Dec. 2, 1941. G. E. GIBBS 2,264,305

METHOD AND APPARATUS FOR REINFORCING WEBS OF PAPER AND THE LIKE

Filed April 1, 1937 6 Sheets-Sheet 1

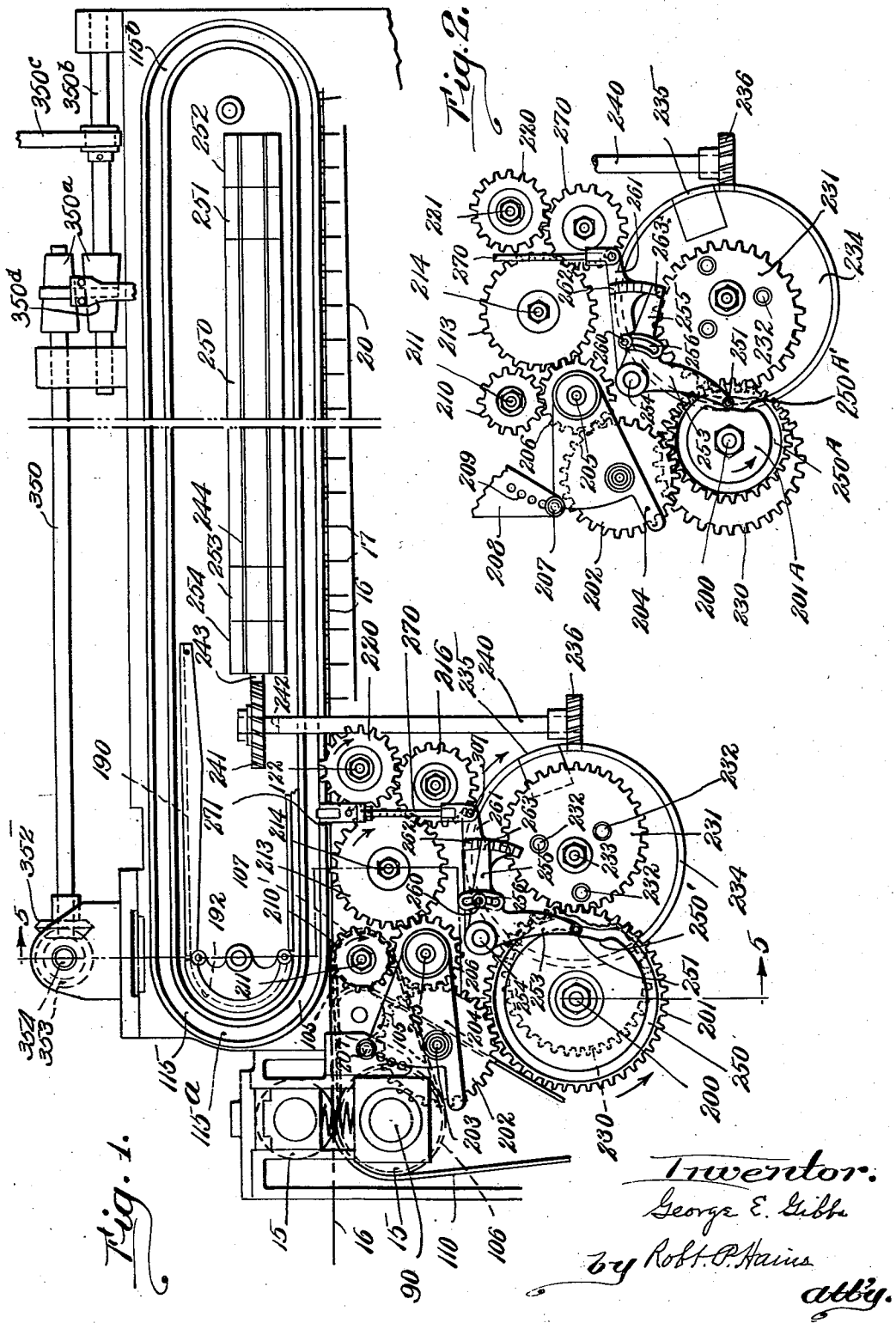


Fig. 1.

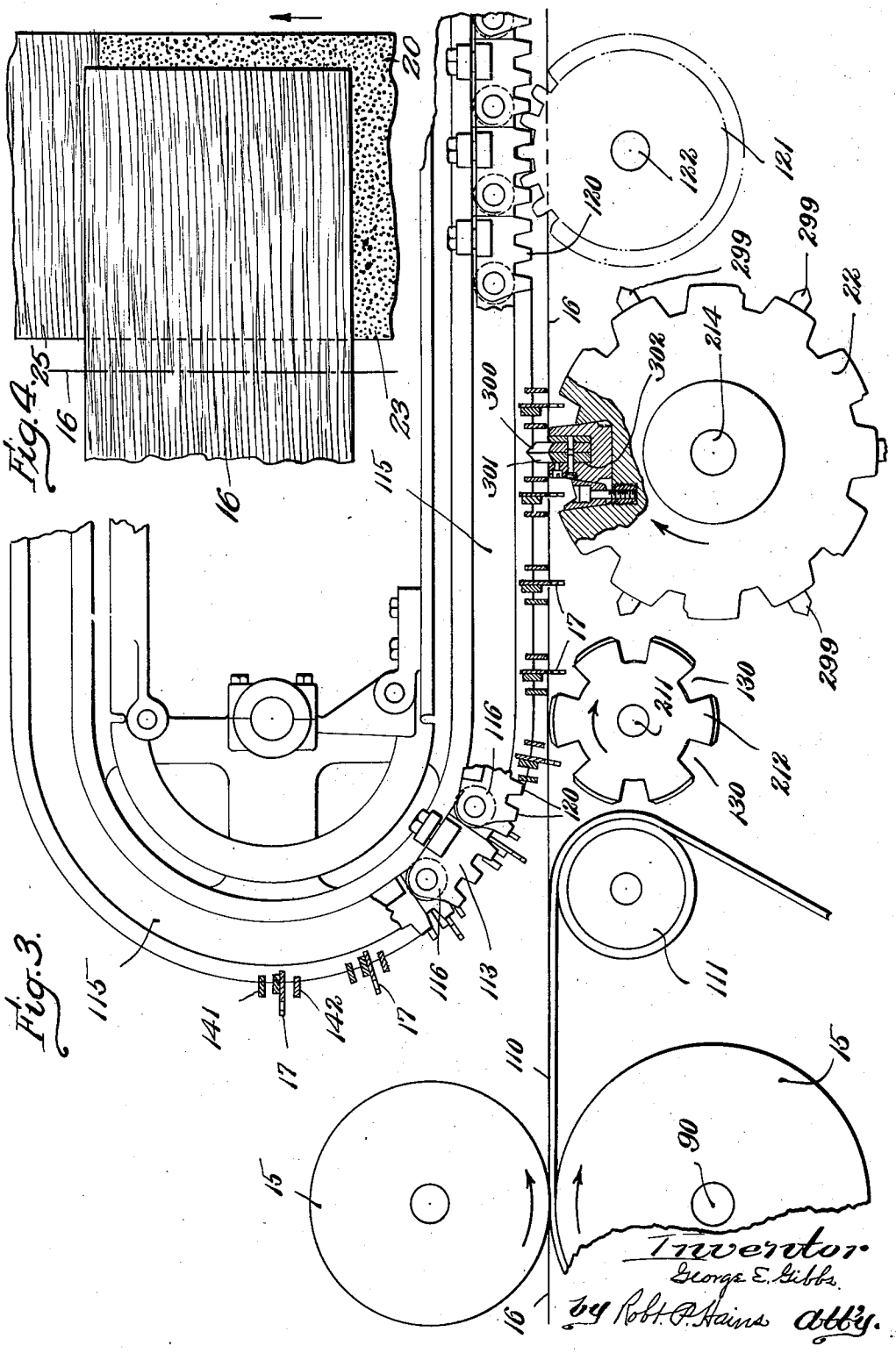
Fig. 2.

