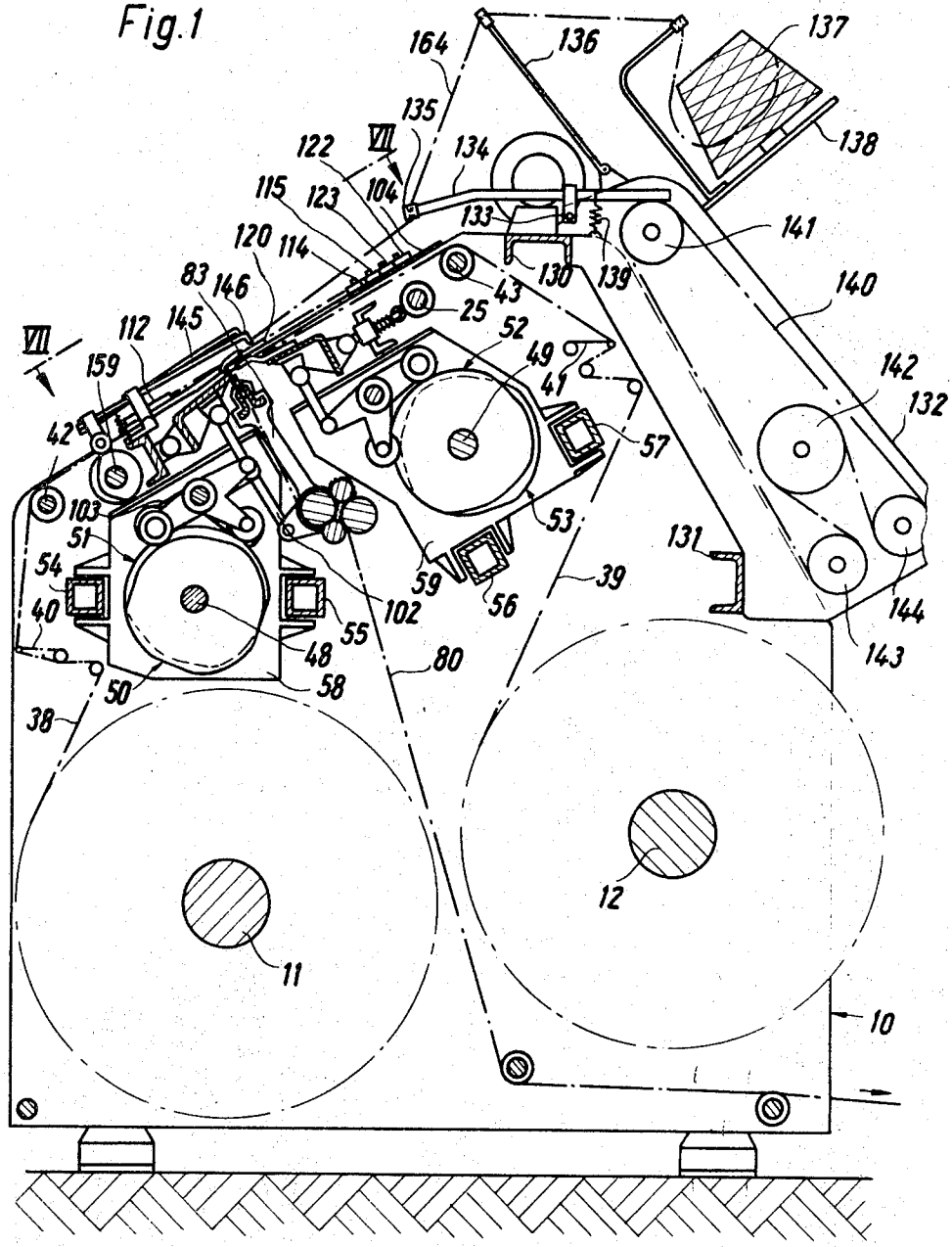
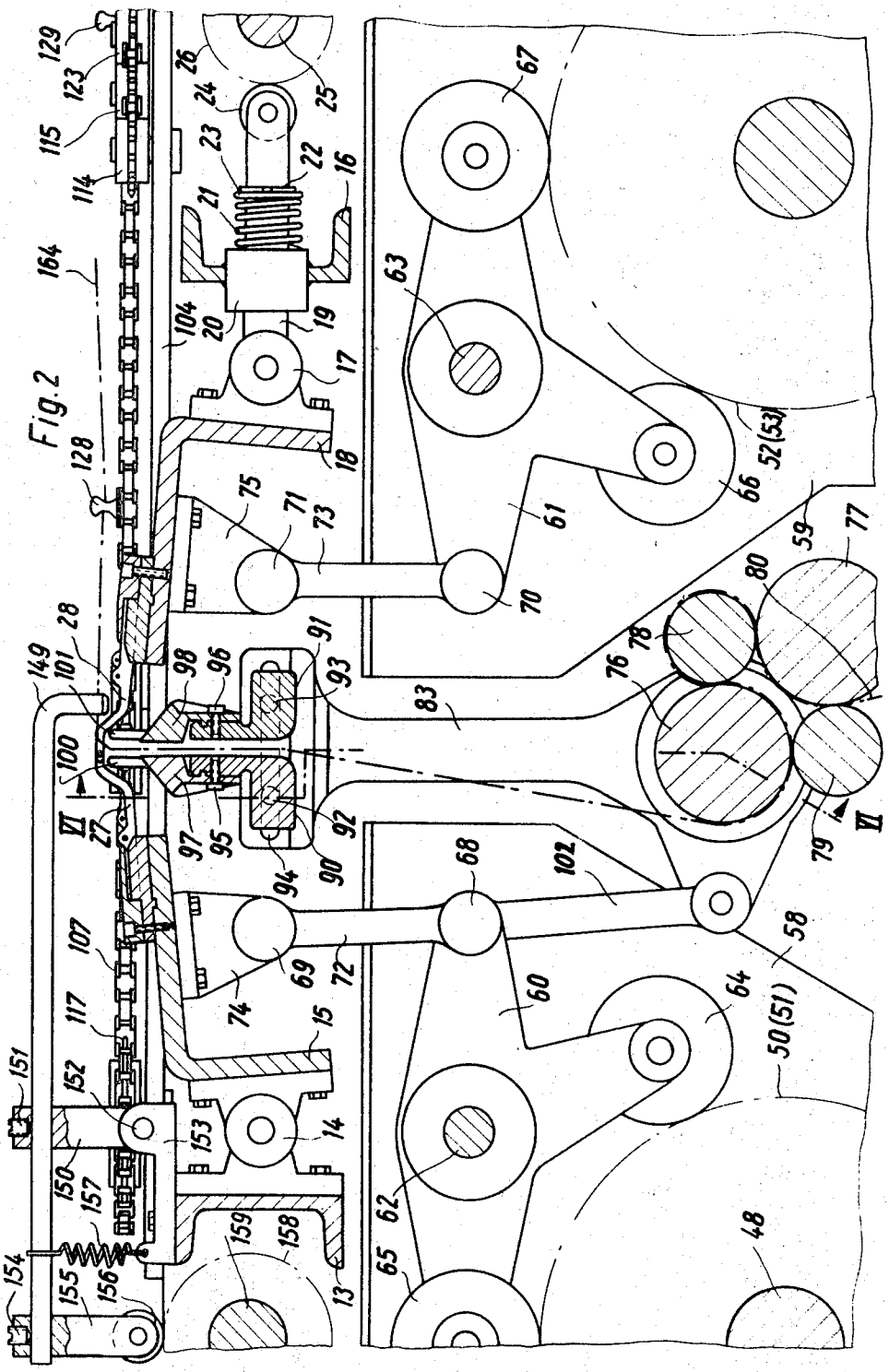
Sept. 22, 1970 W. PALANGE 3,529,443
PROCESS AND DEVICE FOR SHOOTING IN FILLING YARNS FOR WARP KNITTING MACHINES
Filed June 7, 1968 9 Sheets-Sheet 1

Fig.1



Sept. 22, 1970 W. PALANGE 3,529,443
PROCESS AND DEVICE FOR SHOOTING IN FILLING YARNS FOR WARP KNITTING MACHINES
Filed June 7, 1968 9 Sheets-Sheet 2

