Aug. 28, 1934. K. HOWIE 1,972,044

KNITTING MACHINE

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Fig. 1.

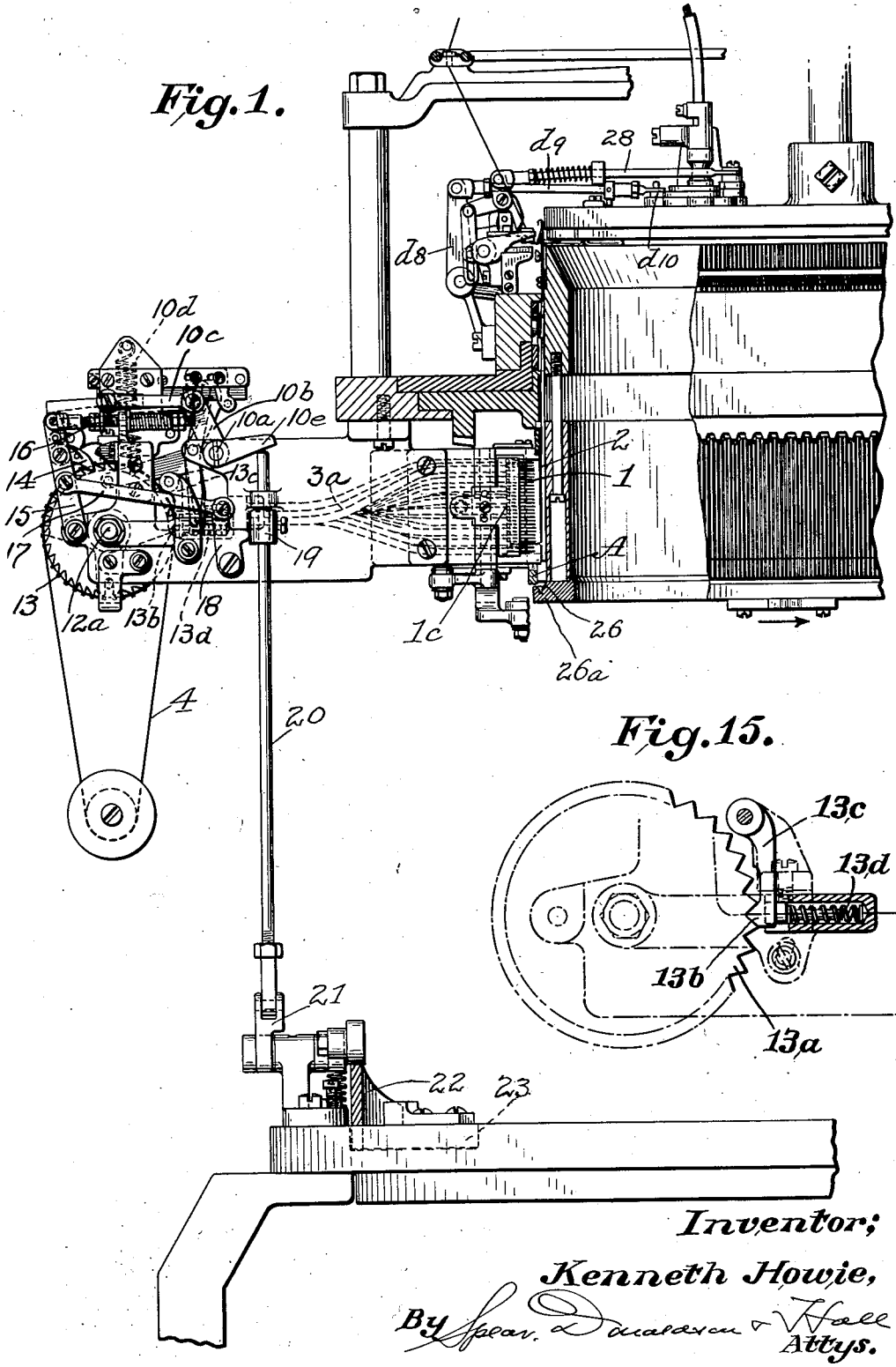


Fig. 15.

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KNITTING MACHINE

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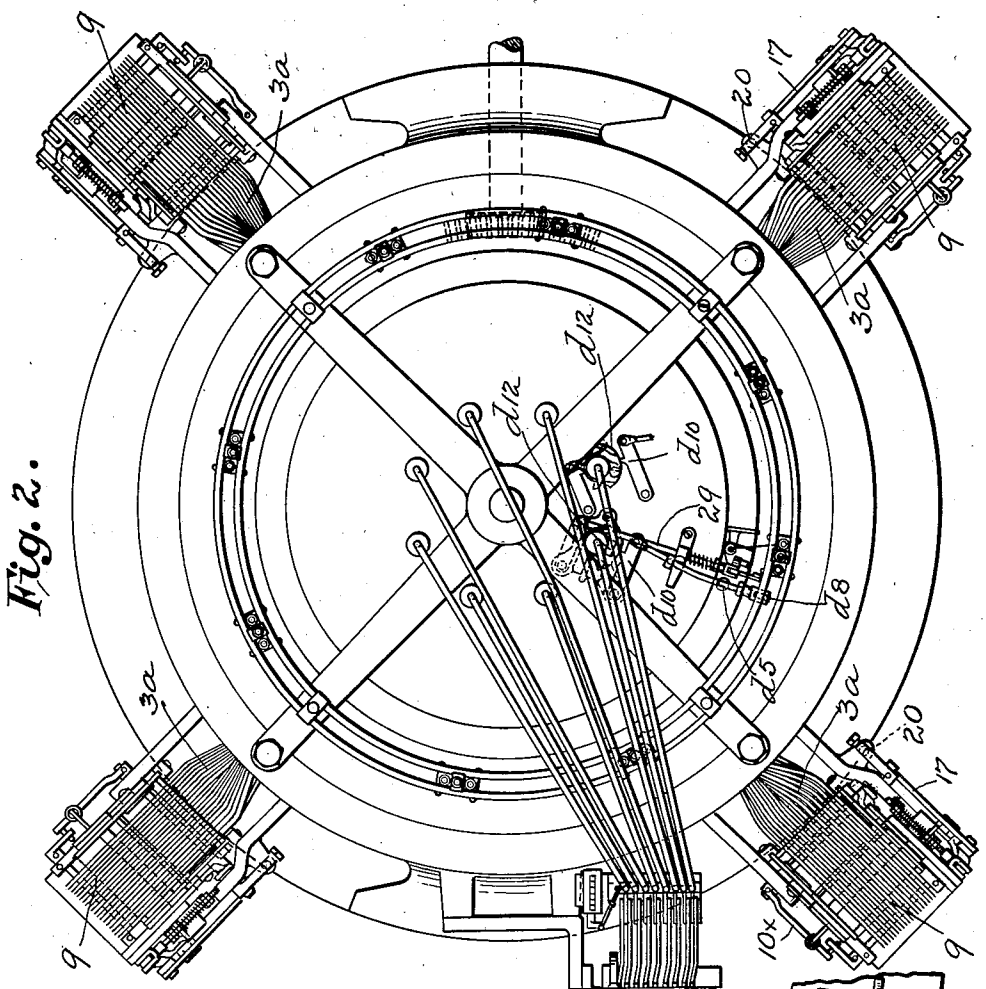


Fig. 2.

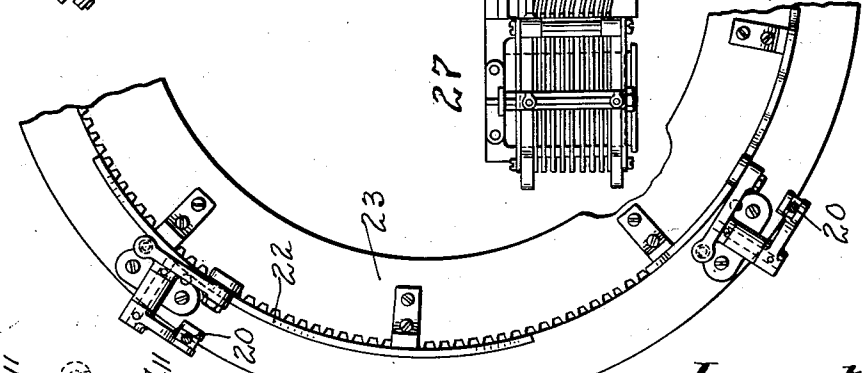


Fig. 3.

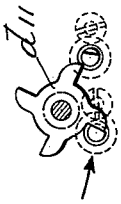


Fig. 2a.

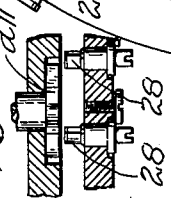


Fig. 2b.

