Feb. 7, 1961 K. HOFFMANN 2,970,461

CAM CONTROL FOR KNITTING MACHINES

Filed May 27, 1959 6 Sheets-Sheet 1

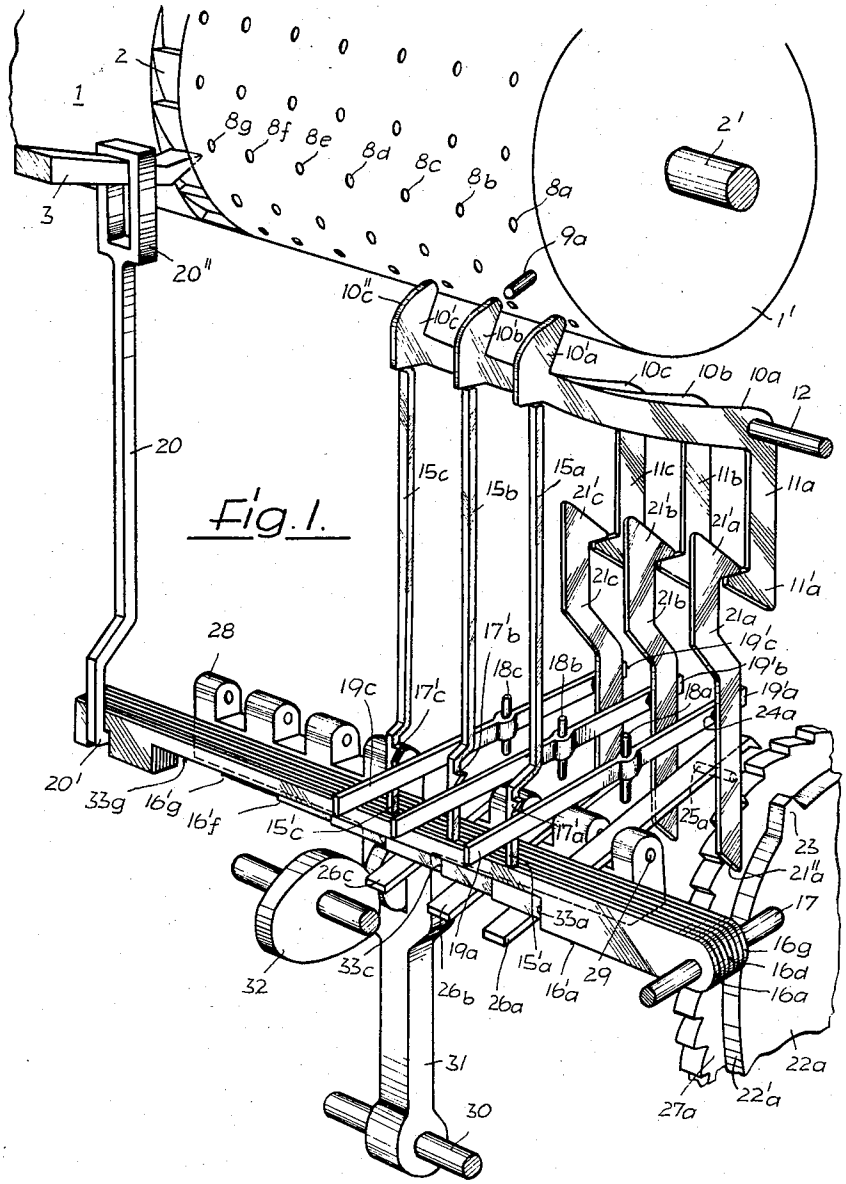


Fig. 1.

INVENTOR.

Karl Hoffmann

BY

Watson, Cole, Grindle & Watson

Attys.

Feb. 7, 1961 K. HOFFMANN 2,970,461

CAM CONTROL FOR KNITTING MACHINES

Filed May 27, 1959 6 Sheets-Sheet 2

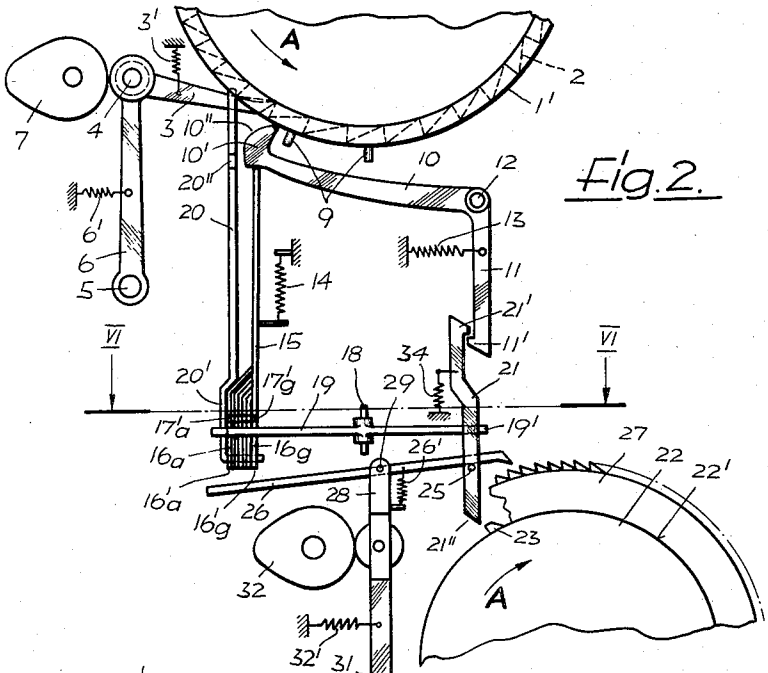


Fig. 2.

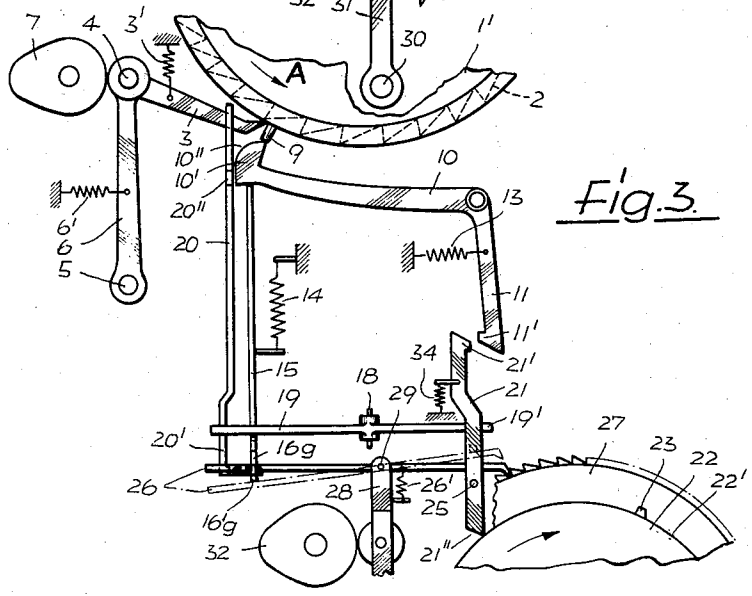


Fig. 3.

INVENTOR.

Karl Hoffmann

BY

Watson, Cole, Grindle & Watson

Attys.

