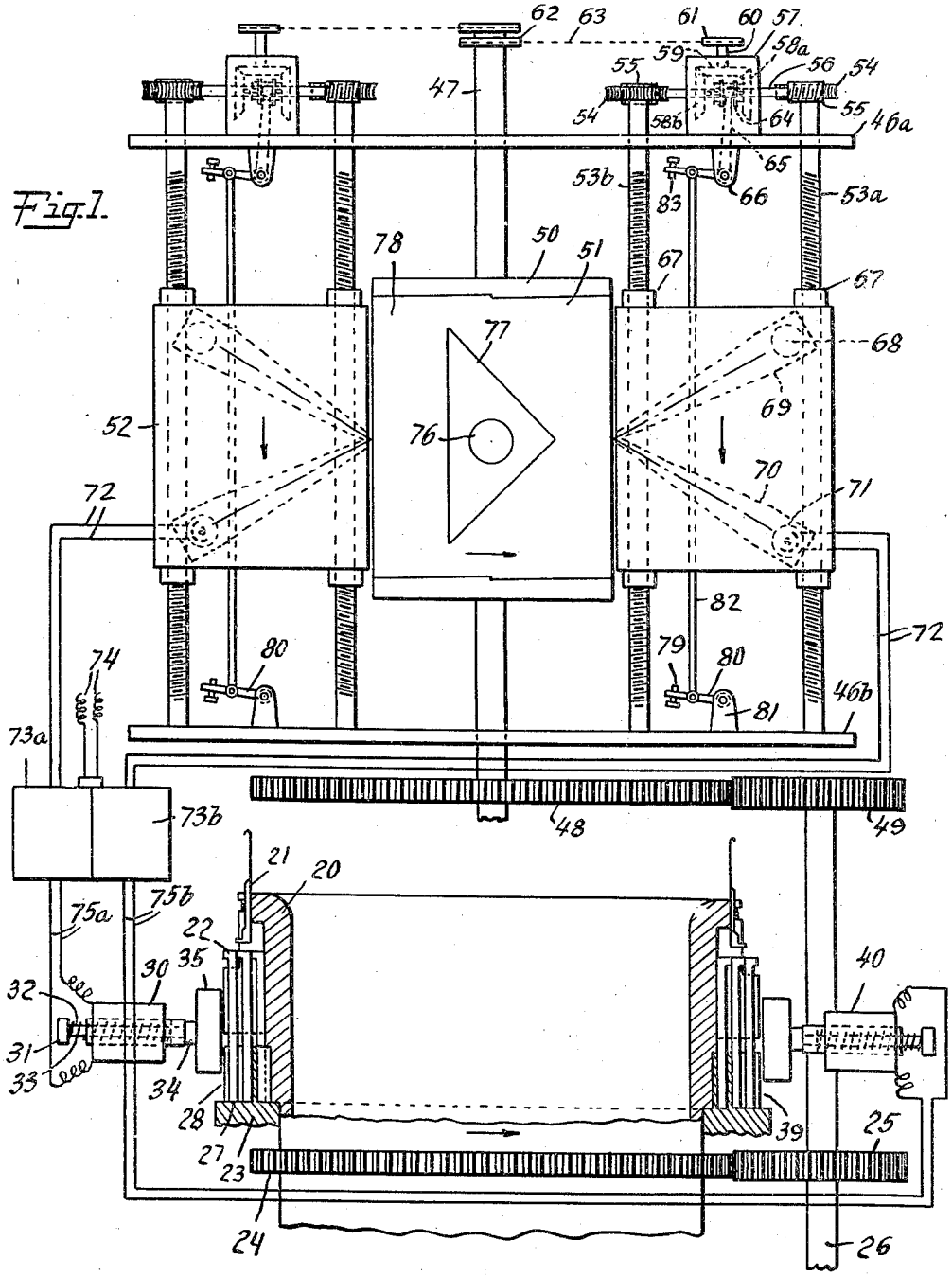
Sept. 19, 1939. W. S. TANDLER ET AL 2,173,488

PATTERN-CONTROL MECHANISM

Filed Sept. 11, 1937 5 Sheets-Sheet 1

Fig. 1.



INVENTORS
William S. Tandler
David Walker
BY Pennie Davis Marvin & Edmonds
ATTORNEYS

Sept. 19, 1939. W. S. TANDLER ET AL 2,173,488

PATTERN-CONTROL MECHANISM

Filed Sept. 11, 1937 5 Sheets-Sheet 2

Fig. 2.

