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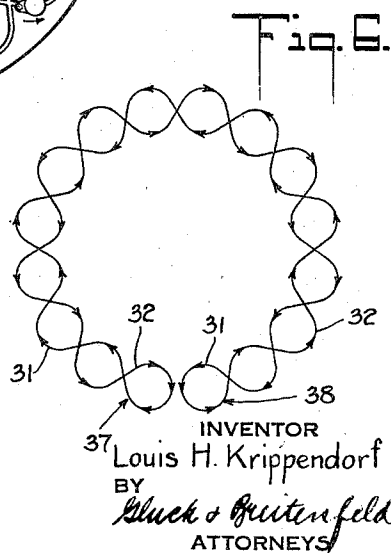
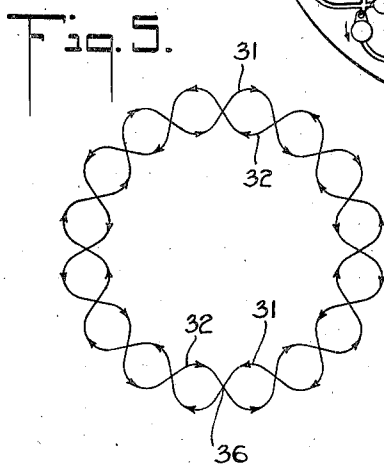
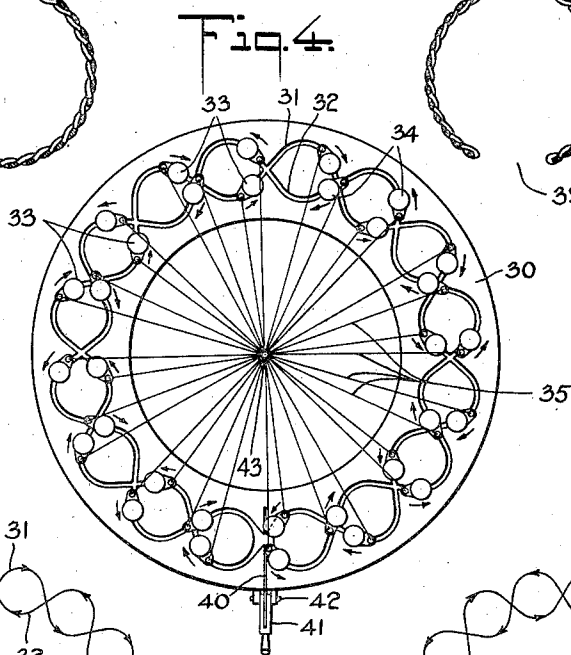
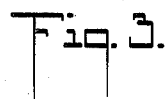
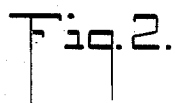
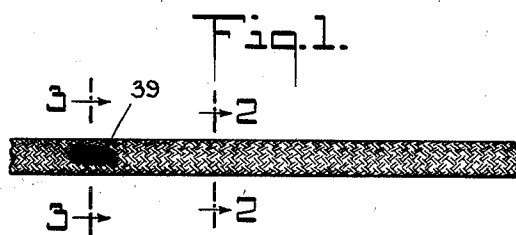
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BRAIDING MACHINE

Filed March 23, 1938

7 Sheets-Sheet 1



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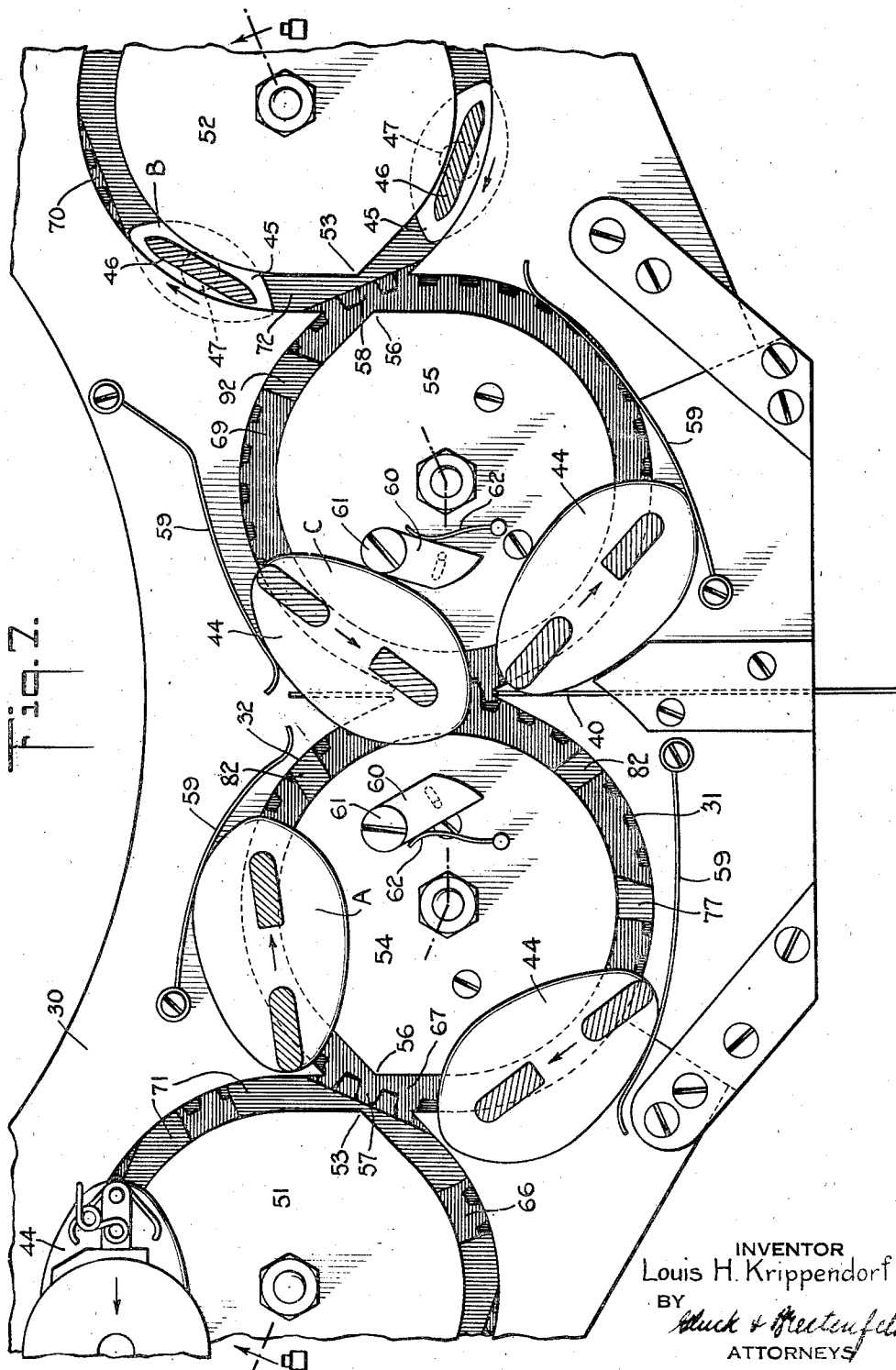
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BRAIDING MACHINE

Filed March 23, 1938

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Feb. 21, 1939.