Feb. 7, 1961 K. HOFFMANN 2,970,461

CAM CONTROL FOR KNITTING MACHINES

Filed May 27, 1959 6 Sheets-Sheet 3

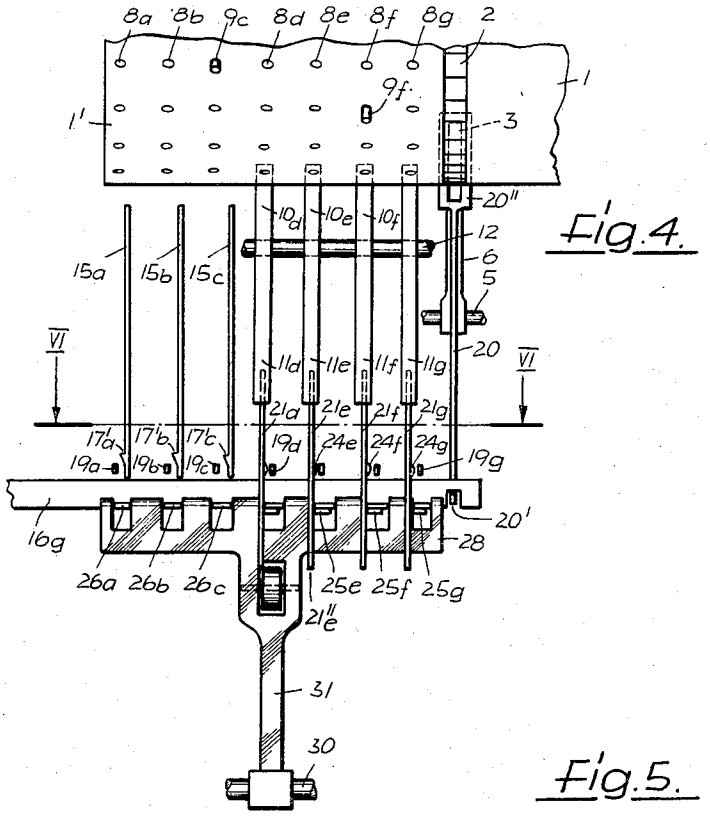
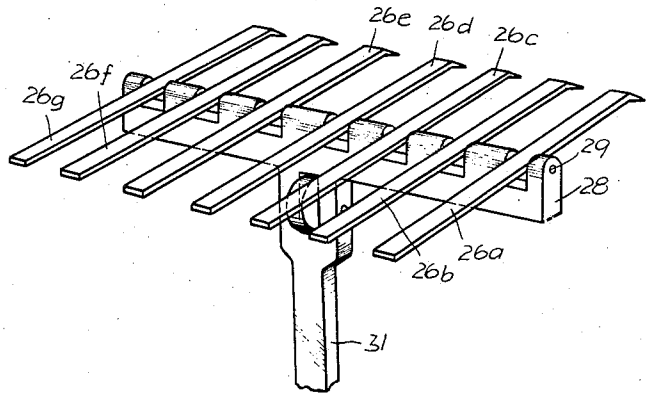


Fig. 4.

Fig. 5.



INVENTOR.

Karl Hoffmann

BY

Watson, Cole, Grindle & Watson

Attys.

Feb. 7, 1961 K. HOFFMANN 2,970,461

CAM CONTROL FOR KNITTING MACHINES

Filed May 27, 1959 6 Sheets-Sheet 4

Fig. 6.

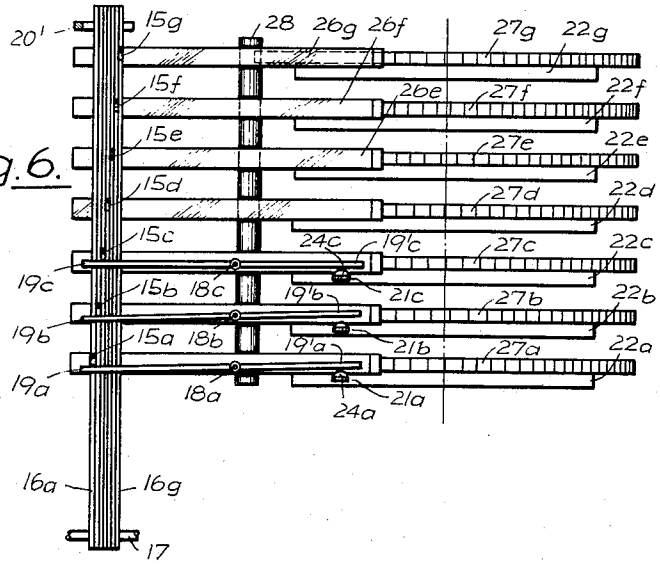


Fig. 7.

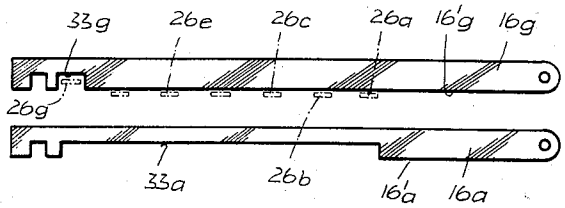


Fig. 8.

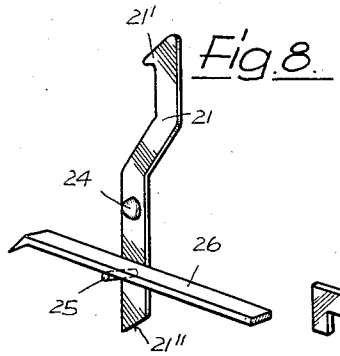
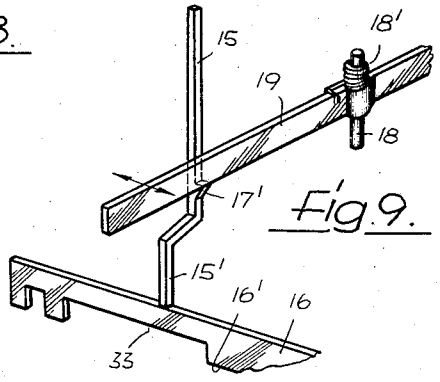


Fig. 9.



INVENTOR.

Karl Hoffmann

BY

Watson, Cole, Grindle & Watson

Attys.

Feb. 7, 1961 K. HOFFMANN 2,970,461

CAM CONTROL FOR KNITTING MACHINES

Filed May 27, 1959 6 Sheets-Sheet 5

Fig. 10.

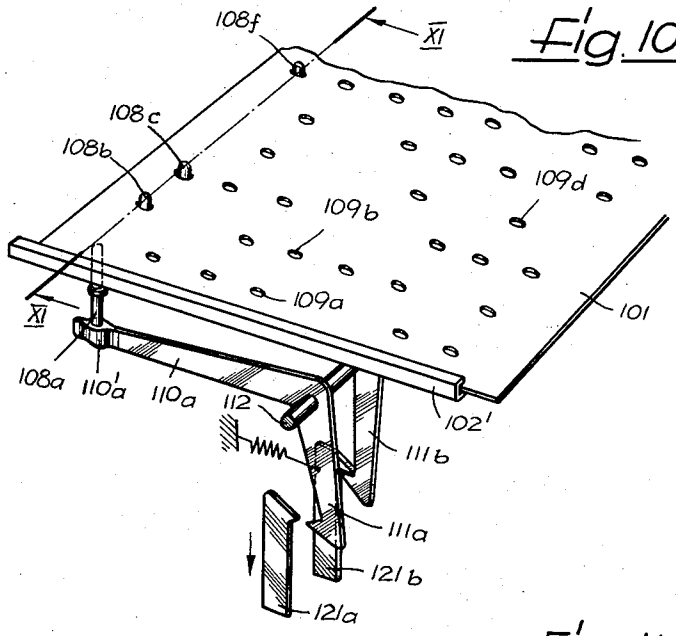
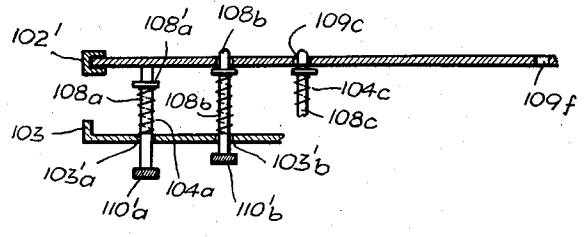


Fig. 11.



INVENTOR.

Karl Hoffmann

BY

Watson Cole Grindle & Watson

Attys.

Feb. 7, 1961 K. HOFFMANN 2,970,461

CAM CONTROL FOR KNITTING MACHINES

Filed May 27, 1959 6 Sheets-Sheet 6

Fig. 12.