Inventor.
George E. Gibbs
by Robt. P. Hains
Atty.

Dec. 2, 1941. G. E. GIBBS 2,264,305

METHOD AND APPARATUS FOR REINFORCING WEBS OF PAPER AND THE LIKE

Filed April 1, 1937 6 Sheets-Sheet 2



Dec. 2, 1941. G. E. GIBBS 2,264,305

METHOD AND APPARATUS FOR REINFORCING WEBS OF PAPER AND THE LIKE

Filed April 1, 1937 6 Sheets-Sheet 3

Fig. 5.

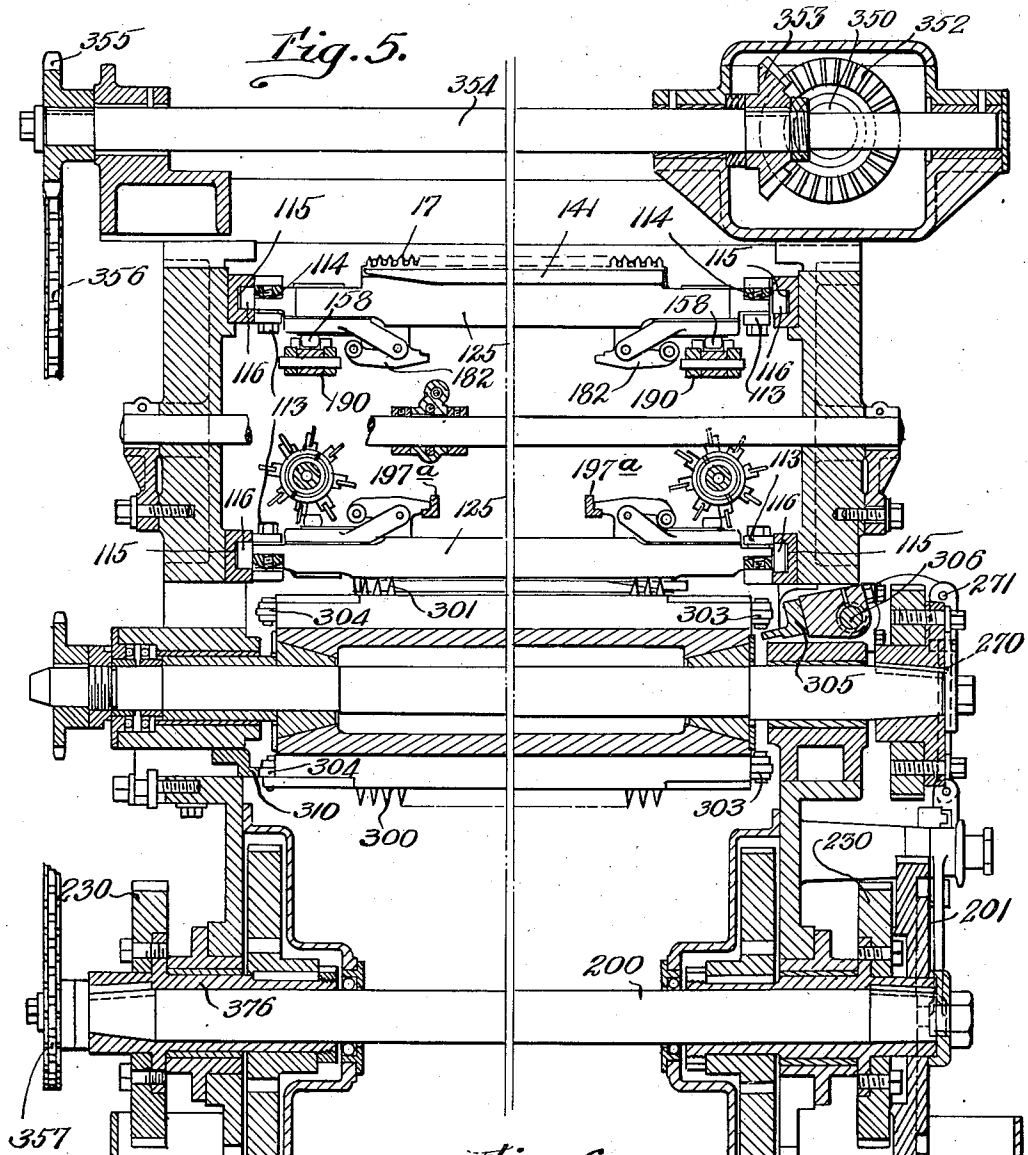


Fig. 6.

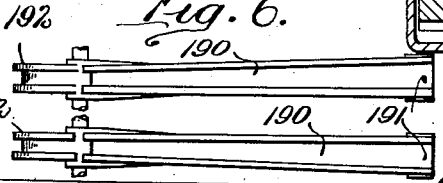


Fig. 7.

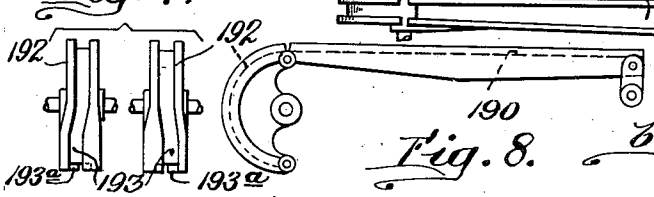


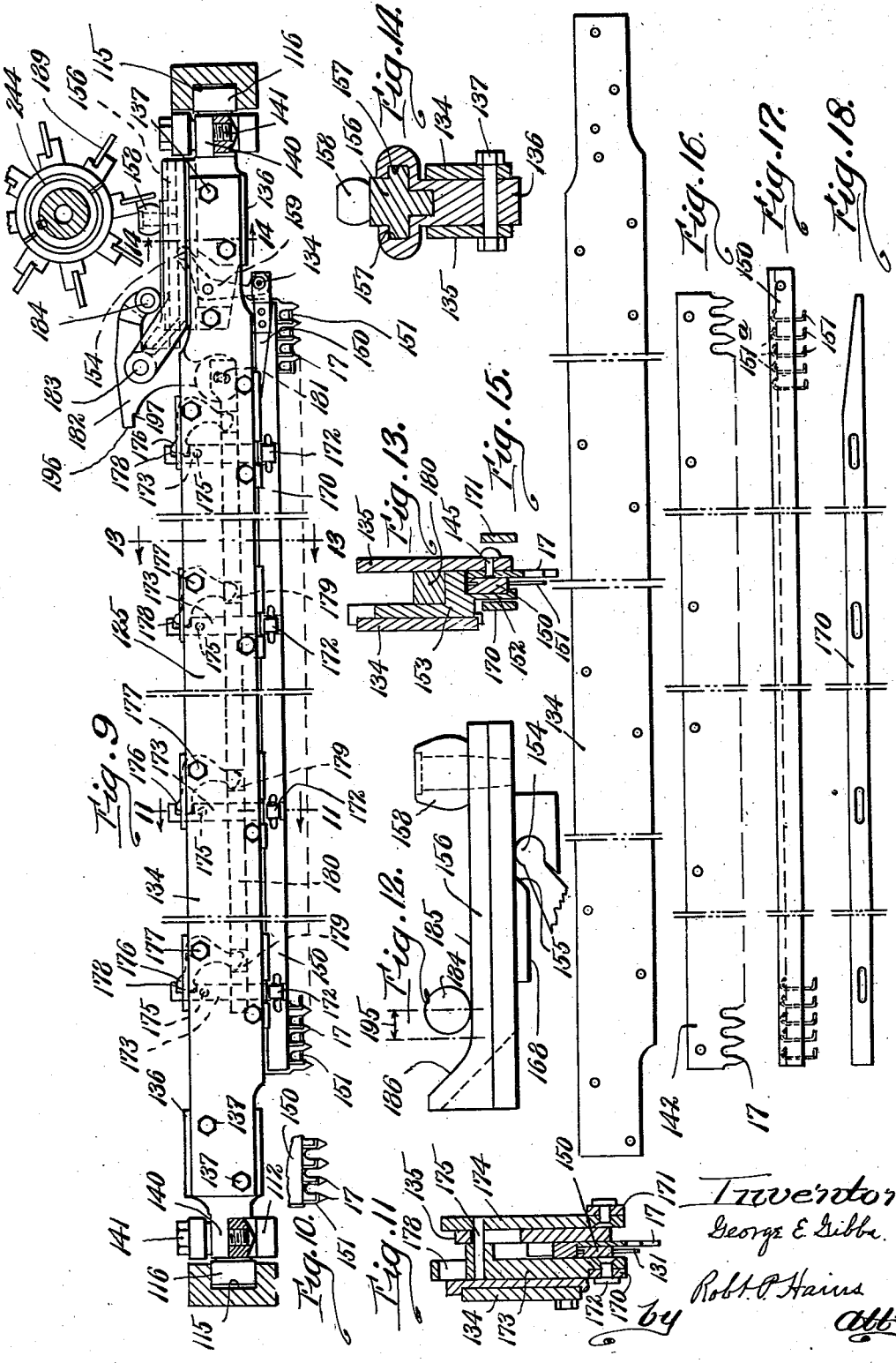
Fig. 8.