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KNITTING MACHINE

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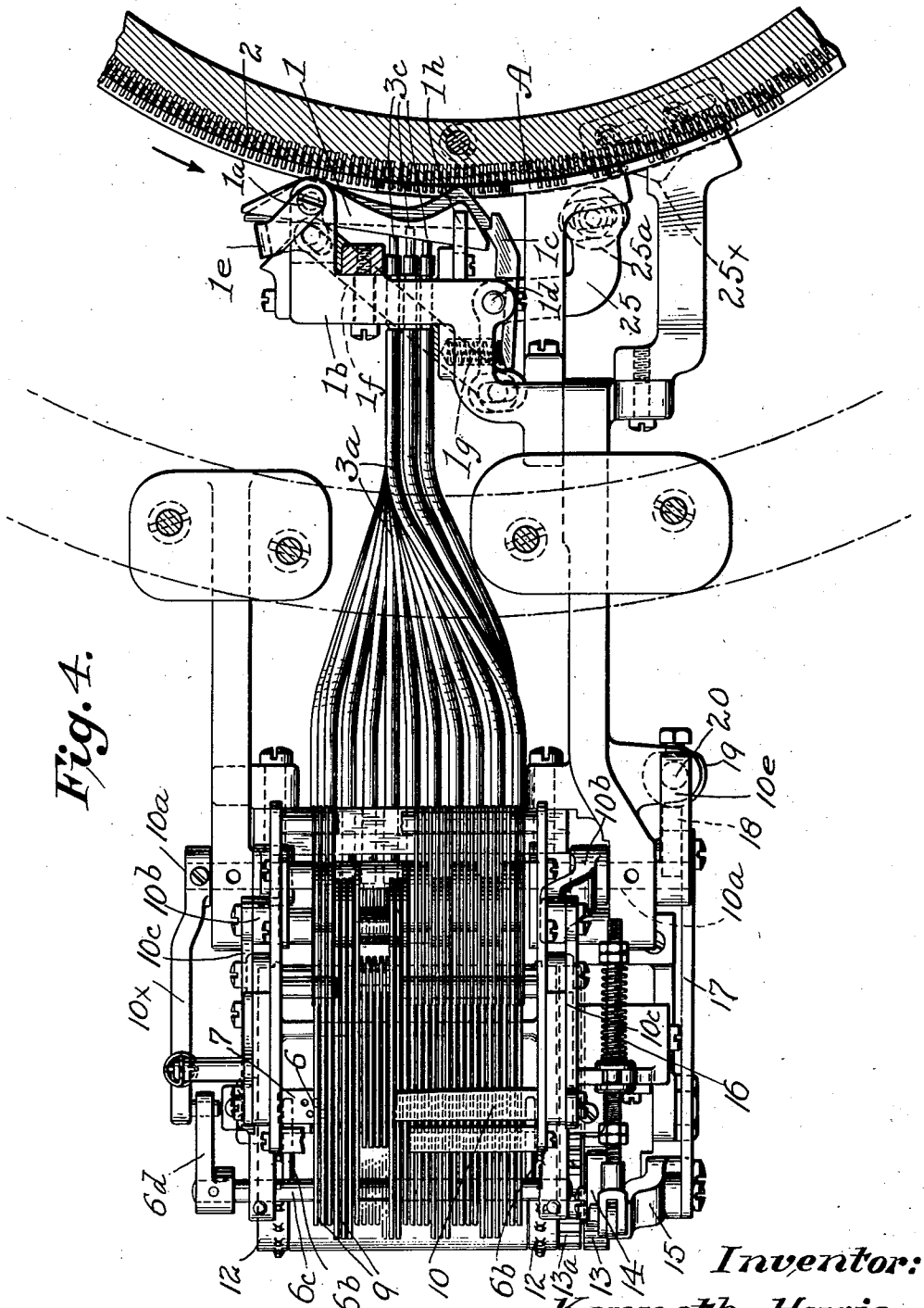


Fig. 4.

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Aug. 28, 1934. K. HOWIE 1,972,044

KNITTING MACHINE

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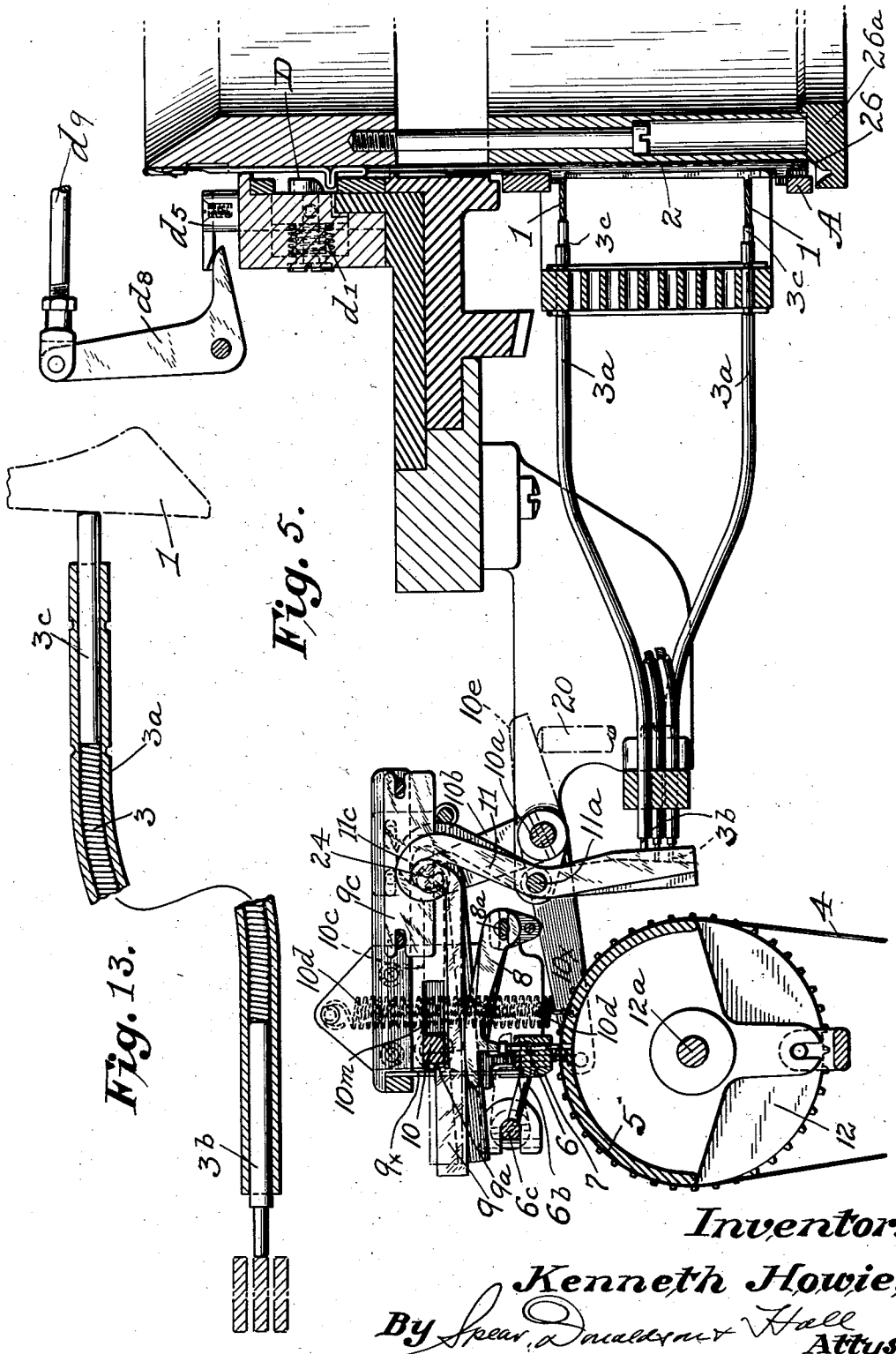


Fig. 5.

Fig. 13.

