Aug. 13, 1968 R. C. TAYLOR ET AL 3,396,558

YARN FEEDING MECHANISMS FOR FLAT BED KNITTING MACHINES

Filed Nov. 9, 1965 11 Sheets-Sheet 1

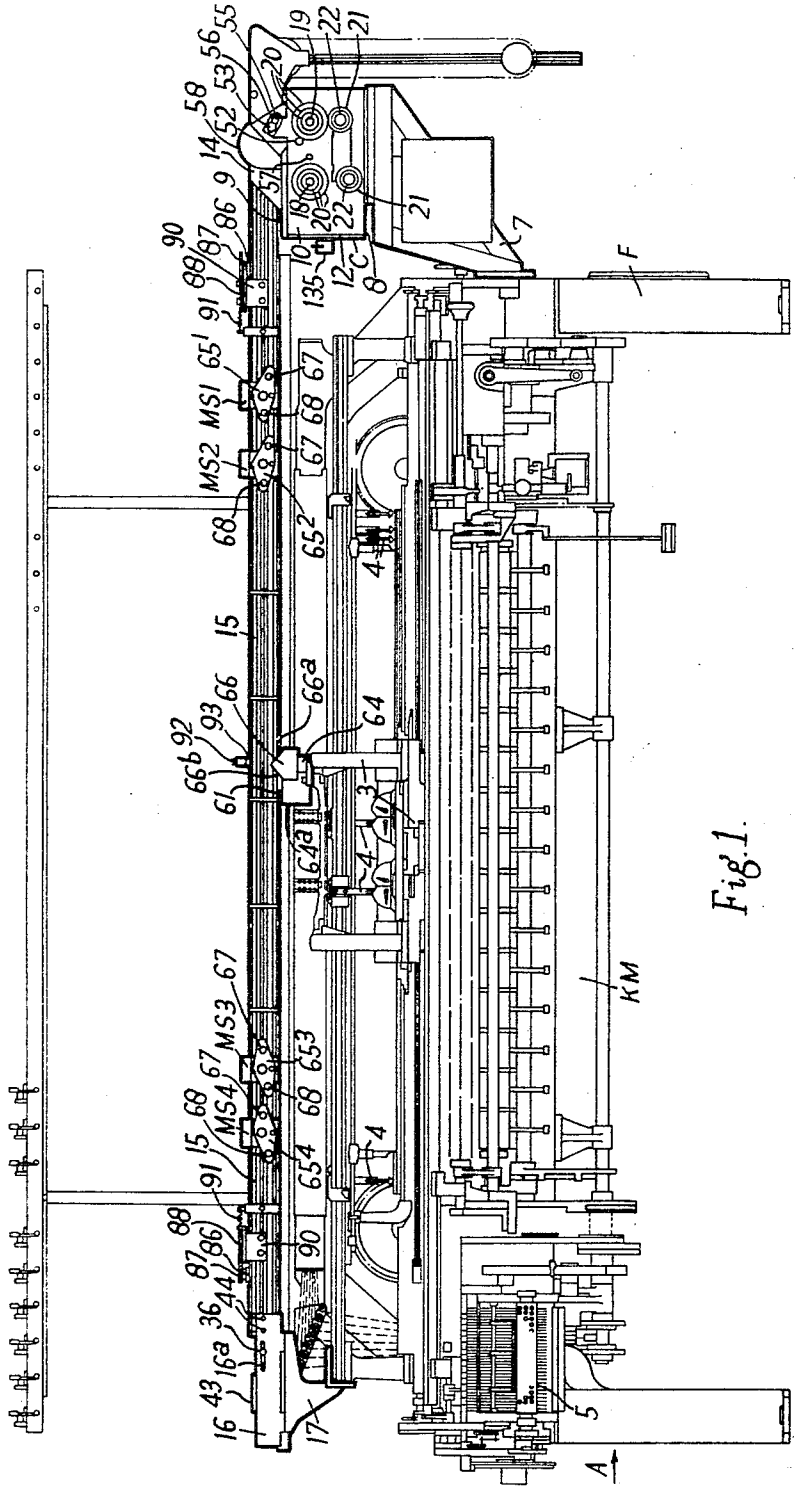

Fig. 1.

YARN FEEDING MECHANISMS FOR FLAT BED KNITTING MACHINES

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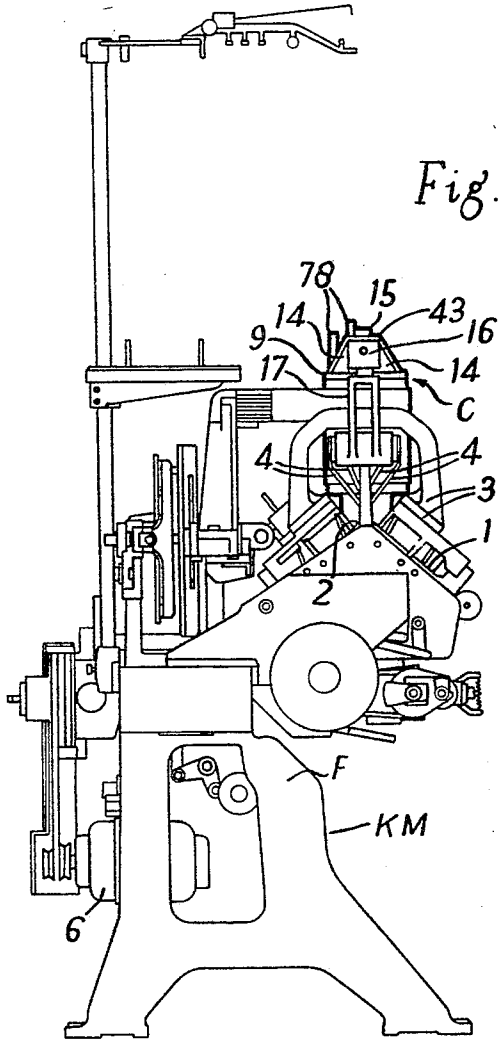
Fig. 2.



YARN FEEDING MECHANISMS FOR FLAT BED KNITTING MACHINES

Filed Nov. 9, 1965 11 Sheets-Sheet 3

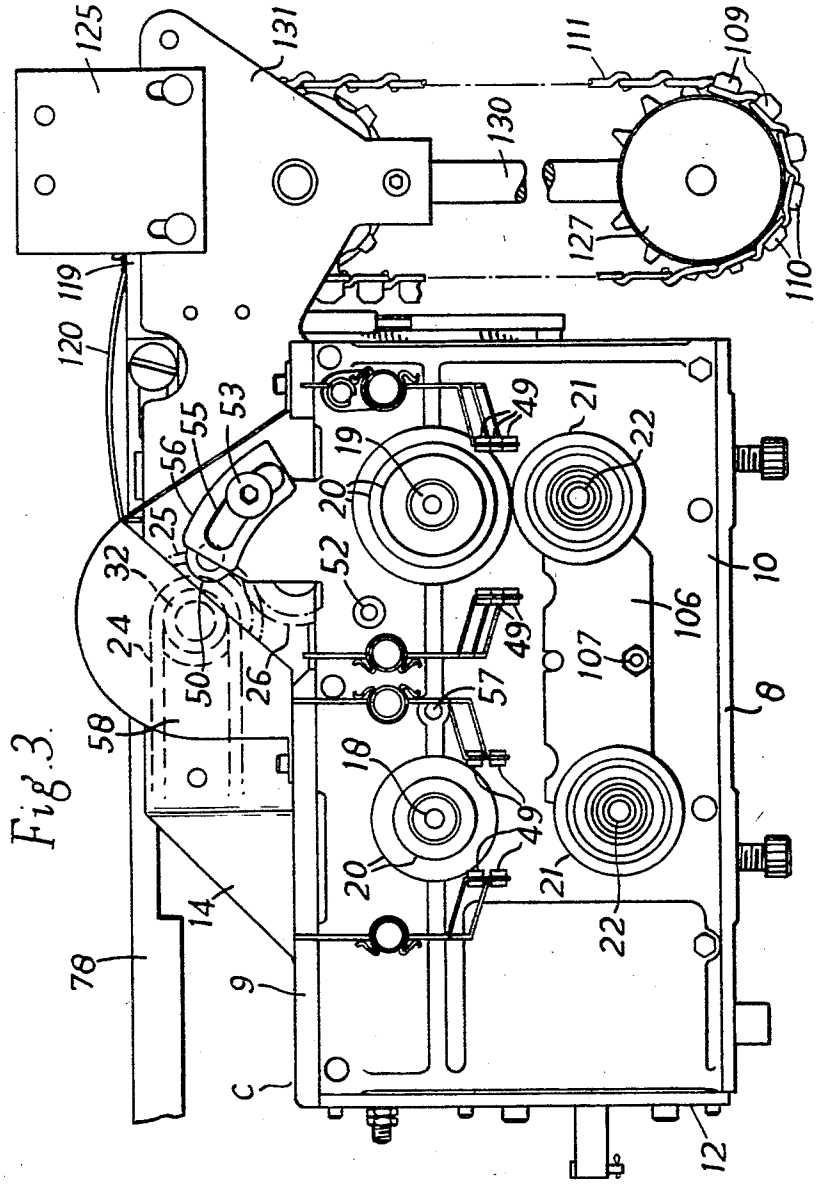


Fig. 3.