Inventor.
George E. Gibbs.
By Robt. P. Stairs
Atty.

Dec. 2, 1941. G. E. GIBBS 2,264,305

METHOD AND APPARATUS FOR REINFORCING WEBS OF PAPER AND THE LIKE

Filed April 1, 1937 6 Sheets-Sheet 4



Inventor.
George E. Gibbs.
Robt. P. Hains
by
Abby.

Dec. 2, 1941. G. E. GIBBS 2,264,305

METHOD AND APPARATUS FOR REINFORCING WEBS OF PAPER AND THE LIKE

Filed April 1, 1937 6 Sheets-Sheet 5

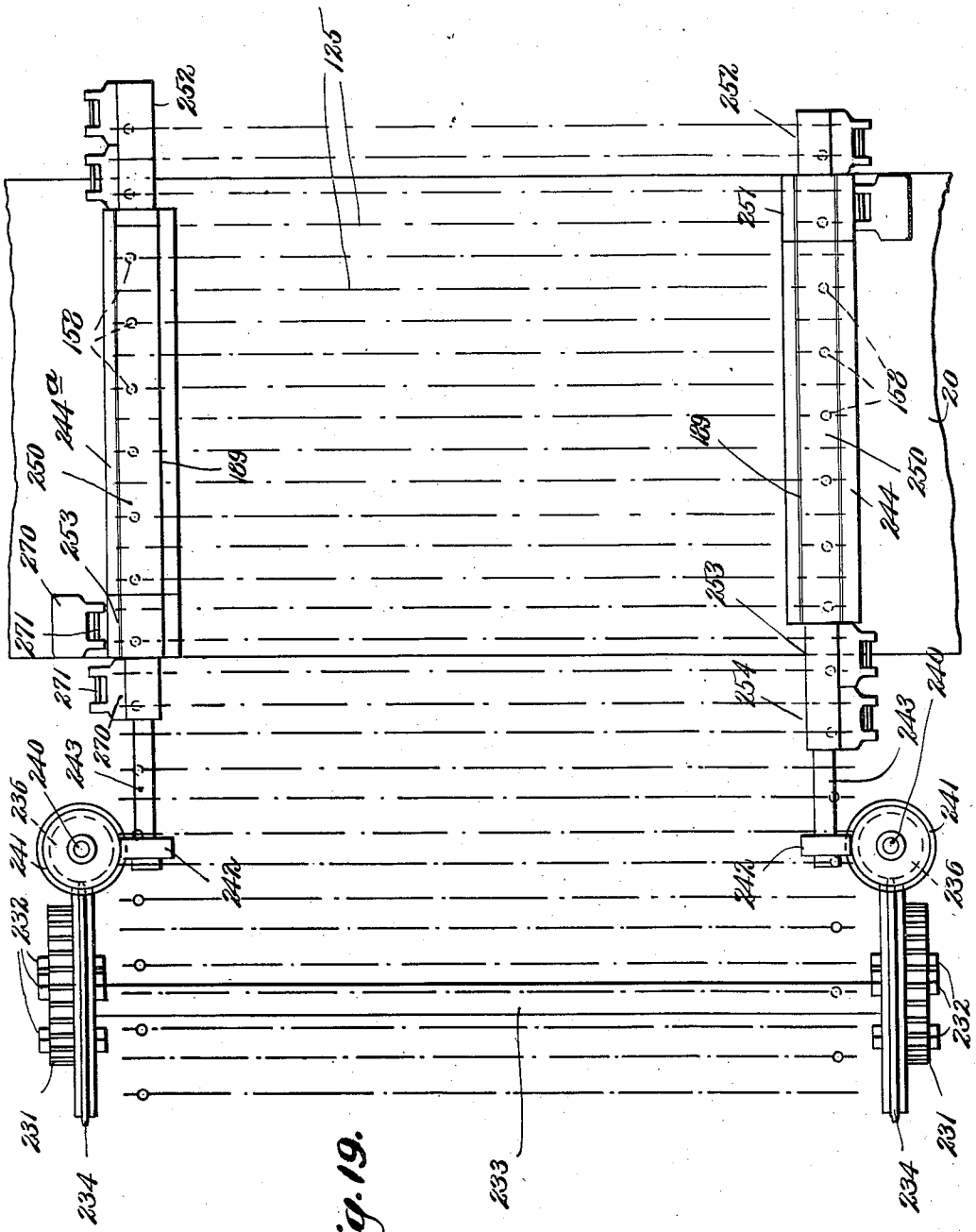


Fig. 19.

Inventor.
George E. Gibbs
by Robt. O. Haines
Atty.