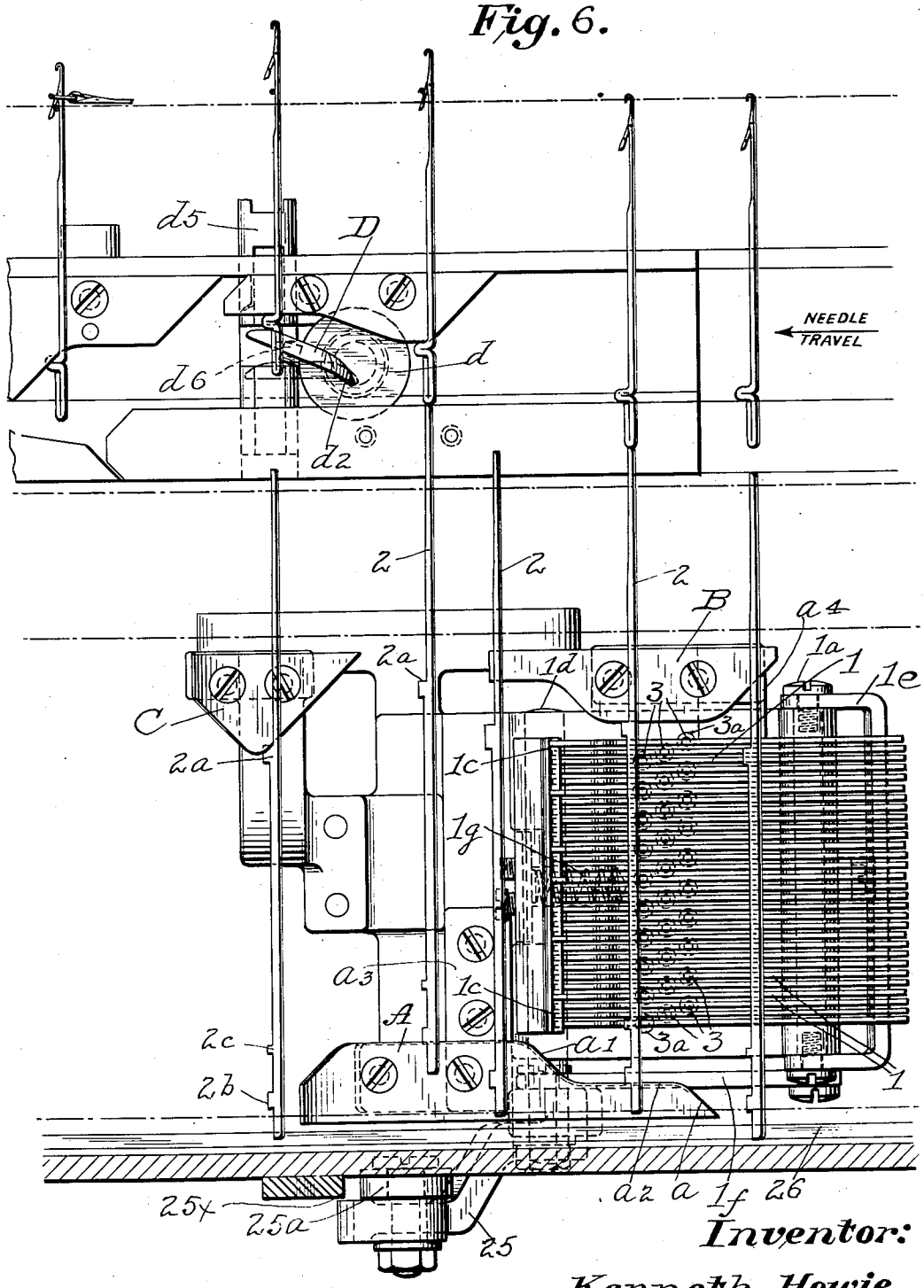
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Aug. 28, 1934. K. HOWIE 1,972,044

KNITTING MACHINE

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Fig. 6.



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Aug. 28, 1934. K. HOWIE 1,972,044

KNITTING MACHINE

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Fig. 7.

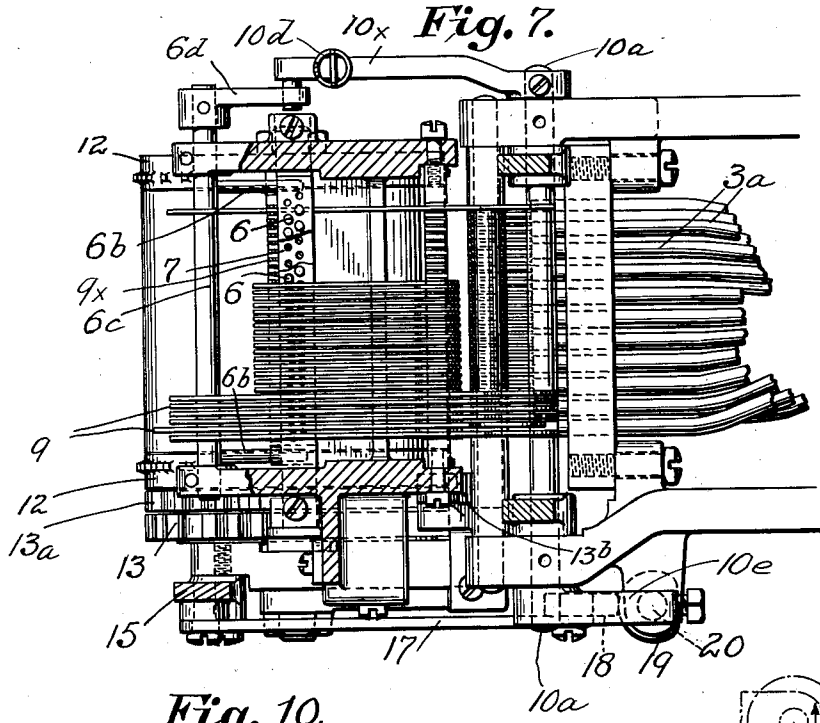
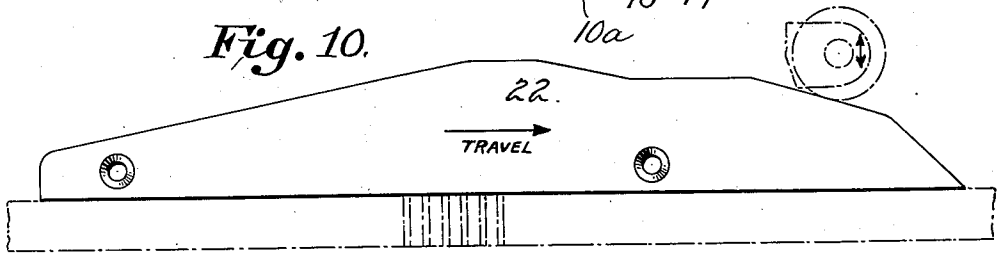


Fig. 10.



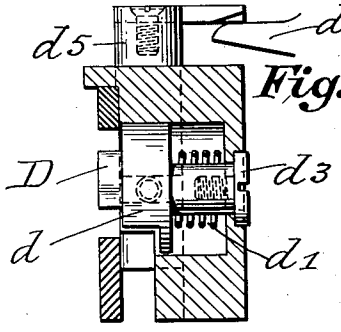


Fig. 11.

Fig. 14.

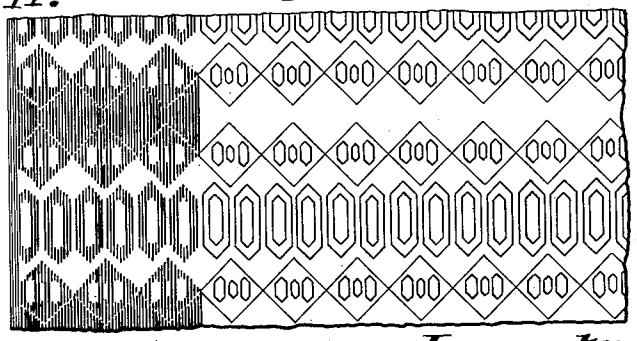
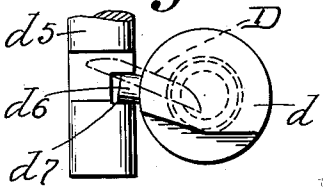


Fig. 12.



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KNITTING MACHINE

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Fig. 8.

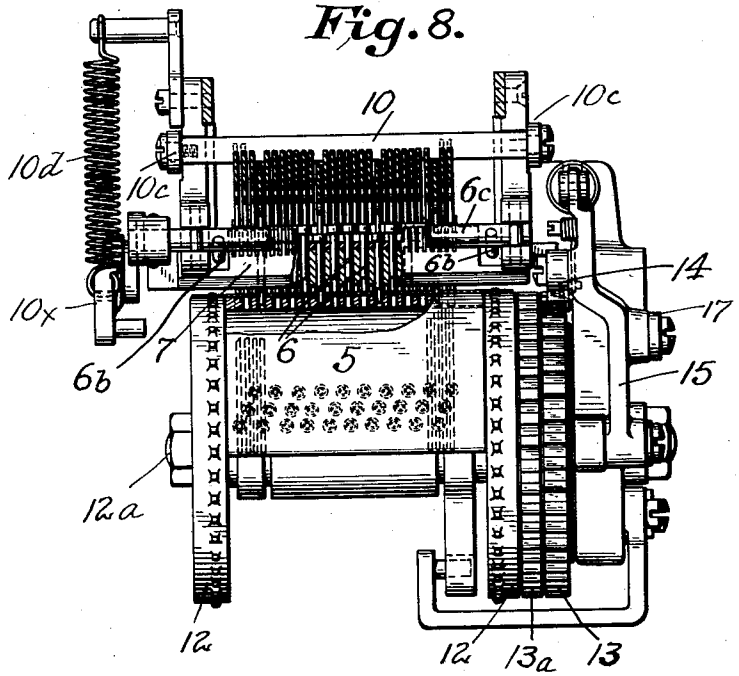
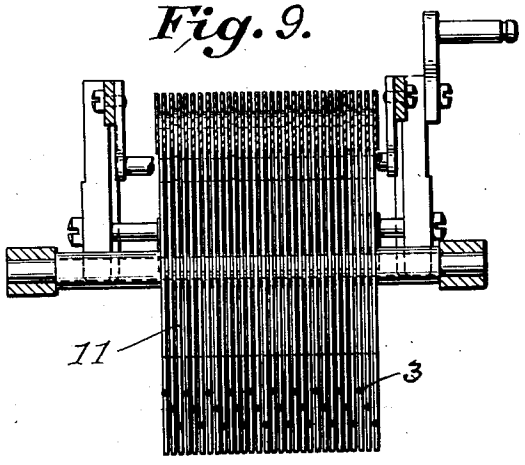


Fig. 9.