Fig. 2



Sept. 22, 1970 W. PALANGE 3,529,443

PROCESS AND DEVICE FOR SHOOTING IN FILLING YARNS FOR WARP KNITTING MACHINES

Filed June 7, 1968 9 Sheets-Sheet 3

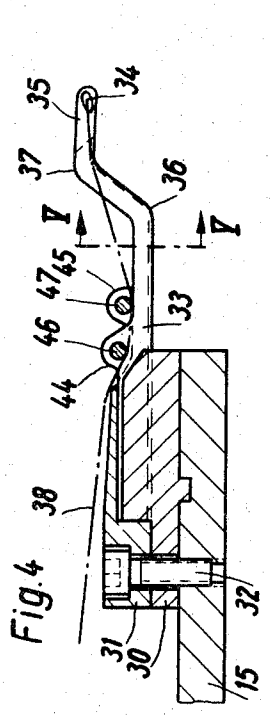


Fig.4

Fig.3

Fig.5

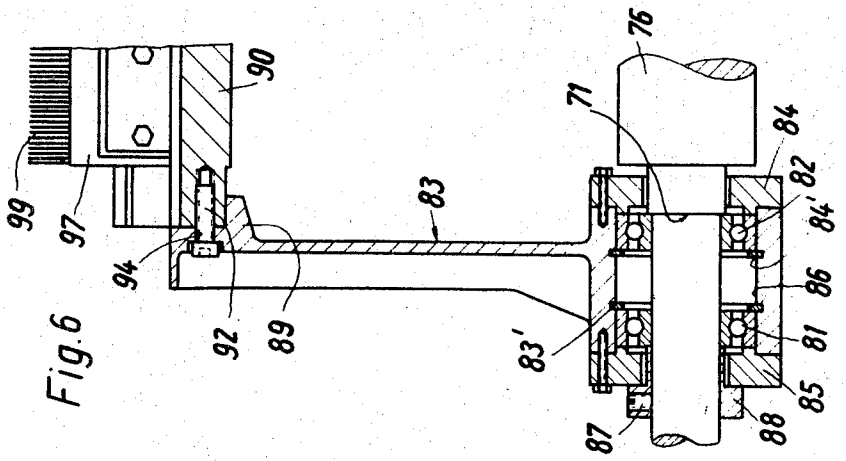


Fig.6

Sept. 22, 1970 W. PALANGE 3,529,443

PROCESS AND DEVICE FOR SHOOTING IN FILLING YARNS FOR WARP KNITTING MACHINES

Filed June 7, 1968 9 Sheets-Sheet 4

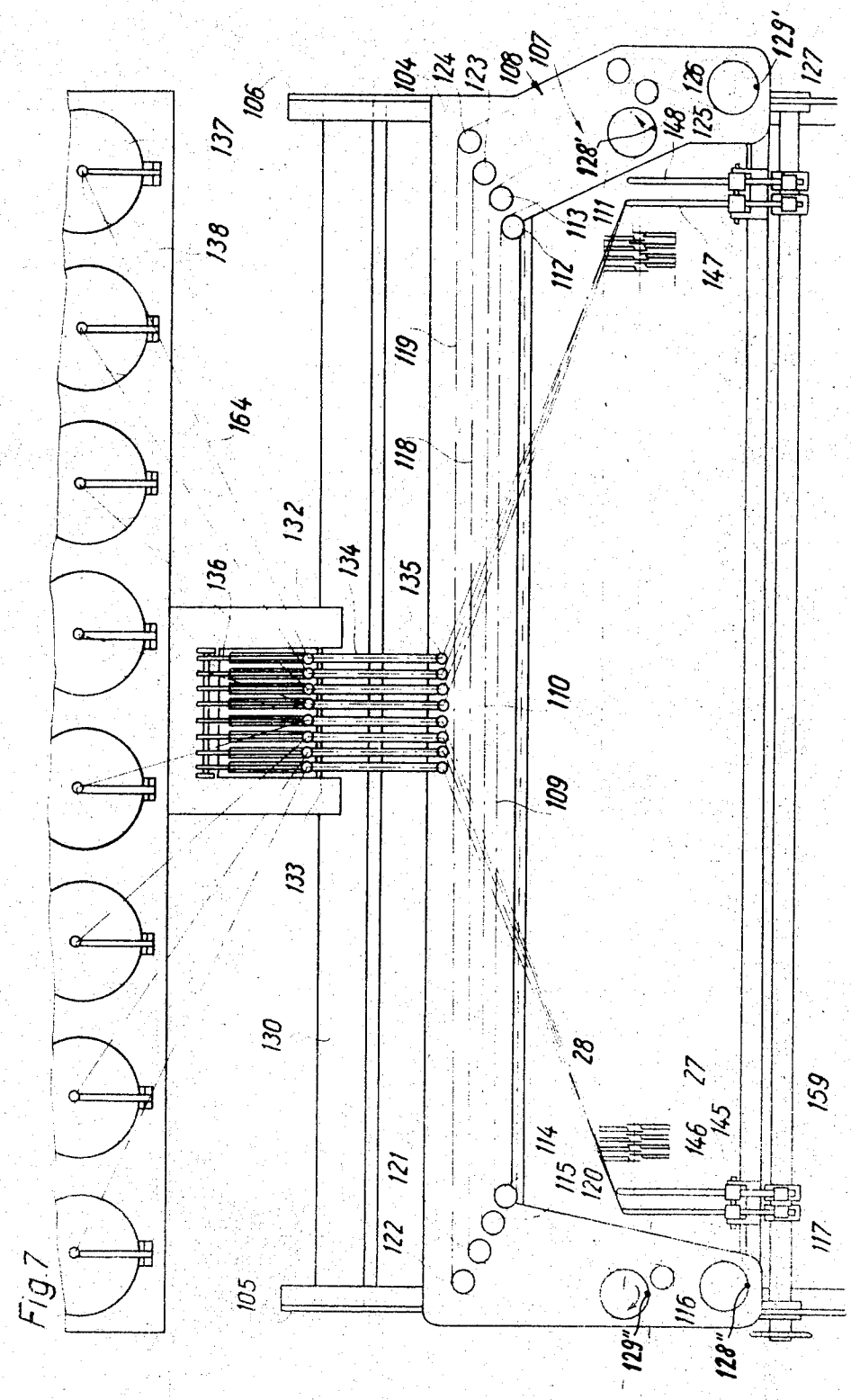


Fig. 7

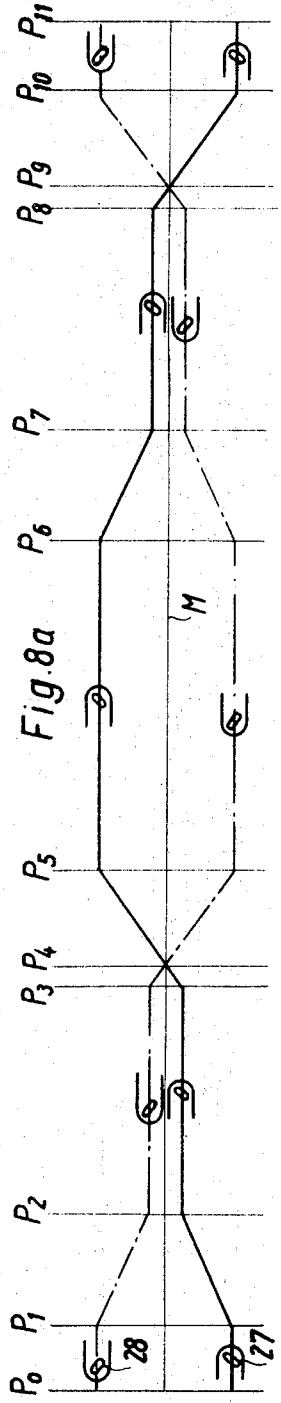


Fig.8a

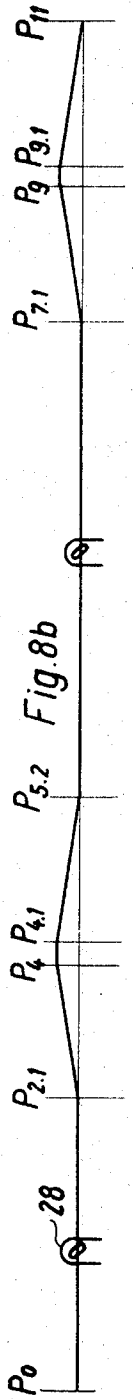


Fig.8b

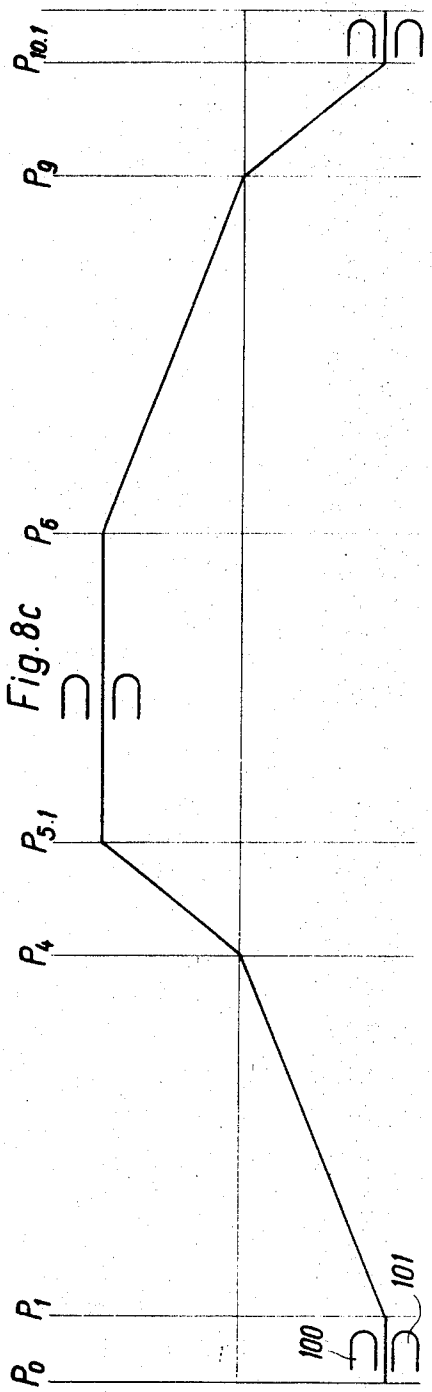


Fig.8c

Fig. 9a

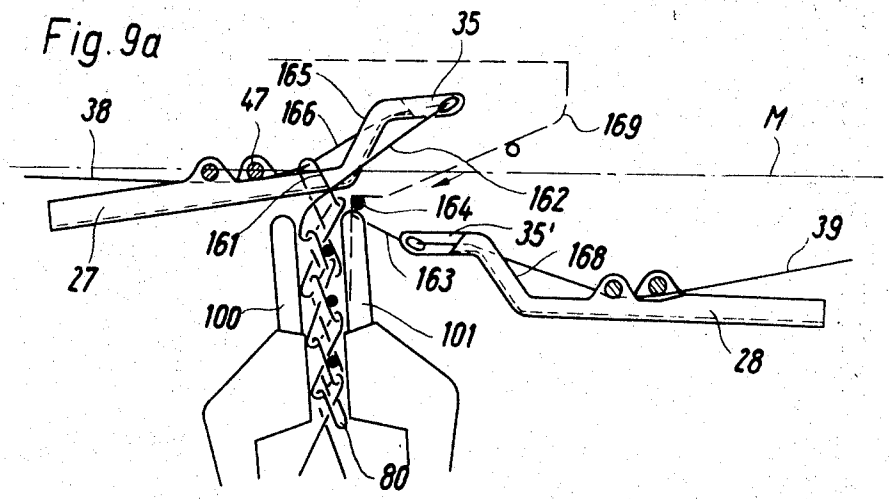


Fig. 9b

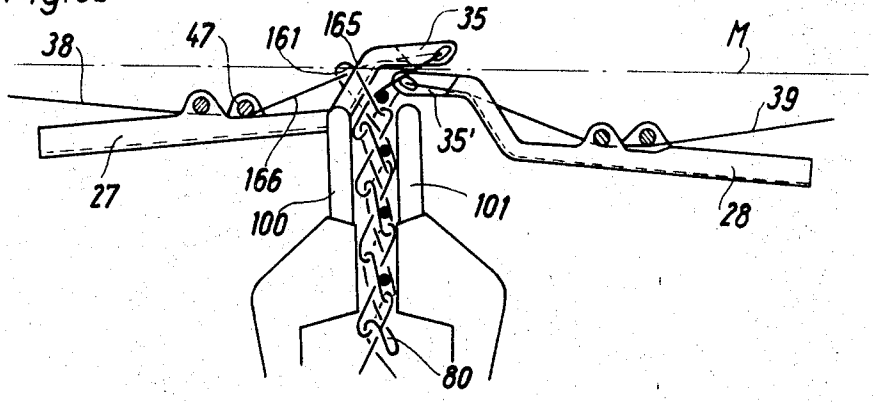


Fig. 9c

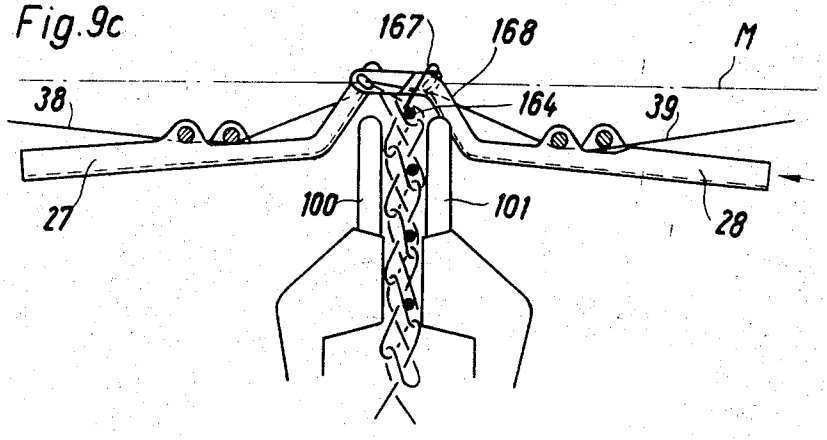


Fig. 9d

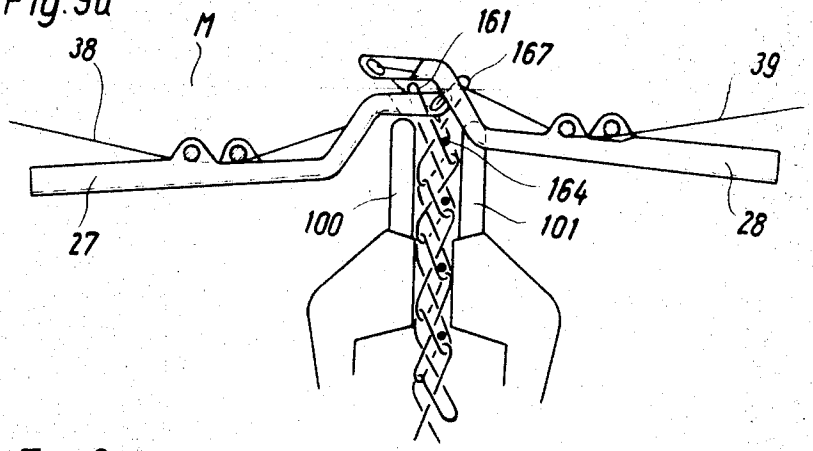


Fig. 9e

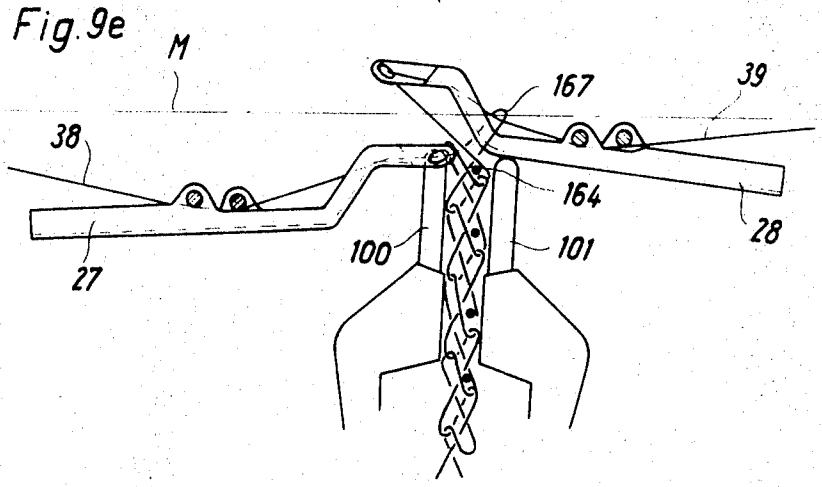


Fig. 9f

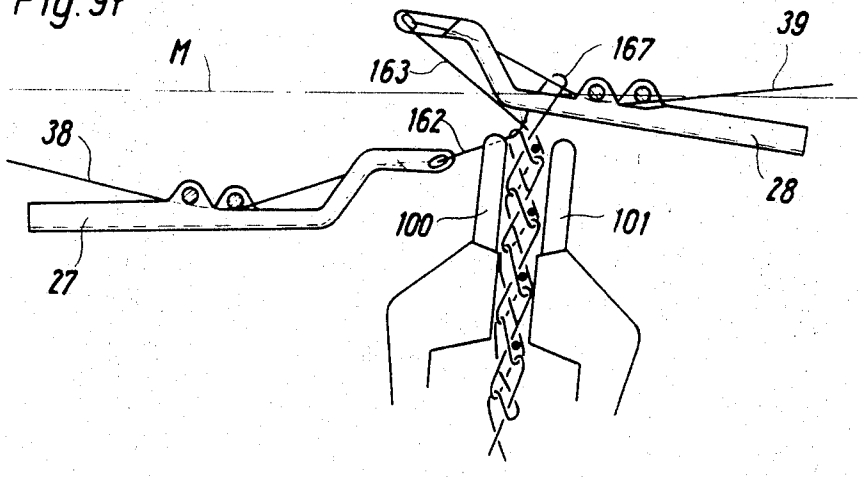


Fig. 10a

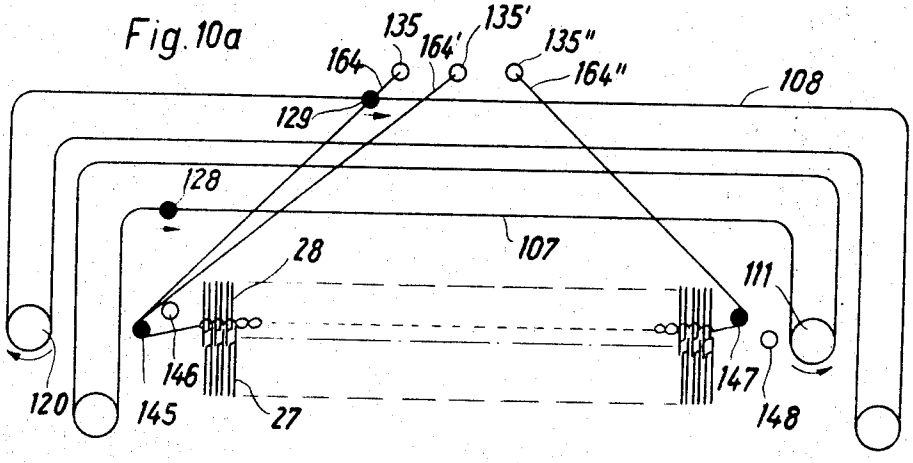


Fig. 10b

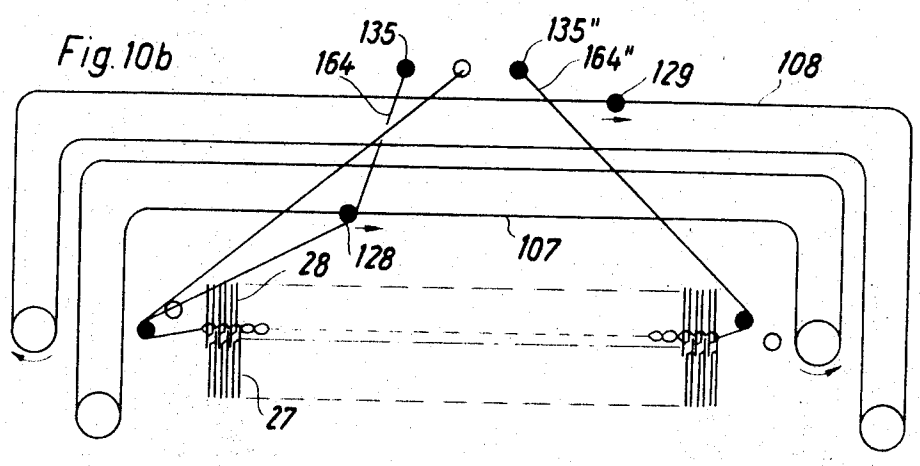


Fig. 10c

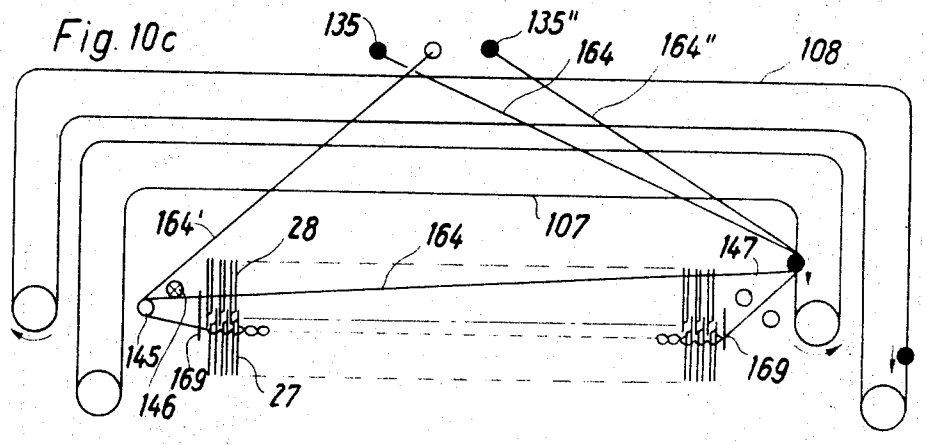


Fig. 10d

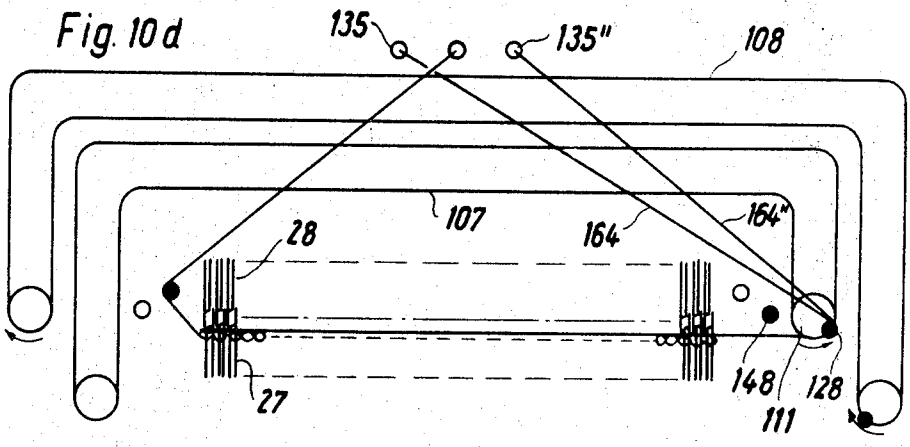


Fig. 10e

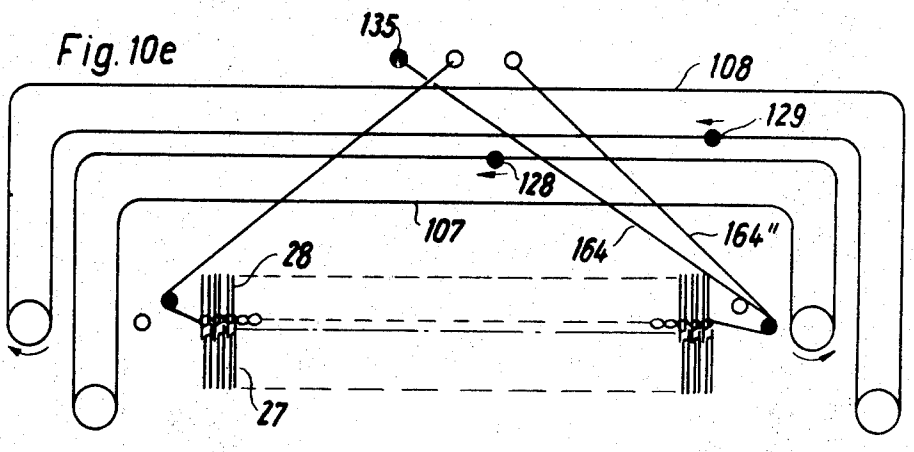
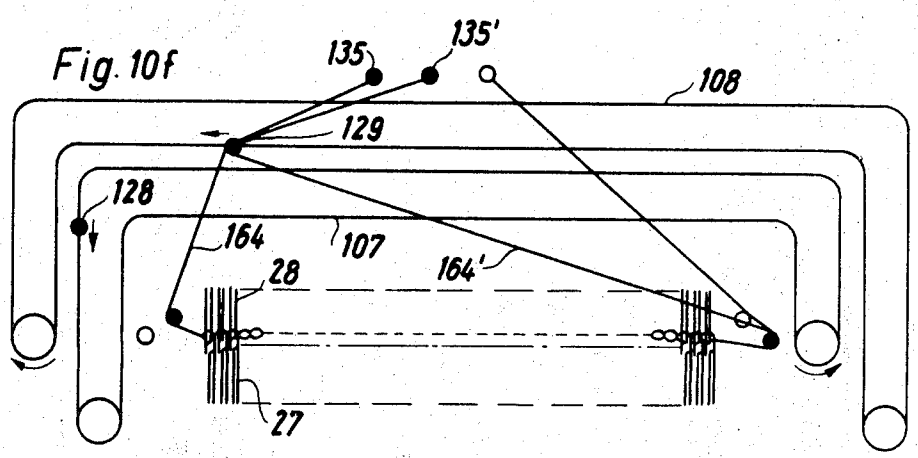


Fig. 10f



United States Patent Office 3,529,443
Patented Sept. 22, 1970

3,529,443

PROCESS AND DEVICE FOR SHOOTING IN FILLING YARNS FOR WARP KNITTING MACHINES

Walter Palange, Oisterwijk, North Brabant, Netherlands, assignor to Jean Gusken, Dulken, Germany

Filed June 7, 1968, Ser. No. 735,459
Claims priority, application Germany, June 7, 1967, 1,635,809
Int. Cl. D04b 23/00
U.S. Cl. 66—86 18 Claims

ABSTRACT OF THE DISCLOSURE

A process and a device for the shooting in of filling yarns for warp knitting machines of the type wherein two rows of guide needles face each other and form a links-links knitted fabric through reciprocal takeover of stitches. The warp threads run from the needle holes to the fabric and form an open shed alternatingly toward