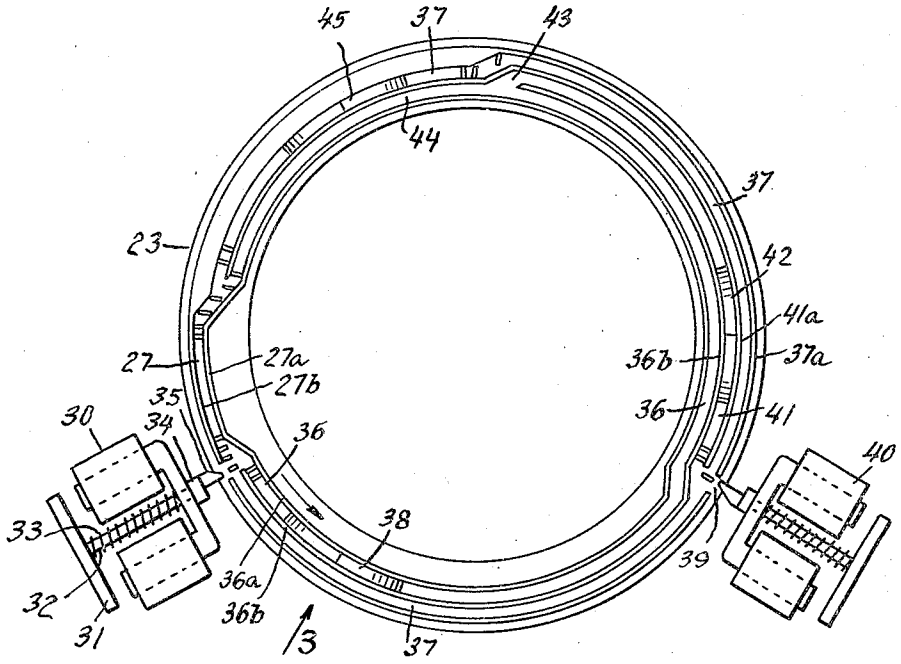
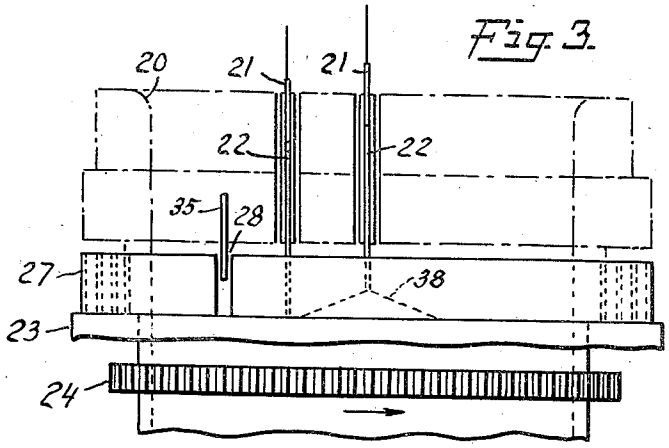


Fig. 3.



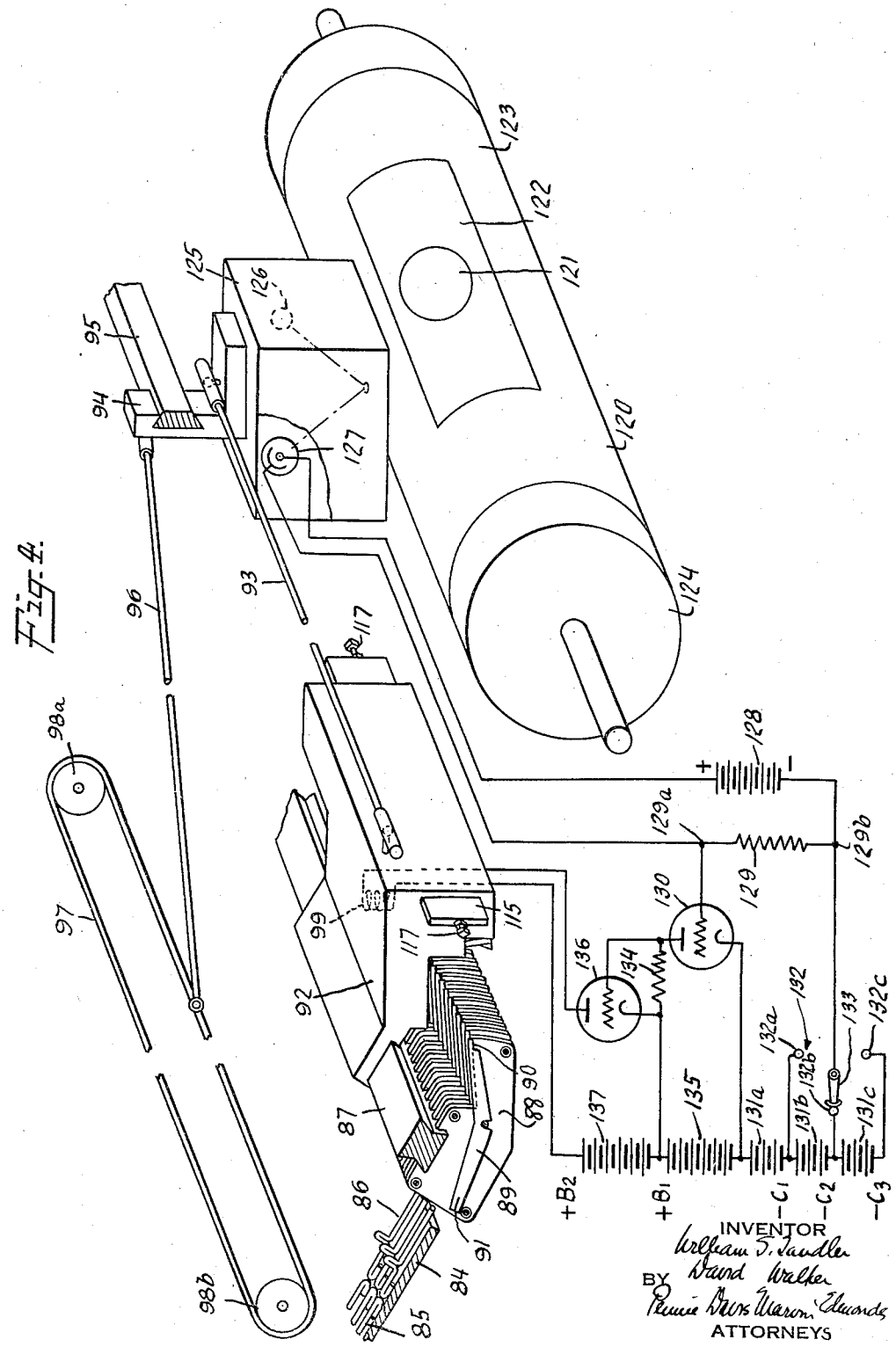
INVENTORS
William S. Tandler
David Walker
BY Pennie Davis Marvin & Edmonds
ATTORNEYS