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Patented Aug. 28, 1934 1,972,044

UNITED STATES PATENT OFFICE

1,972,044

KNITTING MACHINE

Kenneth Howie, Norristown, Pa., assignor to Wildman Mfg. Co., Norristown, Pa., a corporation of Pennsylvania

Application July 1, 1931, Serial No. 548,210

10 Claims. (Cl. 66—50)

This invention relates to circular knitting machines of the independent needle type i. e. wherein slidable needles are individually operable for stitch forming purposes, and it is applicable to machines having needles of either the latch or spring beard type and to both rib machines and plain machines.

The invention concerns the provision of pattern mechanism in such machines for the purpose of effecting automatically changes in the knitting.

The principal object of the invention is to provide in or for circular knitting machines of the kind referred to, mechanism for increasing the scope of such machines for patterning or like purposes.

Another object of the invention is to provide in or for circular knitting machines of the kind referred to an improved form and/or arrangement of mechanism for producing patterns, designs and like effects in the knitted fabric to which end the invention includes jacquard and associated mechanism for effecting selective needle control whereby the operation of the needles can be automatically varied in a predetermined manner.

A further object of the invention is to provide in or for machines of the aforesaid kind wherein there is needle selection or division in relation to an actuating cam, means to prevent the cam or needles or their jacks suffering damage in the event of collision or improper contact occurring between the needles or jacks and the cam such as might arise as the result of insufficiency of or over action of the selective or dividing operation or displacement of a needle or jack prior to contact with the cam.

Mainly the invention appertains to rib or plain circular knitting machines having two or more feeds but the improved jacquard needle control mechanism herein to be described may be applied to a single feeder machine rib or plain.

The specification of U. S. Patent 1,525,608, Feb. 10, 1925 and United States Patent No. 1,540,845 (Krieble) describe a circular multiple feed knitting machine having its feeds distributed at separated points about the needle circle and which machine has mechanism for automatically controlling the feeds i. e. making them active or inactive as prearranged.

It is now proposed, according to the present invention, to employ in a circular multiple feeder knitting machine where the feeds are automatically controlled so that they can be caused to knit or not knit in prearranged manner (in which connection it is to be understood that the aforesaid U. S. patents are referred to as examples of such machine and the present invention in its broad aspect is not to be regarded as necessarily limited in its application to a multiple feeder machine constructed according to the patents referred to), mechanism for effecting selective needle control whereby the operation of the needles can be automatically varied in a predetermined manner.

It should be understood that the selective needle control is variable automatically, that is to say, the selection may be varied in different courses. Thus, some or all of the needles which knit at a feeder in one course may be allowed or caused to be inactive or otherwise produce a different effect in a subsequent course.

The invention therefore includes as one of its features the combination in a circular multiple feeder knitting machine of mechanism for automatically controlling the feeds whereby one or more can be caused to knit or not knit, and mechanism for automatically and variably selectively controlling the operation of the needles whereby in predetermined manner they can be caused to produce different effects in different courses of the knitted fabric.

Thus in one and the same machine there may be effected automatically variation as regards the feed in action and variation as regards the stitches or effects produced by selected needles at the operative feeds thus considerably increasing the scope or capabilities of the machine for patterning, designing and like purposes.

The automatic selective needle control may be such as to allow or cause some needles to knit while others are caused or allowed to miss the yarn or tuck or take an extra yarn. The needle control mechanism may be adapted and employed to vary the operation of selected or prearranged needles to produce pattern, design or like effects by any of the known methods.

According to this feature of the invention there may be automatic control for each feed of the machine or for some or one only of the feeds. Similarly there may be automatic selective needle control for the needles at each feed or at some or one only.

It will be understood by those familiar with circular knitting machines that the term "feed" herein used means that point or locality of the machine and the parts thereat for supplying and forming the yarn into loops.

The combination of mechanism for controlling the action of one or more feeds and mechanism for effecting selective needle control at one or more of the feeds in a multiple feeder machine

constitutes an important feature of this invention since it enables advantages to be obtained which have hitherto not been possible in machines of this kind.

By means of this invention it is possible to produce different designs or pattern effects in different parts of a garment or fabric and also to produce non-patterned fabric where desired.

For controlling the feeds and needles in the automatic manner above referred to, any pattern mechanism of appropriate form may be used the invention being without limitation in this respect but it is preferable and also advantageous to employ jacquard mechanism for both purposes. Convenient forms of jacquard mechanism suitable for the intended purposes will be hereinafter referred to and described but other forms may be adopted.

The United States Patent #1,590,292 granted to Wildman Mfg. Co. as assignee of K. Howie June 29, 1926 shows pattern mechanism which may be applied to knitting organizations of various forms for the purpose of effecting automatically changes in the knitting. This mechanism includes or comprises mainly a jacquard mechanism and one application thereof to a knitting organization is described in the aforesaid U. S. Patent 1,525,608 according to which specific disclosure the said jacquard mechanism effects automatically changes in the knitting by controlling selecting devices at the different feeds which make the feeds active or inactive.

Another manner in which the said jacquard mechanism of U. S. Patent #1,590,292, June 29, 1926 can effect automatically changes in the knitting is by controlling the needles at the feeds as also referred to in the aforesaid U. S. Patent 1,525,608. In the present invention it is proposed to use jacquard mechanism of the same or similar form for the purpose of variable selective needle control whereby the operation of the needles (it may be of the needles individually) can be automatically varied in the knitting of different courses to produce patterns, designs or similar effects. While for this purpose a jacquard mechanism of the construction disclosed in Patent No. 1,590,292 may be used it is preferred to use a jacquard mechanism of improved form which will be hereinafter described. In this connection it should be mentioned that the part of the pattern mechanism of Patent No. 1,590,292 which may be employed as a jacquard mechanism for effecting variable needle control is the arrangement comprising the perforated pattern band, the means to move and platen to support the band, the pins and their carrier, and the members between the pins and the flexible connection; in short all the parts between and including the perforated band and the flexible movement transmitting connections.

In the accompanying drawings

Figure 1 is a sectional elevation of a part of the knitting head with the jacquard mechanism for controlling the needles.

Figure 2 is a diagrammatic plan view of a circular knitting head with a plurality of the jacquard mechanisms disposed about the same and also a jacquard mechanism for controlling the feeds to make the knitting devices knit or not knit.

Figures 2*a* and 2*b* are views of detail.

Figure 3 is a plan view showing a revolving cam for operating the jacquard mechanism and part of the connection between said cam and said mechanism.

Figure 4 is a plan view showing a part of the needle cylinder in section and the jacquard mechanism associated therewith.

Figure 5 is an enlarged view of a portion of the knitting head in vertical section with the jacquard mechanism associated therewith and shown partly in elevation and partly in section.

Figure 6 is a diagrammatic view of cylinder needles with their raising cam jacks and cams for operating the same and in part of the jacquard mechanism, a portion of this figure being in section.

Figure 7 is a plan view partly in section of a portion of the jacquard mechanism.

Figure 8 is a front view partly in section of a portion of the jacquard mechanism.

Figure 9 is a view partly in section of a portion of the jacquard mechanism.

Figure 10 is a diagrammatic view of the revolving cam for operating the jacquard mechanism.

Figure 11 is a detail view of the needle raising cam, a portion of the cam box being shown in section and associated parts being shown in elevation.

Figure 12 is a detail relating to the parts shown in Figure 11.

Figure 13 is a detail view partly in section of the power transmitting connection forming part of the jacquard mechanism.

Figure 14 is a diagrammatic view of a portion of the fabric.

Figure 15 is a detail view of a detent for controlling the position of the drum of the pattern mechanism.

For transmitting the selective control from the jacquard mechanism to the needles there is provided associated means comprising, in the preferred embodiment of the invention, a bank of selecting cams 1 adapted to have selective action upon jacks 2 associated with those needles which are to be controlled and these cams are selectively rendered operative and inoperative by the jacquard mechanism; for instance the said cams may be acted upon by the flexible connections 3 of the jacquard mechanism for this purpose. The improved form of jacquard mechanism to be described presently herein has a series of flexible connections for actuating the cams in accordance with the selection effected by a perforated jacquard band 4.

The jacks for actuating the needles are themselves actuated by a raising cam A, Fig. 6, and the selective operation of these jacks upon the needles is brought about by adapting the jacquard mechanism to select among the jacks some to miss the cam and others to be actuated by the cam.

While the selecting cams may act upon the jacks in any appropriate manner for causing them to miss or to be acted upon by the jack raising cam it is preferred to adopt an arrangement wherein the selecting cams depress the jacks, as hereinafter described, to miss the cam while those jacks not depressed engage and are actuated by the said cam to actuate corresponding needles.

