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## (54) WOVEN SLIDE FASTENER STRINGER TAPE


(71) We, WILLIAM PRYM-WERKE KG, a German Company of 5—7 Zweifallarstrasse, 5190 Stolberg, Rheinland, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—


This invention relates to a woven slide fastener stringer tape.

According to the present invention there is provided a woven slide fastener stringer tape, comprising fastener elements formed by turns of a fastener element woven into the stringer tape fabric, said fastener element consisting of forward loops which carry the coupling faces and which project from the tape edge, rear arcuate portions of the fastener element which are kept free from threads of the tape fabric for the purpose of guiding the slider, and limbs of the fastener element which connect the forward loops of the fastener element to the rear arcuate portions thereof and alternate with stringer tape weft insertions, warp threads which extend exclusively above or below the limbs of the fastener element and which in a direction opposite to that in which they extend pass through gaps between adjacent limbs of the fastener element and extend below or above the stringer tape weft insertions, the weft insertions which extend over the warp threads running below the limbs of the fastener element being disposed at intervals above a stuffer warp thread extending between the pairs of element limbs in the longitudinal direction of the row of elements, and the weft insertions which pass under the warp threads extending above the fastener element limbs being disposed at intervals below the stuffer warp thread.

Because of the simple course of the warp threads it is in the first place possible to achieve rapid and economical production of the slide fastener which, in the marginal zone of the weave, requires only two groups of warp threads acting in opopsite directions, and the fastener element for forming the row of fastener elements can be shed in the manner of a warp thread with one or other of the sheets of warp threads in the upper or lower part of the shed. Troublesome formation of a superposed shed during weaving is unnecessary, so that very high operating speeds can be used during weaving. Also, no faults in weaving occur as a result of frequent stoppages, since the fastener element, advanced in the manner of a warp thread, can be drawn from a supply bobbin of any required capacity. Only one weft-insertion means is required for the weft thread. Low production costs are ensured by the extremely simple course of the warp threads, since one of the groups of warp threads is passed exclusively above the upper limbs of the fastener element, and the other group of warp threads runs exclusively below the lower limbs of the fastener element, and the shedding of these warp threads occurs in corrrelation with the carrier-tape weft insertions between the element limbs where these two groups of warp threads each bind in opposition to their part of travel in the zone of the fastener element limbs. The special course of the thread in relation to the stuffer warp thread between the pairs of element limbs results however in a particularly high strength between the row of fastener elements and the weave of the tape and a particularly precise shape in the turns of the fastener element when the row of fastener elements is being woven. The stuffer warp thread between the pairs of fastener element limbs precisely defines the vertical gap between the two limbs since these are supported on the stuffer warp thread. In this way the desired constant depth of the

row of fastener elements is achieved. In addition however, the axial distance between, and the position of, the turns of the fastener element within the row of elements formed are precisely determined since the warp threads, extending over the element limbs on one or other side of the row of fastener elements are woven-in with the tap weft insertions which are inserted at least at intervals on each of the opposite sides of the stuffer warp thread, so that binding in of the fastener element limbs on one side of the stuffer warp thread to the weft insertions on the opposite side of the stuffer warp thread is achieved with a minimum of expense and complication in the weaving process. It should be noted in this connection that apart from such warp threads no other weft threads whatever are required in the marginal zone of the slide fastener stringer tape, so that all the thread parts in the marginal zone of the weave contribute towards securing and precisely positioning the row of fastener elements. Since the stuffer warp thread is always disposed between associated pairs of element limbs, each limb is completely surrounded by threads so that the limbs of each associated pair are exactly vertically disposed in relation to each other in the required manner, and also retain this position. Because of the stuffer warp thread disposed between the element limbs it is also impossible for the row of fastener elements to be pulled out between the warp threads and transversely to the axis of tape, and because of the opposite shedding of the warp threads, the row of fastener elements cannot move along the stuffer warp thread.

The strength of the bond of the row of fastener elements and the stability of its position are further increased if the weft insertions are each engaged on opposite sides by two groups of warp threads disposed in a mirror-image arrangement, and the points of engagement, are disposed so that they alternate above and below the stuffer warp thread. This results in double safety for the bond since even if the warp threads of one group should be missing, the connection of the row of fastener elements to the woven tape is maintained by the other group of warp threads, in relation to the stuffer warp thread, of the weft insertions that hold them.

This strength of the connection between the row of fastener elements and the woven tape is further increased by having the stuffer warp thread formed by a plurality of separate threads which extend parallel to each other and are separated from each other by warp threads disposed between them. Since these individual stuffer warp threads can be worked into the weave in a like manner and parallel to each other, it suffices to move them in unison during weaving. The formation of the stuffer warp thread by separate threads also results in the warp threads being precisely positioned on the element limbs without the fastener-element having to be profiled to provide transverse notches or the like to bring the warp threads into the required positions on the element limbs. This aspect is particularly important as regards the innermost warp thread that passes over the element limbs and faces the rear arcuate portions of the limbs which, as previously mentioned, should be kept free from threads of the weave so that the slider can be easily moved. This innermost warp thread can be prevented from slipping simply by providing between it and the rear arcuate portion of the element at last one of the stuffer warp threads disposed on the row of elements, which stuffer warp thread safely prevents such transverse movement.

For the purpose of ensuring that the slider can be easily moved in the ideal manner, the row of fastener elements is caused to project from the plane of the weave of the woven tape on one side thereof. It is then also possible to utilize even the connecting portions between adjacent weft insertions for strengthening the connection and stabilizing the position of the row of fastener elements if these connecting portions are caused to engage the pairs of element limbs on that side facing the projecting element loops in the row of fastener elements.