YARN FEEDING MECHANISMS FOR FLAT BED KNITTING MACHINES

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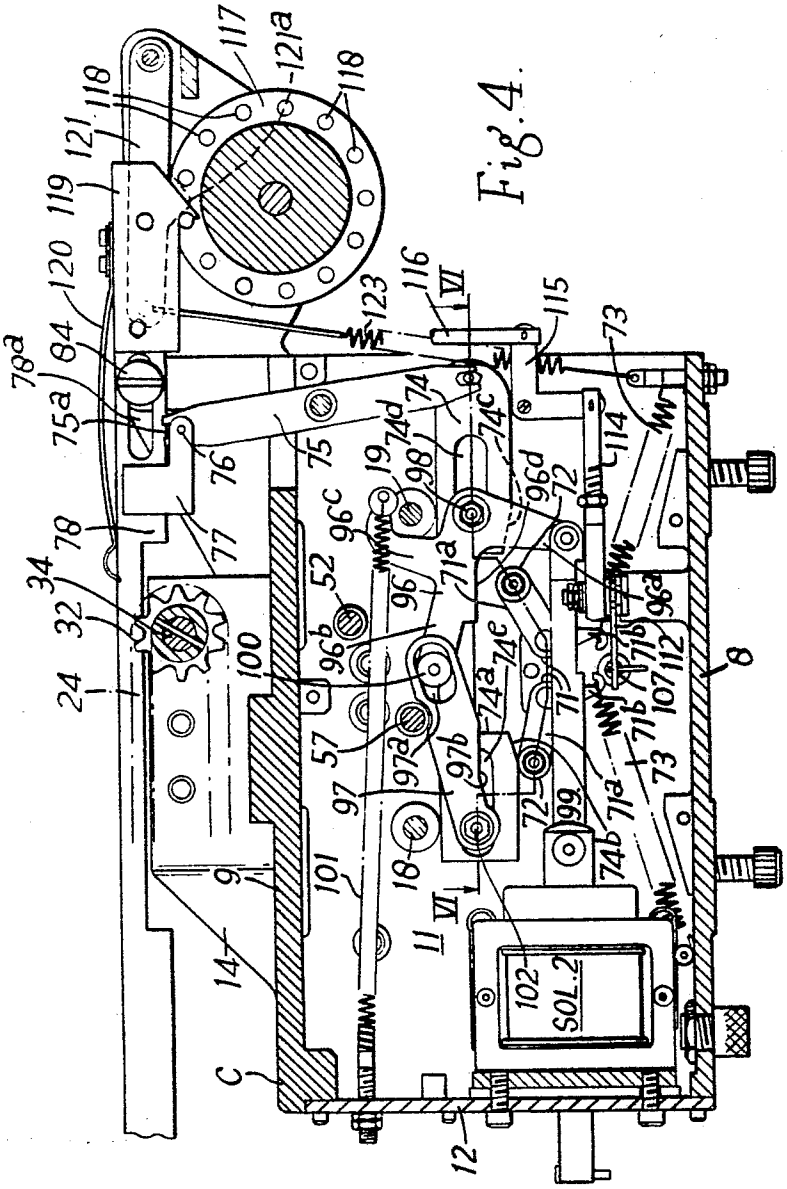

Fig. 4.

YARN FEEDING MECHANISMS FOR FLAT BED KNITTING MACHINES

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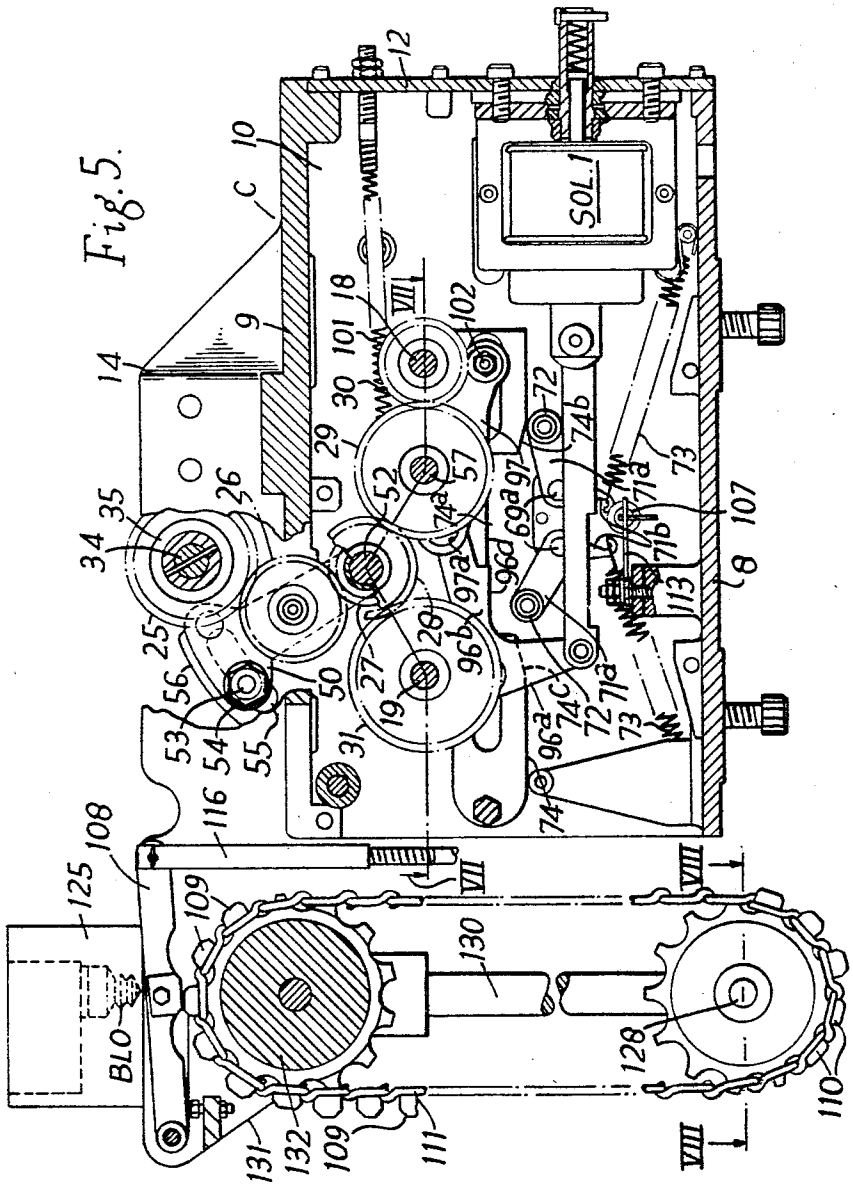
Fig. 5.



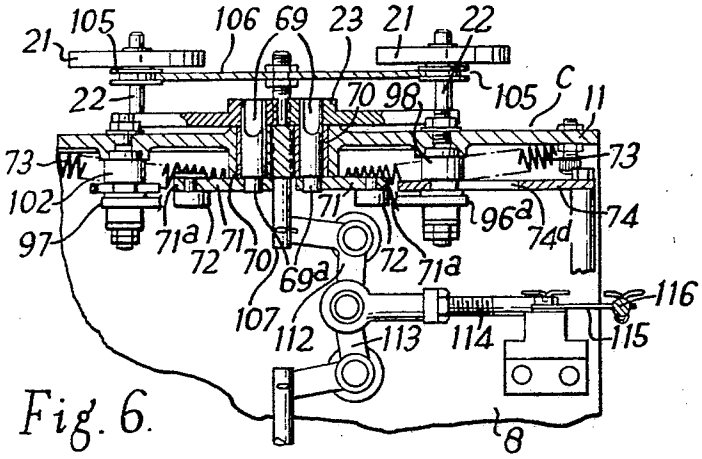


Fig. 6.

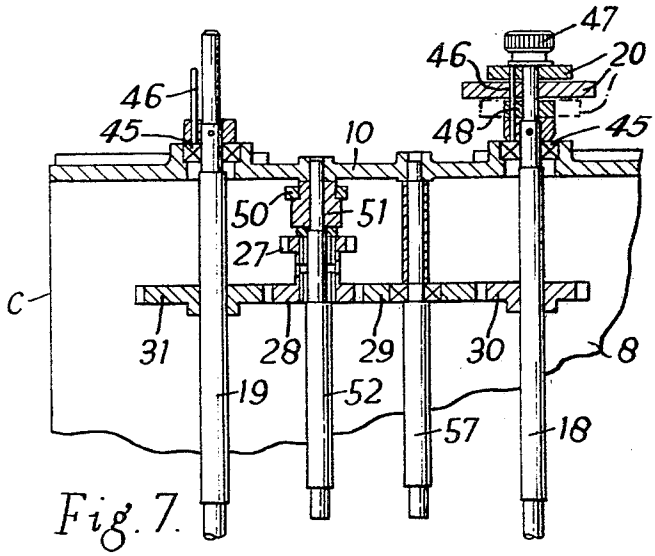


Fig. 7.

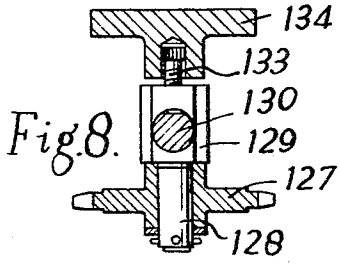


Fig. 8.

YARN FEEDING MECHANISMS FOR FLAT BED KNITTING MACHINES

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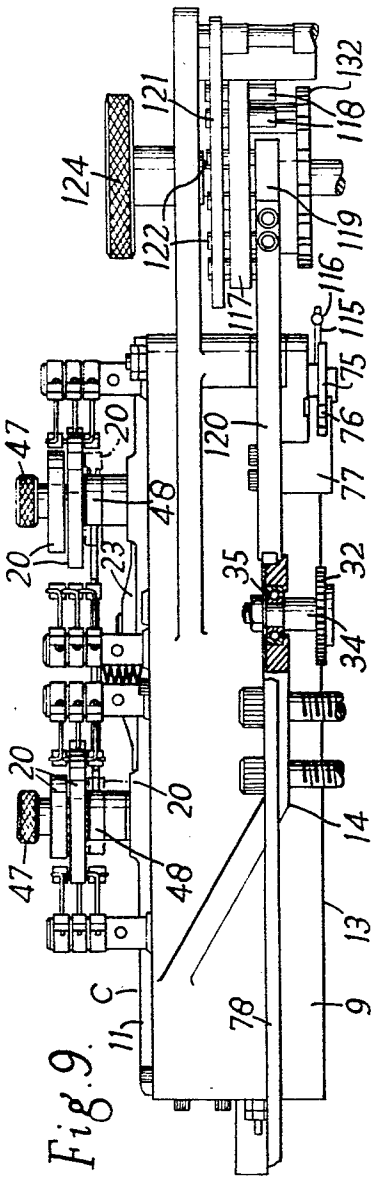

Fig. 9.