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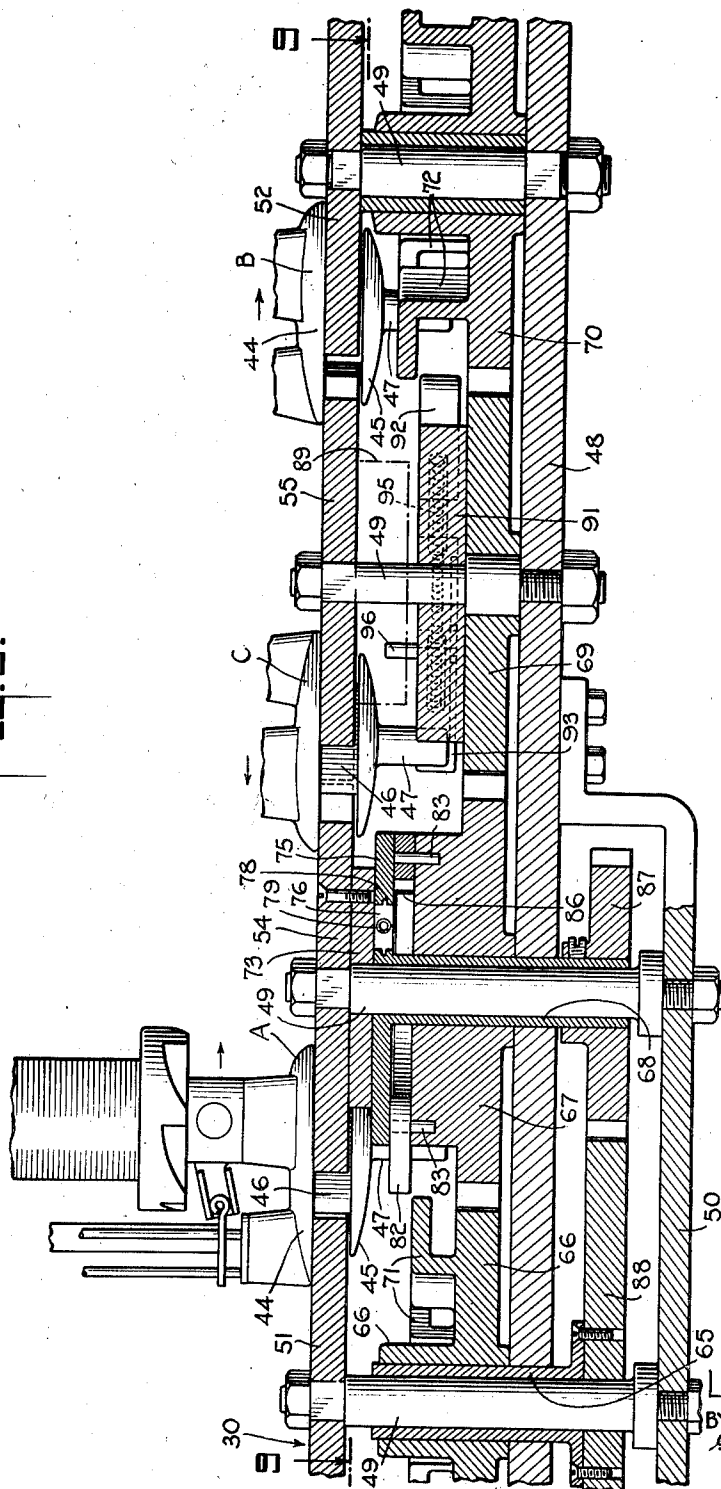
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BRAIDING MACHINE

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Fig. 6.



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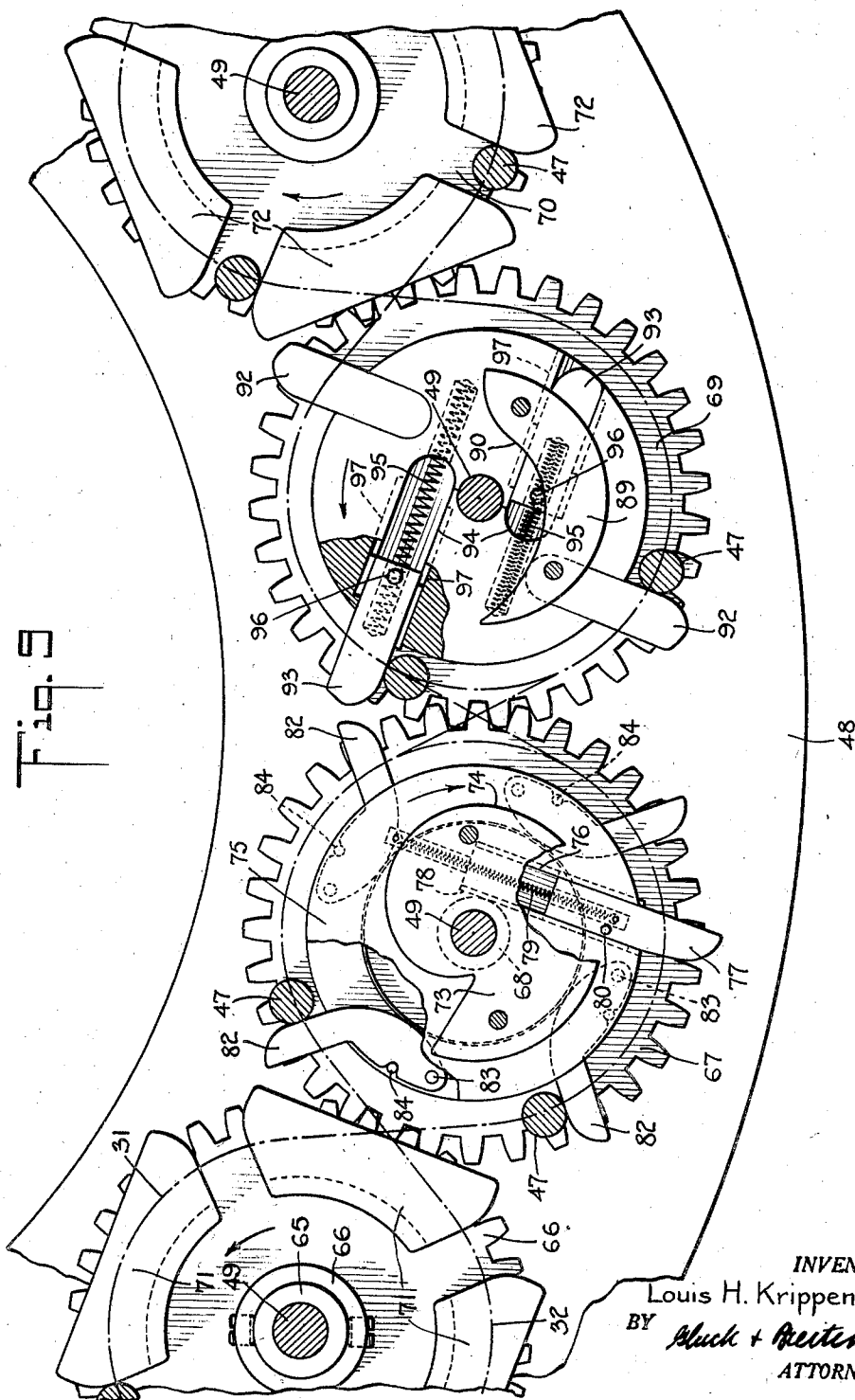
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BRAIDING MACHINE