Some embodiments of the invention will now be described, by way of examples, with reference to the accompanying drawings, in which:—

Figure 1 is an enlarged perspective view, not true-to-scale, of a slide fastener stringer tape produced in accordance with the invention,

Figures 2 and 3 are diagrammatic cross-sections through this slide fastener stringer tape taken along the lines II—II and III—III respectively of Figure 1,

Figure 4 is a further cross-sectional view through another form of slide fastener stringer tape,

Figure 5 is a diagrammatic longitudinal section through the zone of the row of elements of the slide fastener stringer tape of Figure 1 and taken along the line V—V of that Figure,

Figure 6 is a corresponding longitudinal section through a further form of slide fastener stringer tape,

Figures 7*a* to 10*a* are diagrammatic plane views of the slide fastener stringer tape shown in Figures 1 and 5 in the zone where it is being woven and in four different working positions of the various threads,

Figures 7*b* to 10*b* are views, seen in the direction of the warp thread, of the position of the various threads and in the various working positions seen in the associated Figures 7*a* to 10*a* and shown in cross-

sectional view, at the weaving point, on the lines VII*b*—VII*b* to X*b*—X*b* of those Figures,

Figures 11*a* to 14*a* are diagrammatic plan views, corresponding to the plan views of Figures 7*a* to 10*a*, of the working positions of the various threads during the production of another form of slide fastener stringer tape having twice the number of weft insertions per turn of the row of fastener elements, this slide fastener stringer tape being shown in longitudinal section in Figure 6,

Figures 11*b* to 14*b* are again corresponding cross-sectional views through the position of the various threads at the weaving point and for the associated working positions, these sections being seen on the lines XI*b*—XI*b* to XIV*b*—XIV*b* of the respective plan views,

Figure 15 is a diagrammatic side view of an apparatus for producing a slide fastener stringer tape of the kind shown in Figure 1, only the most important components being shown,

Figure 16 is a plan view, partly in section, of the apparatus taken along the lines XVI*a*—XVI*a* and XVI*b*—XVI*b* of Figure 15,

Figure 17 is a corresponding plan view of a modified form of the apparatus of the invention,

Figure 18 shows, on a larger scale than that of the preceding illustrations, a plan view of the rear part of a further form of construction of the apparatus of the invention, and

Figures 19 and 20 are a side view and plan view respectively of the threads in the weaving zone of a last form of construction of the apparatus of the invention for producing a slide fastener stringer tape, the cross-section of which is shown in Figure 4 and is drawn on the line IV—IV of Figure 20.

A first embodiment of slide fastener stringer tape 10, shown in Figures 1, 2, 3 and 5, consists of a stringer tape part 25 used for attaching the slide fastener stringer tape 10 to an article of clothing or the like, and of a marginal part 13, in which, during the weaving of the stringer tape 10, a fastener-element 15 forms a row 14 of fastener elements as a result of there being imparted, to said element 15, coiling movements to be described in detail hereinafter. Warp threads 11 extend in the longitudinal direction of the weave in the stringer tape part 25. These warp threads 11 co-operate with transversely extending weft insertions 34, $34^1$ of a weft thread 12 which however extends not only in the stringer-tape part 25 but also in the marginal part 13 of the slide fastener stringer tape 10. Since, as shown in the plan view of the apparatus seen in Figure 16, the weft thread 12 is inserted into the woven fabric by a weft-inserting needle 17 at the side of the row 14 of fastener elements, each of the weft insertions 34, $34^1$ consists of a looped double thread which, as shown by the plan views of the woven fabric in the various stages of weaving seen in Figures 7*a* to 10*a*, forms, at the opposite selvedge 35 of the woven fabric, loops 36, $36^1$ which are secured, e.g. by knitting these loops 36, $36^1$ within each other to form a selvedge, as seen from Figures 7*a* to 10*a*. It would of course also be possible to insert the weft thread 12 as a single thread by means of a weft shuttle passed backwards and forwards through the woven fabric.

The fastener-element 15, made of a deformable filament of plastics material, forms the row 14 of fastener elements as a result of its travel along a helical path. As seen in Figures 1 to 3, the fastener-element 15 produces, during each helical turn, element loops 20 which project beyond the forward edge of the marginal part 13 and which have coupling faces 21 which, when the slide fastener is closed, engage complementary coupling faces of another stringer tape of the slide fastener. These coupling faces 21 are produced at the required places before the fastener-element 15 is woven in. Positioned on the opposite side of the row 14 of fastener elements are rear arcuate portions 26 of the fastener-element 15 which are free from any threads of the weave and which, particularly as shown in Figure 1, have substantially the same helical pitch. These element loops 20 and arcuate positions 26 of the fastener-element 15 are in each case interconnected by limbs 27, 28 which are superposed substantially vertically in pairs and extend parallel to the plane 32 of the stringer tape part 25, which plane 32 is indicated by a dash-and-dot line in each of Figures 2 and 3. The row 14 of fastener elements could also be formed by turns of a looped thread whereby likewise projecting loops 20 of the elements and limbs 27, 28 of the elements are formed, but here the rear arcuate portions do not serve to connect an upper limb 27 with a following lower limb 28, but alternately connect two adjacent upper limbs 27 and lower limbs 28 to each other. Apart from this difference, the remaining description also applies to such slide fastener. In the longitudinal direction of the row 14 of fastener elements and between the superposed pairs of limbs 27, 28 there extends a stuffer warp thread 60, and the weft insertions 34, $34^1$ of the weft thread 12 alternately pass over and under the top and bottom sides of the stuffer warp thread 60. Furthermore, warp threads 18, 19 extend in the warp direction in the marginal zone 13 of the woven fabric. The warp threads 18 extend exclusively above the upper limbs 27 of the elements