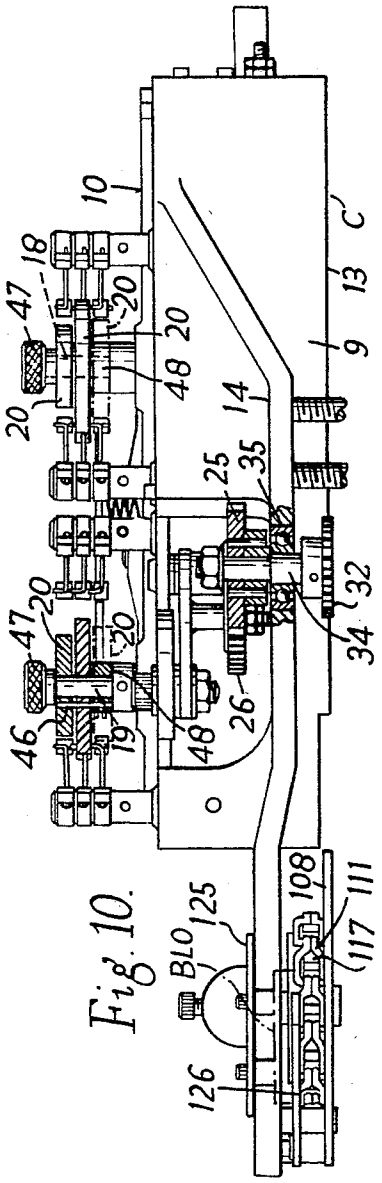

Fig. 10.

YARN FEEDING MECHANISMS FOR FLAT BED KNITTING MACHINES

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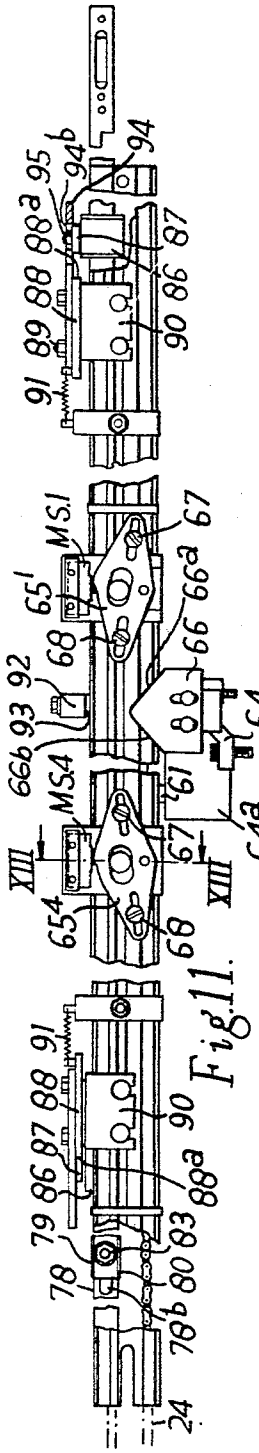


Fig. 11.

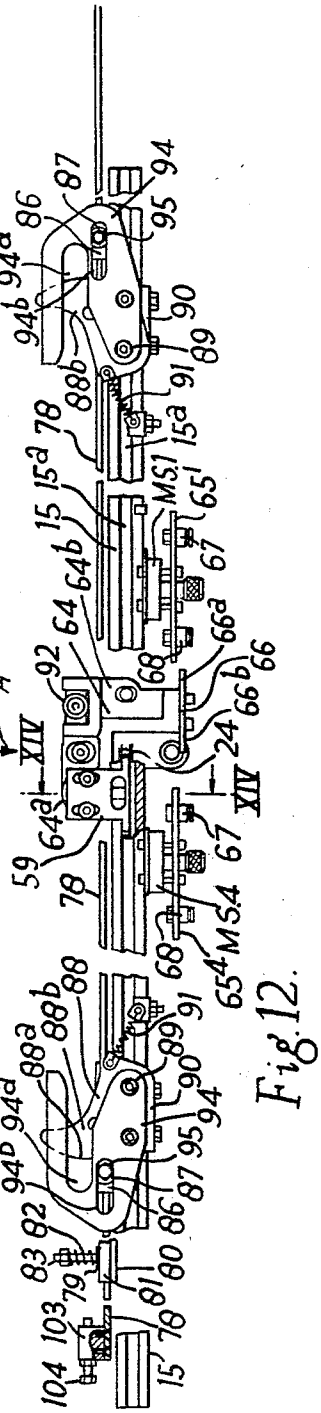


Fig. 12.

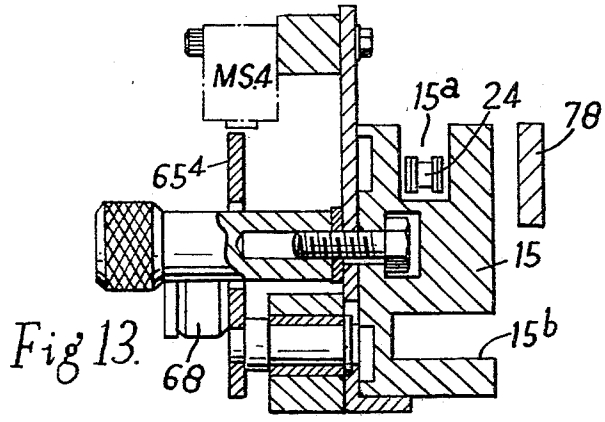


Fig 13.

Fig. 14.

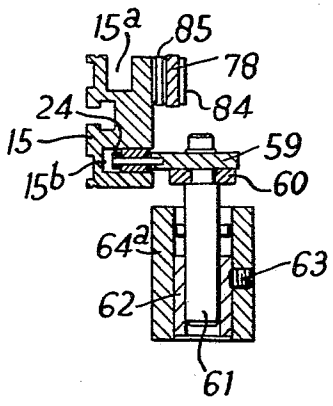
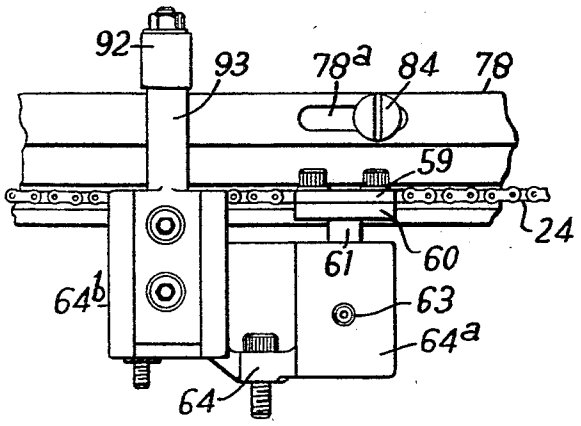


Fig. 15.



YARN FEEDING MECHANISMS FOR FLAT BED KNITTING MACHINES

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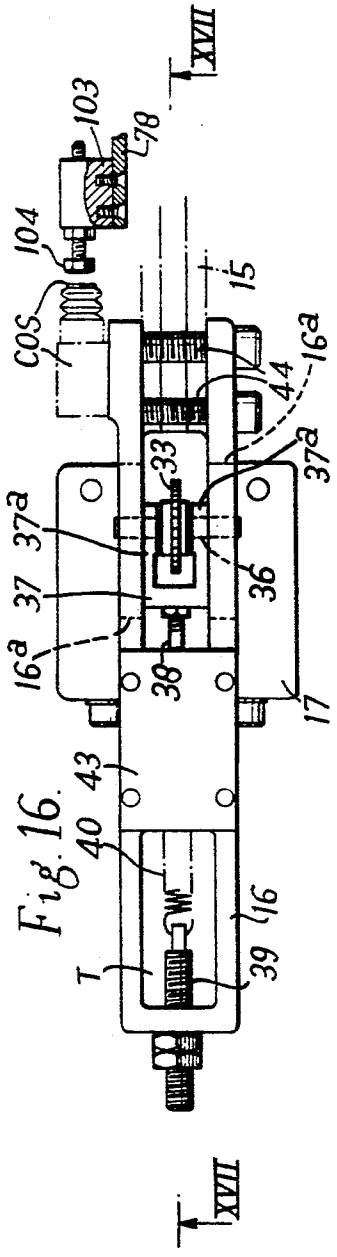

Fig. 16.

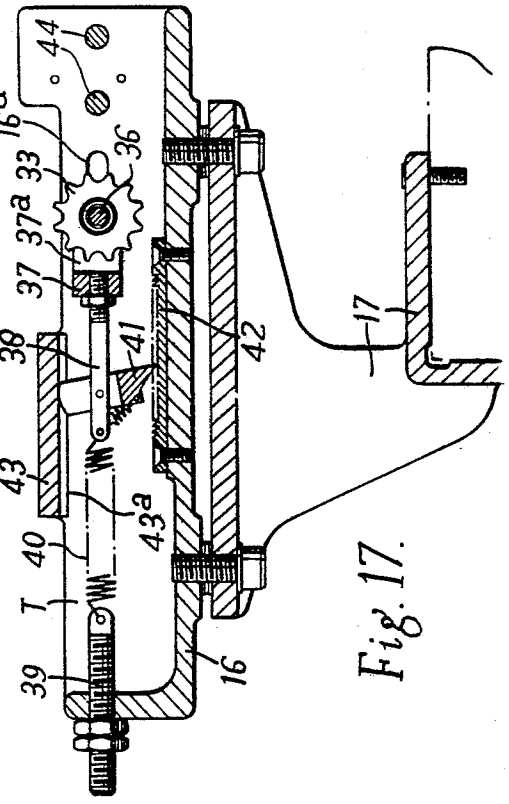

Fig. 17.