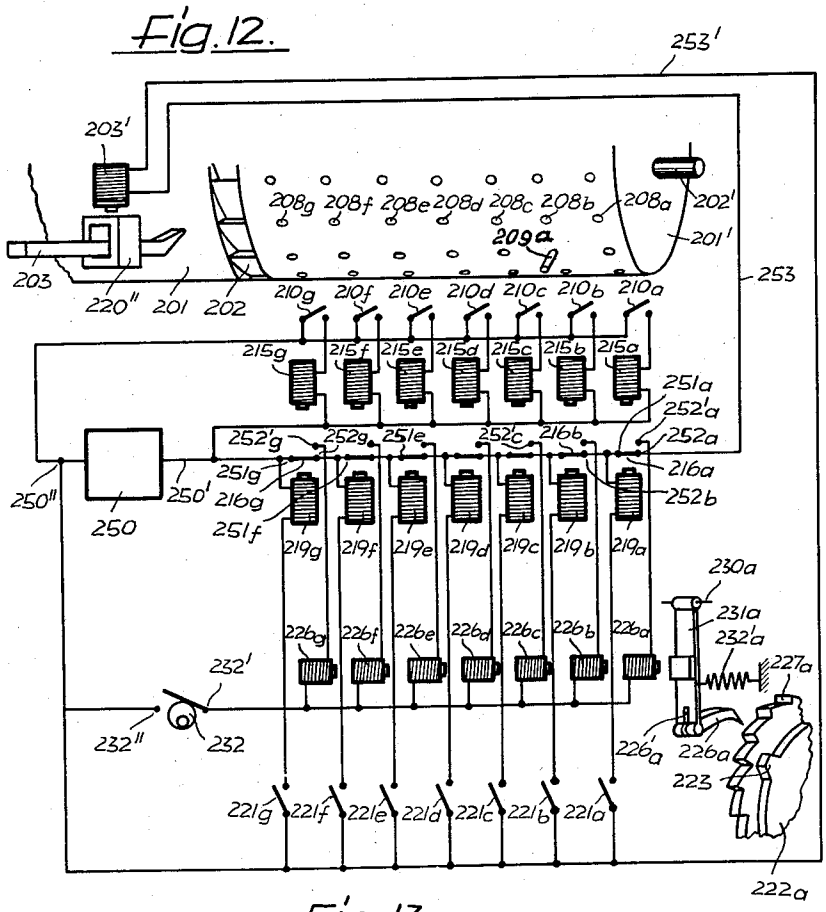
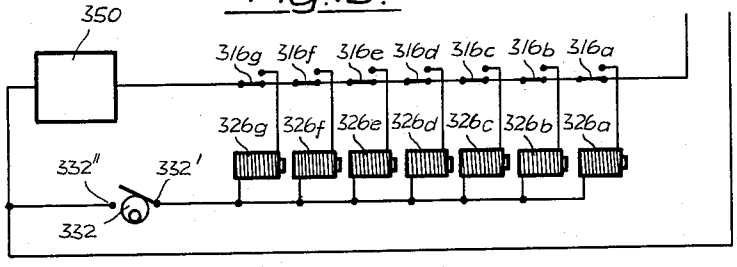


Fig. 13.



INVENTOR.

Karl Hoffmann

BY

Watson, Cole, Grindle & Watson

Attys.

United States Patent Office 2,970,461 Patented Feb. 7, 1961

2,970,461

CAM CONTROL FOR KNITTING MACHINES

Karl Hoffmann, Eichendorffstrasse 71, Kirchheim, Teck, Wurttemberg, Germany

Filed May 27, 1959, Ser. No. 816,157

Claims priority, application Germany May 28, 1958

16 Claims. (Cl. 66—155)

The present invention relates to a cam control mechanism for knitting machines.

The cams of knitting machines. particularly circular knitting machines, are at present usually controlled by so-called counter chains which are progressively advanced during the rotation of the needle cylinder or the cam box. Thus, for example, the counter chain may be advanced by the distance of one whole or one half chain link during each complete revolution of the needle cylinder or cam box. Some of these chain links of the known counter chains are provided with control cams which act through a lever system upon a pawl which, in turn, shifts the control cylinder of the cam control one step forward. This control cylinder is provided with control cams which operate and control cam components, patterning mechanisms, or other fixtures on the knitting machine.

One serious disadvantage of this known cam control mechanism employing a counter chain is the fact that the position of the chain and the position of the control cylinder must be exactly coordinated to each other in order to knit the desired product on the machine. The result will otherwise be broken needles, for example, when knitting the edges of a piece of fabric, since the left stitches will then be held for numerous revolutions of the cylinder or, in other words, since the corresponding cam will remain disengaged for too long a time.

It is an object of the present invention to provide a cam control mechanism for knitting machines which eliminates this disadvantage of the known mechanism.

The present invention relates in general to any type of cam mechanisms for knitting machines which are provided with a main control member which may be advanced in a step-by-step movement for controlling cam components, patterning mechanisms, or the like, and with a mechanism for controlling the movement of the control member which mechanism includes a member for supporting the setting elements which permit an adjustment of the step-by-step movement of the main control member in accordance with the desired relative shifting movements between the cam and the needle carrier for effecting the needle movement. The present invention is therefore not limited to cam control mechanisms as are conventionally used with circular knitting machines, but it is likewise applicable to flat knitting machines.

The present invention resides principally in designing the main control member so as to form the support of the setting elements of the control mechanism. Due to this design it is possible to prevent absolutely that the position of the support of the setting elements will ever be erroneously adjusted relative to the main control member as it occurs frequently when using the conventional counter chain as the support of the setting elements. The main control member may, as frequently provided in control systems, consist of a control cylinder or a card which is provided with suitable markings, or of a tape or the like. Such a card or tape forming the main control member may then be provided with markings not

only for the cam control but also for controlling the movement of the card or tape itself. These markings may be produced by magnetizing or be in the form of perforations or any other form known as such.

If in the control system according to the invention the kind of markings were used as are employed with counter chains, the range of application of the present invention would be considerably restricted. This is due to the fact that it is the principle of a counter chain that it is always advanced by the distance of one or one-half link, for example, at every revolution of the needle cylinder or the cam box. This requires the supporting member of the setting elements to be of a very great length. The same applies to the length of the main control member since this member would likewise require to be continuously advanced if the present invention is applied. The control cams for controlling the cam of the knitting machine would therefore be disposed on the main control member at a distance from each other which is equal to the amount of forward movement of the control member between two change-over movements of the cam controls. This distance may be very considerable, for example, when knitting the length of a stocking.

In order to permit a general application of the present invention to any kind of cam controls, it is a further object of the invention to provide the supporting member with a plurality of positions for accommodating several setting elements thereon which are adapted to act simultaneously upon the control mechanism, permitting one setting element in the various positions to serve as the means for interrupting the step-by-step movement of the main control member in accordance with differently sized movements between the cam and needle carrier. In comparison, the setting elements on the known counter chains, that is, the cams on the chain links, can always assume only one position. These known cams can effect no more than the intermittent forward movement of the main control member. The next change-over movement always occurs at the engagement of the next cam on the counter chain. The control mechanism according to the present invention, on the other hand, additionally permits the length of time of the lock engagement to be varied by providing the setting element in a particular position. In order to set the cam controls for a certain desired period, for example, for the required number of revolutions of the needle cylinder or the cam box, the supporting member of the setting elements is provided with a plurality of setting positions for these elements which are then adapted to act simultaneously upon the control mechanism and permit the length of time of the cam action to be very easily adjusted by a mere selection of the proper position of the setting element.

This feature of the present invention may also be employed successfully in a knitting machine in which the main control member and the supporting member of the setting elements are disposed separately from each other.

A further important object of the present invention is to provide a mechanism for accumulating the effects of several setting elements which are disposed in different positions and act simultaneously upon the control mechanism during the period in which one of these setting elements acts upon the control mechanism to affect the forward drive of the main control member. This means that, during the employment of several setting elements in different positions acting simultaneously upon the control mechanism, the effects of these setting elements will be added to each other. Consequently, the number of possibilities of adjusting a certain cam action to last for a certain length of time, for example, for a certain number of revolutions of the needle cylinder or the cam box, will be considerably increased.

Thus, if provision is made that the effects of a setting element, expressed by the number of certain uniform shifting movements between the cam and needle carrier, form in all positions of said element the terms of a geometric exponential series, and provided that this exponential series, and provided that this exponential series begins with 1, the summation of these numbers will permit all whole numbers to be attained which lie between the individual terms of this exponential series as well as those numbers which lie between the last term of this series and a following term, if the series is continued. These facts apply to all known numerical systems and may by the present invention also be applied to the cam controls of a knitting machine.