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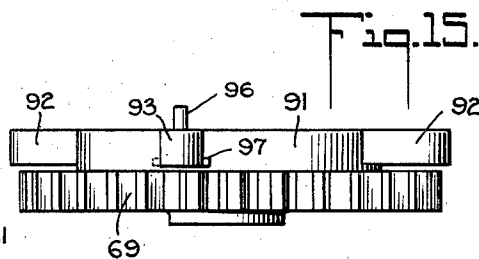
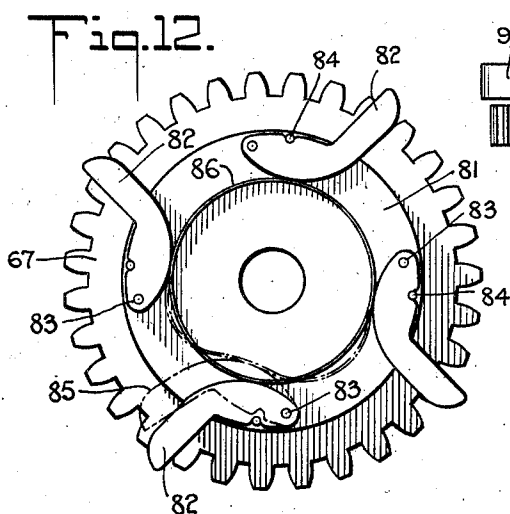
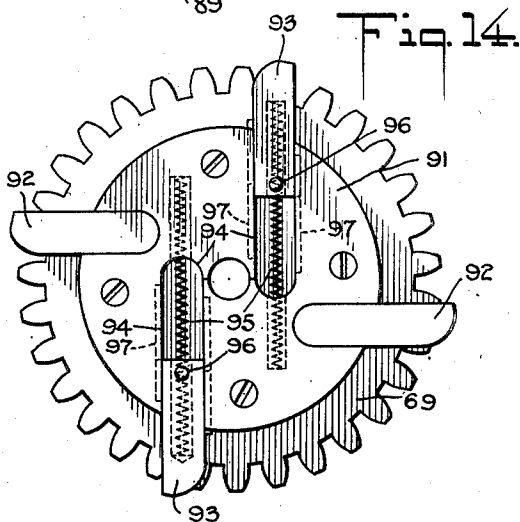
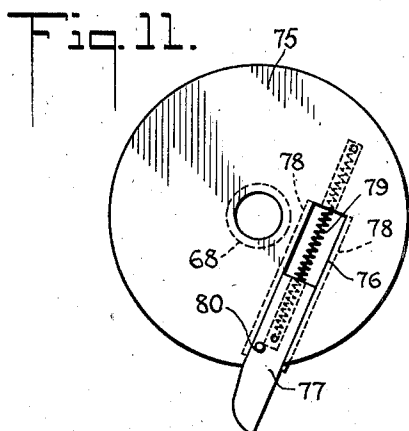
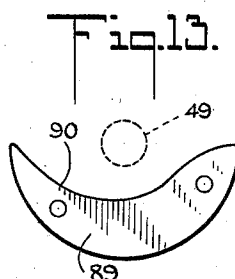
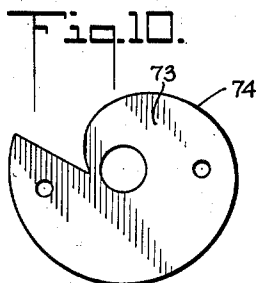
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BRAIDING MACHINE

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7 Sheets-Sheet 5



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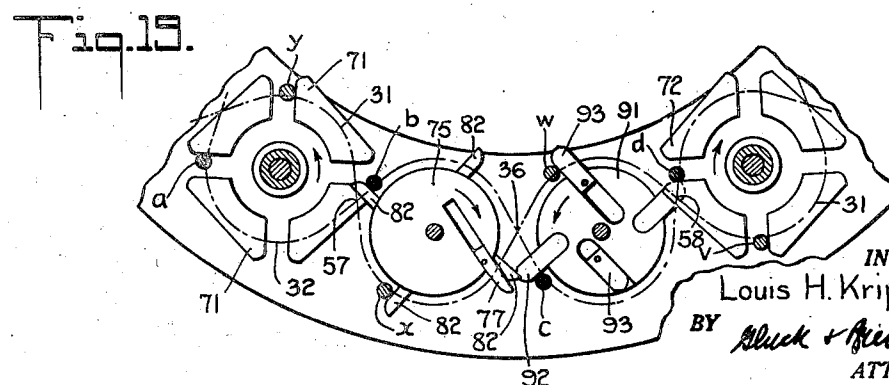
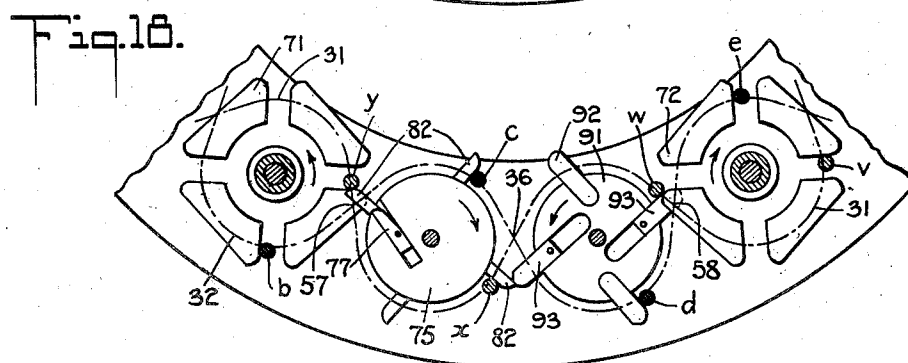
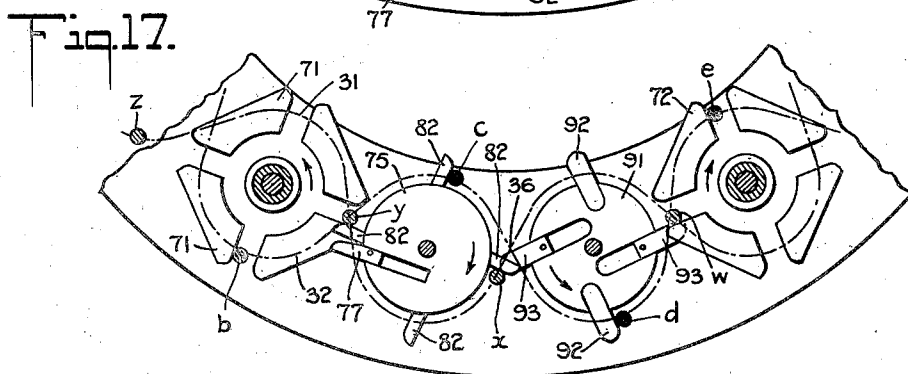
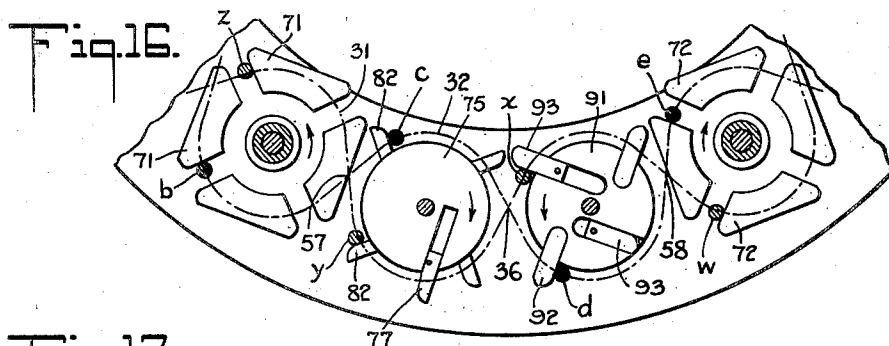
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BRAIDING MACHINE