YARN FEEDING MECHANISMS FOR FLAT BED KNITTING MACHINES

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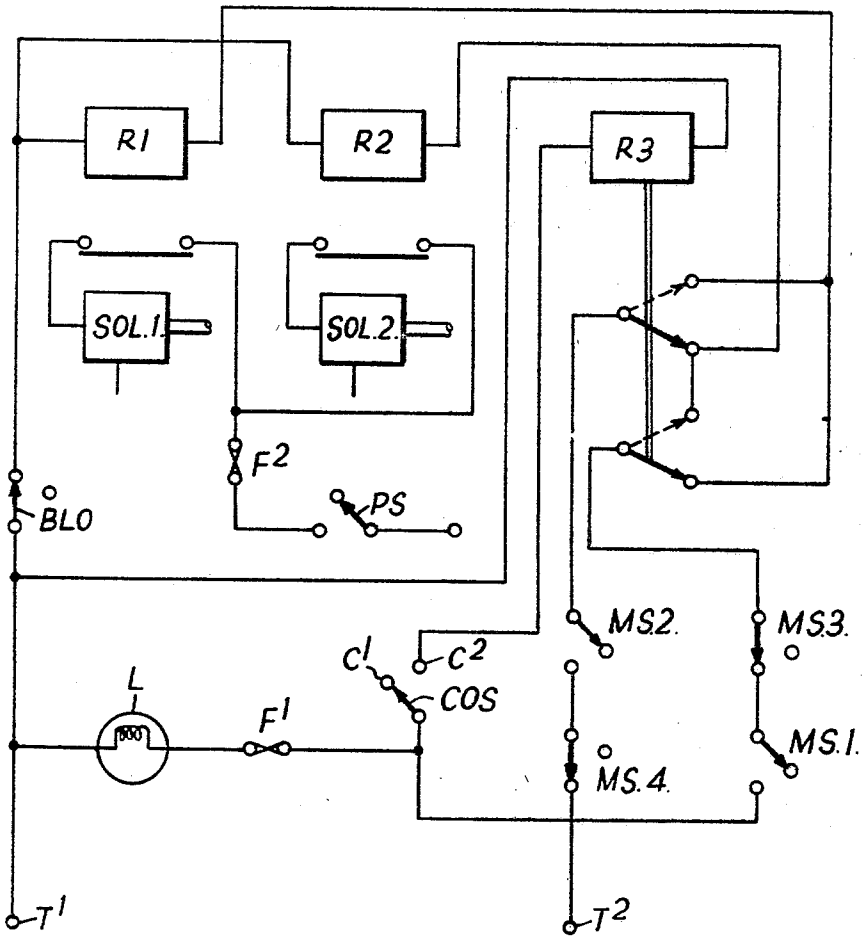
Fig. 18.



United States Patent Office 3,396,558
Patented Aug. 13, 1968

3,396,558

YARN FEEDING MECHANISMS FOR FLAT BED KNITTING MACHINES

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Filed Nov. 9, 1965, Ser. No. 507,071
Claims priority, application Great Britain, Nov. 12, 1964, 46,069/64
19 Claims. (Cl. 66—132)

ABSTRACT OF THE DISCLOSURE

Flat bed knitting machine having two pairs of nip rollers for positively feeding yarn to needles during to and fro traverses of the cam carriage in respectively opposite directions. An endless chain passed around sprockets and connected with the cam carriage, is provided for driving at least one nip roller of each pair through the medium of one of the chain sprockets and an associated gear train; the machine includes means for separating the nip rollers of each pair at required times and permitting them to move into cooperative relationship at other times. The gear train includes a change-gear for controlling stitch and course length.

This invention appertains to yarn feeding or furnishing mechanisms for application to new or existing flat bed knitting machines.

So far as the present invention is concerned, a flat bed knitting machine means one comprising at least one flat or straight horizontal needle bed or plate equipped with a straight series of independently operable needles, and wherein a yarn, under appropriate tension, is fed to and taken by the needles by which it is weft knitted into fabric, the said yarn being drawn from a supply by joint longitudinal traverses in opposite directions of a thread carrier and a cam carriage, and by the knitting action of knitting cams or a "lock" mounted on this carriage. Practical forms of such a flat bed knitting machine are usually provided with two opposed flat or straight horizontal needle beds or plates which are set either at an angle of 90° to each other, as in a V-bed machine of the Lamb type, or in a common horizontal plane as in a purl stitch or links and links type of machine. In a V-bed machine each of the two needle beds or plates may be equipped with a separate series of individually operable needles, whilst in a flat machine of the purl stitch or links and links type there is only one set of such needles which are selectively transferable from one bed or plate to the other through the medium of needle-actuating jacks, all as is well known to those acquainted with the art.

The invention, moreover, is applicable both to single-lock and to double-lock flat bed knitting machines. A single-lock machine has one set or pair of locks (one lock or cam system to each needle bed or plate) whereas in a double-lock machine two sets or pairs of locks are mounted on the same traversible carriage and are set as closely together as possible. A double-lock machine puts on two courses of knitted loops with each traverse of the carriage across the machine, as against one course with the single-lock machine.

The invention is especially concerned with positive yarn feeding mechanism for determining and controlling stitch and course length and consequently also fabric or garment length.

Thus, the primary object of the present invention is to provide, in or for a flat bed knitting machine, means whereby the amount of yarn knitted per stitch and hence per course is maintained substantially constant, the invention accordingly being based on the fact that uniformity in stitch length, course length and fabric or garment length is dependent on the precise amount of yarn consumed by the machine.

Now under ordinary working conditions, the variables that tend to cause differences in coarse length are several: for instance, there are yarn friction variables, changes in machine running speed, temperature variations, variations in the tension and physical properties of the yarn being fed and so on. A particular aim of the invention, therefore is to provide a positive yarn feeding and controlling mechanism adapted to obviate these variables and changes by means of nip rollers measuring the yarn as it goes into the knitting machine and so controlling stitch length and course length.

In this regard the invention provides improvements in the previously proposed arrangement disclosed in the complete specification of United Kingdom Letters Patent No. 948,254, wherein there are provided, in combination in a flat bed knitting machine in which the thread carrier traverse extends to and fro beyond the selvedges of the work, a positive yarn feeding device comprising nip rollers at least one of which is driven and the other of which is separable therefrom, means for operating the said device for positively feeding yarn at predetermined constant or different rates dependent upon the machine speed and upon invariable or different movement relationship respectively between the device and the relevant thread carrier, and selvedge control means which are operable for stopping and re-starting for positive feed of yarn at predetermined times before the end and after the re-start respectively of the thread carrier traverse.

In accordance with the characteristic and distinguishing feature of the present invention there are provided, in or for association with a flat needle bed or plate of a knitting machine, two pairs of positive feed nip rollers, one pair being operable to feed a yarn to the needles in the said bed or plate during each traverse of the cam carriage in one direction and the other pair being operable to feed the yarn to these needles during each carriage traverse in the reverse direction.

These two pairs of nip rollers, in use appropriately spaced apart in the direction of the length of the needle bed or plate, are for feeding yarn to the independently operating needles actuated by or from the particular cam system or lock which is related to that bed or plate. The nip rollers of the pair located nearest the carriage are adapted to be closed together to form a nip for feeding the yarn when the carriage is moving away from the rollers, whereas the rollers of the other pair furthest from the carriage are adapted to be similarly closed together to form a nip for feeding the yarn as the carriage returns, i.e. is moving towards the rollers. Thus, it is convenient to refer to the nip rollers nearest the carriage as the "going" rollers, and the rollers furthest from the carriage as the "coming" rollers.

An important point to appreciate at the outset is that there are two pairs of nip rollers, i.e. four rollers, for positively feeding each yarn which is to pass through a thread carrier and to be taken and knitted by needles in the machine. Consequently, if it is desired to employ a yarn feeding mechanism constructed, arranged and operable according to this invention for positively feeding a single yarn to needles in one needle bed or plate only of a flat bed knitting machine and if, moreover, only a single cam system or lock on the cam carriage is adopted for operating these needles, then the said yarn feeding mechanism will comprise but a single pair of going and a single pair of coming rollers, But if it is the intention to adopt such a yarn feeding mechanism for positively feeding two single yarns to sets of needles in the front and the rear needle beds or plates of a flat bed knitting machine

respectively, then in this case, and again assuming that only a single cam system or lock on the cam carriage is used for operating the needles in each of the two beds or plates, the mechanism will comprise two sets of going and coming nip rollers, viz. a pair of going rollers and a pair of coming rollers for the front bed or plate and a further pair of going rollers and a further pair of coming rollers for the rear bed or plate—the two sets of nip rollers being located at respectively opposite sides of the longitudinal median line of the machine extending between the two parallel beds or plates.

A further possibility is, however, envisaged in regard to a double-lock machine wherein there are provided on the cam carriage two locks per needle bed or plate: in such an alternative case, in which two yarns can be fed via two thread carriers to a set of needles in each of the two opposed beds or plates, it may be desirable or necessary to provide four sets of nip rollers, one set for feeding each of four yarns. But in this rather more complicated arrangement, two of the sets of nip rollers relating to one pair of locks, may be combined into one yarn feeding unit, whilst the remaining two sets of nip rollers relating to the other pair of locks may for convenience be similarly combined into a second yarn feeding unit.

For convenience in the following further description most of the latter will be concentrated on a unitary positive feed mechanism or head applied to a two-bed flat knitting machine wherein only one carriage lock per bed is provided—or, at least, is in use. It is, however, to be clearly understood that what applies to one unitary mechanism or head applies equally to any other similar mechanism or head provided in the machine: similarly, what applies to either of two companion sets of nip rollers (one set to each of two opposed needle beds) applies equally to the minimum of one set (two pairs) of nip rollers.