Sept. 19, 1939. W. S. TANDLER ET AL 2,173,488

PATTERN-CONTROL MECHANISM

Filed Sept. 11, 1937 5 Sheets-Sheet 3

Fig. 4.



INVENTOR
William S. Tandler
David Walker
BY Pennie Davis Marvin & Edmonds
ATTORNEYS

Sept. 19, 1939. W. S. TANDLER ET AL 2,173,488

PATTERN-CONTROL MECHANISM

Filed Sept. 11, 1937 5 Sheets-Sheet 4

Fig. 5.

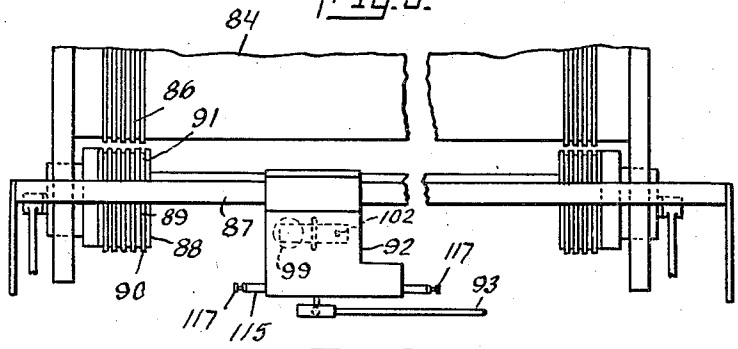


Fig. 6.

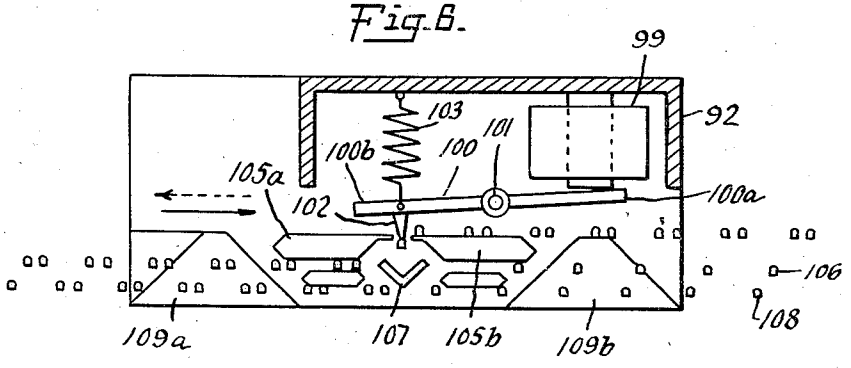


Fig. 7.