while the warp threads 19 extend exclusively below the lower limbs 28. In the gaps between two adjacent pairs of element limbs 27, 28, each of these warp threads 18, 19 is woven with the weft insertions 34, 34¹ of the weft thread 12, the warp threads 19 in each case being passed over a weft-thread insertion 34, 34¹, whereas each of the warp threads 18 is in each case passed below the weft insertions. The warp threads 18, 19 are thus woven to form mirror images of each other. Since the warp threads 18 and 19 are arranged respectively above and below the weft thread insertions 34, 34¹, weaving-in occurs only in co-operation with the limbs 27, 28 of the elements forming the row 14, where the warp threads 18, 19 are in each case passed round on the outside. This co-operation between the transverse limbs 27, 28 of the fastener element and the weft insertions 34, 34¹ on the one hand and the longitudinally extending warp threads 18, 19 and the stuffer warp thread 60 on the other results in an ideal weaving-in arrangement whereby the distances between the limbs of the fastener elements are determined, as seen in Figure 5. When the warp threads 18, 19 are woven-in with the weft-thread insertions 34, 34¹ and in the gaps between the pairs 27, 28 of limbs, the warp threads engage around each individual helical turn of the row 14 of fastener elements so that not only axial displacement is prevented but also radial swinging movement of the row 14 of elements since the elements are embraced in pairs. In this arrangement the stuffer warp thread 60 fills the gap between associated pairs of limbs 27, 28, so that the level of the row 14 of elements is precisely determined. For reasons of greater clarity, the stuffer warp thread 60 is not drawn true-to-scale in Figure 5, but is shown as being smaller than it actually is.

As already mentioned, the rear arcuate portions 26 of the row 14 of the elements of the slide fastener stringer tape 10 according to the invention are completely free of weft threads as well as warp threads as shown not only in Figures 2 and 3 but also in Figure 1. The row 14 of fastener elements is raised on one side from the plane 32 of the stringer tape part 25 so that a good guide surface for a fastener slider (not shown) is created. The weft insertions 34, 34¹ of the stringer tape are woven with the two groups of warp threads 18, 19 in a mirror-image arrangement, and these points 37, 37¹ of weaving alternate above and below the stuffer warp thread 60. In this slide fastener stringer tape 10, only one single weft-thread insertion 34, 34¹ forms a complete helical turn which encompasses a pair of element limbs 27, 28. However, other forms of weaving are possible without departing from the scope of the invention as defined in the appended claims; one of these other forms is shown for example in the longitudinal sectional view of Figure 6, where a different embodiment of a slide fastener stringer tape 10¹ is illustrated.

The slide fastener stringer tape 10¹ differs from the one previously described mainly in that a total of two weft insertions 38, 39 and 38¹, 39¹ are made in the course of a complete helical pitch where corresponding limbs 27, 28 of the fastener elements are produced, so that the fabric of the stringer tape part 25 has twice the density of weft threads. As regards the stuffer warp thread 60 running in the interior of the elements, the contact zones 37, 37¹ of the warp threads 18 and 19, passed respectively above and below, extend alternately twice above, at 37¹, and twice below, at 37, the stuffer warp thread 60. As shown in Figure 6, a particularly stable tying-in of the row of fastener elements is achieved since two such contact points of the weft insertions are disposed between each two adjacent upper limbs 27 and 28 of the elements, namely an upper contact point 37¹ and a lower contact point 37 for the upper limbs 27 of the elements in each case, and, in the case of the lower limbs 28 two upper engagement points 37¹, 37¹ alternating with two lower ones 37, 37. In this slide fastener stringer tape 10¹, a total of four weft insertions 38, 39 and 38¹, 39¹ is involved in the tying system in the zone of the row of fastener elements.

The tying arrangement could also be varied by for example using only one group of warp threads 18 in the slide fastener stringer tape 10, the contact points then however being disposed exclusively below the stuffer warp thread 60 as shown at 37, since all the weft insertions 34 are passed through only below the stuffer warp thread 60. It would also be possible for not all of the warp threads to contact each weft insertion; instead it would suffice if only some of the warp threads of a group were passed through the gap between each two adjacent limbs 27, 27 and 28, 28 of the fastener elements and contact a weft insertion disposed therebetween, but within a tying arrangement, each warp thread 18, 19 is passed once around one such weft insertion in the direction opposite to that of its path on the limbs of the elements, during at least one operating stage.

A woven slide fastener stringer tape of this kind can be produced by means of an apparatus, the most important components of which are shown in detail in Figures 15 and 16. To permit passage of the initially mentioned weft inserting needle 17, shown in side view in Figure 15 and in plan view in Figure 16, the warp threads 11 of the stringer tape part 25, the fastener-element thread 15 and the two groups of warp

threads 18, 19 must be spread out to form a suitable shed which is shown in side view in Figure 15. In the present case normal heald shafts 22, 23 serve as the means for shedding the warp threads 11 of the stringer tape part 25. The number of these shafts will depend upon the kind of weave required, and they have healds 24, provided at the middle with guide eyes for passing the warp threads 11 of the stringer tape through. The control lever system for moving these shafts 22, 23 in the direction indicated by the arrow 29 is of a standard design and is not therefore illustrated. To the rear of the heald shafts 22, 23 are located the means for shedding the warp threads 18, 19, which means take the form of half healds 41, 42 of the required number which each have at their ends eyes 44 through which one of these warp threads 18, 19 passes. These half healds are moved up and down in the direction of the arrow 45 in rhythm with the weaving operation by means of a known control lever system, likewise not illustrated, and during such movement the half healds pass through the working plane 49 of the weft-insertion needles 17, shown by a dot-and-dash line in Figure 15. This movement through the plane 49 has just taken place in the stage illustrated in Figure 15, since the half healds 42 for the lower warp threads 19 normally located in the lower part of the shed below the operating plane 49 through the middle of the shed, have just been raised into the upper part of the shed in Figure 15, whereas conversely, the half healds 41 for the warp threads 18 which are moved downwards, are moved through the operating plane 49 into the lower part of the shed, in a mirror-image arrangement. The warp threads 18, 19 are drawn from supply bobbins, not shown, and are guided in the weft direction as indicated by the arrow 50 around two guide rolls 48, 48¹ spaced from each other in the vertical direction.