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7 Sheets-Sheet 6



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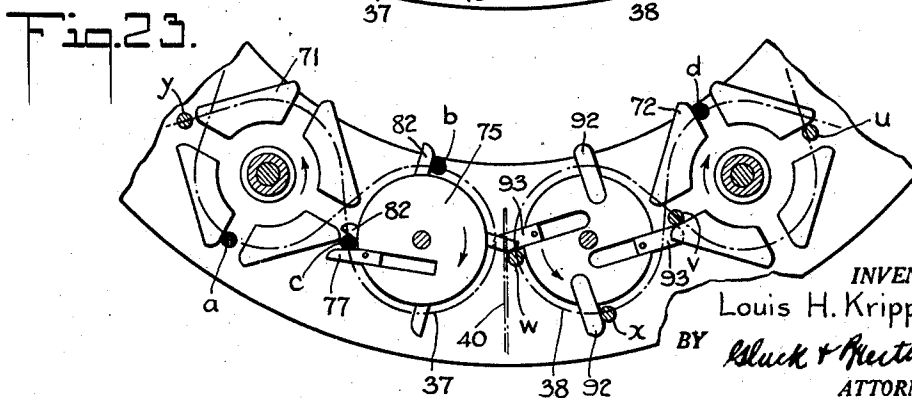
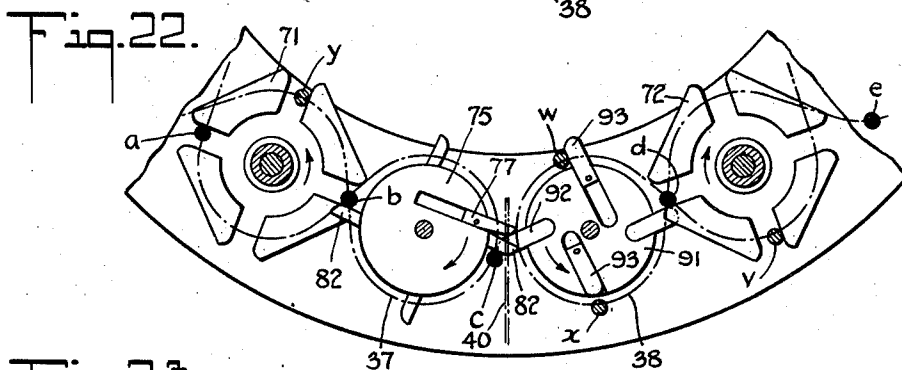
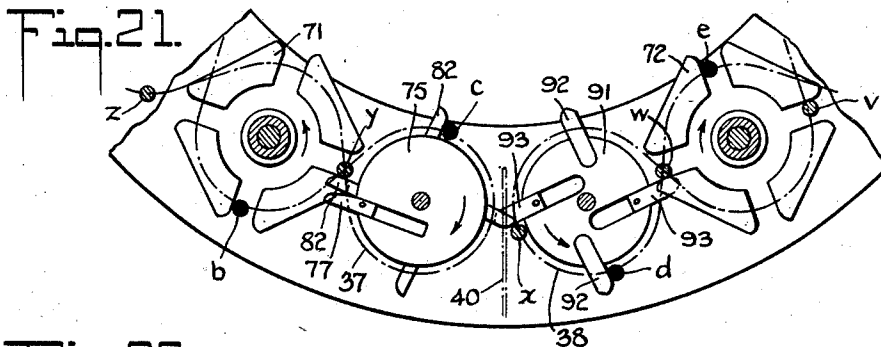
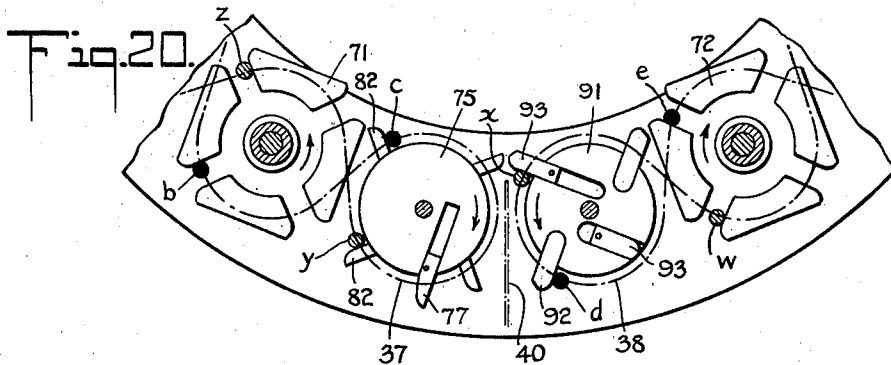
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BRAIDING MACHINE

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UNITED STATES PATENT OFFICE

2,148,164

BRAIDING MACHINE

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Application March 23, 1938, Serial No. 197,590

9 Claims. (Cl. 96—12)

My present invention relates generally to braiding machines.

Generally speaking, a braid is formed from a number of strands of suitable material diagonally interwoven so that each strand passes alternately over and under one or more of the others. A machine for accomplishing this purpose consists essentially of a series of bobbin carriers, each bobbin supporting one of the strands, the carriers being advanced along suitable intersecting paths of travel. Usually, a plate is provided with intersecting serpentine slots, and the bobbin carriers are provided with lugs extending through the slots so as to be engaged by suitable driving members. There is a driving member for each lobe of the slot pattern, usually in the form of a horned element continuously rotating in one or the other direction. The driving members are interconnected by a series of gears so that the driving members rotate in alternate directions. The result is that the bobbin carriers in one serpentine slot are advanced in one direction, while the carriers in the other slot are advanced in the opposite direction.