This mechanism, similarly to that already referred to herein, has an endless perforated pattern band 4, means for moving the same, a platen 5 over which said band passes, pins 6 to pass through the perforations in the band and into the platen, said pins when obstructed by the imperforate part of the band remaining up, and a vertically reciprocating carrier 7 for the pins in which they are slidably mounted and by which they are dropped into contact with the perforated

pattern band. In the present mechanism there are connected levers 8, 9, selectively controlled by the pins and there is a power-actuated reciprocating member 10 which imparts movement to those of the levers which the pins allow to be so actuated and which actuated levers transmit by intermediate members 11 and 3 movement of corresponding jack selecting cams from an inoperative to an operative position. The intermediate members by which motion is transmitted from the aforesaid levers to the selecting cams conveniently consist of push rods or flexible connections 3 guided in tubes 3*a*.

The perforated endless pattern band is made of strong paper or other suitable flexible material and has marginal perforations to engage with rotary toothed carrying discs 12 between which is disposed and held stationary the segmental platen 5 like in U. S. Patent 1,525,608.

The carrying discs are intermittently rotated to advance the perforated band under the pins by a ratchet mechanism including a ratchet wheel 13 operated by a pawl 14 carried upon an oscillatory pawl lever 15 moved in one direction by a spring influence, e. g. a spring-actuated plunger or connecting rod 16, and in the other direction by a connecting link 17 from a lever 18 which receives its necessary movement by the action thereon of a cam, collar 19 or equivalent on a slide rod 20 operated by suitable means e. g. by a lever 21 which is acted upon by a cam 22 on the rotating ring 23 which carries the fabric take up. The cam, collar or equivalent on the slide rod may be adjustable to vary the racking movement transmitted to the band-carrying discs; conveniently the collar 19 is eccentric and adapted for rotative adjustment on the slide rod to engage with a nose on the lever to actuate the latter.

Means are furnished to determine the position of the carrying discs after each racking movement consisting of a wheel 13*a* having a V-notched periphery with which a V-shaped nose 13*b* on a detent 13*c* is pressed into engagement by a spring-actuated plunger 13*d*. The notched wheel is fast with the ratchet wheel or adjacent band-carrying disc and the detent is carried by a lever adjustable, such as by screw and slot means, to permit bodily adjustment of the detent in relation to the pins. As the ratchet wheel, carrying discs and notched disc rotates, the V-nose of the detent rides over the teeth between the notches of the latter disc for which purpose the detent has pivotal movement on its carrying lever the spring plunger allowing the detent to thus move.

The carrier bar 7 for the pins 6, is so mounted as to be capable of vertical reciprocation towards and from the platen which motion carries the pins up and down so that they are brought respectively out of and into contact with the perforated band passing over the platen. The carrier bar works up and down a vertical guide at each end. It falls by gravity and is raised by arms 6*b* projecting from an adjacent rockshaft 6*c* hereinafter referred to.

The parts of the jacquard mechanism now being described are carried by a suitable casting or frame. This for instance carries a stud or axle 12*a* supporting the band carrying discs, ratchet wheel and positioning disc and the platen. The frame carries also the pawl lever and its associated actuating members; it carries the lever upon which the aforesaid detent is mounted; and in it are formed the guides up and down which the pin carrying bar works. The previously mentioned rockshaft 6*c*, horizontally disposed, for lifting the pin carrier bar is also carried by this frame.

There may be any desired number of pins 6 in the series a convenient number being from 30 to 35 and each pin in the carrier bar has a head which when the carrier bar is lifted rests upon the top side of the bar so that the pin is thus supported. Arranged over and resting upon the head of each pin is a horizontal lifter lever 8. The levers in this series are pivoted upon a transverse rod 8*a* carried by the aforesaid frame.

Resting upon and supported by each lifter lever 8 is a horizontal connecting bar 9. Each connecting bar is pivotally attached at one end to the upper end of a vertically disposed rock lever 11. All the rock levers in the series are fulcrumed upon a transverse rod 11*a* carried by the frame.

Each connecting bar has on its upper edge a shoulder or projection 9*a* adapted to be engaged by a horizontal reciprocating actuator bar 10. The said bar is carried by the frame and reciprocates along horizontal guides therein. Conveniently the guides are in the form of slots 10*m* formed in opposite sides of the frame the ends of the reciprocating bar working to and fro along the slots.

The reciprocating movement of the actuator bar is obtained by means of a transverse rockshaft 10*a* carried by the frame and having arms 10*b* thereon pivotally connected to the ends of the said bar by links 10*c*. The said rockshaft has fast on it an arm 10*x* to which a spring 10*d* is connected and it also has fast on it another arm 10*e* acted upon by the upper end of the previously mentioned slide rod. Motion is imparted to the actuator rod in a direction away from the rock levers by the cam-actuated slide rod and it is moved in an opposite direction by the spring-actuated arm.

The previously mentioned rockshaft 6*c* having the arms 6*b* thereon for raising the pin carrier bar has fast thereon an arm 6*d*, Fig. 4, which is engaged by a pin on the spring-actuated arm 10*x* on the other rockshaft 10*a*. The arrangement is such that when the spring-actuated arm operates its rockshaft to move the actuator bar 10 to normal position i. e. towards the rock levers, the pin on said arm operates the arm 6*d* on the other rockshaft 6*c* so that the latter is turned to raise the pin carrier bar 6. In normal position, the carrier bar, pins, lifter levers and connecting bars are all held raised. Suitable means may be provided to determine this normal position of the parts; conveniently the actuator bar limits the rise of the connecting bars and the ends of the guide slots in the frame act as stops to limit the movement of the actuator bar.

When the actuator bar rockshaft 10*a* is turned by reason of the action of the cam-actuated slide rod 20, the actuator bar 10 moves outwards over the connecting bar and by reason of the movement of the spring-controlled arm (against the spring influence) the other rockshaft is turned and thereby allows the pin carrier bar, pins, lifter levers and connecting bars to descend. It should be mentioned here that the outward travel of the actuator bar carries the latter beyond the shoulders or projections on the connecting bars, consequently the shoulder or projection of any one or more of said connecting bars remaining in the path of the actuator bar wil be engaged by the latter.

When, as just described, the carrier bar 7 and elements supported thereby falls, the pins 6 come down to the perforated band with the result that those pins which register with holes in the band pass through said holes into the open part of the platen and thus continue to fall with the carrier bar and in so falling permit their corresponding lifter levers and connecting bars to fall also whereby the shoulders or projections on the connecting bars drop below the horizontal path of movement of the actuator bar and in consequence the said actuator bar does not make contact with these shoulders or projections and the corresponding connecting bars are not actuated by said bar. Those pins which when descending with the carrier bar come into contact with an imperforate part of the pattern band over the platen are arrested in their fall by said imperforate part and are consequently held up thereby while the carrier bar continues its descent the vertical sliding capability of the pins in the carrier bar permitting such action. Those pins which in the manner just described are held up by the pattern band in turn hold up the corresponding lifter levers and connecting bars in which case the shoulders or projections on the latter remain in the horizontal path of the actuator bar with the result that as this moves outwards it makes contact with the said shoulders or projections and imparts to the corresponding connecting bars an outward sliding movement. Each connecting bar thus actuated slides upon that part of the corresponding lifter lever which is holding it up and thus has an endwise movement which, by reason of the before mentioned pivotal connection between the connecting bars and their rock levers 11, causes the corresponding rock lever to turn.

It will therefore be seen that only those rock levers corresponding to the connecting bars which remain up will be moved and as the pattern band determines which connecting bars in the series are to remain up and which are to fall, or in other words which are to be actuated by the actuator bar and which are to be missed, it follows that the rock levers are selectively operated as prearranged by the pattern band.

It may be pointed out that the actuation of the selected rock levers 11 is a positive one in that the motion of the actuator bar for this purpose is applied by power-driven means and the said actuator bar has direct action upon the selected connecting bars (by engagement with the shoulders or projections thereon), which bars have direct pulling action upon the upper ends of the rock levers to which they are connected as aforesaid.

It may be noted that in this jacquard mechanism it is those elements (connecting bars) which are held up by imperforate parts of the pattern band which are actuated by the power-actuated means (actuator bar).

It is therefore a feature of the improved jacquard mechanism, and also of the present invention, that the elements in the series which are to be operated by power-actuated means are positioned for this purpose by obstruction of the corresponding pins by imperforate parts of the pattern band while those elements which are not to be operated by the power-actuated means are displaced from the path of said power-actuated means by the passage of the corresponding pins through perforations in the pattern band.

The actuator bar which forms part of the power-actuated means of the present jacquard mechanism is common to all the connecting bars in the series.