To the rear of these half healds 41, 42 is located a driven rotor 47 which takes the form of a flat circular disc-like wheel. As seen in Figure 16, the rotor 47 is disposed diagonally to the warp direction 50 so that on that side facing the weft-insertion means 17 there is provided space in front of the rotor 47 for the half healds 41, 42. The rotor 47 is accommodated in an annular supporting housing 46 which has an internal channel in which the rotor 47 runs. This can be best seen from the sectional illustration in Figure 16 where the rotor 47 is shown in section taken along the line XVI*b* of Figure 15, but in a position rotated therefrom. As shown in Figure 15, the rotor 47 has an opening 56 near its edge for guiding the fastener-element 15. In Figure 16 this opening is shown in a substantially horizontal position 56¹. Around its periphery the rotor 47 has teeth 51 which mesh with a toothed wheel 52 which is driven by a shaft 53 in the direction of the arrow 54 so that rotation is imparted to the rotor disc 47 in the direction indicated by the arrow 43. The mounting and the drive motor for the shaft 53 and the means for securing the support housing 46 are omitted from the drawings for the sake of clarity. The diameter and vertical position of the rotor 47 are such that the fastener-element thread 15 is passed from the upper part of the opened shed and then into the lower part of the shed upon further rotation.

The rotor 47 is provided with a central insert 55 which is stationary when the rotor turns in the direction of arrow 43. This insert 55 serves firstly for applying one end 31 of an element-forming mandrel 16 which is arranged always to rest on one side of the aforementioned operating plane 49 of the weft-insertion means 17 i.e. in the present case below this plane 49, whereas the other free discharge end 33 of the mandrel 16 extends some distance into the interior of the row 14 of fastener elements as shown in Figures 15 and 16.

The insert 55 also has a hole 59 through which passes the stuffer warp thread 60 which is drawn from a supply bobbin 67 disposed to the rear of the rotor 47. The supply bobbin 67 is mounted on a hollow shaft 69 which has an axial bore and forms part of a rotating means 40 to be described later. The fastener-element 15 is threaded through the axial bore of the hollow shaft 69 before it reaches the hole 56 in the rotor 47. The supply reel for the fastener-element 15 is located farther to the rear of this rotating means 40 and is therefore not shown in the drawings. The threads advanced in the warp direction 50, i.e. the warp threads 18, 19, the fastener-element 15 and the stuffer warp thread 60, as well as the warp threads 11 of the stringer tape part are beaten up at the fell 57 of the fabric by a reed 30 after each weft thread 12 has been inserted and after completion of the shedding, while the reed 30 is travelling in the direction indicated by the arrow 58 from its solid-line position as shown in the drawing to the position 30¹ shown in dot-and-dash lines. During weaving, that portion of the fastener-element 15 located between the fell 57 and the rotor 47 executes a movement along a generated conical path about the mandrel 16 and about the stuffer warp thread 60. The base circle of this conical path is determined by the circular movement, in the direction of the arrow 43, of the hole 56 in the rotor 47. The apex of the cone is located at the fell 57 of the fastener-element 15, at the point where the row 14 of fastener elements is created.

The operating zone 49 (Fiugre 15) for the

upward and downward movement 45 of the half healds 41, 42 is determined by this conical path as shown in more detail in Figure 16. This operating zone must lie within a triangular area which results from the insertion of the aforementioned conical path and the above-mentioned operating zone 49 of the weft-inserting means 17. In Figure 16 can be seen the two other corner points of the triangular area which forms the possible working zone for the longitudinal movement of the half healds 41, 42, since the section through the rotor 47 shown in Figure 16 lies approximately in this operating zone 49 of the weft-inserting needle 17. One of the corner points of the triangle is determined by one of the lateral positions i.e. $56^{1}$ of the guide eye for the fastener-element 15 in the rotor 47, whereas the other corner point of the triangle is determined by the diametrically opposite position $15^{11}$ of the fastener-element 15 where the guide eye is in the position designated $56^{11}$ in Figure 16. The half healds 41, 42, of which more than the four shown can of course be provided if necessary, operate in this triangular area 57, $56^{1}$, $56^{11}$. In the case of a slide fastener stringer tape which is intended for use on articles of clothing and which has the normal width of the finished row 14 of fastener elements, eight such half healds will be provided for eight warp threads 18, 19. When the stuffer warp thread 60 is disposed centrally in the row of fastener-elements, one half of the half healds 41, 42 is advantageously disposed on each side thereof as will be seen from Figure 16, the element-shaping mandrel 16 also extending on both sides of said stuffer warp thread 60.

Upon rotation of the rotor 47 and because of the movement of the fastener-element 15 along a conical path, the required turns about the element-shaping mandrel 16 and the stuffer warp thread 60 in fact occur in the zone of the fell 57, but when the motor turns in the direction 43 the fastener-element 15 also moves along a conical path, inverted in relation thereto, on the rear side of the rotor 47, so that there would likewise occur undesirable looping of the fastener-element 15 in the opposite direction around the stuffer warp thread 60 guided through the stationary hole 59 in the insert 55 of the rotor 47, if steps were not taken to counter this. This undesirable looping at the rear side is compensated by the rotating means 40. This compensation is achieved by means of an off-winding rod 70 which is fitted to the hollow shaft 69 of the rotating means 40 and which, as shown in Figure 15, contains a hole 72 which determines the point at which the stuffer warp thread 60 runs off the supply roll 67. Instead of or in addition to a bobbin brake, the brake spring 76 of which is shown, a toothed locking wheel 65 is coupled with the supply bobbin 67, and this wheel 65 is released at the correct moment by components mentioned below and shown in Figure 15, so that a further portion of the stuffer warp thread 60, corresponding to the amount dealt with at the fell 57, is released. The stuffer warp thread 60 passes through a further eye 73 which is loaded by a tension spring 66, one end of which is fitted to the off-winding rod 70; longitudinal displacement of this eye 73 serves to store a short portion of the stuffer warp thread 60 on the off-winding rod 70. Also secured to this rod 70 is a pivot 74 which carries an angled lever 75 one end of which carries a pawl 77, normally engaged in the locking wheel 65 since a return spring 78 engages the other end of the angled lever 75. Also linked to this end of the angled lever 75 is a lever system 79 which the eye 73 strikes when, after the stored length of stuffer warp thread 60 has been used up, its tension spring 66 is at maximum tension. The angled lever 75 is turned by way of the lever system 79 against the action of the return spring 78, and the pawl 77 is thus lifted from the locking wheel 65 so that the supply bobbin 67 can turn freely and releases thread material. As this happens, the tension spring 66 pulls the eye 73 back again so that the pawl 77 is then returned to its locking position on the locking wheel 65 by the action of the return spring 78.