Dec. 2, 1941. G. E. GIBBS 2,264,305

METHOD AND APPARATUS FOR REINFORCING WEBS OF PAPER AND THE LIKE

Filed April 1, 1937 6 Sheets-Sheet 6

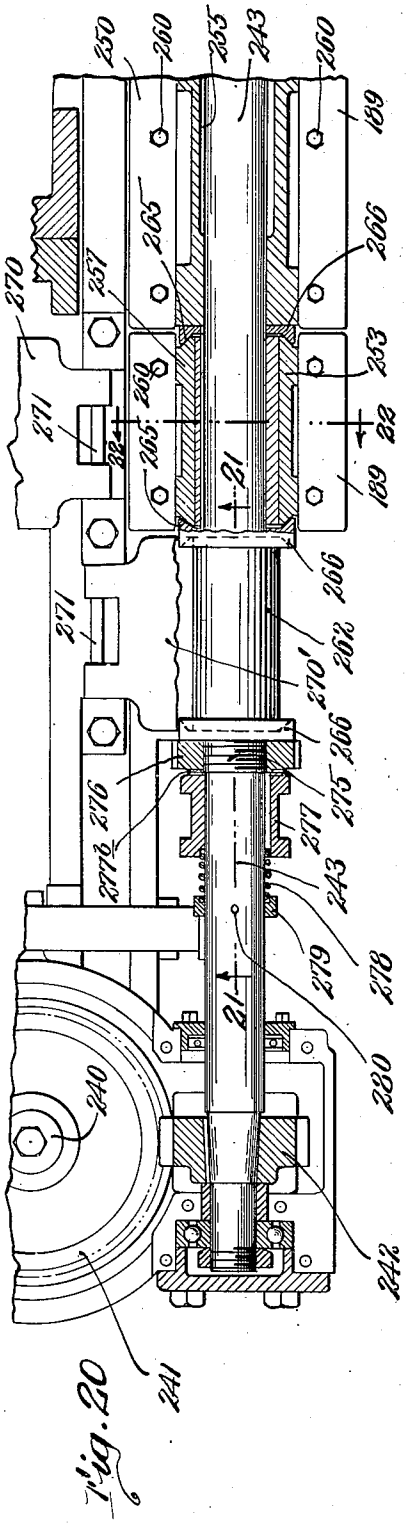


Fig. 20

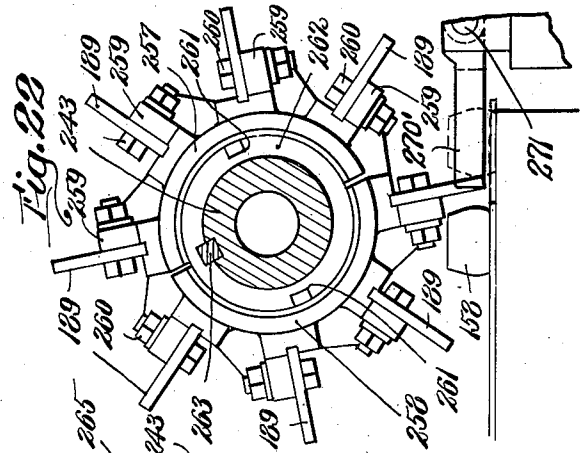


Fig. 22

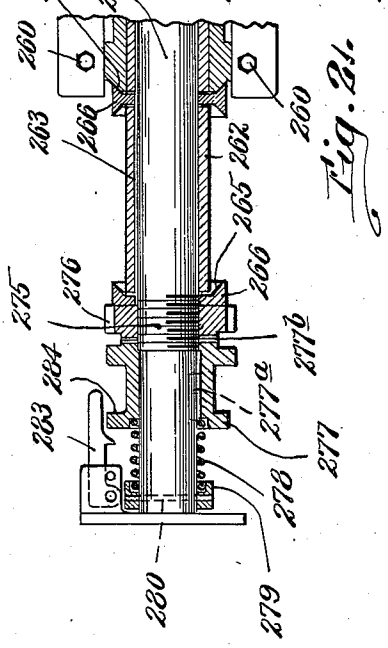


Fig. 21.

Inventor.
George E. Gibbs
by Robt. O. Haines Abby.

Patented Dec. 2, 1941 2,264,305

UNITED STATES PATENT OFFICE

2,264,305

METHOD AND APPARATUS FOR REINFORCING WEBS OF PAPER AND THE LIKE

George E. Gibbs, Attleboro, Mass., assignor to American Reenforced Paper Company, Attleboro, Mass., a corporation of Massachusetts

Application April 1, 1937, Serial No. 134,288

6 Claims. (Cl. 154—1)

This invention relates to methods and apparatus for reinforcing webs of paper and the like, and particularly to improvements in the machines and processes employed to deliver reinforcing fibres to the paper and deposit them transversely thereon.

It is customary, when providing a web of paper with transverse reinforcing fibres, to feed a continuously moving sheet of fibres transversely over a continuously moving web of paper. Lengths of fibre sheet equal to the width of the paper web are cut off and doffed onto the web at such intervals, relative to the speed of travel of the web, that the transverse fibres are deposited in a continuous layer lengthwise of the web. According to prior practices, such as are exemplified in my United States Patent No. 1,841,945 of January 19, 1932, when the width of the web to be reinforced is to be changed, the speed at which the fibre sheet is delivered over the web has been changed proportionally, to insure continuity, lengthwise of the paper web, of the deposited transverse fibres.

It is the primary object of the present invention to provide a process and apparatus for the purpose which not only have the capacity, as before, for reinforcing webs of different widths, but which, in so doing, permit a substantially constant and high rate of speed of the fibre sheet for all widths of web. To that end, I preferably vary, inversely with the width of the web, both the rate of feed of the paper web and the frequency of cutting the fibre sheet and doffing it to the paper. By thereby accommodating substantially constant large areas of paper web per unit of time, regardless of the width of the web, I effect a substantially constant rate of production of the machine and a substantially constant demand on the prior steps in the manufacture.

In its apparatus aspect, my invention provides improvements on prior apparatus of this general character, which particularly adapt it for the speed changes required in performing my novel method. Thus it is one of the primary purposes of the present invention to provide mechanism for doffing the severed fibres to the web which is operable at different frequencies to accommodate different widths of web while, at the same time, maintaining a substantially constant speed of the individual doffing actuations.

In the drawings:

Fig. 1 is a side elevation view showing a preferred embodiment of my invention;

Fig. 2 is a side elevation view of certain parts of Fig. 1 shown in different positions;

Fig. 3 is an enlarged side elevation view, partly in section, of the fibre receiving end of the apparatus;

Fig. 4 is a detail plan view indicating the manner of depositing the transverse fibres on the continuously moving web;

Fig. 5 is a sectional elevation view taken along the line 5—5 of Fig. 1;

Fig. 6 is a plan view of certain cam tracks to be described;

Fig. 7 is an end elevation view of the tracks as viewed from the left in Fig. 6;

Fig. 8 is a side elevation view of one of the cam tracks;

Fig. 9 is an elevation view of my novel fibre carrier bar;

Fig. 10 is a detail elevation view of the carrier bar showing the interdental spaces of the comb unlocked for release of the fibres;

Fig. 11 is a detail vertical section taken on the line 11—11 of Fig. 9;

Fig. 12 is a detail elevation view of the carrier slide bar;

Figs. 13 and 14 are detail vertical sections taken respectively on the lines 13—13 and 14—14 of Fig. 9;

Fig. 15 is a side elevation view of one of the side plates of the carrier bar;

Fig. 16 is a side elevation view of the comb bar;

Fig. 17 is a side elevation view of the locking bar;

Fig. 18 is a side elevation view of one of the doffing blades;

Fig. 19 is a plan view illustrating the operation of the doffing rolls;

Fig. 20 is a detail plan view, partly in section, of one end of one of the doffing rolls;

Fig. 21 is a detail vertical section on the line 21—21 of Fig. 20 and

Fig. 22 is a detail vertical section on the line 22—22 of Fig. 20.

In accordance with my invention a web 20 of paper or the like (Fig. 4), to which, preferably, a coating of asphalt or other adhesive 23 has been applied, passes through the machine in the direction indicated by the arrow to receive a sheet of fibres 16. As a length of web 20 equal to the width of the fibre sheet 16 is advanced beneath the fibre sheet, a length of fibre sheet 16 equal to the width of the web 20 is advanced across the web and doffed onto the web to provide a substantially continuous layer of transverse fibres lengthwise of the moving web. At 16a I have indicated the line along which the fibre sheet is

cut as it approaches the position from which it is doffed to the web.

The sheet of fibres 16, consisting of unspun sisal fibres or other desired reinforcement, after having been withdrawn from a supply and formed into a sheet of the desired thickness in a manner known in the art, is introduced to the machine from the left as viewed in Figs. 1 and 3 between upper and lower feed rolls 15, the lower of which is carried by a power driven shaft 90 and supports a delivery apron 110 which passes over roll 111 and a lower roll, not shown. The upper roll 15 is pressed in any suitable manner on the fibre supported by the apron to grip and to feed the fibre positively. The fibre delivered by the apron is grasped by a series of comb carriers 17 carried by a pair of endless chains or racks 113, one on each side of the machine (Fig. 5). Each link of both racks has a roller 116 that travels in a channel 115 on one side or the other of the machine and, as indicated in Fig. 1, the channels 115 have upper and lower runs connected by semi-circular end courses 115a and 115b to form a continuous path for the rack rollers 116. The racks 113 on both sides of the machine are provided with teeth 120 (Fig. 3) meshing with and propelled by gears 121 on opposite ends of shaft 122 to move the racks and combs 17 continuously to convey the fibre over the web 20 to be reinforced. The construction and operation of these parts may be in all respects identical with the corresponding parts described in my prior patent.