In order that the invention may be more clearly understood and readily carried into practical effect, a specific constructional example of positive yarn feeding mechanism applied to a two-bed flat knitting machine will now be described with reference to the accompanying drawings, wherein,

FIGURE 1 is a front view of the said knitting machine showing the positive yarn feeding mechanism applied thereto, the machine and the said mechanism being respectively drawn in light and relatively heavy lines,

FIGURE 2 is an end view of the machine as seen in the direction of the arrow A in FIGURE 1,

FIGURE 3 is a front view of the unitary positive feed head located at the right-hand end of the machine,

FIGURE 4 is a vertical sectional view through the head as seen from the front of the machine and showing the mechanism lying adjacent to the rear cover plate of the casing of the head,

FIGURE 5 is another vertical sectional view through the head as seen from the rear of the machine and shows the gearing and mechanism lying adjacent to the front cover plate of the said casing,

FIGURE 6 is a detail sectional view taken on the line VI—VI of FIGURE 4,

FIGURE 7 is a further detail sectional view taken on the line VII—VII of FIGURE 5,

FIGURE 8 is a sectional view taken on the line VIII—VIII of FIGURE 5,

FIGURE 9 is a plan view, partly in section, of the rear part of the positive feed head, showing inter alia, the upper rollers of the two pairs of nip rollers for positively feeding a yarn to needles in the rear needle bed of the knitting machine,

FIGURE 10 is a similar plan view, also partly in section, of the front part of the said head including two pairs of nip rollers for feeding a yarn to needles in the front needle bed of the machine,

FIGURE 11 is a fragmentary front view of a portion of a cross beam or rail constituting a chain guide included in the mechanism, and shows mounted on this beam or rail various actuating and control devices, as will be hereinafter described,

FIGURE 12 is a plan view of all that is shown in FIGURE 11,

FIGURE 13 is a cross-sectional view taken on the line XIII—XIII of FIGURE 11,

FIGURE 14 is a cross-section taken on the line XIV—XIV of FIGURE 13,

FIGURE 15 is a detail rear view of the beam or rail, as seen in the direction of the arrow A in FIGURE 12, illustrating means for connecting the cam carriage of the knitting machine with the chain guided in said beam or rail,

FIGURE 16 is a plan view depicting a mounting assembly for the tail end of the cross beam or rail and also an associated tensioner for the chain guided therein,

FIGURE 17 is a vertical sectional view of the same, and

FIGURE 18 is a diagram illustrating the electrical control circuitry of the positive yarn feeding mechanism.

Like parts are designated by similar reference characters throughout the drawings.

Referring to FIGURES 1 and 2, the letters KM designate a typical two-bed flat knitting machine. The front needle bed or plate of this machine is indicated at **1** and the rear needle bed or plate at **2**. The longitudinally traversible cam carriage is represented at **3**. The numeral **4** indicates a few typical thread guides for feeding yarns to the needles in the needle beds or plates. At the left-hand side of **1** there is shown, in purely diagrammatic fashion, a jacquard selecting mechanism **5**, whereas at **6** in FIGURE 2 there is represented an electric motor for driving the machine.

At the right-hand end of the machine frame F viewing the machine from the front, there is attached a mounting bracket **7** upon the top of which is supported the casing C of a stationary positive feed head. This casing comprises a rectangular framework including a closed bottom **8** and a mainly closed top **9**, there being secured to this framework a front cover plate **10**, a rear cover plate **11**, and an end plate **12** disposed at the left hand end of the casing C. The opposite end of the latter (shown at the right-hand side of FIGURE 4 and the left-hand side of FIGURE 5) is left entirely open. The casing C is divided longitudinally into two halves along a line **13** (FIGURE 9 and 10) coincident with a medial plane extending between the two parallel needle beds or plates **1** and **2**. Upon the top **9** of the casing C there are provided two suitably spaced brackets **14** between the left-hand ends of which is secured one end of a cross beam or rail **15**. As shown in FIGURE 2 this beam or rail extends horizontally the full length of the machine and, at its tail end remote from the casing C, is secured in a mounting unit **16** in turn supported upon a bracket **17** bolted to the left-hand end of the machine.

Extending laterally right through the upper part of the casing C are two parallel spaced driveable shafts, viz. a "going" shaft **18** and a "coming" shaft **19**. Upon the outer ends of these shafts are rigidly secured upper steel rollers **20** each of which is adapted for co-operation with a lower pressure roller **21** or wheel. The pressure rollers **21**, which are rubber-covered and free-running, are mounted upon spindles **22** set in a so-called D-arm such as that indicated at **23** in FIGURE 6. The nip rollers **20** and **21** of each pair are superimposed, the lower roller **21** being movable upwards to close the nip and downwards to open the nip. But whilst in the illustrated example only one of each pair of nip rollers is adapted to be positively driven, it is to be clearly understood that, if desired, both rollers of each pair could be driven.

The going and coming shafts **18** and **19** carrying the upper steel rollers **20** are arranged to be continuously driven from an endless chain **24**, e.g. of the roller type, through the medium of a train of gears **25**, **26**, **27**, **28**, **29**, **30** and **31** (see FIGURES 3, 5 and 7), the chain in turn being driven by the cam carriage **3** as it traverses to and

fro, i.e. alternately from left to right and right to left. The upper and lower runs of the chain **24** are guided within longitudinal channels **15***a* and **15***b* formed in the cross beam or rail **15** (see FIGURES 11, 12 and 14). The said chain, moreover, is passed around two chain sprockets **32** and **33** (see FIGURES 16 and 17). The spindle **34** upon which the sprocket **32** is secured is rotatably mounted in a ball bearing **35** provided within the appropriate one of the brackets **14**. The gear **25** (meshing with the gear **26**) is secured upon the end of the rotary spindle **34** remote from the chain sprocket **32**.

The chain sprocket **33**, on the other hand, is secured upon a spindle **36** which, as shown in FIGURES 16 and 17, is mounted to rotate freely within bearing holes formed in the parallel limbs **37***a* of a forked component **37** housed within the tail mounting unit **16**. The opposite ends of the spindle **36** are located in horizontal slots **16***a* formed in the spaced vertical walls of the unit **16**. The forked component **37** is connected with a chain-tensioning device T which comprises a stem **38** screwed at its inner end into the rear of the said component, an adjusting screw **39** adjustable in the rear extremity of the tail mounting unit **16** and an intermediate tension spring **40** connecting the two. A suitably spring-influenced detent **41**, pivotally mounted upon the stem **38** and arranged to co-operate with a toothed rack **42**, constitutes a non-return ratchet device adapted to retain the stem **38** and hence also the forked component **37** in any position to which it may be drawn to the left (see FIGURE 17) by appropriate manipulation of the screw **39** when tensioning the endless chain **24**. A plate **43** longitudinally grooved at **43***a* on its underside and secured upon the top of the unit **16** provides an abutment for the detent **41**. Bolts for securing the tail end of the cross beam or rail **15** in the mounting unit are indicated at **44**.

The end portions of the going and coming shafts **18** and **19** are mounted in ball bearings **45** which are set in the front and rear cover plates **10** and **11**. The bearings **45** set in the front cover plate **10** are shown in FIGURE 7, it being understood that the rear cover plate **11** is omitted from this figure merely for simplicity in illustration. Thus, the illustrated positive feed head comprises two sets of nip rollers so that there are secured upon the going shaft **18** (the left-hand shaft as viewed from the front of the machine) at least two driveable steel going rollers **20**—one at the front and the other at the back of the aforementioned median line **13**, whilst upon the coming shaft **19** (i.e., the right-hand shaft) there are similarly secured at least two coming rollers—again one at the front and the other at the back of the casing C. Preferably, however, and as shown in the drawings, there are provided on each of the opposite ends of each of the two shafts **18** and **19**, a plurality of steel rollers **20** of respectively different diameters for selective co-operation with the companion lower presser roller **21**. Thus, two or even three different sized rollers **20** may be slipped onto and rigidly secured to an end portion of either the going or the coming shaft, according to requirements, and as more clearly shown in FIGURES 7, 9 and 10. Each steel roller **20** slipped onto either of these two shafts is indirectly keyed to the latter by an axially extending locating pin **46** and is clamped in position by a knurled nut **47** applied to a screwthreaded outer extremity of the relevant shaft. If, say, it is desired to fit only two steel rollers **20** onto an end portion of either of the going or coming shafts, then a space reserved for a third steel roller may be temporarily occupied by a spacer **48** of the same thickness. Alternatively, a plurality of initially separate and individually removable upper nip rollers such as **20** for fitting onto one end of either the going or the coming shaft may be replaced by a single upper nip roller having a stepped form and being of such axial extent as to provide adjoining portions having annular surfaces of respectively different diameters enabling a plurality of yarns to be guided beneath the said adjoining portions. In either case, by arranging for the free running lower pressure rollers **21** to be selectively moved laterally to different extents inwards and outwards, by means hereinafter to be described, it is possible to nip and positively feed a selected one of the said plurality of yarns in the production of patterning or other special effects. Yarn guides such as those indicated at **49** in FIGURE 3 are mounted on the front and the rear cover plates of the casing C to guide yarns beneath the upper steel rollers **20** or the adjoining roller portions of the various diameters.