The above-mentioned compensation of the unrequired looping between the fastener-element 15 and the stuffer warp thread 60 to the rear of the rotor 47 is achieved in that the off-winding rod 70 rotates with the hollew shaft 69 in the direction indicated by the arrow 68, this rotary movement occurring synchronously with the movement of the rotor 47 in the direction 43. This results in a circular movement, in the direction of the arrow 71, of the stuffer warp thread 60 to the rear of the rotor 47, which movement prevents undesirable twisting at this point between the stuffer warp thread 60 and the fastener-element 15.

Due to the position of its guide hole 59 in the rotor insert 55, the stuffer warp thread 60 is normally disposed in the lower part of the shed below the plane 69 in which the weft-inserting needle 17 is inserted and where, as shown in Figure 15, the element-shaping mandrel 16 also always extends. Accordingly, as shown in Figure 5, the weft insertions $34^{1}$ extend above the stuffer warp thread 60. To enable the stuffer warp thread 60 to pass to the required positions in the woven fabric above the weft insertions 34, a pusher 62 is disposed in the zone in which the shed opens, which pusher 62 is raised in the direction indicated by the arrow 63 in

Figure 15 by a conventional control lever system, not illustrated, since then a notch 64 in one of the end faces of the pusher 62 engages the stuffer warp thread 60, extending in alignment therewith, and raises it into the upper part of the shed.

The weaving operation for producing the first form of woven slide fastener stringer tape 10 in accordance with Figures 1, 2, 3 and 5 will now be described in greater detail by reference to four working positions illustrated in Figures 7*a* to 10*b*.

In the first working position as shown in Figures 7*a* and 7*b*, a first weft insertion 34 of the weft thread 12 has just taken place from the side at which the row of fastener elements is located and in the direction indicated by the arrow 80. As shown in Figure 7*b*, the warp threads 11 in the stringer tape part 25 are shed in accordance with the weave desired and a shed is also formed in the marginal part 13 to enable the weft thread 34 to pass through. As seen from the cross-sectional view in Figure 7*b*, the element-shaping mandrel 16 is always located in the lower part of the shed, and this also applies as regards all further working positions. The circle 81, shown as a dash-and-dot line is intended to indicate the circular movement of the fastener-element 15 illustrated in Figure 7*b* when this moves along the conical path that it generates. In the illustrated working position 7*b* the fastener-element 15, as indicated, is also located in the upper part of the shed above the weft insertion 34. If, for the purpose of indicating more precisely the particular location of the fastener-element 15 in the various rotary positions, these positions are related to the numbers on a clock, then the fastener-element 15 is at approximately two o'clock in Figure 7*b*. The cross-section of the stuffer warp thread 60, indicated by cross-hatching, shows that, by means of the above-mentioned pusher 62, the stuffer warp thread 60 has been moved into the upper part of the shed above the weft 34. The locations reached by the warp threads as a result of the shedding movement of the half healds 41 and 42 respectively are indicated by the arrows $41^1$ and $42^1$. It will be seen that the upper group of warp threads 18 are moved below the weft 34 into the lower part of the shed, whereas the lower group of warp threads 19 have been moved, in a mirror-image arrangement, through the insertion plane and into the upper part of the shed, above the weft 34. This position of the various threads will also be seen from the plan view shown in Figure 7*a*. In this operating stage a rear arcuate portion 26 of an element 15, which is above the weft, is just being formed along the row 14 of fastener elements.

In the two working positions shown in Figures 8*a* and 8*b*, the fastener-element 15 has moved on in the direction of the arrow 43 through more than 90° along its conical path, represented by the dash-and-dot circle 81, so that the element 15 has just reached the six o'clock position. The weft insertion 34 has been completed by the insertion needle, designated by the numeral 17 in Figure 16, and the needle 17 has been completely withdrawn from the shed. While this is happening, the loop end 36 of the weft insertion 34 is held fast and is passed through a preceding loop $36^1$ to knit the selvedge. The element-shaping mandrel 16 occupies its same position on the under side of the weft-thread insertion plan 49, here shown by a dash-and-dot line, i.e. said mandrel is below this plane. The shed of warp threads 11 in the zone of the stringer tape part 25 has closed again. The pusher 62 has released the stuffer warp thread 60, so that the latter is located in its normal position below the weft-thread insertion plane 49 in which it remains during the subsequent steps of the operation as shown in Figures 9*a*, 9*b* and 10*a* and 10*b*.

While, as shown by the arrow $41^1$, the warp threads 18 remain within the circle 81 of the conical path around which the fastener-element 15 passes, and as illustrated, they occupy a position that is practically unchanged from the preceding operating position of Figure 7*b*, the arrow $42^1$ in Figure 8*b* shows that the warp threads 19 have been moved out of the conical path and are located at an adequate distance 82 from the fastener-element 15, the warp threads 18 located within the cone also being disposed at a sufficient distance 83 from the fastener-element 15.