the front end and the rear of the machine. Filling yarns run from a supply bobbin through a feed position located approximately in the middle of the machine to the rows of the needles. A tied up filling yarn at one edge of the fabric is pulled out in the opposite direction to form a loop, the apex of which moves on a path parallel the rows of needles, up to and beyond the longitudinal extent of the rows of needles. The loop strand running from the apex to the tied up loop is then swung into the knitting shed opened at this point.

BACKGROUND

Field of the invention

The invention concerns a process and a device for the shooting in of filling yarns for warp knitting machines, with two rows of guide needles forming a links-links warp knitted fabric through mutual takeover of stitches, transposable in relation to one another and facing each other, where the warp threads delivered from the needle holes to the fabric will form an open shed alternatingly toward the other longtitudinal side of the machine after each takeover of stitch.

Description of the prior art

Placing of the filling thread in the production of knitted fabrics has been known heretofore. Differing from woven cloths, however, the "filling" in most cases do not extend all the way across the fabric but only across (or to be more precise, "underneath") a limited number of needles in the stitches in which the filling yarns have been tied up. This limitation of the length of the filling is necessary in order to attain a sufficiently high knitting speed which should be several times higher than the weaving speed, without injuring the threads during the drawing off of the fabric.

Placings of fillings underneath a limited number of needles requires an additional guide needle bar. The insertion of such a guide bar does not cause any particular difficulties in the case of raschel knitting machines. However, conditions are different in the case of links-links warp knitting machines of the type to which this invention