping rotor for receiving and grinding chopped crops from said chopping rotor and rotatable about an axis generally parallel thereto, a curved screen disposed under said hammer mill rotor, a housing comprising a single enclosure formed by a pair of cooperative detachable sections divided along a plane passing through the paths of rotation of both of said rotors and above one end of said screen, and means supported on the housing section opposite to that which carries said rotors and substantially on a level with said chopping rotor, coextensive therewith, for feeding crops into said enclosure directly to said hammer mill rotor.

4. A combination chopper and hammer mill comprising, in combination, a chopping rotor, a cooperative cutter bar disposed on one side thereof, means for feeding crops to said cutter bar, a hammer mill rotor disposed below said chopping rotor for receiving and grinding chopped crops from said chopping rotor, a curved screen disposed under said hammer mill rotor, and a single compartment housing comprising a lower section for supporting said hammer mill rotor and said screen, a two-part upper portion divided from the lower section along a generally horizontal plane passing substantially through the axis of said hammer mill rotor, said upper portion comprising two parts, one of which carries said chopping rotor, cutter bar, and feeding means, the other part serving as a detachable cover and divided therefrom along an inclined plane passing adjacent said chopping rotor and intersecting said horizontal plane of division to provide easy access to said rotors and said screen, and a feed chute mounted on said cover part coextensive with and substantially on the same level as said chopping rotor for feeding crops into said compartment directly to said hammer mill rotor.

5. A device as set forth in claim 4, further characterized in that said housing has sheet metal walls and a pair of unitary brackets disposed on opposite sides, respectively, for rigidly supporting said chopping rotor, said cutter bar, and at least a portion of said feeding means, in fixed relation to each other.

6. A combination chopper and hammer mill comprising, in combination, a housing, a chopping rotor journaled therein, a cooperative cutter bar disposed on one side thereof, means for feeding crops to said cutter bar from one side of said housing, a hammer mill rotor disposed in said housing below said chopping rotor and offset therefrom toward the side opposite said cutter bar and adapted to receive chopped crops therefrom, said rotors being disposed for rotation about generally parallel axes, a feed table disposed on the opposite side of said housing substantially on the same level as said chopper feeding means and coextensive therewith, for feeding crops directly to said hammer mill rotor, and means for rotating said rotors in the same direction of rotation, said direction being such that the hammers on top of said hammer mill rotor travel away from said feed table and downwardly beneath said chopping rotor.

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