Where the slots are entirely separate from each other, so that the carriers in one slot never enter into the other slot, the machine is generally spoken of as a "round" braider, the braided product being tubular in character.

Where the slots are connected by adjacent loops adapted to guide the carriers from one slot into the other and thereby reverse their travel, the machine is generally spoken of as a "flat" braider, because the resultant braided product is substantially flat.

It is a general object of my present invention to provide a braiding machine which can be selectively utilized either as a "round" braider or a "flat" braider, without requiring any rebuilding of the machine and without any interruption in the machine's operation. As a result of this unique capability of the present improved machine, braided products of unusual and specialized character can be produced. Merely by way of example, I am enabled to produce a braided tube having one or more openings or "eyes" in it. Such a braided product, heretofore incapable of complete automatic production by machine, enters into the manufacture of surgical catheters. By means of the present machine a large variety of braided products, consisting partly of the so-called "flat" braid and partly of a "round" braid, can now be successfully and inexpensively woven entirely by machine.

The operation of a braiding machine, by the

very nature of the braid to be produced, requires the maintenance of predetermined spacing between successive bobbin carriers and the maintenance of an accurately timed relationship of movement of the carriers, so that each bobbin carrier will cross one of the slot intersections in predetermined timed relation to the bobbin carriers that are traveling in the opposite direction. One of the problems I have had to solve in devising a machine of the present character, i. e., wherein a change-over from round to flat braiding can be effected, resided in the maintenance of the normal spacing between the carriers. The reason for this difficulty becomes apparent upon a comparison of the continuously intersecting slot pattern of the "round" braider with the slot pattern of the "flat" braider. The latter includes two adjacent loops necessarily traversed by each bobbin carrier to reverse its direction of travel. Where a round braider is transformed to a flat braider without changing the number of bobbin carriers, then to avoid collisions and to maintain a proper timed cooperation between the carriers at the slot intersections, it is necessary in one way or another to speed up the travel of the bobbin carriers in one loop and to retard the travel of the bobbin carriers in the other loop.

This latter result may be accomplished in various ways, e. g., by making one loop of shorter peripheral length and making the other loop of longer peripheral length while still maintaining constant the lineal velocities of the carriers; or, e. g., by effecting an actual increase in lineal velocity of movement of the carriers in one loop, and effecting an actual retardation or delay in the movement of the carriers in the other loop. It is the latter system which I prefer to employ and which I have herein illustrated in a preferred embodiment of the invention.

One of the features of my invention lies in the fact that it is not necessary to alter the number of bobbin carriers in effecting a transformation of the machine from one type of braider to the other.

I accomplish the foregoing objects, and such other objects as may hereinafter appear or be pointed out, in the manner illustratively exemplified in the accompanying drawings, wherein—

Figure 1 is a fragmentary view of a tubular braid with an opening or eye therein;

Figure 2 is an enlarged cross-sectional view taken substantially along the line 2—2 of Figure 1;

Figure 3 is an enlarged cross-sectional view

taken substantially along the line 3—3 of Figure 1;

Figure 4 is a diagrammatic plan view of the pertinent portion of a braiding machine of the present character;

Figure 5 is a diagrammatic view showing the directions of travel of the bobbin carriers when the machine is used as a "round" braider;

Figure 6 is a view similar to Figure 5, showing the carrier travel when the machine is used as a "flat" braider;

Figure 7 is an enlarged fragmentary plan view of the lower portion of Figure 4, with parts broken away for the sake of clearness;

Figure 8 is a cross-sectional view taken substantially along the line 8—8 of Figure 7;

Figure 9 is a view similar to Figure 7, taken substantially along the line 9—9 of Figure 8;

Figure 10 is a plan view of one of the cams shown by itself;

Figure 11 is a plan view, shown by itself, of the element that is guided by the cam of Figure 10;

Figure 12 is a plan view of the horned driving member that cooperates with the element of Figure 11;

Figure 13 is a plan view of another cam shown by itself;

Figure 14 is a plan view, shown by itself, of the horned driving member that cooperates with the cam of Figure 13;

Figure 15 is a front view of Figure 14;

Figures 16—19 inclusive are diagrammatic views similar to Figure 7, showing the operation of the machine when used as a round braider; and

Figures 20—23 inclusive are views similar to Figures 16—19, showing the operation when the machine is used as a "flat" braider.

The present machine employs the usual substantially circular plate 30 in which there are two intersecting serpentine slots 31 and 32. Mounted for guided advancement in these slots are a series of bobbin carriers which may be of any usual construction. As viewed in Figure 4, I have shown a series of bobbin carriers 33 in the slot 31, and a series of bobbin carriers 34 in the slot 32.

All the bobbin carriers are alike, but when the machine is operating as a round braider, so that the paths of travel of the carriers are as indicated in Figure 5, the carriers in the slot 31 remain in that slot and never enter the slot 32; while the carriers in the slot 32, traveling in the opposite direction, never enter into the slot 31.

During such operation of the machine, the strands 35 are braided together to form a tubular structure such as that shown most clearly in Figure 2.

In accordance with my invention, I provide an arrangement at at least one of the slot intersections to selectively guide the carriers either across the intersection, or from one slot to the other.

Assuming that the present arrangement is associated with the intersection 36 of Figure 5, I am thus enabled to transform the slot pattern of Figure 5 into that of Figure 6. In the latter pattern, attention is directed to the adjacent loops 37 and 38, the loop 37 serving to guide the carriers in the slot 32 into the slot 31; the loop 38 similarly guiding the carriers in the slot 31 into the slot 32; and there being in each case a complete reversal of travel of the bobbin carriers.

With the carriers traveling along the inter-

secting paths indicated in Figure 6, the machine is operating as a so-called "flat" braider, during which period of operation a product such as that shown most clearly in Figure 3 is produced.

Because of the facility with which the present machine may be selectively transformed between the modes of operation shown in Figures 5 and 6, I am enabled to produce a braided product of the character shown in Figure 1, this product being substantially tubular and having at least one opening or eye 39.

It will be understood that the opening or eye 39 is produced in that region of the tube which corresponds to the intersection 36 of Figure 5, and that it is within the purview of my invention to provide a change-over arrangement at each of any desired number of slot intersections so that openings or eyes may be produced, at will, at any selected circumferential portion of the tubular braid.

For the purpose of explaining the general nature of my invention, however, I have illustrated a machine in which the special arrangement is provided only in association with one slot intersection, viz., the intersection designated 36 in Figure 5.