As already indicated above, the present invention therefore renders it possible to discard any further use of a counter chain in cam controls. Consequently the very complicated and time-consuming assembly of the chain which has to be carried out with greatest dexterity and requires considerable knowledge and experience will be completely avoided.

These and other objects, features, and advantages of the present invention will become further apparent from the following detailed description thereof, particularly when read with reference to the accompanying diagrammatical drawings, in which—

Figure 1 shows a perspective view of a cam control mechanism according to the invention, in which the main control member consists of a control cylinder;

Figures 2 and 3 show two similar side views of a part of the control mechanism according to Figure 1 in two different operating positions;

Figure 4 shows a view of the mechanism as seen from the siding facing toward the cam wheels, in which the cam wheels themselves and the scanning levers and control members at the left part of the drawing are omitted for the sake of clarity;

Figure 5 shows a perspective view of the upper part of an arm supporting the push bars which are adapted to engage with the cam wheels;

Figure 6 shows a cross section taken along line VI—VI of Figure 4;

Figure 7 shows side views of two different contact levers;

Figure 8 shows a perspective view of a control arm with a part of a push bar;

Figure 9 shows a perspective view of the lower end of a connecting link with the end portions of the associated contact lever and locking bar;

Figure 10 shows diagrammatically a simplified perspective view of a part of modified embodiment of the invention;

Figure 11 shows a cross section taken along line XI—XI of Figure 10;

Figure 12 shows a perspective view of a control cylinder similar to the embodiment according to Figure 1 but associated with an electric control mechanism therefor; while

Figure 13 shows the circuit diagram of a simplified modification of the electric control mechanism according to Figure 12.

Referring to the drawings, and first particularly to Figures 1 to 9, the main control member which is adapted to be shifted in a step-by-step movement for controlling the operation of certain cam parts, patterning mechanisms, and the like, not shown in the drawings, consists of a control cylinder **1** which is provided in a manner known as such with control cams, not shown. For producing the step-by-step movement of control cylinder **1** about its shaft **2'**, the cylinder is provided with a gear rim **2**, while a pawl **3** is adapted to engage into the teeth of gear rim **2** and to advance the control cylinder **1** intermittently. This pawl **3** is pivotable about an axis **4** and connected to a lever **6** which, in turn, is pivotable about an axis **5**. Pawl **3** is acted upon by a spring **3'** and by the action of a spring **6'** it is maintained in sliding engagement with a cam plate **7** which, for example, in a circular knitting machine, rotates together with the needle cylinder or the cam box. The transmission ratio may be 1:1 so that at every revolution of the needle cylinder or the cam box, the control cylinder **1** will be advanced by the distance of one tooth spacing.

A part **1'** of control cylinder **1** serves as a supporting member of the setting elements of a control mechanism which, by acting upon pawl **3**, exerts a controlling effect upon the step-by-step movement of control cylinder **1**. For this purpose, the supporting cylinder **1'** is provided with a series of bores **8** which are arranged in parallel longitudinal rows around the periphery of cylinder **1'** and are adapted to receive setting pins **9**. In the particular embodiment of the invention as illustrated in the drawings, each longitudinal row contains seven bores, and each bore within one longitudinal row lies within a circumferential row of bores which are aligned within the same plane transverse to the cylinder axis. The setting pins **9** which are inserted into the bores of one longitudinal row act simultaneously upon the control mechanism. The effect of each setting pin **9** upon the control mechanism is to cause the latter to pivot pawl **3** for a certain length of time, for example, for a certain number of revolutions of cam plate **7**, out of engagement with gear rim **2**. The length of time of this action of the control mechanism upon pawl **3** depends upon the location of the particular bore **8** in one row into which a setting pin **9** is inserted, and it varies in accordance with a change in such location. For this reason, the seven bores **8** of one row and the parts of the control mechanism which are associated with each of these bores will be subsequently identified by the addition of the letters *a* to *g* to the reference numeral of the respective part, provided the difference between the parts of each kind is of importance for explaining the present invention.

Each bore **8***a* to **8***g* in cylinder **1'** is operatively associated with a two-armed scanning lever **10***a*, **11***a* to **10***g*, **11***g*, respectively, which forms a part of a set of transmitting means, which includes a plurality of transmitting members or links. All of these scanning levers **10**, **11** are pivotably mounted on a common shaft **12** and each of these scanning levers is maintained substantially in engagement with cylinder **1'** by a spring **13***a* to **13***g*, respectively. For scanning the periphery of cylinder **1'** to engage with pins **9**, each of the arms **10***a* to **10***g* has a hook-shaped head **10'** which has an inclined or cam-shaped contact surface **10''** along which one of the setting pins **9***a* to **9***g* may slide during the rotation of cylinder **1'** in the direction shown by the arrow A in Figures 2 and 3, so as to depress the respective arm **10***a* to **10***g* and pivot the same about the shaft **12**.

Due to the action of a spring **14***a* to **14***g*, a connecting link **15***a* to **15***g*, respectively, is pressed against the lower surface of each head **10'***a* to **10'***g* of scanning levers **10**. These links are mounted within the control mechanism in a manner not particularly shown in the drawings so as to be slidable only in their longitudinal direction. The lower end of each link **15***a* to **15***g* acts upon another link **16***a* to **16***g*, respectively, which subsequently will be referred to as a contact lever. These contact levers **16***a* to **16***g* are disposed adjacent to each other and mounted so as to be pivotable about a common shaft **17**. In order to ensure that each link **15***a* to **15***g* will properly act upon a certain contact lever **16***a* to **16***g*, the lower ends **15'***a* to **15'***g* of the former are offset at different distances relative to the upper parts. Each link **15***a* to **15***g* is also provided with a projecting detent **17'***a* to **17'***g*, respectively, which cooperates with a locking bar **19***a* to **19***g* which is pivotable about a vertical pivot pin **18***a* to **18***g*, respectively. If one of the scanning levers **10***a* to **10** *g* is pivoted out of its normal position by one of the setting pins **9***a* to **9***g*,

it will press the corresponding link 15 downwardly so that the detent 17' thereof will engage with the lower edge of locking bar 19 and thus maintain link 15 in such depressed position.

The outer ends of contact lever 16*a* to 16*g* are provided with corresponding recesses into which the lower hook-shaped end 20' of a single tie rod 20 engages which has an eye portion 20'' on its upper end through which pawl 3 is inserted. If one of the contact levers 16*a* to 16*g* is pivoted downwardly by one of the links 15*a* to 15*g*, it will take along the tie rod 20 and thus also the pawl 3 so that the latter will be pivoted out of engagement with gear rim 2. Pawl 3 will then be held in this disengaged position until the locking mechanism consisting of the respective locking bar 19 is released.

For releasing this locking mechanism, each scanning lever 10*a*, 11*a* to 10*g*, 11*g* is operatively associated with a control arm 21*a* to 21*g* and a cam wheel 22*a* to 22*g*, respectively. Control arms 21 are mounted in a known manner, not illustrated in the drawings, so as to slidable in their longitudinal direction, that is, in this particular case, in a vertical direction. The upper end of each control arm 21 is made in the form of a hook 21' which is adapted to engage with a corresponding hook 11' on arm 11 of scanning lever 10, 11. Each control arm 21 is acted upon by a spring 34 which tends to draw it in a downward direction. The lower end of each control arm 21 has an inclined surface 21'' which is adapted to engage with cams 23 on the respective cam wheel 22. If hook 21' is engaged with hook 11' on arm 11 of the scanning lever, control arm 21 will be held out of the path of movement of cams 23 on the respective cam wheel 22 and thus out of engagement with these cams.

The other end of each arm 19'*a* to 19'*g* of the respective locking bar 19 opposite to the arm which engages with the link 15*a* to 15*g* abuts against one of the control arms 21*a* to 21*g*. For actuating the locking bars 19*a* to 19*g*, each control arm 21*a* to 21*g* is provided at the side thereof facing toward the corresponding locking bar 19 with a cam 24*a* to 24*g*, respectively, which is disposed at such a level that, when control arm 21 is in its raised position in which it is hooked into contact lever arm 11, the cam will act upon locking bar 19 whereby the latter will be pivoted about its axis 18 so that the detent 17' of the respective link 15 will be out of the path of movement of locking bar 19.