Stitch length and hence also course length may be controlled by roller size or/and by the selected size of a change gear included in the aforementioned train of gears. For example, in the illustrated train of gears provided within the casing C, the spur gear **25** may be the change gear. Thus, whilst a wide range of stitch lengths can be achieved by changing the sizes of the positively driven rollers **20**, nevertheless for certain ranges of stitch length it is necessary to change the gear **25** for one of a different diameter. But, whenever the gear **25** is changed, it is necessary to roll the gear **26** around the gear **27** immediately below it whilst maintaining **26** and **27** in mesh; this is to enable the gear **26** to be bodily swung in either direction both to facilitate actual changing of the gear **25** and also to enable the gear **26** to be disposed in mesh with the changed gear. For this purpose, the gear **26** is mounted on an arm **50** which at its lower end is bossed at **51** and arranged to pivot freely about a lay shaft **52** carrying the combined or connected gears **27** and **28** (see FIGURE 7). The arm **50** is secured in position by a nut and bolt **53**, **54**, the bolt extending through an arcuate slot **53** formed in a part such as **56** of or on the casing C. The gear **29** is carried by a further lay shaft **57**, extending parallel with the shafts **18**, **19** and **52**. The going and coming shafts **18** and **19** have rigidly secured thereto the gears **30** and **31** respectively. The arrangement of the gear train is accordingly such that whenever the chain sprocket **32** is driven in the clockwise direction, as viewed in FIGURE 5, the going shaft **18** will rotate clockwise and the coming shaft **19** anti-clockwise, and vice versa. The upper part of the change gear **25** is protected by a cover **58** secured upon the top **9** of the casing C.

For transmitting the motion of the cam carriage **3** to the endless chain **24**, and thence driving the chain sprocket **22** alternately in opposite directions, the lower run of the said chain is coupled to a pick-up element **59** in the form of an arm which is adjustably mounted upon a support **60**. This support is welded upon the top of a depending vertical peg **61** which is slidable heightwise within a bush **62** (see FIGURE 14). The latter is secured by a set screw **63** within a bossed portion **64***a* of a bracket **64** adapted to be bolted to the longitudinally traversible cam carriage **3** of the machine. The driving of the two shafts **18** and **19** in the manner described thus maintain a constant relationship between the rectilinear speed of the cam carriage and the rotational speeds of the said driven shafts.

Now in all cases more yarn must be positively fed when the carriage is moving away from the unitary mechanism or head than when it is approaching the latter. The course length in the fabric or garment, however, will usually, but not necessarily always, be the same in whichever direction the carriage is travelling. This result may be achieved by a judicious dimensioning of the gears in the aforesaid train which permits of the commensurate driven shaft rotating at a higher speed than the other in a fixed relationship. The driven shafts **18** and **19** have secured thereon nip rollers **20** of different diameters so that the combination of different rotational speeds and different roller diameters provides for commensurately different rates of yarn feed—resulting in a comparatively high rate of feed when the traverse of the carriage **3** is going away from the nip rollers **20** and **21** and a comparatively low rate of feed when the carriage traverse is coming towards the said rollers.

To facilitate the production of special rib and like

effects such, for example, as Milano rib, in a case where the unitary positive feed mechanism or head comprises two sets of nip rollers, one to each of two opposed cam systems or locks, the two driven shafts **18** and **19** may, if desired, each be transversely split into two so that in addition to the provision of different speeds "going" and "coming" as aforesaid, the driven rollers at the front and the rear of the mechanism or head can be caused to rotate at respectively different speeds determined by separate change gears of respectively different diameters.

Separation of the going and coming nip rollers **20** and **21** may conveniently be effected by associated spring-influenced mechanical members (hereinafter to be described) arranged to be actuated by electric solenoid and switch means, the switch means being located near the selvedge needles and operable by a part moving with the cam carriage of the flat bed knitting machine, and selector means operable in reverse senses at respectively opposite extremities of the carriage strokes being provided to permit closure of the nip or nips of only the pair or pairs of rollers appropriate to the direction of carriage travel taking place at any one time and to simultaneously maintain in a positive manner separation of the remaining pair or pairs of nip rollers.

Thus, in the illustrated arrangement of the last described feature, applied to a head equipped with two sets of nip rollers, two solenoids are employed—one SOL. **1** in respect of the pairs of going and coming nip rollers at the front of the casing C and the other SOL. **2** in respect of the similar pairs of nip rollers at the back of the said casing. This enables the said pairs of nip rollers at the front end back to be opened and closed entirely separately and in such a way as to accord with the movements of the two thread carriers **4** functioning in conjunction with the front and rear needle beds or plates **1** and **2** respectively. In this connection it has to be borne in mind that throughout each carrier traverse in either direction the front thread carrier usually leads whilst the rear thread carrier trails, this circumstance dictating the necessity for the opening and closing of the two pairs of front nip rollers a little in advance of the similar pairs of rear nip rollers. Two pairs of micro-switches MS. **1** and MS. **2** and MS. **3** and MS. **4** are mounted in sequence on the longitudinal cross beam or rail **15**. These microswitches, moreover, are operable by pairs of rocker members 65^1 and 65^2 and 65^3 and 65^4 disposed for accurate control of the pairs of going and coming nip rollers **20**, **21** in relation to the fabric selvedges. That is to say, one pair of rockers 65^1 and 65^2 is located near to the casing C and the other pair 65^3 and 65^4 remotely therefrom. The bracket **64** on the carriage **3** is fitted with a striker **66** for operating the rockers. Each rocker is fitted at its ends with adjustable rollers **67** and **68** arranged to be respectively acted upon by the oppositely sloping edges **66***a* and **66***b* of the striker **66**. Assuming that the knitting machine is being viewed from the front, the pairs of nip rollers being, as shown, mounted at the right-hand end of the machine, then during the first phase of the outward traverse of the carriage **3** away from the rollers, i.e. from right to left, the striker **66** first passes the right-hand rollers **67** of the near pair of rocker members 65^1 and 65^2 and then its edge **66***b* strikes the left-hand rollers **68** to operate, one after the other, the two near switches MS. **1** and MS. **2**, as the result of which the front and rear solenoids SOL. **1** and SOL. **2** are energized to permit closing first of the pair of going rollers associated with the front bed or plate **1**, and then of the pair of going rollers associated with the rear bed or plate **2**. During the final phase of the said outwards traverse of the carriage **3**, (just about to commence in FIGURE 1) the striker **66** first passes the rollers **67** of the remote pair of rocker members 65^3 and 65^4 and strikes the rollers **68** thereon to operate, one after the other, the two remote switches MS. **3** and MS. **4** in such a way as to deenergize the two solenoids SOL. **1** and SOL. **2** similarly one after the other, to effect first opening of the closed nip of the pair of going rollers associated with the front needle bed or plate **1** and then with a slight delay, the opening of the closed nip of the pair of going rollers associated with the rear needle bed or plate **2**. Conversely, during the first phase of the inwards traverse of the carriage towards the casing C and the rollers, i.e. from left to right, the striker **66** first passes the left-hand rollers **68** of the said remote pair of rocker members 65^4 and 65^3 and thereupon strikes, with its inclined edge **66***a*, the right-hand rollers **67** thereof to reversely operate seriatim the said two remote switches MS. **4** and MS. **3** as the result of which first one and then the other of the two solenoids SOL. **2** and SOL. **1** are energized to permit closure first of the pair of coming rollers associated with the rear needle bed or plate **2** and then of the pair of coming rollers associated with the front bed or plate **1**. Then, during the final phase of the inwards traverse of the carriage the striker **66** first passes the left-hand rollers **68** of the near pair of rocker members 65^2 and 65^1 and strikes the right-hand rollers **67** thereof to operate one after the other the two near switches MS. **2** and MS. **1** which again de-energize the two solenoids SOL. **2** and SOL. **1** similarly one after the other, to cause first opening of the nip of the pair of coming rollers associated with the rear needle bed or plate **2** and thereafter the opening of the nip of the pair of coming rollers associated with the front bed or plate **1**.

The description of FIGURE 18, which, illustrating the electric control circuitry, shows in purely diagrammatic fashion, the solenoids SOL. **1** and SOL. **2** and the two pairs of micro-switches MS. **1** and MS. **2** and MS. **3** and MS. **4**, will be completed later when all of the switches in the circuitry have been mentioned. In the meantime it will be convenient to describe the manner in which the free-running, rubber-covered pressure rollers **21** at the front and the back of the casing C are carried, and the means by which these rollers are pressed down to separate them from the upper steel rollers to open the nips of the pairs of rollers and are released and permitted to rise into contact with the said upper steel rollers to close the nips of the pairs of rollers at required times.

Thus, the two pressure rollers **21** at the front (and also at the back) of the casing C are, as previously mentioned, mounted upon spindles **22** set in arms **23**. As seen in FIGURE 6, the bossed inner ends of these arms **23** are rigidly secured upon the outer ends of short shafts **69** mounted to turn in bushes **70** secured in the relevant (front or rear) cover plate of the casing C. To the inner reduced ends **69***a* of the shafts **69** are rigidly secured bell-cranks **71**. Upon the arm **71***a* of each of the two bell-cranks is mounted a roller **72** whilst the outer ends of the other arm **71***b* of each bell-crank is of hooked form and has anchored thereto a controlling tension spring **73**. The ends of the springs **73** remote from the bell-cranks **71** are anchored to the bottom **8** of the casing C.

Mounted within the casing C immediately above the rollers **72** on each pair of bell crank arms **71***a* is a longitudinally shiftable selector bar **74** having a cut out **74***a* in the edge thereof opposing the said rollers. The two selector bars **74** are transversely connected to operate in unison and are arranged to be shifted back and forth by a common centrally pivoted lever **75** the upper extremity of which is slotted at **75***a* to engage a pin **76** fixed in a small bracket attached to the appropriate side of a longitudinally movable "racking" bar **78**.