This special arrangement consists essentially of a guiding partition or wall 40 mounted for movement into and out of a position sealing the intersection 36 transversely. The wall 40 is preferably mounted in a slot and guided in a reciprocatory manner by means of a handle 41 pivoted to the machine as at 42. In Figure 4, and also in Figure 7, the wall 40 is in a retracted position, leaving the intersection 36 open for cross-travel of the carriers. When the handle 41 is manipulated to position the wall 40 in an endwise manner across the intersection 36, as indicated by dot-and-dash lines in Figures 20—23, the intersection is sealed transversely and the bobbin carriers then travel in accordance with the pattern of Figure 6.

It will be understood that the strands 35 customarily travel upwardly from the bobbin carriers toward a sort of apex 43 at which the actual braiding takes place, the braided product, as it is formed, being withdrawn upwards and guided in any suitable manner onto a take-up reel or the like. This mode of operation is well known per se and is, therefore, not illustrated in detail.

The bobbin carriers themselves are also well-known per se and are, therefore, not illustrated in detail. However, it may be pointed out, with respect to Figures 7 and 8, that each bobbin carrier is provided with an oval plate 44 which rides on the top surface of the plate 30, and with a bottom plate 45 which rides along the under surface of the plate 30, the plates 44 and 45 being connected by an elongated shank 46 (see right hand portion of Figure 7) which rides in one or the other of the serpentine slots and is guided thereby. Each carrier also carries beneath the plate 45 a downwardly projecting lug 47, this lug being circular in cross-section, and being the element that is engaged by successive driving members in order to advance the carrier along the slot in which it is mounted.

The structure of the bobbin carrier above the plate 44 is a matter which does not enter into the present invention and is, therefore, merely indicated in certain of the figures, more detailed description being unnecessary in the present case.

Referring now to Figures 7, 8, and 9, I will point out first that the plate 30 is retained in spaced relationship from an under plate 48 by means of

of suitable spacer studs designated generally by the reference numeral 49. Wherever necessary, as at the left of Figure 8, the bottom plate 48 is provided with an additional under plate 50, the purpose of these under plates being to serve as a housing for the gearing and also for the driving members.

Because of the intersecting slots 31 and 32, portions of the top plate 30 are completely separated from the body of the plate, constituting islands which are held in position by the studs 49. The normal islands, such as those shown at 51 and 52 in Figure 7, have pointed ends 53 to conform to the slot intersections. The islands 54 and 55 arranged on opposite sides of the intersections 36 are, however, of slightly modified shape, having the pointed ends 56 at the intersections 57 and 58, but having rounded contours adjacent to the intersection 36.

In order to compensate for this relatively deficient slot guidance of the shanks 46 at the intersection 36, I provide the auxiliary guide elements 60 mounted for limited pivotal movements around axes 61 and urged toward the intersection 36 by the leaf springs 62, the elements 60, 61, and 62 being carried by the islands 54 and 55, respectively, as shown most clearly in Figure 7. The elements 60 serve as guides for the plates 44 of the bobbin carriers to facilitate their travel through this region of the machine.

I also prefer to provide the leaf springs 59 which are adapted to bear against the plates 44 of the bobbin carriers as the latter pass through this region of the machine, these springs serving to hold the lugs of the carriers against the horns of the driving members in this region of the machine.

In each lobe of the slot pattern there is a driving member. Beneath the islands 51 and 52 the driving members are of conventional character. Beneath the islands 54 and 55 the driving members are of special character.

Mounted on the stud 49, which is centered with respect to the island 51, is a sleeve 65; and rotatably mounted on this sleeve is the driving member 66 having peripheral gear teeth. The latter mesh with the teeth on a similar gear 67 rotatably mounted on a sleeve 68 on the next adjacent stud 49. The gear 67 similarly meshes with a gear 69 mounted beneath the island 55; and this gear in turn meshes with a driving member 70 beneath the island 52. In a similar way, the driving members throughout the entire machine are geared together, and at a suitable part of the machine a motive power is applied to one of the gears, thereby effecting rotational movements of all the driving members.

The gears 66 and 70 are of the more or less conventional horned variety. I have shown the gear 66 provided with the four horns 71 (see Figure 9), and I have shown the gear 70 provided with the four horns 72. The only difference between the horns 71 and 72 is that the latter stand further away from the body of the gear 70 so that they will not conflict with the horns on the next adjacent normal gear (not shown) which is of the character shown at 66. Similarly, the horns 71 on the gear 66 are lower than the horns on the next adjacent normal gear (not shown) which will be of the type shown at 70. This variance in horns extends around the machine and is a customary expedient.

Reference will now be had to the driving mechanism beneath the island 54, the elements of which are shown most clearly in Figures 10-12.

Mounted directly beneath the island 54 is a cam 73 having a spiral operative surface 74 substantially as shown in Figures 9 and 10. This cam is rigidly secured to the island 54.

Directly beneath this cam is a disc 75 in which a slot 76 is formed. Mounted for reciprocation in this slot is a wiper or special horn 77, preferably provided with fins at its sides adapted to be guided within corresponding grooves 78 in the sides of the slot 76. The wiper 77 is under the constant urge of a tension spring 79 which tends to retract the wiper 77 into the slot 76. The wiper 77, however, carries a pin 80 which bears against the operative surface 74 of the cam 73. Accordingly, under the conjoint dictate of the spring 79 and the cam surface 74, the wiper 77 projects outwardly from the disc 75 during certain regions of its rotative travel, and is retracted into the slot 76 during other regions of its travel.

Immediately beneath the disc 75 is a horned driving member 81 provided with four horns and characterized by the fact that each of the horns is mounted in a yieldable manner. For purposes of illustration, one horn 82 will be described in detail. It consists of an L-shaped member normally projecting in a radial manner as shown in Figure 12, one arm of the L being pivoted, as at 83, to the disc 81. A stop pin 84 limits the outward movement of the horn 82, but the horn is free to yield into the dot-and-dash position 85 of Figure 12 when pushed in a clockwise direction. When it yields, it presses against a yieldable leaf spring 86 serving conjointly to hold all of the horns 82 in their normal projecting relationship.

The member 81 is rigidly secured to the gear 67 and rotates with the latter on the outside of the sleeve 68. The latter is either integral with or securely fastened to the disc 75 and is also secured to a gear 87. The latter meshes with a gear 88 which is in turn secured to the sleeve 65, the latter being keyed or otherwise secured to the normal gear 66.

The gear 88 is larger than the gear 87 by an amount sufficient to drive the disc 75, and with it the wiper 77, at a speed twice as great as that of the horned driving member 81.

Reference will now be had to the driving mechanism beneath the island 55, the elements of which are shown most clearly in Figures 13-15.

Mounted directly beneath the island 55 and secured thereto in any suitable manner is the oddly shaped cam 89 having the operative inner cam surface 90. This cam is shown in dot-and-dash lines in Figure 8 because it is technically not visible along the line 8-8 of Figure 7.