As in my prior patent, a roll 212 mounted on driven shaft 211, and provided with spaced, axially-extending grooves 130 is provided to aid the insertion of the fibre strands into the interdental spaces of the carrier combs 17. Knife mechanism in the form of a rotating cylinder 22 to be described, is also provided as before for severing lengths of the fibre sheet equal to the width of the web to be reinforced.

Referring now to Figs. 9 to 18 inclusive, I will describe the construction of my improved carrier bars advanced by the moving racks 113, and carrying the combs 17 which convey the fibre to the moving web for deposit thereon.

Each of the carrier bars 125 has a pair of side plates 134 and 135 (Figs. 11 and 13) each of which may be of the form shown in Fig. 15. The side plates are secured in spaced relation to each other by blocks 136 at both ends of the plates, to which, as indicated in Fig. 14, the plates are bolted by bolts 137. The blocks 136 have suitable lugs 140 through which pass bolts 141 securing the bars to the links of the carrier racks 113.

The comb 17, which is illustrated in detail in Fig. 16, consists of a plate 142 in the lower edge of which the comb teeth are formed as indicated. The comb is secured to the lower margin of the rear plate 135 by rivets 145 (Fig. 13) disposed at suitably spaced intervals along the comb plate and it will be noted that by this construction the comb teeth 17 project downwardly a substantial distance below the plates 134 and 135 forming the framework of the bar.

As described in my prior patent above noted, it is desirable to lock the fibres in the interdental spaces of the comb while the fibres are being conveyed into position over the web from which they are doffed onto the web. The construction of locking blade herein provided for the purpose differs from that disclosed in my prior patent and, as indicated in Fig. 17, it consists of a bar 150, depending from the lower margin of which is a large number of locking wires 151, bent to the shape indicated and spaced from each other at intervals conforming to the spacing of the comb teeth 17. The wires 151 may be secured in the locking bar 150 in any suitable manner such as by being passed through drilled holes therein and then bent over as indicated at 151a to seat in a recess in the top edge of the bar 150.

The locking bar 150, with wires 151, is mounted adjacent the comb 17 in such a way that it may be moved in the direction of its length from its locking position indicated in Fig. 9 to the position of Fig. 10 in which the interdental spaces of the comb are unlocked for ejection of the fibres. To that end, the bar 150 is carried in a channel 152 (Fig. 13) formed in a plate 153 secured between the frame plates 134 and 135 of the carrier bar. It will be noted that the locking wires 151 are disposed closely adjacent to the teeth of the comb 17. Longitudinal movement of the bar 150 for the purpose above stated is effected by attaching one end of the bar 150 to one end of a bell-crank 159 (Fig. 9), the other end of which bell-crank carries at its extremity, the ball 154 received in a cam recess 155 (Fig. 12) formed in a plate 168 mounted on the under surface of the slide 156. The slide 156 is mounted in a dovetailed groove 157 (Fig. 14) formed in the block 136 at that end of the carrier bar and it is moved in the direction of its length by certain mechanism to be described which is adapted to engage the roller 158 carried by the slide.

It is apparent from the foregoing that when the slide 156 is moved to the right, as viewed in Figs. 9 and 12, the ball 154 will ride out of the depression 155 and onto the flat portion 168 to rotate the bell-crank 159 in a clockwise direction, thereby shifting the locking bar 150 from its locking position of Fig. 9 to its unlocked position of Fig. 10.

When the combs 17 have carried the fibres into position over the web 20 and after those fibres have been severed from the fibre sheet in a manner to be described, it is desirable that they be doffed to the moving web as rapidly as possible. I have found that the apparatus provided in my prior patent for that purpose may be greatly improved by the provision of a pair of blades, one on each side of the comb, for effecting such doffing operation, rather than a single blade as was provided before. The blades which I provide for the purpose are indicated in Fig. 13 at 170 and 171, each of which blades may be of substantially the shape indicated for the blade 170 in Fig. 18. The front blade 170 is secured, as by bolts or rivets 172 (Fig. 9), to bars 173 disposed at spaced intervals along the blade 170, which bars 173 may be of substantially the shape indicated in Fig. 11 and are mounted between the front and back plates 134 and 135 for vertical sliding movement therebetween. For vertical movement of the front and rear doffing blades simultaneously, the rear blade is carried by a similar set of spaced bars 174 (Fig. 11) suitably supported on the outside of the plate 135 and spaced in alignment with the bars 173 carrying the front doffing blade. A pin 175 connects corresponding pairs of bars 173 and 174.

Vertical movement of the doffing blades is effected by bell-cranks 176 mounted on pivots 177 extending between the front and back plates 134 and 135 at intervals conforming to the spacing of the bars 173. Each of the bars 173 has a recess 178 adapted to receive the extremity of one

arm of the adjacent bell-crank, and the other arms of the bell-cranks are received in spaced slots 179 formed in a bar 180 extending lengthwise of the carrier bar as indicated. The bar 180 is slidably mounted between the plates 134 and 135 of the carrier bar (see Fig. 13), and is connected at one end 181 to a bell-crank 182 pivoted at 183 to an extension of the frame of the carrier bar and having a roller 184 adapted to ride on the upper surface 185 (Fig. 12) of the slide 156.

The arrangement is such that when the slide 156 is moved to the right as viewed in Figs. 9 and 12 (which movement, as above described, moves the locking bar 150 to the position of Fig. 10) the roller 184 will ride up on the ramp 186 formed at the end of the slide, thereby rotating the bell-crank 182 counter-clockwise and moving the bar 180 to the right. The resulting rotation of bell-cranks 176 will be effective to move both doffing blades 170 and 171 downwardly from the bases of the teeth 17 to eject the fibres therefrom.

To effect such sliding movement of the cam slide 156, the roller 158 carried thereby is engaged by one of the blades 189 of a doffing roll 244 which is periodically advanced in a counter-clockwise direction by mechanism now to be described.

As described in my prior patent, successive carrier bars 125 (indicated by dot-dash lines in Fig. 19) carry rollers 158 on alternate ends and for operating the rollers 158 on all bars disposed over the web 20, I provide two of the aforesaid doffing rolls, designated 244 and 244*a*, each of which is carried by a shaft 243 having a worm 242 meshing with a worm wheel 241 mounted on the upper end of a vertical shaft 240. Each of the shafts 240 carries at its lower extremity, as indicated in Fig. 1, a pinion 236 meshing with a single toothed gear 234. Both of the gears 234 are mounted on the shaft 233 which is driven continuously in a manner hereinafter to be described and, as the shaft rotates, the teeth 235 on both gears 234, mesh simultaneously with their pinions 236 to impart a slight rotation to both shafts 240. The doffing rolls 244 and 244*a* are thereby simultaneously advanced for actuation of the rollers 158 on both sides of the machine. This rotation; as above described, is effective first to shift to unlocked position the locking bar 150 on all carrier bars disposed over the web and thereafter simultaneously to move both doffing blades 170 and 171 on each of said bars downwardly to eject the fibres therefrom.