Each control arm 21*a* to 21*g* is further provided with a pin 25*a* to 25*g*, respectively, which engages with the lower side of one arm of a push bar 26*a* to 26*g* and is adapted to lift the pawl-shaped end of this arm out of engagement with a gear rim 27*a* to 27*g* on the respective cam wheel 22*a* to 22*g* when the respective control arm 21*a* to 21*g* is in the raised position. Push bars 26*a* to 26*g* are pivotally mounted about a common axis 29 within a common supporting member 28 and, when pivoted, the arms of push bars 26 opposite to those engaging with control arms 21 are adapted to engage with the lower sides of contact levers 16. The supporting member 28 is mounted on a lever 31 which is pivotable about an axis 30 and acted upon by a spring 32' and a cam plate 32 which rotates in synchronism with cam plate 7 so that, during the knitting operation, lever 31 will continuously reciprocate about the axis 30 and thereby reciprocate all of the push bars 26*a* to 26*g*. As long as control arm 21*a* to 21*g* are in their raised position, this reciprocating movement will be without any effect since push bars 26*a* to 26*g* do not engage into the gear rims 27*a* to 27*g* of cam wheels 22*a* to 22*g*, respectively, but ride back and forth along pins 25*a* to 25*g*.

During the period in which the control mechanism, under the action of one of the setting pins 9 acts upon pawl 3, the effects of several setting pins 9 in different bores 8 of the same row and acting simultaneously upon the control mechanism may be accumulated so that these effects will be added to each other. For this purpose, push bars 26*a* to 26*g* and contact levers 16*a* to 16*g* are disposed in such a relation to each other that, when contact levers 16*a* to 16*g* are pivoted so that pawl 3 is moved out of engagement with gear rim 2, the lower edges 16'*a* to 16'*g* of contact levers 16*a* to 16*g* will be in alignment with the upper surface of the arms of push bars 26*a* to 26*g* when the arms of these rods facing toward cam wheels 22 are out of engagement with gear rims 27*a* to 27*g*. The lower side of each contact lever 16*a* to 16*g* is provided with a recess 33*a* to 33*g* to permit those push bars 26 which engage with one end into the recesses 33 of the pivoted contact levers to pivot in a clockwise direction and to engage with their pawl-shaped end into the respective gear rims 27. Recesses 33*a* to 33*g* are of different lengths and each of them begins at a point above the push bar 26 which is associated with the respective contact lever and extends in the particular embodiment shown in Figure 1 across all the other push bars which are located on that side of the associated push rod which faces toward tie rod 20. Accordingly, contact lever 16*g* has a recess 33*g* only for receiving push bar 26*g*, while contact lever 16*a* has a recess 33*a* for receiving all push bars 26*a* to 26*g*.

Gear rims 27*a* to 27*g* of cam wheels 22*a* to 22*g*, respectively, all have the same number of ratchet teeth, namely, in the particularly embodiment illustrated, 128 teeth. However, each cam wheel has a different number of cams 23, namely:

	Cams
Cam wheel 22*a*	1
Cam wheel 22*b*	2
Cam wheel 22*c*	4
Cam wheel 22*d*	8
Cam wheel 22*e*	16
Cam wheel 22*f*	32
Cam wheel 22*g*	64

In order to permit the next cam 23 to act upon the corresponding control arm 21 immediately after a previous cam 23 has acted thereon, the respective cam wheels must be advanced by the following number of steps:

Cam wheel 22*a* by 128 steps
Cam wheel 22*b* by 64 steps
Cam wheel 22*c* by 32 steps
Cam wheel 22*d* by 16 steps
Cam wheel 22*e* by 8 steps
Cam wheel 22*f* by 4 steps
Cam wheel 22*g* by 2 steps.

The operation of the control mechanism as illustrated in Figures 1 to 9 is as follows:

During the knitting operation, the two cam wheels 7 and 32 are rotating continuously and thereby also reciprocate pawl 9 and push bars 26*a* to 26*g* continuously. Pawl 3 then continuously engages with the ratchet teeth of gear rim 2 so that control cylinder 1, 1' will be advanced progressively by one step. Push bars 26*a* to 26*g*, however, are kept constantly out of engagement with gear rims 27*a* to 27*g* by pins 25*a* to 25*g* on control arms 21*a* to 21*g*, respectively.

If, for example, a setting pin 9*a* is inserted in a bore 8*a* of cylinder 1' and then acts upon the hook-shaped head 10'*a* of scanning lever 10*a*, 11*a*, the latter will be pivoted about shaft 12 against the action of draw spring 13*a* so that hooks 11'*a* and 21'*a* will be disengaged from each other. Consequently, control arm 21*a* will be depressed by the action of spring 34*a* so that its lower end will come to rest on the cylindrical surface 22'*a* of cam wheel 22*a* from which cam 23 projects. Pin 25*a* on control arm 21*a* will then also move downwardly with the result that push bar 26*a* will be pivoted by the action of spring 26' about the axis 29 so that the pawl-shaped end of push bar 26*a* will engage with the ratchet teeth of gear rim 27. Each forward movement of push bar 26 will

therefore turn cam wheel 22*a* one step about its axis.

As soon as scanning lever 10*a*, 11*a* is pivoted and releases the control arm 21*a*, it also pushes link 15*a* downwardly with the result that the detent 17'*a* will snap underneath locking bar 19*a* which rests directly on link 15*a* since cam 24*a* has slipped off the arm 19'*a* of the locking bar when control arm 21*a* was moved downwardly. For pivoting the locking bar 19*a* to this position during the downward movement of control arm 21*a*, the locking bar is provided with a suitable spring, for example, a coil spring 18'*a* as shown in Figure 9 which tends to turn the bar in a clockwise direction about its axis 18*a*. Link 15*a* will then swing contact lever 16*a* downwardly about its axis 17 and thereby take along the tie rod 20 and thus also pawl 3. The action of setting pin 9*a* therefore prevents any further advance of control cylinder 1, 1', and instead cam wheel 22*a* will be progressively advanced in a step-by-step movement. During the last step of the movement of control cylinder 1, 1', setting pin 9*a* will be moved slightly beyond the head 10' of the scanning lever 10*a*, 11*a*, so that the return movement of the scanning lever will not be obstructed by setting pin 9*a*.

Since cam wheel 22*a* has only one cam 23, it must be rotated for one complete revolution until cam 23 will engage with control arm 21. Since gear rim 27*a* has 128 teeth, control arm 21 will not be moved by cam 23 until cam plate 32 has carried out 128 revolutions. As soon as cam 23 engages with the inclined surface 21''*a* of control arm 21*a*, the latter will be raised so that hook 21'*a* will snap into hook 11'*a* of scanning lever 10*a*, 11*a* and thus arrest control arm 21*a* in a fixed position. Cam 24*a* on control arm 21*a* then presses upon arm 19'*a* of locking bar 19*a* so that the latter will be pivoted against the action of spring 18'*a* and thereby release the link 15*a* which will then be returned to its original position. This will also return pawl 3, for example, by the action of spring 3', into engagement with the ratchet teeth of gear rim 2. Thereupon, control cylinder 1, 1' will again be advanced.

If in place of setting pin 9*a* another setting pin acts upon the respective scanning lever 10, 11, the further advance of control cylinder 1, 1' will be interrupted in accordance with the number of steps which the respective cam wheel has to advance until its next cam will act upon the control arm 21. Thus, by inserting the setting pin into one or another position in cylinder 1', the step-by-step movement of the control cylinder may be adjusted in accordance with different numbers of revolutions of cam plates 7 and 32, which revolutions, in turn, correspond to a certain relative shifting movement between the cam and needle carrier of the knitting machine. The number of these revolutions depends upon the difference in design of cam wheels 22*a* to 22*g* and amounts to 128, 64, 32, 16, 8, 4, and 2 revolutions, respectively. These numbers are the terms of a geometric exponential series having a quotient of 2. It is a well-known fact that by summarizing the terms of a geometric exponential series, all intermediate values may be attained. Since in the present case the term $2^0=1$ is missing, a few numbers will be lacking. However, this is of no practical importance since in knitting it does not matter whether one row more or less will be knitted. However, by adding further control members together with another cam wheel 22*h* which has the same number of cams 23 as there are teeth on gear rim 27*h*, the term 1 of the exponential series could also be produced. However, in order to simplify the control mechanism according to the invention, these additional control elements have been omitted in the embodiment shown in the drawings.