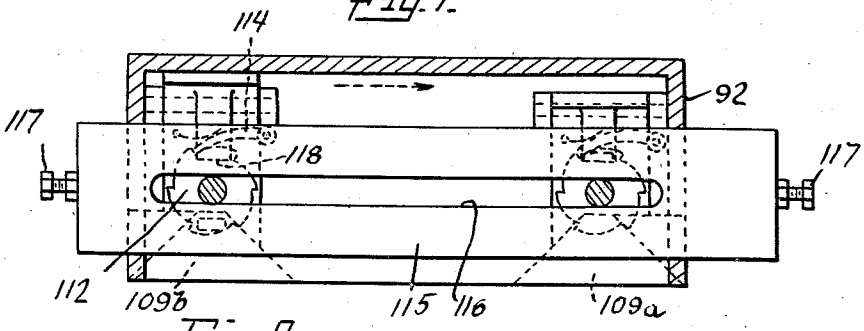
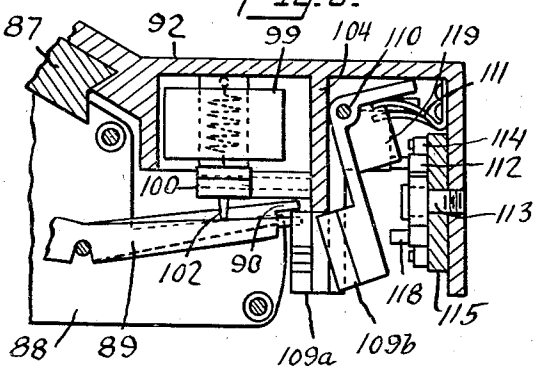


Fig. 8.



INVENTORS
William S. Tandler
David Walker
BY Pennie Davis Marvin & Edwards
ATTORNEYS

Sept. 19, 1939. W. S. TANDLER ET AL 2,173,488

PATTERN-CONTROL MECHANISM

Filed Sept. 11, 1937 5 Sheets-Sheet 5

Fig. 9.

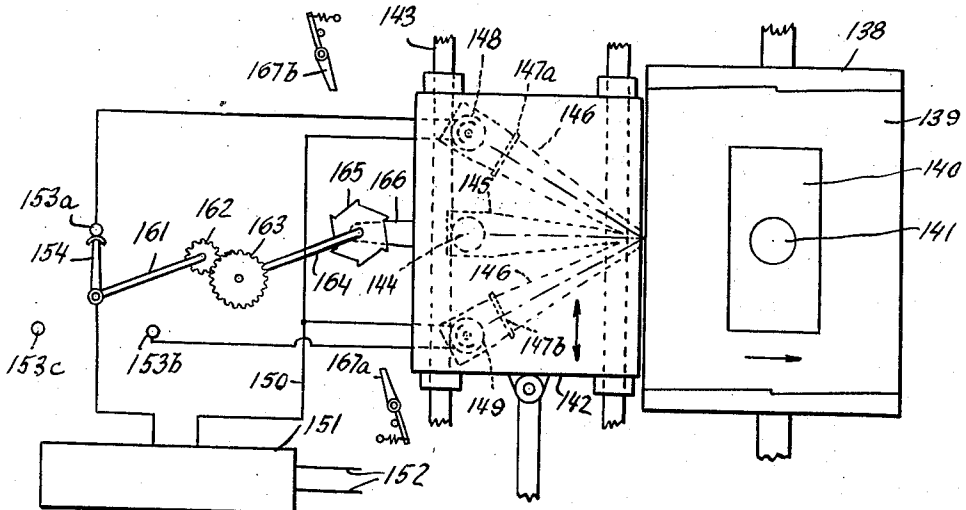
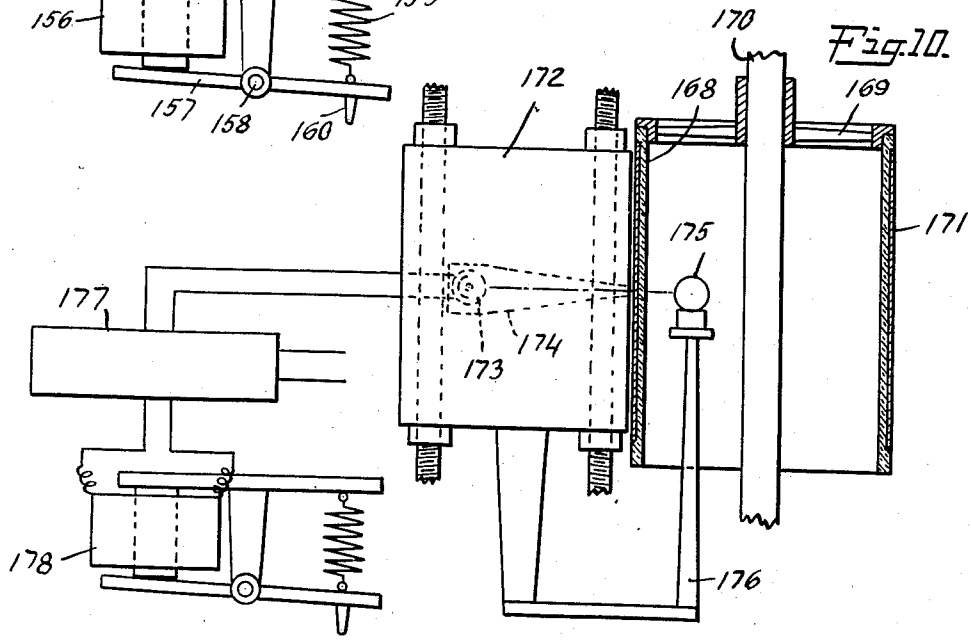


Fig. 10.