After the outward movement of the actuator bar has taken place to move the selected rock levers as previously described the rockshaft arm 10*e* acted upon by the slide rod 20 is in due course released by reverse movement of said slide rod whereupon the said rockshaft is turned in the opposite direction by its spring-controlled arm 10*x* which movement returns the actuator bar to normal position, and by engagement of the pin on said arm with the arm 6*d* on the other rockshaft 6*c* the latter is turned to raise the carrier bar 6, pins, lifter levers 8 and connecting bars 9 to the normal position preparatory to the next action of the jacquard. The cam-actuated slide rod 20 and the parts operated thereby are arranged so that when the said rod moves in one direction it first moves the pawl 14 back and then operates the rockshaft 10*a* to lower the pins and associated elements and move the actuator bar 10 outwards, and when it moves in the other direction it first raises the pins and returns the actuator bar to normal position and then releases the pawl lever so that the pawl moves forward to rack round the band-carrying discs the necesary distance to bring the next row of holes under the pins.

It will be understood that the lifter levers, the connecting bars and the rock levers are side-by-side each their own series. That is to say the lifter levers are side-by-side in one series, the connecting bars are side-by-side in another and the rock levers are side-by-side in a third series. The elements in all the series are however in the same plane. That is to say, each lifter lever is in the same vertical plane as its corresponding connecting bar and rock lever. Thus while each lifter lever is positioned immediately over a corresponding pin it is positioned immediately under its corresponding connecting bar and each rock lever is located in the same vertical plane as its associated connecting bar.

The lifting levers, connecting bars and rock levers are of flat plate-like form and the elements in each series are spaced apart or separated from each other by suitable guide means which conveniently comprise a series of upright wires 9*x* or equivalent members between which the outer ends of the lifter levers and the connecting bars project and move, and a series of blades or thin plates 9*c* disposed vertically and suitably spaced and between which the inner ends of the connecting bars and upper ends of the rock levers move. To enable the connecting bars to occupy the same vertical plane as their associated rock levers the pivotal connection between these associated elements may be of hook formation e. g. the upper end of the rock lever may be bent over or shaped to form a hook-like extremity 11*c* to receive therein the adjacent extremity of the connecting bar which latter extremity may be enlarged to form a rounded or other shaped head 24 to fit and work pivotally within the hook-like part on the other member.

For the purpose of controlling the action of the needles in a variable manner, the rock levers of the jacquard mechanism just described are arranged to act upon transmission means for rendering operative corresponding cams for acting upon jacks. These cams 1, which are the selecting cams, are each horizontally disposed and they are arranged one above another in a vertical series. The cams correspond in number to the

pins and associated elements of mechanism already described.

The said cams are pivotally mounted for movement in a horizontal plane e. g. on a vertical pin 1*a*, and are carried by a bracket 1*b* attached to or forming part of the frame of the jacquard mechanism. The pivoted cams are so arranged that when the mechanism is applied to a knitting machine the profiled edges of the cams will be presented to the adjacent cylinder of the machine in which the jacks are carried.

In the normal inoperative position the cams are retracted away from the jack cylinder but when any cam is to operate it is swung horizontally towards the jack cylinder which motion is imparted by the corresponding rock lever. To this end when any rock lever is moved as aforesaid its lower end acts upon a push pin 3*b* suitably positioned for the purpose which pin by means of the flexible or spring rod 3 working within the tubular housing 3*a* operates a similar push pin 3*c* at the other end of the tubular housing which latter pin is positioned for acting against the back of the corresponding cam in the vertical series. The action of the flexible connection or transmission between the rock shaft and corresponding cam is to press the latter from the retracted inoperative position to a projected operative position. Associated with each rock lever in the before mentioned series is a flexible transmission member and a selecting cam consequently whenever, as determined by the pattern band, a rock lever is actuated in the manner already described, a corresponding selecting cam will be projected into operative position.

The selecting cams 1 are pivoted near one end and the profiled part for action on the jacks is formed near the other end which swings in and out horizontally as will be understood. The action of the selecting cams on the jacks is a pressive one and therefore means are furnished to hold such of the said cams as are moved to the operative position in said position while they function for the intended purpose. These means conveniently comprise a pivoted lock bar 1*c* which after the selected cams have been projected to operative position drops (or is moved to a position behind the free end of the cams) and thus serves as a stop to prevent return of the cams to normal position. The lock bar is mounted to turn on a vertical axis 1*d* and preferably has a shoulder or rabbeted edge with which the backs of the free ends of the selecting cams engage.

For returning the selecting cams to the normal inoperative position after they have acted upon the jacks suitable spring-actuated or other means may be adopted. It is preferred however to provide mechanical means for this purpose and a convenient mechanical arrangement therefor comprises a pivoted strap or yoke 1*e* adapted to act upon the back of the cams at a point beyond their fulcrum. This strap or yoke is conveniently mounted to turn on the axis 1*a* of the cams and is operated by a link 1*f* from a lever 25 pivoted on the underside of the bracket and having a roll 25*a* acted upon by a cam 25*x* on the bottom of the jack cylinder or some other suitable revolving part of the knitting machine. This lever is also arranged to turn the before mentioned lock bar 1*c* the arrangement and operation being such that movement of the lever in one direction turns the strap or yoke 1*e* away from the cams 1 thus leaving them free so that those selected may be projected to operative position while at the same time the lock bar is turned in towards the cams to pass behind the ends of those which are projected to lock same in the operative position. This movement of the said lever is imparted by a spring 1*g* which may be applied to the lock bar. When the lever 25 is moved in the other direction, which motion is imparted by the cam 25*x* aforesaid on the jack cylinder or other revolving part, the lock bar is turned away from the cams to release those projected and the strap or yoke is moved to act upon the opposite end of the projected cams and return them to normal position. To vary this movement the roll may be adjustable on the lever. The pivoted lock bar and the pivoted strap or yoke are disposed vertically and each is common to all the selecting cams in the series.

The selecting cam locking mechanism as shown in Fig. 4 is in its operative position. The cam 25*x* coming in contact with the roller 25*a* moves the lever and latch 1*c* because both are fixed to the same shaft 1*d*. Lever 25 is fixed to link 1*f*. The end of link 1*f* near yoke 1*e* is slotted thereby moving yoke 1*e* only at the extreme limit of the movement of 1*f*. The sequence of placing the cams 1 in inoperative position is first to move the latch which permits the yoke when roller 25*a* is at apex of cam 25*x* to move the cams 1 so that their operating apices are away from the cylinder. The apex of cam 25*x* should be at the center of the roller 25*a* immediately previous to the push bar 10 coming in contact with the shoulder 9*a* of the levers 9 on unregistering pins 6. Simultaneously with the roller 25*a* passing the apex of cam 25*x* the spring 1*g* acts to place latch 1*c* against the cams 1. The selected cams 1 are therefore pushed toward the cylinder under the tension of the latch 1*c* and spring 1*g*. The stroke of cams 1 is sufficient to allow the latch 1*c* to place itself behind the selected cams 1 as they are pushed forward.

The plate-like selecting cams may be mounted upon a common pivot pin and be separated from each other by spacing washers on said pin while their free ends work in a comb-like guide 1*h*.

The improved jacquard mechanism described together with the bank of selecting cams and intermediate transmission connections and associated parts constitutes a complete unit which can be applied to a circular knitting machine for use at the feeder or, in the case of a multiple feeder machine, at one feeder thereof for effecting variable control of the needles, or two or more of such units may be applied to a multiple feeder machine for the same purpose as will be hereinafter described. This unitary assemblage or combination constitutes one of the features of this invention.

In the preferred construction the jacquard mechanism i. e. the band-supporting means, pins and elements controlled thereby, selecting cams and their associated parts and the transmission means, in fact the whole of the mechanism hereinbefore described for effecting needle control with the exception of the operating cams on the revolving parts of the machine, are carried by the before mentioned frame so that by attaching the latter to the machine the complete unit may be applied for use for the purpose stated.

As previously mentioned, the selecting cams are arranged to act upon jacks for the purpose of varying the operation of corresponding needles in the knitting machine. To this end it is convenient to provide the knitting machine with a jack cylinder situated below and co-axial with the needle cylinder. The jacks are slidable in

tricks in the jack cylinder and these tricks are cut to such depth as to permit of the jacks being pushed in and buried, to such an extent that butts on the jacks adapted for actuation by a cam are taken out of the plane of said cam so that no actuation of the jack by the said cam takes place.

In the form preferred each jack has three butts viz. an upper butt 2*a* acted upon by a cam to move the jack downwards, a lower butt 2*b* acted upon by a cam (the jack-raising cam previously mentioned) A to move the jack upwards and a middle or intermediate butt 2*c* to be acted upon by the selecting cam 1 to press the jack backwards into its trick or groove. The upper and lower butts are at the same height on all the jacks but the middle or intermediate butts are positioned on the jacks in accordance with the particular selecting cams which are to operate upon them. The positions of the middle butts vary therefore on different jacks i. e. they are at different heights to suit the planes in which the selecting cams in the before mentioned vertical series are situated, it being understood that when any one of the selecting cams is projected as aforesaid to the operative position it will act only on those butts which occupy a position in the same horizontal plane on the jacks. These jacks will be pressed backwards by the projected selecting cam but the other jacks will be missed and allowed to remain forward in their tricks. The backward or inward movement of the jacks is caused by the middle butt passing in contact with the profiled edge of a projected selecting cam. It is thus possible to press inwards any jack by projecting to the operative position the selector cam which occupies the same horizontal plane or in others which is at the same height as the middle or intermediate butt on said jack.