As the carrier bars 125 progress from their positions above the web, around the continuous tracks 115 and return to the position at which they again take fibres, it is necesary to retrieve the doffing blades 170 and 171 to elevated position. For that purpose I provide, as in my prior machine, cam grooves 190 (Figs. 1 and 5) adjacent the upper runs of the channels 115, adapted to receive the rollers 158 and move them and the slides 156 inwardly as viewed in Fig. 5. As these cam grooves 190 are the same as in my prior patent, they need not be described in detail herein, except to note that both grooves 190 have roller receiving mouths 191 (Fig. 6) and semi-circular end portions 192 disposed adjacent the semi-circular end portions 115*a* of the channels 115 (Fig. 1). As the cam grooves 190 approach said semi-circular end portions 192 they converge toward each other with the result that the rollers 158 will be moved to their extreme inward positions indicated in Fig. 9. The doffing blades 170 and 171 are thereby elevated as desired for reception of the fibres between the teeth of the combs 17. It will be noted, however, that as a result of this movement, the locking blade 150 on each bar 125 will have been shifted to the locking position of Fig. 9. The teeth must accordingly be unlocked before the comb can receive fibres and for that purpose the rollers 158 are now shifted outwardly, or to the right as viewed in Fig. 9, in an amount sufficient to cause the ball extremity 154 of bell-crank 159 to ride out of the cam slot 155, and onto the flat 168, but in an amount insufficient to cause the roller 184 on bell-crank 182 to ride up on the ramp surface 186 of slide 156. The lost motion interval 195 (Fig. 12) is provided for that purpose. Referring to Fig. 7, the semi-circular end portions 192 of the cam tracks are provided with diverging portions 193 to effect the desired slight outward movement of the rollers 158. To insure against the possibility of any rotation of the bell-cranks 182 during this retrieving movement of the locking blades, I provide each bell-crank with a nose 196 (Fig. 9) having a surface 197 that engages a flange 197*a* (Fig. 5) suitably mounted adjacent the semi-circular run 192 on the cam slot.

When the combs, now unlocked, have taken the fibres at the roll 212 (Fig. 3) the locking bars 150 are quickly shifted to locking position by the converging portions 193*a* (Fig. 7) of the cam tracks.

As in my prior patent above noted, the doffing rolls 244 and 244*a* are made sectional in length for accommodating different numbers of carrier bars conforming to different widths of web (Fig. 19). Each doffing roll comprises a main section 250 (Fig. 1) of a length approximating the narrowest width of web 20 to be reinforced, and end sections 251 and 252 on the right-hand side and sections 253 and 254 on the left-hand side adapted to be inserted as required to increase the length of the doffing rolls to conform to increased widths of the web 20. In Fig. 1 the web 20 is shown of a maximum width and the rolls 244 and 244*a* have all end sections in operative position.

The details of construction of the rolls are shown in Figs. 20 to 22 inclusive, and as there indicated, each roll has the main section 250 secured to shaft 243 for rotation therewith in any suitable manner as by the keyways 255. In these views I have shown the end section 253 in place and the section 254 removed to illustrate the assembly when the width of web to be reinforced is such that the section 254 is not needed.

Each end section consists of a pair of semi-circular castings 257 and 258 on the periphery of which are bosses 259 to which the blades 189 are bolted, as indicated at 260. The castings 257 and 258 are adapted to be assembled around sleeve 262 and carry keys 261 received in keyways in the sleeve 262 which itself is keyed at 263 to the shaft 243.

As indicated at 265 in Fig. 20, the castings 257 and 258 are bevelled at their ends, which bevelled ends dovetail with bevelled collars 266 loosely carried on shaft 243.

In proximity to each of the removable end sections of both doffing rolls is a member 270 pivoted on a rod 271 suitably secured to the frame. The member 270 comprises a flat strip of metal of substantially the shape indicated and of a width approximating the length of each of the

removable end sections. They are used for a purpose to be described.

The shaft 243 is screw-threaded for a small portion of its length, as indicated at 275 and a nut 276 is screw-threaded to mate therewith. A sleeve 277, splined at 277a on the shaft 243 for sliding movement thereon, has locking teeth 277b meshing with similar teeth on the face of nut 276. The sleeve 277 is spring pressed toward the nut 276 by a spring 278 interposed between the sleeve and a collar 279 fixed to the shaft 243 by a pin 280.

When a section is to be removed from the shaft 243 the procedure is as follows. The sleeve 277 is first retracted toward collar 279, compressing the spring 278, until the latch member 283 (Fig. 21) pivoted to the frame of the machine, engages over the shoulder 284 on sleeve 277, thereby holding the latter retracted. The nut 276 may then be backed off, permitting the end collar 266 to be slid lengthwise of the shaft and the semicircular castings 257 and 258 to be removed. The nut is then retightened against sleeve 262. In a similar manner other sections can be removed or replaced as desired and it will be noted that the spacing of sections remaining on the shaft is always preserved by the sleeves 262.

Any loosening of the nut 276 on shaft 243 as the shaft rotates is prevented by the locking engagement between the nut and sleeve 277 splined to the shaft.

The members 270 are provided to insure against doffing actuation of those carrier bars positioned in proximity to those portions of the shaft 243 from which the doffing blade sections have been removed. In an obvious manner, when sections are removed as above described the adjacent member 270 is swung downwardly in position to engage the rollers 158 of the adjacent carrier bars, as shown at 270' in Fig. 22.

The construction of the knife mechanism 22 (Fig. 3) is in all respects identical with that shown in my prior patent and, as indicated, the mechanism includes a plurality of knife assemblies 299, each comprising a pair of blades 300 and 301, both of which, as indicated in Fig. 5, have cutting teeth between the interdental spaces of which the fibres are adapted to pass. The tooth blade 301 is stationary and its companion blade 300 is longitudinally movable in the slot 302. Each of the movable blades 300 carries, projecting from its ends, the rollers 303 (Fig. 5) and 304 adapted to be engaged by certain members to move the blade 300 in the direction of its length to sever the fibre strands.

For selective engagement with the roller 303 of the knife to be operated, I provide a finger 305 pivoted at 306, and connected at 271 to a vertical rod 270 (Fig. 1). The rod 270 is pivoted at its lower end 307 to one end of a lever 261 loosely mounted on stud shaft 254. A bell-crank having arms 253 and 255 is also loosely pivoted on the shaft 254. The bell-crank arm 255 has an elongated slotted portion 256 adapted to receive a bolt 260 secured to the lever 261 whereby to secure the bell-crank in different positions of adjustment relative to lever 261. The extremity 263 of the bell-crank arm 255 has a nose adapted for different adjustable positions on the ribbed arcuate piece 262 secured to the lever 261.

The other arm 253 of the bell-crank has a cam follower roller 251 received in a cam groove 250 having a knife actuating portion 250'.

The cam 250 is mounted on, and driven in a counterclockwise direction by, a shaft 200 in a manner to be described. The cam follower 251 is idle during the major portion of the groove 250 which is circular about the center 200, but when the actuating portion 250' receives follower 251, the arm 253 is rotated slightly in a clockwise direction about the pivot 254 to impart similar rotation to the lever 261, thereby moving the rod 270 downwardly. As shown in Fig. 5 the resulting movement of the pivot point 271 causes the finger 305 to project into the path of travel of the rollers 303 thereby actuating which ever of the knives 299 next advances for engagement of its roller 303 with finger 305. When cam follower 251 rides out of cam portion 250' the finger 305 is retracted so that the remaining knives on the cylinder are not operated and the knife that has been so operated is retrieved, as the knife cylinder rotates, by its roller 304 coming into engagement with a fixed stop 310 (Fig. 5) protruding from the frame of the machine.

The mechanism for driving the machine is shown in Figs. 1, 2 and 5. As there indicated, the shaft 350, extending lengthwise of the machine, is driven from shaft 350b by means of the cone pulleys 350a connected by a belt as indicated. Shaft 350b is driven by belt 350c from a suitable power source. The drive thus described is effective to rotate the shaft 350 at a variable speed with relation to the constant speed shaft 350b as determined by the position of the belt on pulleys 350a, shifted by shipper 350d. This mechanism is conventional and need not be further described. Any other suitable mechanism for driving the shaft 350 at adjustable speeds can be employed.