Thus, when the fastener-element 15 is located on that side of the conical path 81 that faces the warp threads 19, the two sheets of warp threads 18, 19 are spread out in the manner of a shed so that there is here formed a passage 83, 82 for unimpeded movement of the fastener-element 15. In this stage of movement the fastener-element 15 forms the lower limb 28 for the next turn in the row 14 of fastener elements, as shown in Figure 8*a*.

In the operating position shown in Figures 9*a* and 9*b*, the fastener-element 15 has moved on through 180°, so that it has reached the twelve o'clock position. In the meantime, the stuffer warp thread 60 and the warp threads 11 have not changed their position, and the element-shaping mandrel 16 remains below the insertion plane 49, again shown by a dash-and-dot line in Figure 9*b*. As indicated by the arrows $41^1$, $42^1$ however the position of the warp threads 18, 19 has been reversed, so that the warp threads 18 are now disposed below the conical path 81 at a distance $82^1$, whereas

conversely the other group of covering threads 19 is disposed on the other side and preferably already occupies that position within the conical path 81 that is required for the next operating position to be described by reference to Figures 10*a* and 10*b*. Thus, a shed-like passage $82^1$, $83^1$ is again created by the upper group of warp threads 18 to permit the fastener-element 15 to move on in an unrestricted manner. Prior to this, the loop 20 provided with the actual coupling faces, will have been formed in the row of fastener elements on the foremost helical turn, and in this operating position as shown in Figure 9*b* the upper limb 27 of an element will also have been created, as can be seen from Figure 9*a*.

In the last operating position as shown in Figures 10*a* and 10*b*, the fastener-element 15 moves on through about 60° in the direction indicated by the arrow 43, so that the two o'clock position is again reached. The fastener-element 15 is located in the upper part of the shed, the threads of which are now again shed for permitting the next weft insertion $34^1$, which can be seen from the position of the warp threads 11 in the stringer tape part 25. This time the stuffer warp thread 60 is located in the lower part of the shed together with the element-shaping mandrel 16 within the space enclosed by the conical path as indicated by the dash-and-dot circle 81. Within this space there are now also located the warp threads 18, 19, and whereas, as indicated by the arrows $42^1$, the lower warp threads 19 occupy the position visible from the preceding operating position, the warp threads 18 of the upper group have been moved through the insertion plane to a position below the weft insertion $34^1$. A rear arcuate element portion 26 for the next helical turn of the row 14 is then formed again. As shown in Figure 10*a*, as this happens, the weft loop $36^1$ is again drawn through the preceding loop 36. This operating position corresponds to the first position described in connection with Figures 7*a* and 7*b* but with the difference that here the stuffer warp thread 60 is located in a lower position. The stuffer warp thread 60 is moved in the same direction as the warp threads 19 during the weft insertion 34, whereas during the following weft insertion $34^1$ the stuffer warp thread 60 moves in the same direction as the other group of warp threads 18, as already explained in connection with Figure 5.

As can be seen by comparing Figures 8*b* and 9*b* on the one hand with Figures 7*b* and 10*b* on the other, the two passages 82, 83, and $82^1$, $83^1$ respectively extend in the direction parallel to the spread of the shed of the warp threads 11 for making the weft insertions 34, $34^1$, but are offset vertically therefrom and from each other, and whereas the weft insertion 34, $34^1$ takes place approximately in the zone of the longitudinal central axis of the conical path, the passages are created at the topmost and lowermost positions respectively along the circular path of movement. Furthermore, it will be seen from the sequence of the above-mentioned operating steps, that the opening of the shed of warp threads and the formation of one or other of the passages 82, 83 and $82^1$, $83^1$ take place one after the other chronologically.

In a similar way, the weaving process for producing a slide fastener $10^1$ using corresponding operating steps is illustrated in Figures 11*a* to 14*b*, the fabric also being shown in longitudinal section in Figure 6. This slide fastener $10^1$ is distinguished by a double density of weft insertions. The same reference numerals as those used in the first example are employed for designating similar parts, so that the same description applies as regards these similar parts and only the special features of this further example will be described in detail.

In the first operating position seen in Figures 11*a* and 11*b*, the fastener-element 15 is in the six o'clock position, the previously mentioned passage 82, 83 having been formed between the warp threads 18, 19. Here again, the element-shaping mandrel 16 is located below the plane 49 in which the weft thread is inserted and where the stuffer warp thread 60 is also held during the four operating positions now to be described. As seen from Figure 11a, the lower limb 28 of an element is formed as indicated at the point A in Figure 6.

While the fastener-element 15 was being moved through less than 90° along the circle 81 of the conical path in the direction indicated by the arrow 43, a first weft insertion 38 is made, while the fastener-element 15 is still in the lower part of the shed in the eight o'clock position. While the warp threads 18 remain in the previous position below the weft-insertion plane, the other warp threads 19 will have moved through the insertion plane into the interior of the conical path so that they are now located above the weft insertion 38. As shown in Figure 12*a*, the element loop 20 is formed around the shaping mandrel 16 during this stage.

In the operating position shown in Figures 13*a* and 13*b*, the upper passage $82^1$, $83^1$ has been formed for the fastener-element 15 in the zone of its twelve o'clock position, the warp threads 18 again being disposed at a distance outside the conical path. As seen in Figure 13*a*, the upper limb 27 of an element is formed as this happens, and is shown at B in the longitudinal section illustrated in Figure 6.

In the fourth operating position shown in Figures 14*a* and 14*b*, the fastener-element

15 has moved along its circle 81 in the direction of the arrow 43 through approximately 60° and has reached approximately the two o'clock position so that it coincides with the warp threads 11 in the upper part of the shed, and the next weft insertion 39 can pass below it. The warp threads 18, 19 are again moved through the weft-insertion plane in a mirror-image arrangement, and are disposed on opposite sides of this weft insertion 39. During this phase of the movement of the fastener-element 15, a rear arcuate portion 26 is formed in the row 14 of fastener-elements as shown in Figure 14*a*.