The summation of the effects of several setting pins 9 within one row occurs as follows: Assuming, for example, that a setting pin 9*a* to 9*g* is inserted into each bore 8*a* to 8*g*, the same procedure as described above will apply to all control arms. Consequently, all contact levers 16*a* to 16*g* will also be pivoted downwardly, about shaft 17. However, the lower edge of contact levers 16*a* to 16*g* will then prevent the push bars 26*a* to 26*f* from engaging with the associated gear rims 27*a* to 27*f* of cam wheels 22*a* to 22*f* so that the reciprocating movement of the supporting member 28 of the push bars will only advance the cam wheel 22*g*. As soon as the next cam 23 of cam wheel 22*g* acts upon control arm 21*g*, all the control elements designated with the letter "*g*" will return to their original position so that contact lever 16*g* will thus also be raised by the action of spring 26'*f* upon push bar 26*f* so that push bar 26*f* will then engage into gear rim 27*f* of cam wheel 22*f*. During this procedure, the other contact levers 16*a* to 16*f* will continue to hold pawl 3 in the disengaged position. Thereupon, cam wheel 22*f* will be advanced step-by-step until cam 23 thereon will act upon the control arm 21*f* and effect the return of all control elements designated with the letter "*f*." The same procedure will then be repeated with push bar 26*e*.

It is clearly evident from the above description that the further advance of control cylinder 1, 1' will be interrupted for the period of 254 revolutions of cam wheel 32, being the sum of $2+4+8+16+32+64+128$. If, therefore, there are more than one setting pin 9 in one row of control cylinders 1', the effects of all the setting pins in this row will be added to each other. The new control mechanism therefore permits the interruption of the forward movement of control cylinder 1, 1' for practically any number of revolutions of cam plates 7 and 32 ranging between 1 and 254. During such interruption, the knitting operation continues at the cam position which was set by the last position of the control cylinder. Thus, if one revolution of cam plates 7 and 32 corresponds to one revolution of the needle cylinder or the cam box of a circular knitting machine, the corresponding number of rows as set on the cam will be knitted.

Figures 10 and 11 illustrate a modification of the invention which differs from the embodiment according to Figures 1 to 9 primarily by the provision of a punch card 101 to serve as a control member in place of the cylinder 1, 1'. This punch card 101 is provided with a plurality of rows of perforations 109 and is advanced row-by-row in its frame 102' by means of a feeding mechanism which is in effect similar to cam plate 7 and pawl 3 and therefore not particularly shown in Figures 10 and 11. After each forward movement of the card, the frame 102' is pressed downwardly for a short time in a direction vertical to the surface of card 101 and, for example, against the action of a spring, not shown. The feeding mechanism of card 101 and frame 102' is operated by a control mechanism similar to that as previously described and illustrated in Figures 1 to 9. Figure 10 therefore only shows the scanning levers 110, 111 which are pivotable about a common shaft 112 and the associated control arms 121, all of which functionally correspond to scanning levers 10, 11 and control arms 21 as shown in Figures 1 to 9.

As shown in Figure 11, underneath frame 102' is a stationary frame 103 in which a row of pins 108*a* to 108*g* extends in a direction vertical to the direction of feed of card 101. Each of these pins 108 is slidable within a bore 103'*a* to 103'*g* in frame 103 in a direction vertical to the surface of card 101. At a point near its upper end, each pin 108 has a flange 108'*a* to 108'*g* for supporting the upper end of a spring 104*a* to 104*g*, the lower end of which acts upon frame 103. Directly underneath the lower end of pin 108 are the heads 110'*a* to 110'*g* of scanning levers 110, 111. Punch card 101 is located in relation to the row of pins 108 so that the pins will always be directly underneath one row of holes 109.

If, after card 101 has been fed forwardly by the distance between two adjacent rows of holes 109, frame

102′ is moved downwardly for a short time, the upper ends of the pins which encounter no holes 109 in punch card 101 will be forced downwardly against the action of spring 104 and thereby actuate the respective levers 110, 111. This movement of scanning levers 110, 111, in turn, actuates the control mechanism in the same manner as described with reference to Figures 1 to 9, and this control mechanism then controls the subsequent feeding of punch card 101 and the further movement of frame 102′. Those holes 109 which are omitted in card 101 therefore take the place of the setting pins 9 in the embodiment according to Figures 1 to 9, while the holes 109 themselves may be regarded as a sort of negative setting elements.

At the right end of punch card 101, not shown in the drawing, that is, at a point beyond the broken edge of the card shown in Figure 10, the card is provided with holes for controlling the cam of the knitting machine, and this righthand end of the punch card is adapted to act upon cams, patterning mechanisms, and the like by means of pins similar to pins 108. Punch card 101 therefor constitutes the main control element of the control mechanism according to Figures 10 and 11 which is equivalent to the control cylinder 1, 1′ of the embodiment according to Figures 1 to 9.

The further modification of the invention as illustrated in Figure 12 differs from the embodiment according to Figures 1 to 9 merely by the fact that the step-by-step movement of the control cylinder is not controlled by mechanical elements but by electrical means. Insofar as the individual parts of the control mechanism according to Figure 12 are either identical with those shown in Figures 1 to 9 or are at least functionally similar thereto, these parts will be identified in Figure 12 by reference numerals which are higher by 200 than those used in Figures 1 to 9. The description of the particular embodiment according to Figure 12 may therefore be confined to those parts which differ substantially from those shown in Figures 1 to 9.

As already indicated, the principal distinction of the embodiment according to Figure 12 over the embodiment according to Figures 1 to 9 is that the setting pins 209 which are selectively inserted into any of the bores 208*a* to 208*g* act upon electric switches 210*a* to 210*g*, respectively, rather than upon mechanical levers 10, 11. These switches are connected in the circuit of a source of electric current 250 in series with electromagnets 215*a* to 215*g*, respectively, which are provided together with electromagnets 219*a* to 219*g* for operating other electric switches 216*a* to 216*g*. Each of these switches 216*a* to 216*g* is adapted to connect one contact 251*a* to 251*g* to one contact 252*a* to 252*g* or to one contact 252′*a* to 252′*g*, respectively. Contact 151*g* is connected directly to one terminal 250′ of the current source 250, while each of the contacts 251*f* to 251*a* is connected to the respective contact 252*g* to 252*b* of the preceding switch. If one of the magnets 215*a* to 215*g* is energized, the corresponding switch 216*a* to 216*g* will be operated so that contacts 251*a* to 251*g* will be connected to contacts 252′*a* to 252′*g*, respectively. This operating position will subsequently be called the position II. If, on the other hand, one of the magnets 219*a* to 219*g* is energized, the corresponding switch 216*a* to 216*g* will be operated so that contacts 251*a* to 251*g* will be connected to contacts 252*a* to 252*g*, respectively. This latter operating position in which all of the switches 216 are shown in Figure 12 will subsequently be called the position I.

Contact 252*a* of switch 216*a* is connected by a conductor 253 to one terminal of an electromagnet 203′, the other terminal of which is connected by a conductor 253′ to the second terminal 250″ of the current source. If all switches 216*a* to 216*g* are in the position I, magnet 203′ will be connected into the circuit of the current source 250 and then acts upon an I-shaped member 220″ and thereby upon a pawl 203 similar to pawl 3 in the embodiment according to Figures 1 to 9, whereby this pawl 203 is lifted to such an extent that, due to its reciprocating movement caused by a cam plate similar to cam plate 7 as shown in Figures 2 and 3 but not illustrated in Figure 12, control cylinder 201 will be advanced in a step-by-step rotation about its shaft 202′.

Contacts 252′*a* to 252′*g* are connected through electromagnets 226*a* to 226*g* to one terminal 232′ of an interrupter 232, the other terminal 232″ of which is connected to the second terminal 250″ of the current source 250.