The shaft 350 carries a bevel gear 352 meshing with bevel gear 353 on shaft 354. The shaft 354 carries secured to it the sprocket 355 (Fig. 5) over which is trained a chain 356 running over a sprocket 357 on shaft 200. The shaft 200 (Fig. 1) carries fixed to it a changeable gear 201 meshing with an idler gear 202 carried on a stud shaft 203 mounted in bearings in a bracket 204, which bracket is loosely mounted on the shaft 205. The shaft 205 carries loosely secured to it an idler gear 206 which meshes both with a gear 210 on the shaft 211 which carries the locking roll 212 (Fig. 3) and also with a gear 213 secured to the shaft 214 on which the cutting cylinder 22 is mounted. The gear 213 meshes with an idler 216 which, in turn, meshes with a gear 220 mounted on the shaft 122 which carries the gear 121 (Fig. 3) adapted to advance the rack carrying the combs 17. The apron 110 and lower roll 15 are driven by chain 105 passing over sprockets on shafts 90 and 211.

It is apparent from the foregoing gear train, that when the shaft 200 is rotated in a counterclockwise direction as indicated, the shafts 211, 214 and 122 carrying the locking roll, cutting cylinder and rack drive respectively, will each be rotated in a clockwise direction. The ratios of the gears in this train are such that peripheral speeds of apron 110, cylinders 212 and 22 and racks 113 are the same.

As described above, the doffing rolls 244 and 244a are periodically advanced through a gear train actuated by the single toothed gears 234 mounted on the continuously driven shaft 233. For a purpose to be described it is desirable to rotate the shaft 233 and single toothed gears 234 continuously, but at a speed which con-

stantly changes during each complete rotation of the shaft **233** and gears **234**. For that purpose the shaft **233** is driven from the shaft **200**, which rotates at a constant rate of speed, by a pair of elliptical gears comprising an elliptical driving gear **230** mounted on each end of the shaft **200** and a complementary elliptical driven gear **231** mounted on each end of the shaft **233**.

It is also desirable at times to change the positions of the single toothed gears **234** on the shaft **233**. By so doing I utilize the varying speed of rotation of the elliptical gear **231** to change the speed at which the single tooth **235** of each gear **234** meshes with its bevel gear **236**. To that end the single toothed gears are loosely mounted on the shaft **233** and are bolted to the driven elliptical gears **231** by bolts **232** (see also Fig. 19) passing through aligned bolt holes in the elliptical and single toothed gears. The three bolts **232** shown indicate three different positions of adjustment of each gear **234** about the shaft **233** and obviously further variations in position can be obtained by increasing the number of bolt holes. It will be understood that identical positions of adjustment are always made for both gears **234** so that their teeth **235** mesh with their corresponding bevel gears **236** at the same instant.

With the mechanism adjusted as illustrated in Fig. 1, the machine is adapted for depositing fibres transversely of a web **20** of the maximum width which the machine will accommodate. By the gear train above described leading from the driving shaft **200** to the fibre locking roll **212**, knife cylinder **22**, and rack drive gears **121**, a length of fibre sheet **16** equal to the said width of the web will be conveyed into position over the web and severed from the remainder of the fibre sheet during one complete rotation of the shaft **200**. By the elliptical gear train connecting the shafts **200** and **233**, the single toothed gear **234** will also rotate one complete revolution during this time, which will be effective for a single operation of the doffing rolls **244** and **244***a* to deposit the fibres on the paper through unlocking of the interdental spaces of the comb **17** and simultaneous actuation of the doffing blades **170** and **171** (Fig. 13) of the comb carriers **125** in position over the web. It will be noted from the relative positions of the knife operating cam portion **250'** and the single tooth **235** that the knife has just been operated and the doffing rolls **244** and **244***a* are immediately to be operated.

As a result of the elliptical gears, the tooth **235** rotates, as stated, at varying speeds during each complete cycle. With the parts in their positions indicated in Fig. 1, when the tooth **235** is about to engage the pinion **236**, the longest radius of the elliptical driving gear **230** is in mesh with the shortest radius of the driven elliptical gear **231**. The rate of movement of the single toothed gear **234** is therefore maximum at that moment. For a purpose which will appear, I desire such maximum speed of actuation of the doffing rolls **244** and **244***a* when the machine is adjusted to process maximum widths of web.

In Fig. 2 I have illustrated the adjustments necessary to accommodate the minimum width of web, it being understood that similar adjustments may be made for all widths of web intermediate the maximum and minimum widths.

The changeable gear **201** of Fig. 1 has been replaced by a smaller gear **201A**, which like the gear **201**, carries on its face a cam grove, indicated at **250A**, having a drop **250A'** adapted to receive the roller **251** on bell-crank **253**. The radius of the circular portion of the groove **250A** is smaller than the radius of the cam groove **250** on gear **201**, thereby necessitating an adjustment between the bell-crank **253** and lever **261** to its position indicated, which adjustment may readily be effected after loosening the nut on the bolt **260** passing through the elongated slot **256** on the arm of the bell-crank.

For the minimum width of web **20** I desire, for a purpose which will appear, to provide a minimum speed of actuation of the doffing rolls **244** and **244***a* relative to the speed of shaft **200**. To that end, I have indicated in Fig. 2 such an adjustment of each of the single toothed gears **234** about the shaft **233** that at the moment each tooth **235** meshes with its pinion **236**, the shortest radius of driving elliptical gear **230** is in mesh with the longest radius of driven gear **231**.

The purpose of these various adjustments is as follows:

The speed at which the web **20** is introduced to the machine preferably varies inversely with the width of the web so that the web is fed faster for narrower widths than for the broader widths. Under ideal conditions, constant areas of web will be processed per unit of time regardless of the width of web which, in turn, will permit a constant rate of speed of the fibre sheet **16** for all widths of web. A high rate of production is of course desired, so that the speed of advance of the fibre sheet **16** is made as high as is practicable.

For the maximum width of web of Fig. 1, the train of gears leading from shaft **200** to the fibre feeding and cutting mechanism feeds the fibre sheet at a predetermined rate, and cuts off a length of fibre sheet equal to the maximum width of web in the same interval of time that a length of web equal to the width of the fibre sheet is fed under the fibre sheet.

Assuming now that the narrowest width of web is to be introduced, the mechanism is changed as indicated in Fig. 2. By the substituation of the smaller gear **201A** for the larger gear **201**, the train of gears leading to the fibre feeding mechanism is rotated more slowly than before relative to the shaft **200**. However, the speed of advance of the web **20** is now increased inversely as its width has been decreased, and, at the same time, I increase the speed of rotation of shaft **200** in such an amount that the fibre is fed at substantially the same rate as before the substitution of the change gear **201A**. As a result of the faster rotation of the shaft **200** and of gear **201A** carrying knife operating cam **250A**, the fibre will be severed at more rapid intervals than before, thus cutting off shorter lengths of the fibre sheet, commensurate with the narrower widths of web now being processed.

The increase in speed of rotation of shaft **200** increases in like amount, through the elliptical gears, the speed of rotation of each single toothed gear **234** so that the doffing rolls **244** and **244***a*, like the knife mechanism, are operated at more frequent intervals to doff the shorter lengths of fibre onto the web **20**. Shafts **200** and **233** always rotate at a one to one ratio.

If the drive from the shaft **200** to shaft **233** comprised the ordinary circular concentric gears, not only would the intervals of actuation of the doffing mechanism be made more rapid upon increase in speed of shaft **200**, as is desired, but, furthermore, the speed of each individual actu-

ation would also be increased, which I have found not to be desirable. As indicated in Fig. 2, I therefore adjust each single toothed gear to the new position indicated relative to the driven elliptical gears 231 to make the comparatively slow portion of the rotation of the single toothed gear 234 come at the time when its single tooth 235 is engaging the bevelled gear 236. As a result of this adjustment any shock to the parts that might arise from increasing the speed of the individual actuations in proportion to the more rapid frequency of the successive operations is eliminated.