The object of pressing desired jacks backwards into their tricks is to carry the lower butts of said jacks out of the vertical plane of the jack raising cam or rather out of the vertical plane of that part of said raising cam which would otherwise raise the jack and cause it in turn to raise a corresponding needle in the needle cylinder.

The jack raising cam in the preferred form has two upward inclines *a* and *a*1, and an intermediate horizontal ledge *a*2. The first incline forms a step to the horizontal ledge and the other incline forms a step higher from said ledge. The lower butts of all the jacks ride up the first incline of the said cam to the horizontal ledge for a purpose hereinafter appearing. They then pass along the horizontal ledge which is parallel to the plane of the selecting cams and it is during the passage of the said lower butts of the jacks along said ledge of the cam that the one or more selecting cams which occupy the projected operative position act upon the middle butts of any jacks which pass in contact therewith whereby said jacks are pressed inwards back into their tricks so that the lower butts are pushed off the horizontal ledge of the jack raising cam before they reach the second inclined part of the said cam. The effect is therefore that those jacks which are acted upon by a selecting cam or cams and are thereby pressed backwards into their tricks are not raised by the second incline of the jack raising cam the lower butts of such jacks passing in front of the said incline, and those jacks which are not so pressed inwards are further raised because their lower butts remain on the jack raising cam and consequently pass up the second incline.

Thus by the jacquard mechanism and associated selecting cams predetermined jacks can be raised while others are not raised and in consequence the needles corresponding to said jacks are respectively lifted or not lifted. This differentiation in the needle movement is employed to produce a desired effect in known manner. For instance the elevated needles may take the yarn and the non-elevated needles may miss the yarn and remain at non-clearing height so that they are inactive for loop forming purposes. Or in another example the elevated needles may clear, take yarn and knit while the non-elevated needles take the yarn and tuck.

It is preferred that the action of the jack raising cam shall be merely for the purpose of dividing or selecting the needles or jacks so that while some of these are further actuated by a cam or cams others are not so actuated. For instance in a convenient arrangement the needles which are elevated by their jacks may be thereafter acted upon by a clearing cam whereas those not elevated will pass under said clearing cam. The jack raising cam may however be designed and arranged to impart the required movement to the needles without subsequent actuation by an additional cam or cams. For example the said jack raising cam may raise some needles to clearing height and allow others to pass the feeder at tucking height. When, as in the preferred construction, the jack raising cam elevates some of the needles to a height to enable them to pass onto a clearing cam for action thereby while the non-elevated needles pass below said clearing cam, the said jack raising cam has a second horizontal ledge, higher than the first, to which the lower butts of the jacks are elevated by the second incline and along which they pass to hold the needles in the elevated position until their butts land upon the clearing cam.

Situated above the jack raising cam is a guard cam B which by action upon the upper butts of the jacks keeps the lower butts in contact with the jack raising cam.

The jack raising cam may be attached to a projecting bracket or arm *a*3 on the before mentioned frame of the jacquard mechanism and the guard cam may be similarly mounted on arm *a*4. This is advantageous in that it makes the unit for effecting needle control more complete and self-contained.

To permit of the inward depression of the jacks into their tricks or grooves these are cut deep enough to provide sufficient space between the backs of the jacks and bottom of the tricks for reception of the jacks when the latter are acted upon by the selecting cams. It will of course be understood that the tricks are longitudinal in the jack cylinder and that after having been depressed inwards the jacks must be moved outwards to project their butts in readiness for the next action by the jack raising cam. It may be here mentioned that outward movement of the jack within its trick to an extent sufficient to project the butts beyond the side of the jack cylinder is all that is necessary so that the butts can be acted upon by the cams as described herein. This projection of the butts can be obtained without projecting the jack beyond the side of the cylinder or beyond the tops of the trick walls.

For the purpose of moving forward again those jacks which have been inwardly depressed within their tricks there is provided at the lower end

of each trick a forward incline or bevelled back 26 with which the lower ends of the jacks engage when they are moved downwards in their cylinder. As the jacks near the lowest point in their descent their lower ends ride on the forward incline or bevel and are thus caused to move forward to what may be regarded as a normal position in which the butts are projected beyond the jack cylinder and in a position to engage the jack raising cam. Conveniently the incline or bevelled back for the tricks is constituted by a ring 26*a* inserted into or attached to the lower end of the jack cylinder.

The first incline on the jack raising cam imparts an upward movement to the jacks to carry their lower ends above the forwardly inclined or bevelled backs at the lower parts of the tricks and places them in a position on the horizontal ledge of the cam where there is a clear space behind them so that they can be pressed backwards in their tricks if selected for this purpose.

At those times when the lower butts of the jacks ride up the inclines of the jack-raising cam the jacks occupy the forward position in their tricks and since there is a space behind them and consequently nothing to hold the jacks in the forward position, the inclined portions of the said cam are bevelled slightly downwards transversely from the front edge and the lower butts of the jacks are correspondingly bevelled on the underside. By this construction the inclined steps of the cam tend to hold the jacks forward in their tricks while the butts are passing up the same. In other words the bevel on the cam edge prevents the engaging butts from slipping off the front during their upward travel. The horizontal ledge of the cam between the top of the first incline and the bottom of the second incline is either similarly bevelled and if so preferably to a less extent, or it is made flat transversely so that the engaging butts can slip off when the jacks are inwardly depressed as aforesaid.

The frame of the unitary mechanism or assemblage hereinbefore mentioned may also carry the cam C for acting upon the upper butts of the jacks for moving them down which cam is positioned so that it operates for this purpose after the jacks have passed the highest part of the jack raising cam e. g. after they pass off the second horizontal ledge.

Referring now to the means for preventing a cam or needles or their jacks suffering damage in the event of collision or improper contact occurring previously alluded to herein this may be carried out by mounting the cam D Fig. 6 in such a manner that it may yield if and when struck by the butt of a passing needle or jack. For example the cam may be carried by a spring-controlled member *d* in the cam box or equivalent part of the machine said member being mounted in a manner which permits it to move radially i. e. outwards in the cam box against the spring *d*1 and in order that this yielding movement can be imparted by a misplaced needle or jack butt the cam is bevelled or rounded on the front at the point or part *d*2 which the butt will strike. If therefore a butt approaches the cam in such a position that it will strike the point or part of the cam instead of passing over or under the same as it should, it will by contact with the bevelled or rounded front of said point or part press the cam outwards away from the needle cylinder and thus by forcibly causing the cam to yield pass the same without damage to itself or to the cam.

This feature of the invention is mainly intended for application to the clearing cam D for acting upon the needles in such cases where some needles (e. g. those elevated by jacks as aforesaid) are to pass over said cam and other needles (those not previously elevated) are to pass under said cam. It may however be applied to a clearing or other cam where there is no pre-division or selection of needles or jacks but where there is a danger of collision between butts and cam.

In a constructional example applied to a clearing cam the said cam is formed on or attached to the inner end of a plunger *d* slidable radially in the wall of the cam box whereby the cam is movable bodily towards and from the needle cylinder. The plunger is housed in a socket or recess formed in the inner face of the cam box and a compression spring *d*1 is located between the back of the pocket and the plunger to press the latter forward i. e. to project the cam for use. A screw *d*3 passing through a hole in the back of the pocket and into the plunger limits adjustably the projection of the cam and determines its operative position. At its point or lowest extremity where the needle butts should either pass on to the top of or below the cam the latter is bevelled or rounded on its front face or edge so that any butt approaching the cam at this level will strike the shaped front and by acting thereon will press the plunger back into the pocket for the purpose already described.

If as may be the case and as will be described presently the cam is a movable one i. e. movable to and from an operative position this movement may be additional to the yielding movement already described. For example if the above described clearing cam is to be movable from a clearing to a tucking position as is sometimes desired this may be achieved by mounting the before mentioned plunger so that it is capable of a part rotary movement in its pocket or housing and thereby serves as a pivot to enable the clearing cam to be turned from one position to another in the cam box while occupying the projected position. This turning movement which raises and lowers the cam for clearing and tucking respectively, may be effected by any suitable means. Conveniently for the purpose a vertical plunger *d*5, Fig. 12, is provided in the cam box and is movable up and down therein by a lever and spring and when so moved it oscillates the cam carrying plunger by means of a pin *d*6 which projects therefrom into a slot or notch *d*7 formed in the vertical plunger. The opening in the vertical plunger engaged by the pin on the cam-carrying plunger is made deep enough to permit the cam-carrying plunger to be depressed into its pocket as aforesaid when the cam yields and the arrangement is such that this yielding movement of the cam away from the needle cylinder can take place when the said cam is held in either the clearing or tucking position by the vertical plunger.