Interrupter 232 is driven mechanically so that the electrical connection between its two terminals 232′ and 232″ will be interrupted during the forward movement of pawl 203. This mechanical operation of the interrupter 232 may, for example, be carried out by means of a cam which acts upon the movable element of the interrupter, as indicated diagrammatically in Figure 12.

Each magnet 226*a* to 226*g* faces toward a lever 231*a* to 231*g*, respectively, only one of which, namely, lever 231*a*, is shown which is pivotable about an axis 230*a* to 230*g* and attracted toward the respective magnet against the action of a spring 232′*a* to 232′*g*. Each lever 231*a* to 231*g* carries a pawl-shaped push bar 226*a* to 226*g*, respectively, which is pivotably secured thereto. By means of a stop member 226′*a* to 226′*g*, this push bar will be maintained in such a position that, when the respective magnet 226 is deenergized, the push bar will be moved by spring 232′ so that its blade will engage into gear rim 227*a* to 227*g* of cam wheels 222*a* to 222*g*, respectively, and will shift the respective cam wheel forwardly by one step whenever the respective magnet 226 is deenergized. Similarly as in the embodiment according to Figures 1 to 9, each gear rim 227*a* to 227*g* has 128 ratchet teeth. The number of cams 223 on the different cam wheels 222*a* to 222*g* corresponds to the number of cams 23 on cam wheels 22*a* to 22*g* of the embodiment according to Figures 1 to 9. Cams 223 are adapted to operate the electric switches 221*a* to 221*g* mechanically in a manner known as such, and in the embodiment as illustrated in Figure 12, they are adapted to close these switches.

Each control magnet 219*a* to 219*g* mentioned above is connected at one side to a contact 251*a* to 251*g* of switch 216*a* to 216*g*, respectively, and at the other side through one of switches 221*a* to 221*g* to the terminal 250″ of the current source 250.

The operation of the control mechanism according to Figure 12 substantially corresponds to the operation of the control mechanism according to Figures 1 to 9. During the knitting operation, pawls 203 are continuously reciprocated by a cam plate similar to cam plate 7 in Figures 2 and 3. At the same time, the interrupter 232 remains continuously in operation. If switches 216*a* to 216*g* are set in the position I, magnet 203′ will be energized so that pawl 203 acts continuously upon gear rim 202 of control cylinder 201, 201′ and thereby continuously advances the latter by one step after another. Since in the position I of switches 216*a* to 216*g* the electromagnets 226*a* to 226*g* receive no current and are deenergized, levers 231*a* to 231*g* will be at rest so that cam wheels 222*a* to 222*g* will not be shifted.

If, for example, a setting pin 209*b* should now be inserted in the bore 208*b*, the engagement of this pin upon the corresponding switch 210*b* will cause the magnet 215*b* to be energized so that switch 216*b* will be shifted to the position II. During the movement of control cylinder 201′, the action of setting pin 209*b* upon switch 210*b* will last only for a short time. Therefore, at the termination of this movement, setting pin 209*b* will have passed beyond switch 210*b* so that the latter can again open. This forward movement of control cylinder 201′ may be attained by designing the pawl 203 so as to engage into gear rim 202 in such a manner that, as long as

pawl 203 is pushed forwardly by cam 7, it cannot become disengaged from the gear rim and such disengagement cannot occur until pawl 203 is being retracted. When the switch is thus changed over, the circuit through magnet 203' will be interrupted so that the I-shaped member 220'' will drop downwardly and thereby move pawl 203 out of the range of engagement with gear rim 202 so that the further reciprocating movement of pawl 203 will be without effect during the period in which the magnet 203' remains deenergized.

When switch 216*b* is in its position II, as above described, magnet 226*b*, is connected through the interrupter 232 to the current source 250 and thus acts upon the corresponding lever 231*b*, not shown. This lever is then continuously reciprocated by the periodic energization of magnet 226*b* and the action of spring 232'*b* so that push bar 226*b* will engage into gear rim 227*b* of cam wheel 222*b* and shift the latter forwardly by one step at every movement caused by the action of spring 232'*b*. In accordance with the number of cams 223 on cam wheel 222*b*, switch 221*b* will in this case be closed after cam wheel 222*b* has progressed 64 steps, whereupon the magnet 219*b* will be energized and thereby return switch 216*b* to its original position I in which the same conditions occur as previously described.

The accumulation and addition of the effects of several setting pins 209 in one row occurs as follows:

Assuming for example that a pair of setting pins 209*b* and 209*c* is inserted in bores 208*b* and 208*c* within the same row, the switching operation as above described will occur twice, that is, both switches 216*b* and 216*c* will be shifted into the position II. However, in this position there will only be the electromagnet 226*c* which is connected to the circuit of the current source 250 since the current supply to the electromagnet 226*b* is interrupted by the shifting of switch 216*c* to the position II. Cam wheel 222*c* will therefore advance 32 steps in accordance with the number of its cams 223. The respective cam 223 will then act upon switch 221*c* and thereby cause switch 216*c* to return to position I. During this time, however, the supply of current to magnet 203' remains interrupted by switch 216*c* which will then energize the electromagnet 226*b* in the manner as above described. Cam wheel 222*b* will therefore advance 64 steps so that the forward movement of control cylinder 201, 201' will be interrupted for 32+64 steps, that is, for a total of 96 steps.

The control mechanism according to Figure 12 therefore permits the same result as described in detail with reference to the embodiment according to Figures 1 to 9, namely to interrupt the movement of control cylinder 201, 201' for the period of virtually all numbers of revolutions of cam plate 7 between 1 and 254.

The further modification of the invention as illustrated in Figure 13 is very similar to the embodiment according to Figure 12. All the parts shown in Figure 13 which are similar to those in Figure 12 are indicated by reference numerals which are higher by 100 than those applied in Figure 12, while all those parts of the mechanism which are not illustrated in Figure 13 are substantially identical with those shown in Figure 12.

The only difference between the embodiment according to Figure 13 and that according to Figure 12 resides in the fact that the switches 316*a* to 316*g* are operated mechanically by setting pins 209*a* to 209*g* and by cams 223. The mechanical connection provided operates in such a manner that setting pins 209 shift the switches 316 to the position II, while cams 223 shift the switches to the position I. Magnets 326*a* to 326*g* will therefore be energized and deenergized by the interrupter 332 similarly as magnets 226 in Figure 12. The remaining operation is similar as described above with reference to Figure 12.

Although my invention has been illustrated and described with reference to the preferred embodiments thereof, I wish to have it understood that it is in no way limited to the details of such embodiments, but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed my invention, what I claim is:

1. In an automatic knitting machine, a cam control comprising, in combination, a main control member for controlling automatically operated parts of the machine, shifting means, driving means for moving said shifting means continuously so as to shift said control member in a step-by-step movement, a supporting member operatively connected to said main control member for synchronous movement therewith, said supporting member having a plurality of surface parts spaced from each other and arranged in rows and lines, said rows crossing the direction of the movement of the surface of said supporting member, said lines being parallel to said direction of movement, each of said parts being adapted to be changed from one condition to another condition, one of said conditions being an active condition and the other an inactive condition, scanning means associated with each of said lines and adapted to be actuated by any one of said surface parts in said active condition within said line, transmitting means comprising a plurality of members functionally interposed between said scanning means and said shifting means, each of said scanning means being associated with at least some of said transmitting members of one of said transmitting means for changing said transmitting members from an inactive position to an active position when a scanning means is acted upon by one of said surface parts in said active condition, each of said transmitting members in said active position being adapted to interrupt the shifting action of said shifting means, means for returning said transmitting members from said active position to said inactive position, a member movable in a continuous succession of cycles in timed relation with said driving means, a plurality of counters operatively connected to said movable member, each of said counters being associated with the surface parts in the active position in one of said lines for counting a predetermined number of said cycles of said movable member, each of said scanning means comprising means for starting the operation of the counter associated therewith, means associated with each counter for delaying the action of said returning means until each actuated counter has completed its counting operation and for then releasing said returning means, and means for retaining at least one of several actuated counters in an inoperative condition as long as another counter operates so that said actuated counters operate successively.