INVENTOR
William S. Tandler
BY David Walker
Pennie Davis Marvin & Edmonds
ATTORNEYS

Patented Sept. 19, 1939

2,173,488

UNITED STATES PATENT OFFICE

2,173,488

PATTERN-CONTROL MECHANISM

William S. Tandler, New York, and David Walker, East Elmhurst, Long Island, N. Y., assignors to Lefier Patent Company, Inc., New York, N. Y., a corporation of New York

Application September 11, 1937, Serial No. 163,346

31 Claims. (Cl. 66—50)

This invention relates to mechanisms for controlling the operation of a machine having a plurality of elements to be selectively actuated, examples of such machines being circular and flat bed knitting frames, in which the needles are individually operated, and looms, in which the controlled elements are the heddles. More particularly, the invention is concerned with a novel control mechanism in the operation of which a pattern sheet determines the order of actuation of the controlled elements, the sheet being scanned by scanning means, each controlling the operation of an electromechanical translating device by which the selection of the elements is effected. The control mechanism of the invention, in which the scanning is preferably carried on photoelectrically, may be employed for controlling the operation of machines of various kinds, but since it offers special advantages when used in connection with knitting frames, an embodiment of the principles of the invention suitable for that purpose will be illustrated and described in detail by way of explanation. It is to be understood, however, and will be readily apparent, that the utility of the mechanism is not limited to that specific application.

In circular knitting frames of the usual conventional constructions, it is common practice, when knitting a patterned fabric, to employ control means in the form of trick wheels for controlling the action of the needles knitting stitches of the different threads. While such trick wheels are generally satisfactory, each such wheel is suitable for the reproduction of a single pattern only, and when a change is to be made in the pattern to be reproduced, a new set of trick wheels must be prepared and installed in the frame. To avoid the expense in the use of trick wheels, it has been proposed to substitute pattern control mechanism therefor, one mechanism being used for each thread supply and each mechanism including a pattern sheet and means for scanning the sheet and bringing needles into operation in accordance with the requirements of the pattern carried by the sheet. With control mechanisms of this type, the knitting frame may be shifted from the production of one fabric to another by substitution of appropriate pattern sheets, and the use of the mechanisms consequently effects substantial savings in time and cost.

The present invention is directed to the provision of a pattern mechanism of the kind referred to, which is especially adapted for use in controlling the operation of a machine in accordance with the requirements of a pattern containing areas of several different kinds. Thus, when employed in connection with a knitting frame, the latter may be operated to produce a patterned fabric in which the pattern is made up of design figures of several different colors or stitches and a ground, and the control of the machine is carried on by means of a single pattern sheet instead of a sheet for each different thread supply. The use of a single pattern sheet for controlling the entire operation of the machine not only simplifies the control mechanism, but also makes possible substantial savings in the cost of the equipment and also in the cost of operation, particularly when patterned fabrics of many different kinds are to be produced.

In the various forms of embodiment of the invention, the pattern sheet employed bears a representation of the pattern to be reproduced, made up of control areas of different kinds, as, for example, contrasting colors, which are not necessarily the same as those in the pattern which is to appear in the final product. This sheet is scanned by photoelectric scanners which react differently to the different kinds of areas on the sheet, and each scanner controls an electromechanical selector by which the selection of the elements of the machine which are to be actuated is effected. In an ordinary circular knitting frame, threads from all supplies thereof are knitted simultaneously, and the number of scanners is, therefore, the same as the number of different colored threads being knitted in the design. These scanners may contain cells of different kinds, or different light sources or filters may be used, or cells of the same kind may be employed in different circuits. With a flat bed knitting frame in which stitches of thread from one supply only are knitted at a time, a plurality of wholly separate and complete scanners, one for each thread supply, may be used if desired, but preferably, the scanning is effected by the use of a single photoelectric cell employed with different kinds of light beams or in different circuits to obtain the desired differences in reaction to the control areas on the pattern sheet.

The control mechanism of the invention may be employed to great advantage in connection with circular knitting frames of the type disclosed in the copending application of Tandler, Serial No. 163,345, filed September 11, 1937, since with that frame, the number of scanners required is one less than the number of thread supplies to be controlled. For the same reasons, the mechanism may be advantageously employed in con-

nection with a flat bed frame of the construction disclosed in the copending application of Ruinnet, Serial No. 101,251, filed September 17, 1936. Embodiments of the invention suitable for use with the Tandler and Ruinnet frames are, accordingly, disclosed in the accompanying drawings, in which

Figure 1 is a view in side elevation, with parts shown in section, illustrating one form of the new control mechanism employed in connection with a knitting frame of the Tandler type;

Figure 2 is a plan view of a portion of the knitting machine;

Figure 3 is a view in side elevation of a portion of the knitting machine;

Figure 4 is a view in perspective showing the control mechanism employed in controlling the operation of a flat bed knitting frame of the Ruinnet type;

Figure 5 is a fragmentary plan view of a portion of the knitting machine shown in Figure 4;

Figure 6 is a view, partly in elevation and partly in section, of a part of the control mechanism employed in the machine illustrated in Figure 4;

Figure 7 is a similar view showing other parts of the control mechanism employed in Figure 4;

Figure 8 is a transverse sectional view of the mechanism shown in Figure 7;

Figure 9 is a view, partly in elevation and partly in perspective, of a modified form of the new control mechanism; and

Figure 10 is a view similar to Figure 9, of another modified form of the new mechanism.