The plunger *d*5 carrying the needle raising cam D may be adjusted automatically for getting different knitting effects by a lever *d*8, Fig. 5, operated by a rod *d*9 from a lever *d*10, Fig. 2, which is operated by a cam *d*12 from a star wheel *d*11. This star wheel is vertically movable and is pushed downwardly at prescribed

intervals as called for by the pattern by a flexible connection leading from the jacquard mechanism indicated generally at 27, Fig. 2. When thrust downwardly the star wheel will be operated by pins 28 fixed to the dial. This mechanism is similar to that disclosed in Letters Patent of the United States granted to C. C. Krieble 1,540,845, June 9, 1925. In Fig. 2 is also indicated a connection 29 for controlling yarn feed, clamp and cutter mechanism in a manner generally similar to the disclosure in said patent.

In Fig. 6 the needle raising cam D as shown in full, lies in position to raise the needles, which are presented thereto by the action of the jacks, to make regular knit stitches, and one of the needles is shown in its raised position. This cam is also shown in dotted lines, in inoperative position, this being a horizontal position. The needle immediately at the right of this cam has been raised to tucking position by its jack and if the cam has been adjusted to its horizontal or dotted line position this needle will not be affected by this cam and hence a tuck stitch will be made by it. The next two needles at the right of this figure are in position for the making of a welt stitch and such stitch will result if in their further travel the jacks of these needles are operated by the jack selecting cams off from the jack raising cam A.

The present invention is primarily intended for application to circular knitting machines (rib or plain) having rotating needle cylinders but it is not to be regarded as limited in this respect. When applied to a rib machine its chief application is to the cylinder and dial type though it may be applied to other types.

As already mentioned herein the mechanism for automatically effecting variable needle control, such mechanism comprising the bank of selecting cams selectively controlled by jacquard means, constitutes a feature of the present invention.

This mechanism may be applied and used in combination with the feed control mechanism forming the subject matter of Patent No. 1,525,608. It may also be used in combination with the mechanism described in the U. S. Patent to Krieble No. 1,540,845 and further it may be applied to a machine of the type described in the Patent No. 1,525,610, June 10, 1925.

In a circular multiple feeder knitting machine having a rotating needle cylinder and dial equipped with independent needles for production of ribbed fabric, it is found both convenient and advantageous to provide mechanism of the kind described in the U. S. specification No. 1,540,845 in combination with jacquard pattern as described in U. S. Patent 1,590,292 for automatically controlling the feeds and to provide jacquard and associated mechanism of the kind herein described for effecting automatic variable needle control at some or all of the feeds.

In a practical form of such machine constituting an example of the present invention there are eight feeds and in order that these may be automatically controlled i. e. rendered active and inactive the dial of the machine is equipped with means and associated mechanism is provided of the kind described in the aforesaid U. S. specification No. 1,540,845 which means and mechanism are controlled by jacquard mechanism of the kind described in Patent No. 1,590,292. Thus any feed of the machine can in a prearranged manner be caused to knit or by withdrawal and clamping of the yarn and movement of cylinder and dial needle clearing cams to an inoperative position it can be rendered inactive. At four of the feeds of the machine a jacquard mechanism of the unitary form previously described herein is applied and arranged whereby the needles which pass the active feeds of the machine are automatically variably controlled in the manner already fully explained in connection with said unit. In this machine, the clearing cams D for the cylinder needles at those feeds where the needles are selectively controlled by a jacquard unit are mounted in the yielding manner previously described which cams are also movable from clearing to tucking position when the feeds are to be rendered inactive.

It will be understood that each jacquard unit for controlling the needles is complete in itself and independent of the others and the machine is equipped with a jack cylinder carrying jacks upon which the selecting cams of the jacquard units act in turn. A greater or less number of the units may be applied if desired. There may for instance be one jacquard mechanism unit to each feed of the machine.

The individual control of the different feeds enables the jacquard needle control mechanism at certain of the feeds to operate only at the formation of certain portions of a garment or fabric and therefore the particular design produced at certain feeds can be restricted to the desired parts of the garment or fabric being knitted. In addition non-patterned fabric can be produced at any period at the feeds under control.

The different jacquard units for controlling the needles may be prearranged to make different patterns. In the eight feeder machine previously described the desired pattern effect may be produced by two, three or four of the jacquard units. According to one example two of the units may be arranged to operate at corresponding feeds so that needles which take and miss yarn at one of said feeds will respectively miss and take yarn at the other thereby producing a pattern or design. In the same machine the other two units may be arranged to make a diqerent pattern or design and by reason of the automatic control of the feeds, the different patterns or designs can be made in different parts of the garment or fabric. In the formation of such patterns or designs differently coloured yarns may be used.

The important feature in the machine described is the combination in one and the same machine of the automatic variable selective needle control mechanism and the automatic feed control mechanism.

While for a machine having a cylinder and dial, that is with two sets of needles, selective feed control mechanism of the kind described in U. S. specification No. 1,540,845 is preferred, in the case of a machine with one set of needles, that is without a dial, mechanism of the kind described in U. S. Patent 1,525,608 would be more suitable, the important feature in either case being the combination with such feed control mechanism of variable needle control mechanism such as herein described.

The details of construction may be varied without departing from the scope of the invention.

I claim:

1. In combination in a knitting machine, needles, needle cams, jacks for advancing said needles to be operated by the needle cams, a jack cylinder, a jack advancing cam, selecting cams arranged adjacent the jack cylinder and movable

to and from the same for operating the jacks to determine which of said jacks shall be and which shall not be advanced by said jack cam, flexible slidable push rod connections, one for each jack selecting cam, for operating the same, means for guiding said push rods, and pattern mechanism for selecting and operating said push rod connections, substantially as described.

2. Apparatus according to claim 1 in which the jack selecting cams are arranged horizontally one above another, and are pivotally mounted to swing towards and from the jack cylinder, and the said push rods are arranged in vertical series and engage said selecting cams.

3. Apparatus according to claim 1 in which the jack selecting cams are horizontally disposed one above another and are pivotally mounted, and locking means for engaging the free ends of the operated jack selecting cams, said locking means being common to all the selecting cams, and independent of the cam operating means.

4. Apparatus of the character described in which jack selecting cams are pivotally mounted, push rods for operating the selecting cams, locking means for holding said cams when moved to operating position, said locking means being independent of the operating means, and means for releasing said locking means automatically and for returning said selecting cams to normal position, substantially as described.

5. In combination in a knitting machine, a jack elevating cam, pivoted jack selecting cams to determine which of the jacks shall be elevated by the jack elevating cam, pattern mechanism for selectively operating the jack selecting cams, locking means for and operating upon the chosen jack selecting cams to hold them in operative position, a lever for restoring the selecting cams to normal position, said lever operating upon said cams, means for automatically releasing the locking means and operating the restoring means, and a part mounted on and traveling with a rotary part of the knitting head to operate the automatic means for releasing the lock and for restoring the jack selecting cams.

6. In combination in a knitting machine, a jack elevating cam, jack selecting cams to determine which of the jacks shall be operated by the elevating cam, said selecting cams being horizontally disposed and pivotally mounted intermediate of their length, push rods engaging the outer edges of the selecting cams, pattern mechanism controlling said push rods, locking means for engaging operated selecting cams, a member to engage the tail portions of the selecting cams for restoring them to inactive position, and means operated by a cam on a rotary part of the head for releasing the locking means and operating the restoring member, substantially as described.

7. In combination in a knitting machine, a jack elevating cam, a group of jack selecting cams, pivotally mounted on vertical axes and horizontally disposed one above another, jacquard mechanism having bars pivoted to swing vertically and disposed side-by-side in a horizontal plane, a series of flexible push rods having their ends adjacent the jacquard mechanism arranged in horizontal series and bent intermediate of their length so that their ends at the jack selecting cams are arranged in vertical series, tubes for guiding the push rods, means for selecting the vertically swinging bars and for operating them lengthwise, and means operated by said bars for selectively operating the push rods.

8. In combination in a knitting machine, pattern mechanism comprising a perforated pattern band, pins to pass through the perforations of said band or to contact with intact portions of the band, a vertically movable carrier in which the pins are slidably mounted, connecting bars to be selected by the pins, an actuator bar for operating the selected connecting bars, rock levers operated by the connecting bars, push rods operated by the rock levers, a platen for supporting the pattern band, means for giving the band a traveling movement including a pawl and ratchet, a vertically operable slide rod, cam means rotating with a part of the knitting head for operating the slide rod, means operated from the slide rod for operating the pawl, and a transmitting connection also operated from said vertically movable slide rod for operating the actuator bar, substantially as described.

9. Apparatus according to claim 8, in which pivoted lifter levers rest upon the pins, and the connecting bars rest upon the lifting levers, substantially as described.

10. Apparatus according to claim 8 in which the connecting bars and rock levers are of plate like form pivotally connected together by a hook-shaped part on one, engaging a rounded terminal portion of the other, thus forming a pivot connection between them permanently mounted; and means for guiding said parts in their swinging movement and preventing lateral displacement of one in relation to the other, said guiding means involving a comb like structure, substantially as described.

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