Before the entire woven connection is completed within the marginal part of this slide fastener stringer tape $10^1$, the four described operating positions involving the warp threads 18, 19 and the fastener-element 15 occur again, the next element limbs 27, 28, a rear arcuate portion 26 and a loop 20 for the coupling being formed as can also be seen from the longitudinal section shown in Figure 6, but the position of the stuffer warp thread 60 is raised as regards the weft insertions $38^1$, $39^1$ that now take place, in acocrdance with the previously described second and fourth operating positions. For this purpose the stuffer warp thread 60 is held in the raised position above the weft-insertion plane 49 by means of its pusher 62 from the second up to and including the fourth subsequent working position, this not being illustrated. Complete woven connection in the marginal zone of the slide fastener $10^1$ thus involves the mode of operation illustrated in Figures 11*a* to 14*b* being carried out twice, with a total of four weft insertions 38 to $39^1$. Only then is the cycle repeated.

Figure 17 shows a plan view, similar to that of Figure 16, of another form of the apparatus. Where the components are unchanged, description thereof is the same as for Figure 16. The important difference resides in the fact that the element-shaping mandrel is bifurcated to provide two arms $16^1$ and $16^{11}$ which enclose the above-described working zone of the longitudinal movement of the half healds 41, 42. The two mandrel arms 16 and $16^1$ converge in the direction of the fell 57 of the row 14 of fastener-elements, but a gap 84 remains between the ends $33^1$ and $33^{11}$ of the arms, which gap corresponds to the required internal width of the row 14 of fastener elements. In this way the elements are shaped more precisely and the elements are positioned in a more accurate manner. The two arms 16 and $16^1$ of the element-shaping mandrel are of course located within the conical path generated by the fastener-element 15 as will be clearly seen from the diametrically drawn positions of the element 15 and its position $15^{11}$ shown in dash-and-dot lines.

Figure 18 illustrates a modified form of the components disposed to the rear of a rotor 47. The warp threads 11 advanced in the warp direction 50 and the two groups of warp threads 18, 19 are shown in their positions, but the warp threads are omitted from the drawing in the zone of the guide rollers 48, $48^1$ in order to make the drawing clearer. The supply bobbin 67 for a stuffer warp thread 60 is positioned to the rear of the rotor 47 in a space within the generated conical path which is formed by the portion of the element 15 that is fed to the guide eye 56 in the rotor 47. In principle, a rotating means for preventing undesirable twisting between the fastener-element 15 and the stuffer warp thread 60 can be dispensed with in this case. However, since in the present example the stuffer warp thread 60 does not consist of a single thread but of a plurality of stuffer warp threads 61, $61^1$, $61^{11}$, which are wound side by side on a common supply bobbin 67, a special positioning device 90 is provided for proventing the individual stuffer warp threads 61, $61^{11}$ from becoming twisted with each other when the supply bobbin 67 delivers this thread material during the weaving process. The positioning device 90 ensures that the point at which this thread material is pulled off remains in the illustrated position, this pull-off point taking the form of a slot 85 formed in a stationary bobbin case 86.

For this purpose the supply bobbin 67 is mounted by its spindle 87 in said case 86. A brake spring 76 surrounding the free end of the bobbin spindle 86 inhibits rotation of the supply bobbin 67 through a brake disc 88. A radial flange 89 is connected to the bobbin case 86, and this flange carries on its peripheral surface a ball and roller bearing 91 on which a race ring 92 runs with as little friction as possible and in synchronism with the rotor 47. The race ring 92, which has a toothed ring 93 at its outer periphery, is driven by a gear wheel 94 which is mounted on a drive shaft 95 and is caused to rotate by a motor, not illustrated. At its outer edge the race ring 92 has a bore 97 which extends parallel to its axis and through which is threaded the fastener-element 15 which is drawn from a supply roll, not illustrated, located to the rear of the supply bobbin 67 for the stuffer warp thread 60.

At the side of its toothed ring 93, the race ring 92 carries further ball and roller bearing units 98 and 99 which ensure that the race ring 92 runs, as free from friction as possible, in a two-part casing 96, which in shape resembles a pair of spectacles and which, as indicated at 100 is secured to the apparatus frame, not illustrated. The casing 96 has at a point along its periphery a radial slot 101 through which extends the gear wheel 94 that drives the race ring 92 and

that meshes with the toothed ring 93. This ensures that the race ring 92 rotates while the outer casing 96 is held fast and that said ring does not entrain the bobbin case 86 disposed within it. In this way, the fastener-element 15 executes, in the zone of the supply bobbin 67, a circular movement in the direction indicated by the arrow 102 around the stationary bobbin case 86. The rear conical path generated by the fastener-element 15 is thus extended since because of this synchronized arrangement the bore 97 in the race ring 92 moves in alignment with the guide eye 56 in the rotor 47, so that after a half-turn of the rotor, the fastener-element 15 also moves from the solid-line position into the dash-and-dot position $15^{11}$ on the rear side of the rotor.

The various stuffer warp threads 61, $61^{1}$, $61^{11}$, after leaving the run-off point in the slot 85 in the bobbin case 86, are each passed through a corresponding bore 59, $59^{1}$ or $59^{11}$ in a suitably shaped rotor insert 55 before they reach the front side of the rotor 47. During this circular movement, the rotor insert 55 is stationary so that if necessary it may be connected to the likewise stationary bobbin case 86. The stuffer warp threads 61 to $61^{11}$ move side by side in a horizontal plane at predetermined distances apart, in the zone of the element-shaping mandrel which in the present case is preferably bifurcated to form two arms $16^{1}$ and $16^{11}$ as previously explained in connection with the foregoing examples of Figure 17.