On the other hand, when the wide web of Fig. 1 is being processed I prefer to have the doffing mechanism operate rapidly when it is operated, by having the rapid portion of rotation of each gear 234 effective to advance its pinion 236. There is little danger of shock to the parts when the Fig. 1 adjustment is being used as a slower speed of rotation of shaft 200 is employed with that adjustment as above noted. By utilizing the highest available speed of gear 234 to rotate the doffing rolls I insure that the blades 189 of the doffing rolls (Fig. 19) are advanced with sufficient speed to clear the way for the rollers 158 on the carrier bars next succeeding those operated by such advancement of the doffing rolls.

By a proper design of gears 230 and 231 I may, within limits, maintain substantially constant the speed of the individual actuations of the doffing mechanism while increasing or decreasing the frequency of the successive actuations thereof.

It is thus apparent that my invention provides doffing mechanism, which embodies two independently variable characteristics of actuation. That is, the frequency of the successive doffing actuations may be varied and the rapidity of each individual actuation may also be varied entirely independently of the said frequency. I am thus able materially to speed up the rate of production for narrow widths of web by effecting a rapid succession of doffing operations while preserving such a moderate speed of each doffing stroke as is conducive to a smooth operation of the machine. Although I have employed for the purpose a variable speed of rotation of single toothed gears 234 effected by the drive through the elliptical gears, it will be apparent to those skilled in the art that many other equivalent mechanisms may be employed for the purpose and my invention is not to be limited to the mechanism herein disclosed except as indicated in the appended claims.

The web which is thus provided with transversely disposed fibres, is thereafter usually supplied with a top layer of paper, coated on one su ace with asphalt or other adhesive by which it is secured over the transversely reinforced web. Also, if desired, longitudinally extending fibres as well as transverse fibres may be interposed between the two webs by suitable apparatus, such as is disclosed in my prior United States Patent No. 1,850,301 of March 22, 1932.

Whereas I have described my machine as being adaptable for processing constant areas of paper per unit of time, it is of course to be understood that my invention is not to be limited to precisely constant web speeds for all widths of web because, in some instances, it may be desirable to increase the rate of production for certain widths of web.

I claim:

1. The method of reinforcing webs of material of different selected widths which comprises forming reinforcing fibres into a continuous sheet of predetermined width, advancing a sheet of fibres so formed at a predetermined speed for a given width of web to be reinforced, advancing said web of given width at a predetermined speed beneath the fibre sheet in a direction transverse of the direction of advance of the fibre sheet, cutting the fibre sheet and doffing the cut portions onto the web at a predetermined frequency to form a continuous layer of transverse fibres lengthwise of said web, and changing the web width, increasing or decreasing the speed of the web advance inversely as the change in web width, increasing or decreasing the cutting and doffing frequency with the increase or decrease respectively of the speed of the web while maintaining substantially constant the said predetermined speed of fibre feed so that substantially constant areas of web are processed per unit of time.

2. The method of reinforcing webs of material of different selected widths which comprises forming reinforcing fibres into a continuous sheet of predetermined width, advancing a sheet of fibres so formed at a predetermined speed for a given width of web to be reinforced, coating a web of given width with adhesive and advancing the coated web at a predetermined speed beneath the fibre sheet in a direction transverse of the direction of advance of the fibre sheet, cutting the fibre sheet and doffing the cut portions onto the web at a predetermined frequency to form a continuous layer of transverse fibres lengthwise of said web, and coating a web of different width, advancing the web at a speed of advance which is increased or decreased inversely as its width is so changed, increasing or decreasing the cutting and doffing frequency with the increase or decrease respectively of the speed of the web while maintaining substantially constant the said predetermined speed of fibre feed so that substantially constant areas of web are processed per unit of time.

3. In a web reinforcing machine, the combination with a plurality of carriers for delivering fibres transversely of a moving web, of mechanism for doffing severed lengths of fibre from the carriers onto the web including a doffer, a drive shaft adapted to operate at selected constant rates, a driving element on said shaft, a driven element connected to said driving element to be driven thereby through a cycle at a speed which varies during each cycle while the speed of said drive shaft remains at a selected constant rate, and means, connecting said driven element with the doffer, which actuates the doffer during a limited period in said cycle and at a frequency governed by the speed of said shaft, the relative positions of said driven element and said connecting means being adjustable so that the period during said cycle when the doffer is actuated is changed from a relatively fast period or a relatively slow period to a relatively slow period or a relatively fast period, respectively, whereby the frequency of operation of the doffer, governed by the speed of said shaft, and the speed of operation of the doffer, governed by said relative positioning, are independently variable.

4. In a web reinforcing machine, the combination with a plurality of carriers for delivering fibres transversely of a moving web, of mechanism for doffing severed lengths of fibre from

the carriers onto the web including a doffer, a drive shaft adapted to operate at selected constant rates, a driving element on said shaft, a driven element connected to said driving element to be driven thereby through a cycle at a speed which varies during each cycle while the speed of said drive shaft remains at a selected constant rate, means connecting said driven element with the doffer, which actuates the doffer during a limited period in said cycle and at a frequency governed by the speed of said shaft, and means for changing the speed of said shaft to change said frequency, the relative positions of said driven element and said connecting means being adjustable so that the period during said cycle when the doffer is actuated is changed from a relatively fast period or a relatively slow period to a relatively slow period or a relatively fast period, respectively, whereby the speed of actuation of the doffer is maintained substantially constant notwithstanding its said change in frequency.

5. In a web reinforcing machine, the combination with a plurality of carriers for delivering fibres transversely of a moving web, of mechanism for doffing several lengths of fibre from the carriers onto the web including a doffer, a drive shaft adapted to operate at selected constant rates, a driving gear eccentrically mounted on said shaft, a driven gear, also eccentrically mounted, and meshing with said driving gear so that by the eccentricities of said gears said driven gear is rotated at a speed which varies during each revolution while the speeds of rotation of said drive shaft and said driving gear remain constant, and means, connecting said driven gear with the doffer, which actuates the doffer during a limited period in the cycle of rotation of said driven gear and at a frequency governed by the speed of said shaft, the relative positions of said driven gear and said connecting means being adjustable so that the period during said cycle when the doffer is actuated is changed from a relatively fast period or a relatively slow period to a relatively slow period or a relatively fast period respectively, whereby the frequency of operation of the doffer, governed by the speed of said shaft, and the speed of operation of the doffer, governed by said relative positioning, are independently variable.

6. In a web reinforcing machine, the combination with a plurality of carriers for delivering fibres transversely of a moving web, of mechanism for doffing severed lengths of fibre from the carriers onto the web including a doffer, a drive shaft adapted to operate at selected constant rates, a driving element on said shaft, a driven element having a doffer actuating member adjustably secured thereto, the said driven element being connected to said driving element so that said driven element and said member are driven through a cycle at a speed which varies during each cycle while the speed of said drive shaft remains at a selected constant rate, means connected to the doffer and disposed in the path of movement of said member to be engaged and advanced thereby during a limited portion only of the cycle of movement of the member and, when advanced, to actuate the doffer at a speed determined by the speed of movement of the member when it engages and advances said means and at a frequency governed by the speed of said shaft, means for changing the speed of said shaft to change said frequency, the relative positions of said driven element and said member being adjustable to change the period during said cycle when the member engages and advances said means to actuate the doffer from a relatively fast period or a relatively slow period to a relatively slow period or a relatively fast period respectively, so that the speed of actuation of the doffer is maintained substantially constant notwithstanding its said change in frequency.

GEORGE E. GIBBS.