Beneath the cam 89, and firmly secured to the gear 69, is the horned driving member 91 shown most clearly in Figures 14 and 15. This member has four horns, two of which are fixed and two of which are retractable. The fixed horns 92 are diametrically opposite each other and may be formed in any convenient manner. The other two horns 93, also diametrically opposite each other, are mounted in slots 94 and are under the constant urge of the compression springs 95, tending to force the horns 93 outward. Each horn 93, however, is provided with the pin 96 adapted to engage with the operative surface 90 of the cam 89, thereby periodically retracting each horn 93 during a predetermined region of its rotative travel. Each of the horns 93 is preferably provided with lateral fins adapted to ride in corresponding grooves 97 for guiding purposes.

The operation of the machine can best be described upon reference first to Figures 16-19, and by subsequent comparative reference to Figures 20-23.

In Figures 16-19 the machine is operating as a "round" braider, the element 40 of Figure 4 being retracted so as to leave the slot intersection 36 unimpeded; whereby the carriers in the slot 32 travel continuously in one direction, always within the slot 32, while the carriers in the slot 31 travel continuously in the opposite direction, always in the slot 31.

For illustrative purposes, I have shown lugs *b*, *c*, *d*, and *e* of four carriers in the slot 32 traveling, so far as Figures 16-19 are concerned, from left to right. I have also shown lugs *w*, *x*, *y*, and *z* of four carriers traveling from right to left within the slot 31. It will be noted upon viewing Figure 16 that the lug *b* is under the influence of one of the horns 71; the lug *c* is under the influence of one of the horns 82; the lug *d* is under the influence of one of the fixed horns 92; and the lug *e* is under the influence of one of the horns 72. Similarly, traveling in the opposite direction, the lug *w* is under the influence of another horn 72; the lug *x* is under the influence of one of the retractable horns 93; the lug *y* is under the influence of another of the horns 82; and the lug *z* is under the influence of another of the horns 71.

The lug *c* has just completed crossing the intersection 57 and the lug *y* is just about ready to cross this same intersection in the opposite direction. The lug *x* is about to cross the intersection 36, at which time it will be picked up by one of the horns 82. The lug *w* is approaching the intersection 58, at which time it will be picked up by the horn 93 which is shown retracted in Figure 16 but which will have advanced into operative position by the time it reaches the intersection 58.

It should not be noted that the high-speed wiper 77 is completely inoperative, and that it does not in the least interfere with the carrier lugs, being well behind the lug *y* and being incapable of catching up to the lug *y* before the latter has reached the position of Figure 17.

Figure 17 shows the parts after one-eighth of a revolution. The lug *b* is still under the influence of the horn 71; the lug *c* is still under the influence of the horn 82; the lug *d* is still under the influence of the horn 92; and the lug *e* is still under the influence of the horn 72. The lug *w*, crossing the intersection 58, is being picked up by the horn 93 which has sprung out into operative position. The lug *x* has been picked up by one of the horns 82; and the lug *y*, in process of crossing the intersection 57, is being picked up by one of the horns 71.

After an additional one-sixteenth revolution, the parts assume the relationship of Figure 18 in which the wiper 77 is shown in retracted position and in which an ensuing lug *v* has made its appearance in the slot 31.

After an additional one-fourth revolution, the parts assume the positions shown in Figure 19. The carriers having almost completed a revolution of 180°, as compared with Figure 16, it will be observed that the wiper 77 has almost completed a revolution of 360°. Again, this wiper is too far behind the lug *x* to have any effect upon it, since the lug *x* will be at the intersection 57 before the wiper 77 catches up to it.

It will also be noted in Figure 19 that the horn 93, formerly operative to advance the lug *x*, is now inoperative and in retracted position.

Also, a lug "a" in the slot 32 has now made its appearance at the left of Figure 19.

The parts of Figure 19 are substantially correspondent to the parts in Figure 16, except that all the lugs have been advanced across one of the slot intersections. Thus, the lug *b* has advanced across the intersection 57; the lug *c* has advanced across the intersection 36; and the lug *d* has advanced across the intersection 58. Similarly, the lug *w* has advanced across the intersection 58; the lug *x* has advanced across the intersection 36; and the lug *y* has advanced across the intersection 57.

This advancement of the carrier lug is continued in the same way, as long as the machine continues to operate as a round braider.

The special functions of the wiper 77 and of the retractable horns 93 have not yet manifested themselves. But the unique functioning of these parts will become readily apparent upon a similar examination of Figures 20-23, which represent the operation of the machine when it is functioning as a flat braider.

In the first place, it will be noticed that the guiding partition 40 of Figure 4 has been advanced across the intersection 36, as a result of which the slot pattern is of the character shown in Figure 6.

In Figure 20 the parts are in exactly the same relative positions as they are in Figure 16, except for the fact that the partitioning wall 40 has been advanced. It may be noted, in passing, that this adjustment of the wall 40 is all that is necessary to transform the operation from that indicated in Figure 5 to that indicated in Figure 6; and it will thus be obvious that the present machine is an outstanding improvement in the art since the change-over requires no interruption of operation, nor any removal of excess bobbin carriers, nor substitution of new gears or parts.

It should be observed that the carriers *b*, *c*, *d*, and *e*, both in Figure 20 and also in Figure 16, are spaced from each other by 180°. Thus, the lug *c* is 180° in advance of the lug *b*; the lug *d* is 180° in advance of the lug *c*; and the lug *e* is 180° in advance of the lug *d*. The same spacial relationship exists between the lugs *w*, *x*, *y*, and *z*.

In Figure 21, I have shown the relationship of parts after the gears have rotated through one-eighth of a revolution. This view corresponds, therefore, to Figure 17 and the parts are in the same relationship as in Figure 17 except for the lug *x*. In Figure 17, this lug has been picked up by the horn 82; but in Figure 21 it is deflected by the wall 40 and, therefore, remains under the control of the lug 93.

This impairs the spacing between lugs, as will be noted upon a consideration of lugs *y* and *d*. The lug *y* should have behind it a lug which is 180° to the rear. In Figure 17 this requirement is met by the lug *x* which is 180° behind the lug *y*. In Figure 21, however, the lug *x* has been deflected and it is the lug *c* which is now behind the lug *y*. The lug *c*, however, is 270° behind the lug *y*, and this gap must be closed up during the traverse of the lug around the loop 37.

Similarly, the lug *d* in Figure 17 is followed up by the lug *c* which is 180° behind it. In Figure 21, however, it will be observed that the lug *x* has been interposed, and it is the lug *x* which now follows the lug *d*. The lug *x*, however, is only 90° behind the lug *d* and must, therefore, be retarded during its traverse of the loop 38.

This necessary readjustment of the normal

spacing between the lugs is taken care of by the present mechanism, as indicated most clearly in Figures 22 and 23. In Figure 22, the high-speed wiper 77 has just about caught up to the lug c; and in Figure 23 it has already succeeded in advancing the lug c, at an accelerated rate of speed, to a point which is approximately 180° behind the lug y. In effecting this movement of the lug c, it will be observed from Figure 23 that the lug c is caused to bear upon the rear surface of one of the horns 82. Unless the horn 82 is yieldable, the smooth operation would be interfered with. That is the reason why the lugs 82 are each of yieldable character, as illustrated most clearly in Figure 12. In Figure 23, the horn 82 upon which the lug c is pressing is in the process of yielding to permit passage of the lug c.