The further path taken by these stuffer warp threads 61 to $61^{11}$ in the zone of the weaving point can be seen from Figures 19 and 20 which show respectively a side view and plan view of the corresponding weaving point. The same reference numerals as in the first example seen in Figures 15 and 16 are used for designating similar components. The slide fastener stringer tape $10^{11}$ produced in accordance with the example illustrated in Figures 19 and 20 is also shown in cross-section in Figure 4.

Referring to Figure 20, a pair of warp threads 18, 19, binding in opposite directions to each other, are arranged in each gap between stuffer warp threads 61 to $61^{11}$ disposed at predetermined distances 103 apart, and as shown in Figure 4, there is positioned on the rear arcuate portions 26 of the row 14 of fastener-elements, the innermost stuffer warp thread $61^{11}$ forwardly of which there is no further upper warp thread 18 that could slide over this rear arcuate portion 26 of an element. This arrangement ensures that the rear arcuate portions of the elements are kept free from threads for the purpose of guiding the fastener slider. In Figures 19 and 20, the stuffer warp threads 61 to $61^{11}$, the fastener-element 15 and the warp threads 18 and 19 occupy a position as explained in detail in connection with the operating position shown in Figures 7*a* and 7*b*. The stuffer warp threads 61 to $61^{11}$ are engaged by associated pushers 62, as shown in Figure 19 and each having a notch 63 at its end face, and are raised into the upper part of the shed and over the plane 49 in which the insertion needle 17 operates For this purpose the various pushers 62 are mounted on a common holder 104 which will have been raised in the direction indicated by the arrow 63. At this stage in the movement a rear arcuate portion 26 of an element is just being formed as shown in Figure 20. The weft-insertion needle 17 is just moving, in the direction of the arrow 80 seen in Figure 20, into the formed shed and is executing a new weft insertion 34.

It should be noted that the two arms $16^{1}$ and $16^{11}$ of the mandrel, which embrace all the stuffer warp threads 61 to $61^{11}$ and all the warp threads 18 and 19, are disposed one on each side of the working plane 49, shown by a dash-and-dot line, of the weft-inserting needle 17. Whereas one arm $16^{1}$ of the mandrel always extends above the working plane 49, the other arm $16^{11}$ is kept below this plane 49. This leads to a particularly precise weaving-in of the various threads by each of the weft insertions 34, $34^{1}$. Furthermore the required internal width of the turns of the row 14 of fastened elements is precisely maintained in correspondence with the distance 84 between the two arms $16^{1}$ and $16^{11}$ of the mandrel.

It will be seen from Figures 1, 7*a* to 10*a* and 20 that the row of fastener elements 14 which is disposed on one side of the stringer tape fabric and which, in Figures 2 and 3, stands proud of the plane 32 of the stringer tape part 25 on one side, and in Figure 4 on the other side, are engaged by each of the connecting portions 105 between successive weft insertions 34, $34^{1}$ at the junction with the projecting loop 20 of each element, whereas the weft insertions 34, $34^{1}$ run through below the fastener-element 15 in the zone of the rear arcuate portion 26 of each element. These connecting portions 105 thus contribute to the strength of the weave between the row of fastener-elements and the stringer tape fabric on account of this opposite course of the weft thread on the two longitudinal edges of the row 14 of fastener-elements. This also applies as regards the slide fastener stringer tape $10^{1}$ of Figures 11*a* to 14*b*, for which dense weft insertions 38 and 39 are used and where corresponding connecting portions 105 extend over each of the limbs 28 of the elements.

The methods and apparatus described above form the subject of our co-pending United Kingdom Patent Application No. 27177/1974 (acceptance No. 1,449,582).

WHAT WE CLAIM IS:—

1. A woven slide fastener stringer tape, comprising fastener elements formed by turns of a fastener element woven into the stringer tape fabric, said fastener element consisting of forward loops which carry the coupling faces and which project from the tape edge, rear arcuate portions of the fastener element which are kept free from threads of the tape fabric for the purpose of guiding the slider, and limbs of the fastener element which connect the forward loops of the fastener element to the rear arcuate portions thereof and alternate with stringer tape weft insertions, warp threads which extend exclusively above or below the limbs of the fastener element and which in a direction opposite to that in which they extend pass through gaps between adjacent limbs of the fastener element and extend below or above the stringer tape weft insertions, the weft insertions which extend over the warp threads running below the limbs of the fastener element being disposed at intervals above a stuffer warp thread extending between the pairs of element limbs in the longitudinal direction of the row of elements, and the weft insertions which pass under the warp threads extending above the fastener element limbs being disposed at intervals below the stuffer warp thread.

2. A woven slide fastener stringer tape as claimed in claim 1, in which the stringer tape weft insertions are each engaged on opposite sides by two groups of warp threads disposed in a mirror-image arrangement, and the points of engagement are disposed so that they alternate above and below the stuffer warp thread.

3. A woven slide fastener stringer tape as claimed in claim 1 or claim 2, in which the stuffer warp thread is formed by a plurality of separate threads which extend parallel to each other and are separated from each other by warp threads disposed between them.

4. A woven slide fastener stringer tape as claimed in claim 3, in which between the innermost warp thread passing over the limps of the fastener element, on the one hand, and the rear arcuate portions of the fastener elements of the row, on the other hand, is disposed a last of the separate threads, forming the edge of the stuffer warp thread.

5. A woven slide fastener stringer tape as claimed in any one of claims 1 to 4, in which the weft thread, which passes between adjacent of said weft insertions extends over the row of fastener elements, projecting from the plane of the weave of the stringer tape fabric on one side thereof, on that side of the pairs of element limbs that faces the projecting element loops.

6. A woven slide fastener stringer tape substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

7. A slide fastener having a woven slide fastener stringer tape as claimed in any preceding claim.

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