pertains. Here, the formation of the stitch is accomplished exclusively by two guide needle rows passing alternatingly with their heads through the paths of needles lying opposite each other. A third row of guide needles of placing of filling yarns would not only bring about a considerably increased expenditure by way of construction but, beyond that, it would decrease considerably the knitting performance because of the periods of disuse

of the remaining rows of needles required for the placings of the filling yarns.

On the other hand, in the case of links-links the formation of a distinct shed between the warp threads (which differing from the shed of a weaving machine is open in the transverse direction) offers the possibility for the shooting in of continuous filling yarns which extend accross the entire width of the fabric without being limited for the tentering of these filling yarns to the time period of the opening of the shed. Rather, it will be possible to tenter the filling yarns during the preceeding formation of stitches or, preparatorily, even prior to that, and then to shoot them in to the open shed in the transverse direction. Nevertheless, an interruption in the drawing off of the filling yarns from the supply bobbin for the duration of the shooting in of the filling yarn has not been avoided, so that during the drawing off itself very high drawing off speeds must occur. Further, the lengthwise drawing off of the filling yarns used in the case of weaving machines and the subsequent transverse movement of said yarns into the shed in the path raises construction problems, which, heretofore, were impossible to solve economically as well as technically in a satisfactory manner.

SUMMARY OF THE INVENTION

It is an object of the present invention to solve these problems and to provide a process for shooting in the filling yarn in the case of warp knitting machines of the kind mentioned above, wherein the drawn off filling yarn is conserved as much as possible.