This racking bar is supported from the cross beam or rail **15** through the medium of screws **84** screwed into the said beam or rail and extending through slots **78***a* formed in the said bar (see FIGURE 14 and 15). Spacers such as **85** are mounted on the screw **83** and located between the heads of the screws and the back

of the cross beam or rail. The racking bar **78** is thus shiftable to and fro, i.e. rightwards and leftwards, by means presently to be described. But to exercise control over these to and fro movements and prevent bouncing of the racking bar **78**, the latter is arranged to slide through tension devices such at that indicated at **79** in FIGURES 11 and 12. Each of such devices comprises friction blocks **80** and **81** held together frictionally by the pressure exerted thereon by a compression spring **82** associated with a screw **83** which latter extends through a slot **78***b* in the racking bar and is screwed into the cross beam or rail **15**. The racking bar **78**, moreover, has secured to it longitudinally spaced operating blocks **86** each carrying on the top thereof a cam-following roller **87**. The rollers on these operating blocks are arranged to be acted upon by the operative edges **88***a* of cams **88** which are pivotally mounted at **89** upon brackets **90** bolted upon the cross beam or rail **15**. The pivoted cams **88** are controlled by springs **91** arranged as shown in FIGURES 1, 11 and 12. The pivoted cams **88** are formed with profiled noses **88***b* in turn arranged to be acted upon by a cam-striking roller **92** which is carried by an upstanding stem **93** secured in a portion **64***b* of the aforementioned bracket **64** bolted to the cam carriage **3** (FIGURE 15). As the cam-striking roller **92** contacts the operative edge **88***a* of the relevant pivoted cam **88** during a traverse of the carriage **3** in either direction, the said roller enters an open-ended guide slot **94***a* formed in a fixed steady plate **94** disposed immediately above the cam. Each of these plates **94** is slotted at **94***b* to avoid fouling the nuts **95** employed to retain in position the cam-following rollers **87**.

The form of the cut out **74***a* in the appropriate edge of each of the two connected selector bars **74** is such as to provide at opposite ends of each such bar, on its lower edge, oppositely inclined cam edges **74***b* and **74***c* for action upon the rollers **72**. But also for action upon the two rollers **72**, both at the front and also at the back of the casing C, to assist in the control of the relevant bell-cranks **71** and hence also the corresponding pressure rollers **21**, there are provided two associated pivoted levers **96** and **97**. The lever **96** which fulcrums about a stud **98** secured in the relevant cover plate of the casing C and extends through a slot **74***d* in the relevant selector bar **74**, is formed with three limbs **96***a*, **96***b* and **96***c*. Of these three limbs, **96***a* is connected by means of a straight link **99** with the relevant solenoid SOL. **1** or SOL. **2** depending on whether the linkage is at the front or back of the casing C. The limb **96***b* carries a roller **100** and is formed with a lower straight edge **96***d* opposing the relevant roller **72**. The limb **96***c* is connected to one end of an adjustable tension spring **101** the opposite end of which is anchored in the end plate **12** of the casing. The simple lever **97**, on the other hand, has only one limb in the outer end of which is formed an elongated hole or slot **97***a* accommodating the roller **100** on the limb **96***b* of the lever **96**. The lever **97** fulcrums about a stud **102** which is secured in the same cover plate as the stud **98** and extends through a slot **74***e* in the appropriate selector bar **74**. The lower straight edge **97***b* of the lever **97** opposes a roller **72**. Thus, whenever the particular solenoid (SOL. **1** or SOL. **2**) connected with the link **99** is energised and consequently pulled in, the said link will be drawn back suchwise as to swing the lever **96** about its fulcrum stud **98** against the action of the controlling spring **101**. As a result the limb **96***b* will be swung upwards to move the edge **96***d* well clear of the roller **72** opposing it. But by virtue of the permanent engagement of the roller **100** within the elongated hole or slot **97***a* in the lever **97**, the latter will be simultaneously swung up to move the edge **97***b* similarly well clear of the other roller **72**. It will be appreciated that in this way energisation of the solenoid results in the relevant two bell-cranks **71** being freed for control by the corresponding selector bar **74**. Conversely, whenever the solenoid is de-energised it releases the link **99** so that the lever **96** is reversely turned under the action of the spring **101** so that both the lever limb **96***b* and the associated lever **97** will be swung down together. As a consequence, the edges **96***d* and **97***b* will press down upon the rollers **72**, thereby depressing them and the bell cranks **71** into lower positions clear of the revelant selector bar **74** so that the latter can be safely shifted rightwards or leftwards.

The arrangement is accordingly such that towards the extremity of each stroke of the cam carriage **3** in the rightward direction the racking bar **78** is longitudinally shifted to the right as a consequence of which the connected selector bars **74** are both shifted to the left through the medium of the centrally pivoted lever **75**, whereas towards the extremity of each leftward carriage stroke the said racking bar is shifted to the left and the selector bars **74** are shifted to the right. The form of the cut out **74***a* in the edge of each selector bar **74** opposing the rollers **72** on the bell cranks **71** connected with the arms **23** carrying the lower rubber-covered pressure rollers **21** at the elevant side of the positive feed unit or head allows only the pressure roller appropriate to the direction of carriage travel to swing up under the action of its spring **73** into co-operative nip relation with the companion upper driven roller **20** whenever the appropriate solenoid is energised, the other pressure roller **21** at that side being positively held down against its spring action by the inclined edge **74***b* or **74***c* of the selector bar edge. Thus, from what has been said and also from the foregoing description of the operation of the rocker members 65^1, 65^2, 65^3 and 65^4 and the microswitches MS. **1**, MS **2**, MS. **3** and MS. **4**, it will be realised that whenever a switch is operated to de-energise a solenoid only one lower pressure roller **21** at the front or the back of the casing C will be pressed down to open a nip, the other pressure roller at that side of the mechanism already being held down by the relevant selector bar **74**. Conversely, whenever a switch is operated to energise a solenoid only one lower pressure roller **21** at the side concerned will be free to swing up into co-operative nip relation with its companion upper driven roller **20**, the other lower pressure roller at that side being positively prevented from swinging up by the selector bar **74**. But, of course, shifting of the selector bars alternately to the right and to the left at the respectively opposite extremities of the carriage strokes determines which pairs of nip rollers are to be open and which closed at any particular operation of two switches one after the other as hereinbefore described. In all instances, the solenoid-operated spring-controlled levers **96** and **97** function to hold the bell-cranks **71** down during shifting of the selector bars **74** in either direction, and to release the bell-cranks for control by the selector bars subsequent to each such shift.

In the principal case of a flat bed knitting machine having a cam system or lock and a thread carrier functioning in conjunction with each of two needle beds or plates, one thread carrier always preceding the other, the complete arrangement may conveniently, and as shown, include a change-over switch COS operation of which, via a relay R3 (FIGURE 18), changes the connections of the solenoids SOL. **1** and SOL. **2** to the various microswitches on the beam or rail **15**. The changeover switch COS, when provided, may be operated in this sense by or from the racking bar **78** as this is longitudinally shifted at the extremity of each outward traverse of the machine carriage **3** away from the nip rollers **20**, **21**. Each time the carriage returns to the rollers and the racking bar **78** is thereby automatically shifted in the opposite direction the change-over switch COS is released and the solenoid-to-switch connections revert to their initial condition. In each of FIGURES 12 and 16 it will be seen that there is attached to the tail end of the racking bar **78** a small block **103** into which is screwed an adjustable abutment

screw **104** adapted to operate the change-over switch COS by direct contact therewith.

If, as already described, each of the two driven going and coming shafts **18** and **19** has secured upon each end thereof either a plurality of upper rollers **20**, or a stepped upper driven roller, a plurality of yarns to be guided beneath the separate rollers or adjoining portions of a stepped roller, then by arranging for the lower pressure rollers **21** to be selectively moved laterally to different extents inwards and outwards it is possible to nip and positively feed a selected one of the said plurality of yarns in the production of patterning or other special effects. In this specific example illustrated in FIGURES 3–6, the two pairs of lower, free-running pressure rollers **21** respectively at the front and back of the casing C are slidable along their spindles **22** towards and away from one another and are rigidly combined with circumferentially grooved yokes **105** in which are engaged the outer ends of yarn change plates such as **106**, the lower central portions of these plates being connected through slidable spindles **107** to linkages adapted to be operated by a pivoted lever **108** (FIGURE 5) controlled by studs or bit **109**, **110** on an intermittently movable pattern dictating component such as the chain **111**. The spindles **107** are arranged to slide axially through bosses formed on the inner sides of the casing cover plates **10** and **11**. The inner ends of these spindles are as depicted in FIGURE 6, articulated to oppositely arranged bell crank levers **112** and **113**. The ends of the last mentioned levers remote from the spindles **107** are pivotally connected to a common adjustable link **114** which, through the medium of yet another bell crank lever **115** is in turn connected with the lower end of a rod **116**. This rod extends upwardly and at its upper extremity is pivotally connected with the lever **108**.

The construction, arrangement and operation of this particular system are such that if a stud or bit **109** or **110** raises the pivoted lever **108** the two pairs of lower pressure rollers **21** will simultaneously be laterally moved inwards towards one another through the connections **107**, **112**, **113**, **114**, **115** and **116**. Conversely, if by a movement of the pattern dictating component **111** the pivoted lever **8** is lowered the two pairs of pressure rollers **21** will be drawn laterally outwards away from one another. Studs or bits of varying heights enable the two pairs of pressure rollers to be selectively moved to various positions for cooperation, when the nips are produced, either with selected upper steel rollers **20** or selected portions of stepped upper driven rollers for the purpose of feeding the desired yarns. Although the upper driven rollers **20** or the adjoining portions of stepped rollers will usually be of different diameters there is no limitation in this respect since all of these rollers or adjoining portions could be of the same or substantially the same diameter.

When, as in the illustrated example, a patterning chain **111** is provided, then this is passed over a pattern wheel **117** located near to the pairs of nip rollers, this wheel being provided with a circular series of ratchet pins **118** adapted to be racked round intermittently by a pivoted pawl or clawker **119** upon one end of the racking bar **78**. A leaf spring **120** controls **119**. Thus, when the carriage moves to its extreme position away from the rollers **20**, **21** the racking bar **78** is longitudinally shifted as previously described, and this shift is utilised to cause the pawl or clawker **119** to rack round the pattern wheel **117** to the extent of one step, whereas on return of the carriage towards the rollers the racking bar is reversely shifted and sets itself in readiness for the next racking or indexing operation. For accurately locating and centralising the pattern wheel **117** each time it is turned a step by the pawl or clawker **119**, there is provided a pivoted centralising lever **121** having on its lower edge a downwardly protuberant nose **121***a* adapted to engage between two of a further circular series of pins **122** provided on the side of the pattern wheel remote from the ratchet pins **118** (see FIGURES 4 and 9). The centralising lever **121** is urged downwardly by a controlling tension spring **123**. For turning the pattern wheel **117** by hand there is provided a knob **124**.