Referring to the drawings, the apparatus shown in Figure 1 includes a circular knitting frame of the Tandler type comprising a cylindrical needle bed **20** having vertical slots in its cylindrical surface, in which are mounted a series of needles **21** and associated operating jacks **22** lying in alignment therewith. The jacks rest upon a support **23** on which the bed is also supported and the bed is rotated by means of a girth gear **24** which encircles it and meshes with a pinion **25** on a vertical drive shaft **26**.

The support **23** is provided with a track **27** defined by upright flanges **27*a***, **27*b*** and receiving the lower ends of the jacks, and in the rotation of the bed, the lower ends of all of the jacks move along the track **27** to the point **28** at which the flange **27*b*** is broken away to provide an opening opposite which lies an electromechanical selecting device. This device may take various forms, but in the construction shown, it includes an electromagnet **30** provided with an armature **31** to which is attached a rod **32** encircled by a spring **33**, the spring bearing at one end against the under side of the armature and at the other against a fixed part of the device. The rod is provided with a head **34** which engages a fixed part of the device and limits the movement of the rod by the spring, and attached to the head is a vertical blade **35**. The construction is such that upon energization of the electromagnet, the armature is attracted against the action of the spring and moves the blade **35** through the opening **28** to engage the jack which happens to lie opposite the opening at that moment. Any jack so engaged is shifted so that its lower end passes into a track **36** defined by flanges **36*a***, **36*b***, while the jacks, which have not been shifted, enter a track **37** defined by flange **36*b*** and flange **37*a***. Within the track **36** is a cam hump **38**, and as the jacks are carried along by the rotation of the cylinder, those jacks which have been shifted into the track **36** are raised by the cam to engage and elevate their associated needles so that the latter take part in the knitting operation. As the jacks move down the cam, their needles are restored to inoperative position by an appropriate cam not shown.

The selector **29** thus functions to segregate the jacks and needles into two groups, those which are to become operative in the knitting of stitches of thread from a particular supply, and those which remain inoperative. The jacks of the second group progress through the track **37** to the point **39**, at which the outer flange **37*a*** of the track is broken away to provide an opening opposite which is a second selector **40**. Immediately ahead of the point **39**, the track **36** shifts inwardly and an intermediate track **41** is formed. This track is defined in part by the flange **36*b*** and in part by a flange **41*a***, and it contains a cam hump **42**. At the point **39**, the group of previously inoperative jacks is subdivided into two groups by the action of the selector **40**, and the jacks which are to become operative are shifted into the track **41** where they ride up the cam hump so as to elevate their corresponding needles and cause them to take part in the knitting operation. When this action has been completed, the jacks continue along the track **41** to the point **43** where the tracks **36** and **41** merge, so that beyond this point, the jacks which have been raised by either cam **38** or cam **42** move together along a single track **44**. Beyond the point **43**, the track **37** turns inward slightly to continue in alignment with the track **41** and it contains a cam **45** which raises the jacks so that they cause their associated needles to take part in the knitting. Beyond the cam **45**, the tracks **37** and **44** merge and continue as track **27**.

With the arrangement described, it will be apparent that as the jacks are moved successively into registry with the first selector **29**, the latter may be operated to select the jacks of the needles which are to knit stitches of a particular thread, and the selector acts to segregate the jacks into two groups, those which are to be active, and all the remaining jacks. The jacks of the second group are then presented successively to the second selector **40** where they are subdivided into two groups, the first of which contains the jacks which actuate the needles which are to knit stitches of the second thread. The remaining jacks, which have not been acted on by either of the selectors, are then all raised by the cam **45** and the needles of these jacks knit stitches of the third thread, which is the ground of the pattern.

The control of the selectors **29** and **40** for the purpose referred to is accomplished by means of a single pattern sheet, the details of the control mechanism being illustrated in Figure 1. The mechanism includes a frame comprising upper and lower plates **46*a***, **46*b***, supported in any suitable way and provided with bearings for a vertical drive shaft **47** carrying a gear **48** meshing with a pinion **49** on the drive shaft **26**. The shaft **47** is driven at the same rate of rotation as the needle bed **20**, and it carries a drum **50** on which is mounted a pattern sheet **51** carrying a representation of the pattern to be reproduced in the fabric. The pattern is scanned by two scanning devices which are disposed in the same angular relation with reference to the drum, as the selectors in relation to the needle bed. As illustrated in Figure 2, the selectors are approximately 120° apart and the scanning means have the same relation.