According to the present invention this problem is solved by drawing out a filling yarn running from a supply bobbin through a feed position located approximately in the middle of the machine, spaced transversely from the rows of needles, and running to a tied up filling at one edge of the fabric. The filling yarn is drawn in an opposite direction to form a loop whose apex moves on a path which is located parallel to and is spaced transversely distant from the rows of needles, up to and beyond the longitudinal extent of the rows of needles, whereupon the looped strand running from the apex to the tied up filling is swung into the knitting shed which is open at this time. Since in the case of the process according to the invention the apex of the loop develops gradually from a filling yarn running to the tied-up filling at the edge of the fabric, drawing off the thread starts very gently and can then be increased by a correspondingly quick movement at the apex of the loop to a very high drawing-off speed without any impermissably high stresses of the filling yarn occurring.

Effectively, swinging that looped strand running to the tied-up filling into the knitting shed takes place through a continuous movement of the loop apex transversely to the lengthwise extent of the rows of guide needles. It is also advantageous to control the stitch forming movements of the rows of guide needles in such a manner that the swinging-in movement of the looped strand running to the untied filling takes place in a knitting shed which is open in the direction of the swing-in side, whereby the knitting shed, for practical purposes, will close immediately after completion of the swing-in movement. But it is also possible for the filling yarn to be shot into a knitting shed pointed oppositely to the shooting-in side, whereby the filling yarn is then guided above the heads of the guide below said needles.

A device for carrying out the process according to the invention comprises two drivers, movable back and forth alongside the rows of guide needles and transposed in the longitudinal direction of the rows of guide needles, each time through whose lagging driver at least one filling yarn arriving from a supply bobbin can be drawn out to form a loop. The drivers at the ends of the back-and-forth

movements, running along the rows of guide needles, carry out movements which are additional to these former movements whereat the lagging driver moves in a direction away from the rows of guide needles.

According to another feature of the invention, a filling yarn feed and exchange arrangement, which can be operated by control chains, and which and is known per se, is arranged at the feed position of the filling yarns, through which arrangement a number of filling yarns can be brought singly or several of them into the path of the lagging driver in a sequence which can be controlled as desired.

Preferably the drivers are carried by two endless chains revolving around end wheels staggered in relation to one another in a longitudinal direction. In place of the chains, of course, it is also possible to use bands, belts or the like. On one longitudinal side of the machine all chain strands effectively run parallel and at a small distance from one another. It will also be advantageous if the two end wheels which drive the chains are located at the lengthwise ends of rows of guide needles around which the chain is looped. Since the drivers complete the shooting in of the filling yarns during their turn around these driving gears a tensing of the filling yarns takes place simultaneously as a result of this choice of rotational direction of the driving wheels.

According to another feature of the invention, given by way of example, maneuverable thread retarders are arranged at the ends of the rows of guide needles, around which, in the operating state, the filling yarns emerging at the pertinent edge of the fabric will loop.

Thus, it is an object of this invention to improve shooting-in of filling yarns in a links-links knitting machine. Other objects and the advantages will become apparent from the detailed description to follow.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be explained in more detail with reference to a preferred embodiment as shown in the drawing by way of example, whereby further objects and advantages of the invention will become apparent.

FIG. 1 shows a perpendicular section through a links-links warp knitting machine in the area of the knitting tools,

FIG. 2 shows a section of FIG. 1 on an enlarged scale and turned clockwise by 30°.

FIG. 3 is a top view of a part of a needle bar with the guide needles attached to said bar in actual size, and wherein the parts, lying one on top of the other, have been broken away at varying lengths.

FIG. 4 is a sectional view along line IV—IV in FIG. 3.

FIG. 5 is a cross section through the shaft of a guide needle, taken along line V—V in FIG. 4, but shown on an enlarged scale.

FIG. 6 is a longitudinal section through a swing bearing of the sinker combs, taken along line VI—VI in FIG. 2.

FIG. 7 is a top view of the machine obliquely from above taken along line VII—VII in FIG. 1, wherein the chains of the shooting-in arrangement for the filling are shown schematically.

FIGS. 8*a* to 8*c* are symbolic drawings of the vertical movements (as reviewed in FIGS. 9*a* to *f*) of the guide needles, the forward movement of the rear guide needle bar from a reference position, and the traverse movement of the sinker combs, respectively.

FIGS. 9*a* to 9*f* show one guide needle each of the front and rear rows of the needles, as well as the sinker combs, in various working positions during one-half revolution of the main shaft of the machine.

FIGS. 10*a* to 10*f* show various stages in the operation of the device for shooting in the filling yarn of the warp knitting machine according to the invention during two revolutions of the main shaft of the machine.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

According to the present invention as shown in FIGS. 1 and 2, the warp knitting machine of the preferred embodiment has a machine frame **10**, which in the conventional manner has two parallel frame walls connected by several bars, between which walls there are two warp beams **11**, **12** as well as the knitting tools and between which the finished knitted fabric is drawn off.

A first needle bar **15** is articulated to a bar **13** through a stationary axis and slidable to a limited degree. The bar **13** is U-shaped in its cross section and has several axial thrust joints **14**, distributed along its length. The bar **15** is located in front (when viewed from the operating side of the machine which is the left side in FIG. 1). A second bar **16**, U-shaped in its cross section, is articulated to a rear needle bar **18** through an axis which has axial thrust joints **17**. The bar **16** is swingable and axially slidable to a limited degree on said axis. The axial thrust joints **17** are not attached to the bar **13**, as is the case with the first needle bar **15**, but they are carried by connecting rods **19**, which are slidable through the bar **16** within guide bushings **20**. A spiral spring **21**, mounted on each connecting rod **19**, is supported between the guide bushing **20** and a disk **23** which, in turn, is secured by a resilient ring **22**. A cam follower roller **24**, mounted at the other end of the connecting rod **19**, continuously rests on a cam disk **26** which is mounted on cam shaft **25**.

During operation and in a manner which will be explained in more detail further below, this cam causes the bar **18** to be moved periodically and by a small amount toward the front needle bar **15** and back again.

The needle bars **15**, **18** comprise magnesium profiles, whose free ends are directed essentially towards each other. Each needle bar **15**, **16** carries a row of guide needles **27**, **28** respectively. The guide needles **27**, **28**, as shown FIGS. 3 and 4, are not attached to the needles in the usual manner but are inserted into spaced apart recesses **29** in middle beds **30**. The needles are kept in place with the help of a number of covers **31** which are attached above the needle beds **30** with the help of screws **32** on the needle bar. Preferably, the separating seams between the covers **31** run obliquely in relation to the guide needles to assure that all guide needles are covered by the covers **31**.

As FIG. 5 shows, each guide needle **27**, **28** has a shaft **33** having a U-shaped profile above, which is followed by the needle head **35**, and the needle shaft **33** aside from being straight has two approximately equally large opposing curvatures **36**, **37** limited to relatively short areas, through which the needle head **35** attains a position parallel to shaft **33** and staggered toward the top in relation to the needle shaft **33**. This parallel staggering corresponds approximately to half the swiveling path through which the needle head **35** passes in a perpendicular direction during the stitch formation.

The warp threads **38**, **39**, as shown in FIG. 1, after arriving from the warp beams **11**, **12**, are fed to the guide needles **27**, **28** via thread tensioning rockers **40**, **41** and guide rolls **42**, **43**. The warp threads running freely across the cover **31** are guided, as shown in FIG. 4, for needles **27**, by two lengthwise staggered eyes **44** and **45** along guide wires **46**, **47** inserted in the profile sides of the needle shaft **33** into the inside to the needle shaft profiled in a U-shape. The wires thus serve as guides for the warp threads up to the needle heads **35** and prevent the portion of the warp thread between shaft **33** and needle eye **34** from being seized by a needle **28** passing between the needle shafts **33** at needles **27**. Such seizure would lead to an immediate break in the thread.

The swnging movements of the needle bars **15**, **18** around the swinging axes on which are formed the axial thrust joints **14**, **17**, are controlled by cam disks, which are arranged on two main shafts **48** and **49** extending below the bars **13**, **14**. The main shafts **48**, **49** mounted

in a known manner in the walls of the machine frame **10**, are driven from the same driving source (not shown) as the cam shaft **25** and at the same rotational speed. Such driving source would be located outside the walls of the frame **10**. The main shafts **48, 49** each carry several pairs of cam disks **50–51** and **52–53**, distributed over its length. Each pair of cam disks is enclosed by a box **58, 59** mounted on square pipe bars **54–55** and **56–57**, in which box a three-armed compensating lever **60, 61** has been mounted to be swingable around a bearing axis **62, 63**. Two arms of each compensating lever **60, 61** extending in opposite peripheral directions along the surface of the cam disks carry follower rollers **64, 65** and **66–67** on opposite sides, which roll, one each on the cam disks **50–51** and **52–53** and continuously contact their respective cam surface. The swinging movement of the compensating levers **60, 61** is thus dependent upon the shape and rotation of the cam disks.

The free third arm of each compensating lever **60, 61** is articulated to a bearing block **74, 75**, which blocks are screwed to the undersides of the sides of the needle bars **15, 18** carrying the needle beds **30**, via coupling links **72, 73** which are provided at both of their ends with ball joints **68–69** and **70–71**, the length of which couplings are preferably adjustable. The ball joints **68-69** and **70–71**, together with the axial thrust joints **14, 17** make possible the staggering movement of the needle bars **15** and **18** required for knitting, which movement is controlled in a known manner by a staggering arrangement placed outside one frame wall of the machine frame **10** at a certain relationship to the swinging movement of the rows **27, 28** of guide needles, and brought about by the cam disks **50–51** and **52–53**. Since such staggering arrangements are well known per se, a more detailed description is not thought to be necessary.

Between the boxes **58, 59** for the cam disks there is a fabric removing arrangement comprising two delivery rolls **76** and **77**, as well as two pressure rolls **78** and **79** for the knitted fabric **80** produced by the guide needles **27, 28**. The fabric winds around the delivery rolls **76** and **77** between the upper pressure roll **78**. The delivery rolls **76, 77** are driven positively. The pressure rolls **78, 79** have been mounted to be shifted towards and away fram each other. The pressure roll **78** is drawn by the material **80** winding around it, into the wedge-shaped gap between the delivery rolls **76** and **77**. However the pressure roll **79** is pressed against the delivery rolls **76, 77** by the force of a spring (not shown).