With respect to the lug x, it will be noted from Figure 22 that the retraction of the horn 93, which has theretofore served to advance the lug x, leaves the lug x stranded until it is again picked up by the succeeding horn 92, as shown in Figure 23. This permits the lug d to advance through 90° while the lug x stands still; and in this way the normal spacing of 180° between the lug d and the lug x which follows it is restored.

After a desired period of operation as a flat braider, during which time an opening or eye is formed in the normally tubular braided product, the partitioning wall 40 may be again withdrawn to enable a resumption of operation of the character illustrated in Figures 16-19. During the operation of the machine as a round braider, as indicated in Figures 16 and 19, the high-speed wiper 77 fulfills no function and the periodic retraction of the horns 93 is similarly of no utility.

It will be understood that, from certain aspects, my invention is not restricted to a machine which is necessarily transformable from one mode of operation to another. For example, the functioning of the special mechanism, as indicated in Figures 20-23, is useful in a machine that is constructed to serve permanently as a flat braider. By the employment of the present improved mechanism the flat braider is enabled to operate with an even number of bobbin carriers, a capability which is absent from conventional flat braiders so far as I am aware.

I mention this feature because it is customary at the present time for the user of a round braider to rebuild the same to make it serve as a flat braider. At the present time, this rebuilding necessarily involves the removal of one of the bobbin carriers. By means of the present invention, such removal would be unnecessary.

I further draw attention to the fact that the adjustment of the partitioning wall 40, while illustrated as a procedure to be accomplished by a manual operation, may obviously be taken care of by mechanical or electrical means, and I do not consider my invention to be limited to a manual adjustment of the partitioning wall.

Furthermore, I have illustrated the invention in connection with a simple type of braid, in which a single strand interweaves alternately with other single strands. It is within the purview of my invention to apply its features also to braiding machines which are timed and arranged to produce modified types of braided products and various fancy braids which are well known per se.

As hereinbefore mentioned, the maintenance or restoration of proper spaced relationship between the bobbin carriers, when the machine is adjusted from one type of operation to the other, need not necessarily be accomplished by the actual increase

in velocity of one set of carriers and an actual reduction of the other. While this mode of accomplishing the result is preferable, it is nevertheless within the purview of my invention to accomplish this same result by other means, e. g., by making the loop 37 (Figure 6) relatively small with respect to the loop 38. This would cause the lug c (Figures 21-23) to travel through a shorter distance within a given period of time, and would cause the lug x (Figures 21-23) to travel through a longer distance within the same period of time, thereby closing the gap between the lugs c and y, and enlarging the gap between the lugs x and d.

In general, it will be understood that changes in the details, herein described and illustrated for the purpose of explaining the nature of my invention, may be made by those skilled in the art without departing from the spirit and scope of the invention as expressed in the appended claims. It is, therefore, intended that these details be interpreted as illustrative, and not in a limiting sense.

Having thus described my invention and illustrated its use, what I claim as new and desire to secure by Letters Patent is:

1. In a braiding machine, a plate with intersecting serpentine slots, a series of bobbin carriers, means for advancing the carriers in one slot in one direction and the carriers in the other slot in the opposite direction, means for selectively guiding the carriers across one of the slot intersections or guiding them into the other slot to reverse their travel, and means controlling the movements of the carriers during their reversal to maintain the normal spacing between them, whereby the machine may be selectively transformed from a round to a flat braider and vice versa without reducing or increasing the number of bobbin carriers.

2. In a braiding machine, the combination set forth in claim 1, said last-named means comprising mechanism for momentarily speeding up the carriers on one side of said intersection, and mechanism for momentarily retarding the carriers on the other side of said intersection.

3. In a braiding machine, a plate with intersecting serpentine slots, a series of bobbin carriers, means comprising a horned driving member for each lobe of the slot pattern for advancing the carriers in one slot in one direction and the carriers in the other slot in the opposite direction, means at one of the slot intersections for selectively guiding the carriers across the intersection or guiding them into the other slot to reverse their travel, mechanism operable during such reversal for momentarily speeding up the carriers on one side of said intersection, and mechanism operable at the same time for momentarily retarding the carriers on the other side of said intersection; said speeding-up mechanism comprising a wiper movably mounted alongside of one of the driving members adjacent to said intersection, and means for moving said wiper at twice the speed of the horns of said driving member.

4. In a braiding machine, the combination with the elements of claim 3, of means for rendering said wiper inoperative within a predetermined region of its travel.

5. In a braiding machine, a plate with intersecting serpentine slots, a series of bobbin carriers, means comprising a horned driving member for each lobe of the slot pattern for advancing the carriers in one slot in one direction and the carriers in the other slot in the opposite direction,

means at one of the slot intersections for selectively guiding the carriers across the intersection or guiding them into the other slot to reverse their travel, mechanism operable during such reversal for momentarily speeding up the carriers on one side of said intersection, and mechanism operable at the same time for momentarily retarding the carriers on the other side of said intersection; said retarding mechanism comprising means for rendering inoperative, within a predetermined region of their travel, certain horns of one of the driving members adjacent to said intersection.

6. In a braiding machine, a plate with intersecting serpentine slots, a series of bobbin carriers, means comprising a horned driving member for each lobe of the slot pattern for advancing the carriers in one slot in one direction and the carriers in the other slot in the opposite direction, means at one of the slot intersections for selectively guiding the carriers across the intersection or guiding them into the other slot to reverse their travel, mechanism operable during such reversal for momentarily speeding up the carriers on one side of said intersection, and mechanism operable at the same time for momentarily retarding the carriers on the other side of said intersection; said retarding mechanism comprising retractable horns on one of the driving members adjacent to said intersection, and means for retracting said horns to render them

inoperative within a predetermined region of their travel.

7. In a braiding machine, a plate with intersecting serpentine slots, a series of bobbin carriers, means comprising a horned driving member for each lobe of the slot pattern for advancing the carriers in one slot in one direction and the carriers in the other slot in the opposite direction, the slots being connected by adjacent loops adapted to guide the carriers from one slot to the other and thereby reverse their travel, and means controlling the movements of the carriers during their traverse of said loops to maintain the normal spacing between them, said means comprising mechanism for momentarily speeding up the carriers in one of said loops, and mechanism for momentarily retarding the carriers in the other loop.

8. In a braiding machine, the combination set forth in claim 7, said speeding-up mechanism comprising a wiper movably mounted alongside of the driving member in said first-named loop, and means for moving said wiper at twice the speed of the horns of said driving member.

9. In a braiding machine, the combination set forth in claim 7, said retarding mechanism comprising means for rendering inoperative, within a predetermined region of their travel, certain horns of the driving member in said other loop.

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