Whenever the herein described positive feed mechanism is required to be put out of commission this can be done electrically, at the dictates of the pattern chain **111**, via a bluff out switch BLO (FIGURES 5 and 18). Appropriate actuation of this switch may serve to isolate from the solenoids SOL. **1** and SOL. **2** the micro-switches on the cross beam or rail **15**. As will be seen, the switch BLO is carried by a plate **125** and is arranged to be actuated by contact with the top edge of a lever **126** (FIGURE 10) brought about by virtue of the latter being raised by a stud or bit on the chain. In this regard it will be noted in FIGURE 10 that the links of the chain **111** are formed to provide two parallel tracks in one of which the bits for raising the lever **108** are disposed and in the other of which are disposed other bits for actuating the lever **126**.

At its lower end the chain **111** is passed around a sprocket **127** which, as illustrated in FIGURE 8, is mounted for rotation about a spindle **128** carried by a block **129**. This block is adjustable axially along a support rod **130** secured at its upper end in a depending portion of a bracket **131** on which the pattern wheel **117** and an upper chain sprocket **132** combined therewith is rotatably mounted. A set screw **133** turnable by a knob **134** is provided to set the block **129** in position after an adjustment to suit the length of the particular pattern chain being used.

Turning again to FIGURE 18, it will be seen that there are included in the 24 volt A.C. circuit two relays **R1** and **R2** associated respectively with the two solenoids SOL. **1** and SOL. **2** and each adapted to be closed and opened, by actuation of the relevant micro-switches as hereinbefore described, before the corresponding solenoid can be respectively energised and de-energised by the application thereto and cutting off therefrom of current from a source of higher voltage, e.g. 240 volts. T^1 and T^2 are the terminals of the 24 volt A.C. supply. Operation of the change-over switches COS to move it alternately between contacts C^1 and C^2 causes the contactors of the relay **R3** to move alternately between the full-line and dotted-line positions. Whenever the bluff out switch BLO is so actuated as to cause it to open, the micro-switches MS. **1**, MS. **2**, MS. **3** and MS. **4** will be isolated from the solenoids SOL. **1** and SOL. **2**. The circuitry includes a 24 volt "tell-tale" lamp L, a panel switch PS wired into the high voltage side of the system and fuses F^1 and F^2. Although the relays **R1**, **R2** and **R3** can operate with the switch PS open, the said switch must, of course, be closed before the solenoids will operate. The following lists show the wired positions of the various micro-switches:

Switch	Operation	Wired position
MS. 1	Solenoid operating	Normally closed, held open.
MS. 2	do	Do.
MS. 3	do	Normally open, held closed.
MS. 4	do	Do.
BLO	Bluff out	Normally closed.
COS	Change-over	Normally open.

By employing an appropriately shaped pawl, the pattern wheel may alternatively be racked round each time the carriage is at the termination of a traverse towards the nip rollers. Yet again, and by the provision of suitable racking pawls, the pattern wheel may be arranged to be racked round at the ends of both the rightward and leftward traverses of the carriage.

In any event, the pattern wheel, when provided, advantageously carries a length of chain composed of individual links some of which are plain whilst others are

provided with welded-on bits of different heights. The sequence of bits is predetermined to accord with pattern cards on the knitting machine.

As an alternative to the adoption of a pattern wheel or its equivalent, a punched tape system with an accompanying reader device may be employed. From this all the various operations of the feed unit or head could be controlled, through the medium of either mechanical linkages or electrical means.

Stop motions, e.g. incorporating two-bar electrode and dropper devices, are preferably provided between the or each positive feed unit and the knitting machine. One such device is indicated at **135** in FIGURE 1.

We claim:

1. In a flat bed knitting machine including, in combination, a framework, a needle bed mounted in said framework, needles in said bed, a longitudinally transversable cam carriage mounted on the framework to travel along a course, first in one direction and then in the reverse direction, said cam carriage having a cam system for operating said needles, a thread carrier for supplying yarn to the needles, and a regulating means for maintaining substantially constant the amount of yarn knitted for each run of the cam carriage along said course, said regulating means including two pairs of positive feed nip rollers, one pair of feeding yarn to the needles during each traverse of the cam carriage in said one direction, and the other pair for feeding yarn to these needles during each carriage traverse in the said reverse direction, at least one of the nip rollers of each pair being a drive roller which drives the other roller of its pair from power received from the feed machine, and means for separating the said rollers of each pair at required times and for permitting them to move into cooperative relationship at other times, the improvement wherein said machine includes an endless chain supported on, and movable about sprockets which are rotatably connected to the machine and are drivingly engaged with said chain, said chain extending the length of the machine and generally parallel to the course along which the cam carriage travels, means for positively engaging the cam carriage with said chain such that the chain is positively driven to and fro by rectilinear movement of said cam carriage in said one direction and said reverse direction, and a drive means for positively engaging the said chain with said drive rollers such that the drive rollers are positively rotated by movement of said chain, whereby a constant relationship is maintained between the rectilinear speed of the cam carriage and the rotational speed of the drive rollers.

2. The invention of claim **1** including a cross beam supported on the machine by brackets at opposite ends of the machine and extending the length of the machine and generally parallel to the course along which the cam carriage travels, said endless chain being mounted on said cross beam.

3. The invention of claim **1** wherein said drive means comprises a gear train connecting one of said spockets to said drive rollers.

4. The invention according to claim **1**, wherein the means for positively engaging the cam carriage with the chain includes a pick-up arm mounted on a support and coupled to a run of the endless chain; a depending peg to which said support is attached, and a bushed bracket in which the peg is slidable vertically, said bracket being bolted to the traversable cam carriage.

5. The invention according to claim **1**, wherein the nip rollers of each part superimposed, the upper roller being on metal and being the said drive roller, and the lower roller having a resilient periphery and being movable vertically towards and away from the upper roller.

6. The invention according to claim **1** wherein said drive means includes two spaced parallel shafts each having rigidly secured thereto one of the said drive rollers, the shafts being connected in said drive means to be rotated in opposite directions.

7. The invention according to claim **3**, wherein the gear train includes a change-gear means for permitting at least partial control of stitch length and hence also course length.

8. The invention according to claim **1** including a separating means located near the ends of the cam carriage stroke and operable by the cam carriage for simultaneously maintaining separation of both pairs of nip rollers, and selector means operable in reverse senses at respectively opposite extremities of the carriage strokes for permitting closure of the nip of only the pair of rollers appropriate to the direction of carriage travel taking place at only one time and when the nip rollers are not acted upon by the said separating means.

9. The invention according to claim **6** wherein each of the two shafts has secured thereon a plurality of separate upper nip rollers of different diameters to enable a plurality of yarns to be guided beneath the separate rollers, and including means for selectively moving the lower pressure rollers laterally to different inward and ontward positions to nip and feed a selected one of the said plurality of yarns.

10. The invention according to claim **8** wherein said separating means includes a pair of solenoids, and a pair of electrical switches for operating the solenoids, the switches being mounted on a longitudinal cross beam extending the length of the machine and generally parallel to the course of travel of the cam carriage, said switches being actuated by movable members disposed on the said beam to control the solenoids and thereby control engagement of the nip rollers during movement of said cam carriage, and including a striker member mounted on the cam carriage of the machine and movable therewith for operating said movable members in response to movement of said cam carriage.

11. The invention according to claim **10** including a pair of bell-cranks, one bell-crank connected to a roller of each pair of rollers, and spring means urging the bell-cranks to engage their associated pair of rollers, and wherein said separating means includes a pair of levers spring biased to cause disengagement of both pairs of nip rollers and including a link connecting the levers to the armature of one of said solenoids, so that operation of that solenoid by its associated switch moves the levers so that the bell-cranks are free from operative engagement with said nip rollers thereby permitting closure of the pair of rollers permitted by the selector means.

12. The invention according to claim **11**, wherein the selector means includes a selector bar arranged to be shifted back and forth by a longitudinally movable racking bar which is mounted on the cross beam to be shifted to and from by means movable with the cam carriage of the machine.

13. The invention according to claim **12** wherein a longitudinal edge of the selector bar is recessed and so shaped as to provide spaced and oppositely inclined cam edges for action on the spring-influenced bell-cranks.

14. The invention according to claim **12** wherein the racking bar includes spaced blocks, each carrying a roller, and including cam levers pivotally mounted upon the said crossbeam and arranged to be acted upon and turned by a roller mounted on the cam carriage.

15. The invention of claim **12** including a change-over switch for changing the connections of the solenoids to the switches on the cross beam, said change-over switch being a micro-switch arranged to be operated by the racking bar at the extremity of each outward traverse of the machine carriage away from the nip rollers.

16. The invention according to claim **9** wherein the lower pressure rollers are slidable axially along spindles and have circumferentially grooved portions in which are engaged the outer ends of yarn change plates, the latter being mounted on guided shafts movable to different ex-

tents axially by intermediate connections connected with a pivoted lever controlled by bits on an intermittently movable pattern dictating component.

17. The invention according to claim **16** wherein the pattern dictating component is a chain passed over a pattern wheel which is provided with ratchet means adapted to be racked around intermittently by a pivoted pawl mounted upon the racking bar.

18. The invention according to claim **17** including bits on the chain for action on a movable member arranged for action, at desired times, upon a bluff out switch operation of which renders the yarn feeding mechanism inoperative.

19. The invention according to claim **12** wherein the selector means further comprises a cam plate mounted on the cross beam adjacent each spaced block and spring biased away from said spaced block and positioned to be moved against the spaced block to shift the racking bar when acted upon by said roller mounted on the cam carriage.

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