As becomes clear in FIG. 6, at the reduced cross-section ends of the delivery roll **76**, a supporting lever **83** has been rotatably mounted on ball bearings **81, 82**. Annular covers **84, 85**, which are screwed to the ends of a hub formed on the supporting lever, hold the outside ball races of the ball bearings **81, 82** in position against spring rings **83, 84** inside a bore **86** in the hub. The inside ball races of the ball bearings **81, 82** are held in position between a shoulder shaped section **71** at the reduced end of the delivery roll **76** and a casing **88** fixed by a clamp screw **87** on the delivery roll **76**.

The free ends of the supporting levers **83**, strengthened on the outside by ribs, as shown in FIG. 6, have been broadened in the shape of a hammer in the tangential direction about the axis of roll **76** (see FIG. 2) and across their entire width they have a projection **89**, projecting toward the other lever **83**, the flat upper side **90** of said projection directed tangentially and serving as a guide surface for two sinker bars **90, 91** which have an angular shape in their cross section. The sinker bars **90, 91** have been attached at their front sides to the supporting levers **83** by means of screws **92, 93**, which penetrate through an elongated slot **94** extending almost across the entire hammer-shape broadening of the supporting lever **83**. By loosening screws **92, 93**, it is possible to change the spacing between the sinker bars **90, 91** within a wide range.

Sinker comb leads **97, 98** are attached by screws **95, 96** to the outsides of the upward directed sides of the sinker bars **90, 91**, into which the sinkers **99** (FIG. 6) have been inserted with the same spacing as with the rows **27, 28** of the guide needles. The sinkers **99** form two sinker cams **100, 101** running toward each other at a transverse distance from each other, between which the drawn off fabric **80** is guided. The outside bevelled edges of the sinker bars **90, 91** have been rounded in order to prevent damage to the fabric passing between them.

The entire sinker comb arrangement is driven through cam discs (not shown), which are located in pairs outside the cam disks **50, 51** on the front main shaft **48** and which have associated therewith three-armed compensating levers in the same manner as the cam disks **50, 51**. Part of the outline of such a compensating lever **103** can be recognized in FIG. 1 behind the compensating lever **60**. The compensating levers **103** are each connected through a coupling **102** with a second arm of the compensating lever **83** developed as toggle levers. Special ball bearings at the ends of the couplings, as in the case of the couplings **72, 73**, are unnecessary in the case of couplings **102** since the sinker cam arrangement, differing from the needle bars, does not execute an axial stagger movement.

As becomes clear particularly in FIGS. 2 and 7, a base plate **104** of a hollowed out U-shape (when viewed from above as in FIG. 7), and which has its sides directed forward, rests on the frame walls **105, 106** of the machine. The plate **104** extends on three sides around the rows **27, 28** of guide needles at about the height of the upper sides of the needle bars **15, 18**. A number of chain sprockets are mounted on the base plate **104** around which two endless chains **107** and **108** are wound to follow a path corresponding to the U-shape of the plate. The chain **107** extends with its strands **109** and **110** guided essentially in parallel from one driving wheel **111**, located in the middle of the right-hand side of the base plate, following the shape of the base plate **104** around wheels **112, 113, 114, 115**, as well as an intermediate wheel **116**, to a tension wheel **117**, located at the front end of the left-hand side of the base plate **104**. The chain **108** also extends with its strands **118, 119** essentially parallel and outside of chain **107** and following the same general course, from a driving wheel **120**, located in the middle of the left-hand side of the base plate, and around wheels **121, 122, 123, 124** and intermediate wheels **125, 126** to a tension wheel **127**, located at the front end of the right-hand side of the base plate. Through different positions of the driving wheels and of the tension wheels on the sides of the base plate, a staggering of the two chains **107, 108** will be achieved for a reason that will be explained below.

The driving wheels **111, 120** are driven via driving shafts and gears, not shown here, at such a ratio to the main shafts **48, 49** of the machine that during two revolutions of the main shafts the chains will each revolve once in the path determined for it by its sprocket wheels. The rotational directions of the driving wheels **111, 120** have preferably been selected in such a manner that the chains in the area where they wind around the driving wheels **111, 120** will move away from the rows **27, 28** of the guide needles as indicated in FIG. 7 by arrows.

Chains **107** and **108** each carry on one of its links an upright driver **128, 129** (FIG. 2), which consists of a sheetmetal tongue beveled in an upward direction and riveted onto a chain link, the upward pointing part of said tongue having been constricted in the middle. The drivers **128, 129** have been shown arranged on chains **107, 108**, in such a manner that after each half turn of the chain alternatingly (a) the driver **128** of the inside chain **107** will be located at the foremost position of the right-hand driving wheel **111**, and (b) the driver **129** of the outside chain **108** will be located at the foremost position of the left-hand drive wheel **120**. The position

of the drivers at position (a) has been indicated in FIG. 7 by circles designated in FIG. 7 by circles designated by **128'** and **129'**, while the position (b) reached one-half rotation of the chain later has been indicated by circles designated by **128''** or **129''**. At both points in time, the knitting tools are in the same position since the main shafts **48**, **49** as well as the cam shaft **25** have executed a complete revolution in the meantime.

Two additional bars **130** and **131**, U-shaped in their cross-section, carry the housing **132** of a filling yarn feed and exchange arrangement located at the upper rear part of the machine frame **10** and in the longitudinal center of the machine. On the open upper end of the housing **132** is a horizontal axis **133**, on which a number, for example eight, thread feed levers **134** have been mounted. The front ends of the thread feed levers **134** contain vertically opening guide eyes **135** to which the filling yarns are fed from yarn supplf bobbins **137** via a corresponding number of levers **136**, which are resilient and which are likewise provided with eyes at their ends. The bobbins **137** are arranged on a bar **138** carried by the housing **132**. The rear ends of the thread feed levers **134** are held by tension springs **139** against a corresponding number of control chains **140**, which revolve around sprocket wheels **141**, **142**, **143**, **144** inside the housing **132**. Each one of the sprocket wheels **141**, **142**, **143**, **144** is turned continuously via a driving connection, not shown, by the main drive of the machine. The links at various heights of the control chains are known per se, and for that reason are shown only schematically in FIG. 1. At certain times the links of chain **140** press against levers **134** to urge the front ends of the thread feed levers **134** downward in selected groupings, as will be explained subsequently with respect to FIGS. 10*a* to *f*. This movement of levers **134** moves the pertinent filling yarns into the path of revolution of the drivers **128**, **129**, which seize them and guide them in a manner described further below, to the rows **27**, **28** of guide needles.

In order to avoid damage or fouling of the filling yarns seized by the drivers **128**, **129**, the chains may be covered up effectively by a protective plate, not shown, of the same general shape as base plate **104**, which are provided with two circular slots in the shapes of chains **107**, **108**, through which penetrate the parts of the driver wheels pointing upwardly. The filling thread feed and exchange arrangement also includes four thread retarders **145**, **146**, **147**, **148** (FIG. 7), arranged in pairs on the two front ends of the rows **27**, **28** of the guide needles.

Referring to FIG. 2, each thread retarder includes a bar **149**, beveled at one end, and adjustably clamped in a bore in the upper end of a swiveling lever **150**, by a screw **151**. The swiveling lever **150** is mounted in a mounting block **153** which serves in common for two thread retarders each, by means of a bolt **152**, said mounting block **153** being screwed onto the upper side of bar **13**. The end of bar **149** remote from the bevelled end is adjustably clamped to thrust piece **155** by screw **154**. The thrust piece includes a cam follower roller **156** at the end, which, under the effect of a spiral spring **157** acting between the bar **149** and the mounting block **153**, is held against a cam disk **158**. The cam disks **158** of all thread retarders are mounted on a common cam shaft **159**, the ends of which are supported in the walls of the frame **105**, **106**, in a manner similar to that of the main shafts **48**, **49** and the cam shaft **25**. This shaft **159** is driven by the main drive of the machine. In contrast to the above mentioned shafts, however, the cam shaft **159** revolves at only half the speed, so that a revolution of the cam shaft **159** corresponds to one complete revolution of the chains **107**, **108**. The ends of the bars **149** of the thread retarders **145**, **146**, **147** and **148**, which have been bevelled downwards, will dip, in the working position, as shown in FIG. 2, into the plane of the protective plate above chains **107**, **108**, and they are staggered in pairs in relation to one another in the direction of the guide needles, so that the bevelled ends of the inside thread retarders **146**, **147**, directly adjoining the guide needles, lie somewhat farther toward the rear of the machine than the bevelled ends of the outside thread retarders **145**, **148**.

The cam disks **50–51** and **52–53** on the main shafts **48**, **49** are shaped in such a manner that during one revolution of the main shafts the rows **27**, **28** of the guide needles carry out movement in a vertical plane around the center line M as shown in the crank circle diagram according to FIG. 8*a*, which corresponds to a field of traverse across an angle of about 7.5° and thus is below half the angle of traverse of known machines of this type. Starting from the point in time P_0, in which the front guide needles **27** assume their lowest position and the rear guide needles **28** their highest position, the two rows of needles approach each other between the points P_1 and P_2 through equally large traversing movements up to only a small vertical distance (as viewed in FIGS. 9*a* to 9*f*) and maintain said distance by one or several spacings of the needle between the points P_2 and P_3 for the duration of the stagger movement of the rows of guide needles, which now takes place. Subsequently, row **27** of the guide needles is raised to the highest position at point P_5 and row **28** of the guide needles is simultaneously lowered to the lowest position at the same point P_5, whereby the needle heads reciprocally pass through the needle paths of the opposing row of guide needles at the point in time of crossing P_4. After a prolonged dwell time, the course of movements described previously is repeated, from point P_6 in a reverse order, through points P_7, P_8 and P_9 to the point P_{10}. Between P_7 and P_8 a staggering of the rows of guide needles again takes place in the longitudinal direction and at point P_9 the needle heads pass through the needle paths of the opposing rows of needles in the opposite direction.