The scanners are of the same general construction and each includes a carriage **52** mounted on screws **53*a***, **53*b***, mounted for rotation in the plates **46*a***, **46*b***, the screws being of opposite pitch and

driven in opposite directions. For this purpose, each screw is provided with a worm gear 54 at its upper end, and the gears are engaged on opposite sides by worms 55 on a shaft 56 which extends through and is supported in bearings in a housing 57 mounted on top of the plate 46a. Within the housing, the shaft 56 is provided with a pair of bevel gears 58a, 58b, which gears are held against movement lengthwise of the shaft but are loose thereon, the gears being in constant mesh with a bevel gear 59 on a vertical shaft 60 mounted in suitable bearings in the top of the housing. The shaft 60 is driven from the shaft 47 by sprocket wheels 61, 62 on the respective shafts, and a chain 63.

The bevel gears 58a, 58b are provided with clutch members on their opposed faces, and splined to the shaft 56 between the gears is a cooperating clutch member 64, which is illustrated as engaged with the clutch member of gear 58a. The clutch member 64 is engaged by one arm 65 of a bell crank pivoted in a bracket 66 depending from the plate 46a, and by rocking the bell crank, the clutch member 64 may be shifted to engage the clutch member of gear 58b. When the clutch member 64 is engaged with the cooperating clutch member of a gear, that gear is held against rotation relative to shaft 56 so that it drives the shaft and the screws 53a, 53b in one direction, and when clutch member 64 is shifted, the direction of rotation of the screws is reversed. The carriage 52 is provided with nuts 67 engaging the screws, and the carriage is raised or lowered, depending upon the direction in which the screws rotate.

Within each carriage 52 is a light source 68 which directs a beam through a passage 69 upon the surface of the pattern sheet, and the beam is reflected from the pattern through a passage 70 to a photoelectric cell 71. The cells of the two carriages are in circuit through lines 72 with amplifiers 73a, 73b, respectively, and current is supplied to the amplifiers from a source through lines 74. The amplifiers supply current through lines 75a, 75b to the selectors 29 and 40, respectively, and the electrical connections are such that amplified current is supplied to each of the selectors in accordance with the reaction of its associated photoelectric cell to the control areas on the pattern sheet.

The pattern sheet carries a representation of the pattern made up of different kinds, for example, contrasting colors, which, of course, need not be the same as those in the fabric, but must, however, be such as to make it possible to obtain different reactions from the cells. Thus, for example, the circular figure 76 in the pattern may be grey, the triangular figure 77 green, and the background 78 black. In that case, current will flow through the photoelectric cell of the scanner for the selector 29 when the beam of the scanner strikes a grey area, and current will flow through the cell of the scanner for selector 40 when the scanner beam strikes both grey and green areas. No current will flow through either cell when their beams strike the black background. Accordingly, as the pattern rotates while the carriages move down, for example, current may be supplied to the selector 29 whenever the photoelectric cell of its scanner receives light reflected from the spot 76, and each time the electromagnet of the selector is energized, its blade moves inward to shift any jack in front of it. If the spot 76 is of substantial size, the electromagnet of the selector may remain energized while several jacks are passing in front of its blade, in which case the blade remains in its inner position and shifts the jacks inward by cam action. At the same time, the selector 40 is receiving energy throughout the period that the photoelectric cell of its scanner is receiving light reflected from figures 76 and 77, but since certain of the jacks have previously been shifted out of cooperative relation with the selector 40 by the action of the first selector, selector 40 acts merely to shift the jacks of needles which are to take part in the knitting of the area 77 lying outside the area 76. Both selectors are idle while their scanners are scanning the background 78.

As the carriages 52 approach the lower end of their path of travel, they engage adjustment screws 79 mounted in levers 80 pivoted on brackets 81 extending upward from the lower plate 46b. Each lever is connected by a rod 82 to one arm of a bell crank 65, and when the levers are swung to the proper extent, they swing the bell cranks and thereby shift the clutch members 64 so as to reverse the direction of rotation of screws 53a, 53b. The carriages then move upward until they strike the adjustment screws 83 in the arms of bell crank levers 65 and restore the clutch members 64 to their initial position, in which they connect gears 58a to their shafts 56 and drive the carriage down again. This automatic reversal of the carriages may be omitted if desired, in which event, the frame is stopped and the carriages restored manually to initial position when the sheet has been scanned along a helical track from top to bottom or vice versa.

With the circular knitting frames described, which is of the Tandler construction, the number of selectors, each controlled by its own scanner, is one less than the number of different thread supplies in each group, and the scanners are so constructed that their photoelectric cells react differently to light reflected from the different kinds of areas on the pattern sheet. In an ordinary circular knitting frame, it is necessary to employ as many selectors and scanners as there are different thread supplies in a group, and the scanners are equipped with cells of different types or other expedients are employed to obtain differences in reaction relative to the different kinds of areas on the pattern sheet.