2. In an automatic knitting machine as defined in claim 1, wherein said main control member and said supporting member together form a single element.

3. In an automatic knitting machine as defined in claim 1, wherein said surface parts are formed by bores in said supporting member and said surface parts in the active condition are formed by setting pins adapted to be inserted selectively into said bores, said bores being arranged in rows extending parallel to the axis of said cylinder, the corresponding bores within each row being in alignment with each other within a plane extending transverse to the axis of said cylinder, each of said bores of one plane being associated with one of said scanning means.

4. In an automatic knitting machine as defined in claim 1, wherein each counter is preset to count a predetermined number of cycles which is different from the predetermined number of cycles to which any of the other counters are preset, the numbers counted by each of said counters corresponding to the terms of a geometric exponential series.

5. In an automatic knitting machine as defined in

claim 1, wherein said main control member comprises a control cylinder, a part of said cylinder forming said supporting member of said surface parts, said scanning means comprising a separate scanning lever for each line of said surface parts on said supporting member for scanning said supporting member for said surface parts in the active condition, said transmitting members being disposed between said scanning levers and said shifting means for acting upon said shifting means for a certain length of time in accordance with the action of said delaying means to disengage said shifting means from said control cylinder when one of said scanning levers has completed its engagement with one of said surface parts.

6. In an automatic knitting machine as defined in claim 1, wherein said delaying means further comprise a plurality of locking members, each associated with said transmitting members of one of said scanning means and adapted to arrest said transmitting members in a position in which they are actuated by one of said scanning means.

7. In an automatic knitting machine as defined in claim 6, wherein each of said transmitting means further comprises a contact lever pivotably mounted at one end about a stationary axis, and a tie rod having one end engaging with the other end of all of said contact levers, said shifting means comprising a gear rim on said control member, a pawl normally in engagement with said gear rim, said driving means being adapted to reciprocate said pawl continuously to effect said step-by-step movement of said control member, and a member on the other end of said tie rod adapted to engage with said pawl to disengage the same from said gear rim when one of said scanning means is in engagement with one of said surface parts in the active condition, a common supporting member for pivotably supporting all of said push bars adjacent to each other so as to be individually pivotable about a substantially central horizontal axis, each of said push bars having two arms, one of said arms facing toward the gear rim on one of said cam wheels, the other arm extending underneath said contact levers, the lower edge of at least one contact lever when in the actuated position engaging with said other arm of said push bar and thereby holding at least one of said push bars disengaged from the teeth of said gear rim, the lower edge of each of said contact levers having a recess for receiving one of said push bars associated with one of said contact levers as well as all other push bars disposed at one side of said push bar.

8. In an automatic knitting machine as defined in claim 1, wherein each of said counters further comprises a separate cam wheel having at least one cam thereon for controlling the operation of each delaying means, means for connecting said movable member to each of said cam wheels to drive the same, a gear rim mounted on each of said cam wheels, and a separate push bar adapted to engage the teeth of each of said gear rims when said transmitting members are actuated, said movable member comprising a shaft and a cam plate on said shaft for reciprocating said push bar.

9. In an automatic knitting machine as defined in claim 8, wherein each of said counters further comprises a control arm associated with one of said cam wheels and the cam thereon and with one of said scanning means, and having one end facing toward said cam wheels and having a hook-shaped end opposite thereto, each of said scanning means comprising a scanning lever having an angular shape forming two arms, one of said arms facing toward said supporting member and adapted to engage with said surface parts in the active condition thereon, and the other arm having a hook-shaped end adapted to engage with said hook-shaped end of said control arm to hold the other end of said control arm out of engagement with said cam, a spring acting upon said scanning lever to maintain one of said arms thereof in engagement with said supporting member and the other hook-shaped arm in engagement with the hook-shaped end of said control arm when said scanning lever is not in engagement with one of said surface parts in the active condition, a member mounted on said control arm for holding said push bar out of engagement with said gear rim on said cam wheel, each of said locking members comprising a locking bar pivotably mounted substantially at the center thereof for movement within a plane vertical to the direction of movement of said control arm, one of said transmitting members engaging with one of said scanning levers and adapted to interlock with said locking bar, and a cam mounted on said control arm for pivoting said locking bar out of said locking position when said cam on said cam wheel acts upon said control arm.

10. In an automatic knitting machine as defined in claim 1, wherein each of said counters comprises a cam wheel having a different number of cams thereon than the other cam wheels, the number of said cams on each of said cam wheels forming a term of a geometric exponential series having a quotient of 2, a gear rim connected to each of said cam wheels, said gear rims on all of said cam wheels having the same number of teeth, said number corresponding at least to the number of cams on the cam wheel having the largest number of cams of all of said cam wheels.

11. In an automatic knitting machine as defined in claim 1, wherein each of said transmitting means further comprises a contact lever pivotably mounted at one end about a stationary axis, and a tie rod having one end engaging with the other end of all of said contact levers, said shifting means comprising a gear rim on said control member, a pawl normally in engagement with said gear rim, said driving means being adapted to reciprocate said pawl continuously to effect said step-by-step movement of said control member, and a member on the other end of said tie rod adapted to engage with said pawl to disengage the same from said gear rim when one of said scanning means is in engagement with one of said surface parts in the active condition.

12. In an automatic knitting machine as defined in claim 1, wherein said main control member comprises a card, strip or the like having said surface parts in said active and inactive conditions thereon.

13. In an automatic knitting machine as defined in claim 1, wherein said main control and supporting member comprises a card, strip, or the like, said shifting means being adapted to shift said card for equally spaced distances in a step-by-step movement within the plane of its surface and after each shift to reciprocate said card in a direction vertical to its surface, said scanning means comprising a plurality of pins spaced from each other within a row extending transverse to the direction of said step-by-step movement and in a plane intersecting with said card at a line of rest of said card intermediate its movements and so as to be movable in their axial direction vertical to the surface of said card, said card having perforations therein at least at some points thereof lying within said line of rest and forming said surface parts in said inactive condition, some of the solid parts of said card forming said surface parts in said active condition, a plurality of pivotable scanning levers, each having the end of one arm thereof adapted to engage with one of said pins, said intermediate transmitting members being interposed between said scanning levers and said shifting means for acting upon said shifting means for a certain length of time to disengage the same from said card to interrupt the step-by-step movement thereof when at the termination of one forward movement said card is moved in said vertical direction toward said pins and if at least one of said pins does not coincide with a perforation in said card and is therefore depressed by one of said solid parts of said card against the end of said arm of said scanning lever, thereby

pivoting the same, while any pin coinciding with a perforation in said card enters the same so that the associated scanning lever is not pivoted.

14. In an automatic knitting machine as defined in claim 1, wherein said transmitting means comprise separate electromagnetic control means associated with each line of said surface parts and operatively connected with said shifting means, each of said scanning means comprising separate electric switch means adapted to be acted upon by each of said surface parts in the active position within one line for controlling the operation of said electromagnetic means.

15. In an automatic knitting machine as defined in claim 14, wherein each of said counters comprises a cam wheel associated with said surface parts in the active position, each of said cam wheels having a different number of cam surfaces thereon, means for connecting said cam wheels to said shifting means, and means for shifting said cam wheels in a step-by-step movement, said electromagnetic means being adapted to act intermittently upon said last shifting means to produce said step-by-step movement.

16. In an automatic knitting machine as defined in claim 15, wherein said transmitting means comprise an electromagnet adapted to act upon said shifting means of said control member, said counter further comprising an interruptor, a source of current, said switch means being controlled by said surface parts in the active condition and by said cam wheels and connected to said current source in series with said electromagnet, said cam wheels being adapted to move said switch means to the closed position in which said electromagnet is energized to allow said shifting means to act upon said control member, said surface parts in the active condition being adapted to move said switch means to another position in which said switch means interrupt the circuit of said current source and connect the same to said interruptor and said electromagnetic means in series with said interruptor for shifting one of said cam wheels in a step-by-step movement in accordance with the operation of said interruptor.

References Cited in the file of this patent

UNITED STATES PATENTS

2,841,970 Saunders ---------- July 8, 1958