As the crank circle diagram according to FIG. 8*c* shows, the sinker combs **100**, **101**, during one such revolution of the main shafts **48**, **49**, move from a rear end position at the point in time P_1, first of all evenly up to the point of crossing P_4 into a middle position and, from there, with increased speed and without interruption, to the front end position, which they reach at a point in time $P_{5.1}$ which is somewhat behind point P_5, and which they maintain up to point P_6. Then the same course of movement is repeated in the reverse direction via the middle position at the point of crossing P_9 up to the rear end position in a point in time $P_{10.1}$ which is somewhat behind point P_{10}.

As mentioned above, row **28** of guide needles, in addition to its traversing movement and its stagger movement, carries out a third periodic movement which comprises forward movement toward the front row **27** of guide needles. This movement is controlled by the cam disk **26** on the cam shaft **25**. This forwardly directed movement is shown in FIG. 8*b* as a schematic indication of such a guide needle **28**. It begins at point $P_{2.1}$ between points in time P_2 and P_3 it reaches its front end position at the point of crossing P_4, which it maintains for a short time up to the point $P_{4.1}$, and then it returns again up to a point in time $P_{5.2}$ behind point P_5 into the rear end position. The same process is repeated from a point in time $P_{7.1}$ between points P_7 and P_8 to points P_9 and $P_{9.1}$ and up to a point in time P_{11} which coincides with the end of the crank circle diagram and which corresponds it its starting point P_0.

The knitting process which results from these movements has been illustrated for the second half of the crank circle diagrams of FIGS. 8*a*, *b* and *c* in the FIGS. 9*a* to *f*. FIG. 9*a* shows the position of the guide needles **27**, **28** and of the sinker combs **100**, **101** within the area between the range of the points in time $P_{5.2}$ and P_6. The front guide needles **27** have been totally raised and the rear guide needles **28** have been completely lowered. The sinker combs **100**, **101** stand completely in front, below row **27** of the guide needles. The knitted fabric **80**, guided between the sinker combs **100**, **101**, is suspended

from stitches **161**, each of which form the last row of stitches formed from a warp thread **39**, fed via a rear guide needle **28** after it passes over the straight root sector of shaft **33** of a front guide needle **27**. There the stitch **161** loops around the warp thread **38**, running into the needle hole of the front guide needle row **27** and subsequently passing to the knitted fabric **80** as stitch **162**. This stitch **162** passes from the needle hole **35** freely like a cord below the bent guide needle **27** and, with the sector **163** of the warp thread **39** arriving from the needle hole of the rear guide needle **28** to the stitch **161**, forms a knitting shed opened toward the rear, into which, during its opening, a filling yarn **164** can be shot in, in a manner explained in detail below.

The front guide needle **27**, beginning with the point in time P_6 is now lowered, the rear guide needle **28** is raised, and the sinker combs **100, 101** simultaneously move to the rear (that is, toward the right in relation to the series of FIGS. 9*a* to *f*). At the same time, the fabric **80** is carried along by the lagging sinker comb **100**, and the stitch **161** moves in the direction toward head **35** of this needle **27**, on the back **165** of the front guide needles **27** or on the warp thread sector **166**, where it runs in and is held in tension between the guide wire **47** and the needle hole **34** of this guide needle **27**. At the point in time P_7, the guide needles **27, 28** have approached each other to the point where the heads **35'** of the rear guide needles **28** engage between the outcoming thread sections **162** of the front warp threads **38** whereby the shot in filling yarn **164** comes to lie below the head **35'** of the rear guide needle **28**. If heretofore the guide needle **28** is staggered relative to the point of view of FIGS. 9*a* to *f*, for example staggered rearwards by one half spacing of a needle in relation to the front guide needle **27**, then, in the case of the staggering movement of the rear row of guide needles which now follows, the warp thread sector **162** emerging toward the viewer from the needle hold of the guide needle **27** is seized by the head **35'** of the rear guide needle **28** and is forced away in a lateral direction by the front guide needle **27**. This condition, which corresponds approximately to the point in time $P_{7.1}$ according to FIGS. 8*a, b* and *c*, is shown in FIG. 9*b*.

From this position, the entire rear row **28** of guide needles is now shifted forward against the front row **27** of guide needles by cam disk **26** by a limited degree. With this shift, the upper curve **37'** of the rear guide needle **28** is brought within the area of the needle hold **34** of the front guide needle **27**, so that during the subsequent alternating passage of the needle heads through the needle paths at the point of crossing P_9, which is shown in FIG. 9*c*, the new stitch **167**, formed by the thread strand **162**, immediately reaches the inclined back sector **168** of the rear guide needle **28** receiving said stitch, on which the stitch **167**, upon the further upward transverse movement of the guide needle **28** to the root sector of the needle shaft, is moved on by the sinker combs **100, 101** as shown in FIGS. 9*d* and 3. The warp thread **164** is now tied up in the new stitch **167**.

With the formation or "take over" of the new stitch **167**, the preceding stitch **161** is sloughed by the rear sinker comb **100** from the head of the front guide needle **27**. This positive sloughing of the stitch is brought about according to FIG. 9*e* especially by the fact that as the front guide needle **27** lowers, the lagging sinker comb **100** comes ever closer to the guide needles **27** and, finally, dips in between them, whereby it directly seizes the stitches which are to be sloughed.

In the further course of the traverse movement of the sinker combs **100, 101**, the lagging sinker comb presses the new stitch **167** completely into the end position on the root sector of the guide needle **28**, as shown in FIG. 9*f* and, indeed, counter to the tension of both warp threads **38** and **39** which, with their running thread strands **162** and **163**, now form a knitting shed open toward the front.

Center line M has been drawn in FIGS. 9*a* to 9*f* to show the line around which the rows **27** and **28** of the guide needles with their needle holes are swung. By noting this center line M it becomes clear, that first of all the old stitch **161** and later on also the newly formed stitch **167**, during their movement from right to left, for practical purposes, move always on this center line. This is a consequence of the movement of the stitch forced by the sinker combs **100, 101** and of the adaptation of the needle shape to the vertical movement (as viewed in FIGS. 9*a* to *f*) of the guide needles **27, 28** in relation to the movement of the sinker combs **100, 101**, as well as of the small angle of traverse of the guide needles forming or "taking over" the new row of stitches to be swung so far back that they finally exerted a pull on the knitted fabric which sloughed the old row of stitches. This necessitated large angles of traverse and brought about a very unsteady operation of the machine. In the case of the present invention, the stitches are sloughed by the lagging sinker comb, which simultaneously moves the newly formed stitches to the root section of the shafts of the row of needles which form the new stitches. Sloughing of the old row of stitches and forming of the new row of stitches, as a result of the present arrangement, takes place without jerks in a smooth movement, as a result of which the knitting speed can be increased considerably. At the end of the sinker comb movement, the lagging sinker comb acts similarly to a weaving comb and beats up the stitches with the shot in fill thread. As a consequence, a very dense and firm fabric is obtained.

The operation of the device for shooting in filling yarns is best understood with reference to FIGS. 10*a* to *f*, in which the chains **107, 108** have been shown simplified in their principal course. Furthermore, for a better understanding, only three filling yarns **164, 164'** and **164''** and, correspondingly, only three thread feed levers with their guide eyes **135, 135'** and **135''** are shown in the figures. The presentation of the guide eyes as a ring surrounding a white circular surface means that that particular feed lever is in its idle position according to the presentation in FIG. 1, in which the pertinent filling yarn has not been seized by the drivers **128, 129**. If the ring is filled in with black, then the feed lever is pressed down by the pertinent control chain **140**, and the pertinent filling yarn lies in the path of the drivers **128, 129**. A corresponding characterization has been used for the bevelled bar ends of the thread retarders **145, 146, 147, 148** likewise drawn in merely as rings. If a thread retarder appears as a ring which is white inside, then it has been lifted, and it is therefore in an inactive position. If, on the other hand, the ring has been filled with black, then the thread retarder will dip with its bevelled bar end below the plane of the surface of the protective plate (not shown), which covers up the chains **107, 108** in the manner described above. The dot in the ring of the thread retarder **145** in FIG. 10*c* indicates that this thread retarder is just being raised from its active position to its inactive position, while the "X" in the ring of the thread retarder **146** in the same figure represents that a lowering of this thread retarder is just taking place.

In FIG. 10*a*, all three guide eyes **135, 135'** and **135''** of the thread feed lever are raised. The filling threads **164** and **164'** extend from the guide eyes **135** and **135'** to the left end of the rows **27, 28** of the guide needles, and there they are guided around the lowered outside thread retarder **145**. The filling yarn **164''** extends from guide eye **135''** to the right-hand end of the needle rows **27, 28** and there it is guided around the lowered inside thread retarder **147**. The leading driver **129** of the outside chain **108** is just about to pass below the filling yarn **164**.

Just as driver **129** has run under the filling yarn **164**, the feed lever for yarn **164** is pressed down with the guide eye **135**. As a result, the filling yarn **164** reaches the path of the lagging driver **128**. After the leading

driver **129** has passed underneath the filling yarn **164''**, the feed lever for yarn **164''** is also down and the filling yarn **164''** likewise reaches the path of the lagging driver **128**. The latter seizes the two filling yarns **164** and **164''** and at first pulls them parallel to the rows **27, 28** of the guide needles and then pulls them out at a right angle to said rows in the shape of a loop (FIGS. 10*b* and 10*c*).

During this loop-shaped pulling out, the loop sector of the filling yarn **164**, running to the thread retarder **145**, arrives in front of the left-hand inside thread retarder **146**, which now is lowered, while the left-hand outside loop retarder **145** is raised (FIG. 10*c*). As a result, the left-hand thread retarder **146** releases the filling yarns **164, 164'', 164'**. The filling yarn **164'**, however, is held immediately by the left-hand inside thread retarder **146**, while the loop-shaped pulled out filling yarn **164** is released completely.

Simultaneously, the right-hand inside thread retarder **147** has also been raised and opens the way for the shooting in of the loop strand of the filling yarn **164**, leading to the fabric, into the knitting shed opened toward the rear at this point, where this loop strand arrives below the heads of the rear row **28** of guide needles. In order to assure the shooting in of the filling thread it is possible to arrange metal guide plates **169**, if need be, between the inside thread retarders **146, 147** and the front ends of the rows **27, 28** of the guide needles, as indicated in FIG. 9*a* at **169** in a broken line. The guide plates will press the filling yarns downward in the final sector of the shooting and move them securely below the heads of the front row of guide needles.

As soon as the loop strand of the filling yarn **164** has been completely shot into the knitting shed, the feed levers with the guide eyes **135** and **135''** return to their rest position and the right-hand outside thread retarder **148** is lowered, as shown in FIG. 10*d*. As a result, the filling yarns **164** and **164''** have now been looped around thread retarder **148** by the driver **128** (which now leads), and they retain this state when the leading driver **128**, according to FIG. 10*e*, releases the filling yarns **164** and **164''**. After release of these two filling yarns and after driver **128** has passed therebeneath, the guide eye **135** of the filling yarn **164** again is lowered and brings the filling yarn **164** into the path of the lagging driver **129**. When subsequently the leading driver **128** has run underneath the filling yarn **164'**, the guide eye **135'** is also lowered and moves this filling yarn likewise into the path of the lagging driver **129**, which now pulls out the filling yarns **164** and **164'** in the reverse direction, as described below, into a loop (FIG. 10*f*), and at the end of this pulling out movement shoots in the strand **164'** of this filling yarn, running to the fabric, into the again rearwardly opened knitting shed. At the same time, the raising and lowering of the thread retarder is repeated in a manner similar to the process described above, so that finally after competition of the shooting in of the filling and renewed running of the drivers **128, 129** toward the right, the state shown in FIG. 10*a* is again reached.

The preferred direction of rotation of the driving wheels **111, 120**, which has been mentioned above in connection with the description of the structure of the device for shooting in the filling, is such that the chains **107, 108** move away inside the looping range of the driving wheels from the rows of guide needles and this assures that the shot in strands of loops of the filling yarn will lie tensed in the knitting shed and that no loose loops of the thread will develop at the edges of the fabric.

For proper functioning of the described device it is important that those filling yarns already extending to the end of the fabric towards which the drivers move always be moved into the path of the lagging driver. Only when this is taken into consideration will these leading filling yarns be resuspended by the lagging driver, from an inner retarder **146** or **147** to the outside thread retarder **145** or **148**.

Otherwise, and particularly in the case of use of a larger number of filling yarns with correspondingly numerous feed levers, one or several filling yarns can be selected simultaneously in any desired sequence for shooting in, and it will not be necessary that the same filling yarn always be shot in twice in succession. Rather, under certain conditions, which one skilled in the art will easily recognize, one can through a suitable selection of the sequence, change the filling yarn, after each shooting in of the filling yarn so that one can operate therefore pic a pic.

Although the invention had been described in considerable detail with respect to a preferred embodiment, it will be understood that the invention is capable of numerous modifications and variations apparent to those skilled in the art.

I claim:

1. A process for the shooting-in of filling yarns in a warp knitting machine of the type having two longitudinally extending rows of guide needles facing each other, the neeedles of each row being transposed in relation to the neeedles of the other row, for forming a links-links knitted fabric through reciprocal takeover of stitches wherein the warp threads running from the holes in the needles to the fabric form an open shed alternatingly toward the one and the other longitudinal side of the machine, comprising the steps of: running a length of filling yarn from a supply source located at a feed position approximately in the longitudinal center of the machine to one end of the facing rows of needles via first thread retarder located on the said one end of the facing rows of neeedles and being in an effective position for retaining the said filling yarn, engaging said length between the supply source and the said one end by driving means, pulling the length in the direction towards the other end of the facing rows of needles, thereby forming a loop, the apex of which moves on a path substantially parallel to and spaced from the facing rows of needles, continuing said pulling step until the strand of the loop between the apex and the said one end of the rows is swung into the knitting shed opened at this time, thus bringing the said first thread retarder to an ineffective position in which it releases the filling yarn and bringing a second thread retarder located on the said other end of the facing rows from an ineffective position to an effective position for retaining the said filling yarn as the said driving means returns to the opposite direction.

2. A process according to claim **1** wherein during the swinging of the loop strand into the knitting shed, the loop apex is located beyond the said other end of the longitudinal extent of the rows of guide neeedles and is moving transversely towards the said rows of needles.

3. A process according to claim **2** wherein the loop strand running from the apex to the said one end, which is swung into the knitting shed, moves into the shed below the neeedle heads of the row of guide needles pointing in the direction opposite to said transverse movement.

4. A process according to claim **1**, wherein the stitch forming movements of the rows of guide needles are controlled to be synchronized with the swinging-in movement of the loop strand running to the said one end to form said knitting shed open toward the swing-in side as the loop is swung in.

5. A process according to claim **4**, wherein the loop forming movement of the rows of guide needles are further controlled to close the knitting shed immediately after conclusion of the said swing-in movement.

6. In a warp knitting machine of the type having two longitudinally extending rows of guide needles facing each other, the needles of each row being transposed in relation to the neeedles of the other row for forming a links-links knitted fabric through reciprocal takeover of stitches wherein the warp threads running from holes in the needles to the fabric form an open shed, alternatingly

towards one and then the other side of the machine, the improvement comprising: means for running at least one length of filling yarn from a supply source located at a feed position approximately in the longitudinal center of the machine to one end of the facing rows of needles, a driving means movable along a path back and forth along one side of the rows of needles for engaging at least one length between said source and said one end to pull the length towards the other end of the rows of neeedles, thereby forming a loop, the apex of which moves along said path toward the said other end of the rows of neeedles, and for swinging that strand of the loop between the apex and the said other end into the said knittting shed which is formed at this time.

7. The invention of claim **6** wherein said driving machine comprises two driver members, each movable along a separate path back forth along the side of the rows and mounted such that during said movement along the side of the rows, one of the driver members lags behind the other in the longitudinal direction, and means for placing said at least one length of filling yarn into the path of the lagging driver member to be pulled thereby.

8. The invention according to claim **7** wherein the path of the driver members at the ends of the back-and-forth movement running along the rows of guide needles includes portions running transverse to the rows of needles, and means in said portions for moving the lagging driver member in a direction away from the adjacent end of the rows of guide needles.

9. The invention according to claim **7** including a filling yarn feed and exchange means located at the feed position, movable chains for operating the feed and exchange means for placing a number of filling yarns, in any desired controllable number of sequence, into the path of a lagging driver member.

10. The invention according to claim **7** wherein the driving members are each carried by a separate endless chain, each chain being mounted to revolve about a set of ends wheels, one set being staggered in a longitudinal direction in relation to the other set.

11. The invention according to claim **10** wherein all strands of the two chains run substantially parallel to one another along one longitudinal side of the machine.

12. The invention according to claim **11** wherein the said wheels of each set are located at the longitudinal ends of the rows of guide needles, and including reversing wheels for turning the chains to run transversely of said rows at the ends of their parallel longitudinal extent in relation to the rows of guide needles, towards their respective end wheels.

13. The invention according to claim **12** wherein one end wheel at each set is a drive wheel for driving its respective chain.

14. The invention according to claim **12** wherein each driving wheel revolves in a direction to move the chain away from the rows of guide needles.

15. The invention according to claim **8** including thread carriers positioned at the longitudinal ends of the rows of guide neeedles, wherein said lengths of filling yarn pass around said thread retarders and then pass into the edge of the fabric formed between the rows of needles.

16. The invention according to claim **15** wherein each thread retarder is mounted for swiveling movement and includes a hooked end.

17. The invention according to claim **15** including a pair of thread retarders at each end of the rows, each said pair including an inner and an outer thread retarder positioned closer to and farther away from the adjacent ends of the rows, respectively, and wherein the filling yarns running into the formed fabric pass around the hooked end of the outer thread retarder, and wherein the filling yarns to be shot into the knitting shed alternatingly pass around one and then the other of the inner thread retainers.

18. The invention according to claim **17** including a guide plate positioned between the inside thread carriers and the respective adjacent ends of the rows of guide needles, wherein the filling yarns are guided downwards through the plates at the end of the shooting-in movement below the needle heads of the guide needles facing the shooting-in side.

References Cited

UNITED STATES PATENTS

1,286,349	12/1918	Kopp	66—87 XR
1,924,649	8/1933	Morton	66—87 XR
2,906,109	9/1959	Efland	66—1
3,134,248	5/1954	Kubelka	66—85 XR
3,143,868	8/1964	Palange	66—1
3,327,501	6/1967	Bahlo	66—85 XR
3,390,439	7/1968	Kalwaites	28—1
3,422,511	1/1969	Seguin	28—1

FOREIGN PATENTS

44,426	7/1930	Denmark.
1,394,748	3/1965	France.
712,506	10/1941	Germany.
334,842	9/1930	Great Britain.

RONALD FELDBAUM, Primary Examiner