In a flat bed knitting frame, in which the needles knit a row of stitches first of one color and then of another, separate scanning means, one for each color and each complete in itself, may be employed, but preferably, the several scanners make use of a single cell and means are provided to vary the reaction of the cell depending on the kind of thread, the knitting of which is being controlled at a given time. With a Ruinnet flat bed frame, one less scanner may be used than the number of different threads being supplied to the needles.

A control mechanism suitable for use with a frame of the Ruinnet type is illustrated in Figures 4 to 8, inclusive, and this frame includes a needle bed 84 on which needles 85 with corresponding jacks 86 are mounted in parallel slots, the jacks projecting out beyond the edge of the bed. A bar 87 extending parallel to the bed at one side thereof supports a plurality of plates 88 between each pair of which is a pivoted lever 89. Each lever has a tail 90 which extends out beyond the rear edges of the plates 88, and means are provided for shifting the levers selectively to positions in which their forward ends

91 lie in alignment with associated jacks. When the levers have been thus selectively positioned, the bar 87 is moved toward the needle bed and the selected levers engage their associated jacks and move them and their related needles to a position in which the needles take part in the knitting operation.

The selecting mechanism includes a carriage 92 in the form of a housing mounted on the bar 87 and movable lengthwise thereof by a rod 93 connected to a block 94 which is mounted for reciprocating movement on a bar 95. The block is connected by an arm 96 to a chain 97 trained about sprocket wheels 98a, 98b which are driven in timed relation to the operation of the frame.

Within the housing 92 is a selecting device which includes an electromagnet 99, the armature 100 of which has the form of a lever pivoted at 101 and having an end 100a lying adjacent to the electromagnet. The other end 100b of the lever is provided with a stud 102, and a spring 103, connected to the housing and to the lever adjacent the end 100b, holds the lever in a position in which its end 100a lies remote from the electromagnet. The tails 90 of the levers 89 lie in such position that as the housing 90 is moved along the bar 87, the rocking of lever 100 upon energization of the electromagnet 99 will cause the stud 102 to strike the tail of any lever 89 which lies beneath the stud at the moment of energization and shift the tail downward. If the stud is in downward position as it moves into contact with a tail, the tail will be moved down by the cam action of the stud.

The housing 92 is provided with a vertical partition 104 on which are mounted a pair of cams 105a, 105b, and these cams have opposed sloping faces at their ends. As the housing advances, the tail of any lever which is engaged by the stud 102 and shifted downward is engaged by one of the opposing surfaces of the cams and is moved down until the tail lies in a row 106.

At the beginning of operation of the frame, the levers 89 are all in a position in which their tails 90 lie at the top of the plates 88, and after the first traverse of the housing 92, certain of the levers will have been shifted so that their tails lie in the row 106. Upon movement of the bar 87 toward the needle bed, the shifted levers engage their associated jacks and move the jacks and their related needles so as to cause the needles to take part in the knitting of stitches of thread from one supply. When the row of stitches has been completed, the housing 92 starts back along bar 87, and during this movement, the tails of levers whose needles have previously been active are moved to inactive position, and the levers of the desired needles of the previously inactive group are shifted so that their tails lie in the line 106. To move the previously selected levers out of the line 106, the partition 104 carries a double cam 107 which engages the tails of all levers in the row 106 and moves them to a lower row 108. The front ends 91 of levers whose tails are in the line 108 lie above their associated jacks so that they will not engage the jacks when the bar 87 is shifted toward the needle bed.

During the second traverse of bar 87 by the housing 92, a selection is made of the needles which are to take part in the knitting of stitches of the second color, and after this row of stitches is completed, a row of stitches of the ground color is to be formed. For this purpose, all of the levers 89 which have not been shifted in the two previous selecting operations are now engaged by stud 102 of the selecting device, actuated as will be later described, and their tails forced into the line 106, while the levers whose needles knitted the second color are shifted into the line 108. At the completion of the row of ground stitches, all the levers must be restored to their initial position, and for this purpose, a pair of cams 109a, 109b are provided.

Each of the cams 109a, 109b is mounted on the end of a bell crank pivoted on the housing at 110, and one arm of each bell crank is acted on by a spring 111 so as to swing the cam away from an opening through the partition 104. When the bell crank of either cam is swung clockwise (Figure 8) against the action of its spring, the cam extends through the opening, and when in this position, the cam is effective to engage the tails of levers in the rows 106, 108 and restore these levers to their initial position. The apparatus illustrated is appropriate for the knitting of a fabric containing two colors in the design plus a ground color, so that one or the other cams 109a, 109b comes into action each time the carriage 92 has made three traverses of the bar 87, corresponding to the knitting of three rows of stitches.

To avoid the necessity of having the carriage 92 traverse the group of levers 89 for restoration purposes only, that one of the cams 109a, 109b which lies in advance of the stud 102 in the direction of movement of the carriage 92 is brought into action when the carriage is making a traverse in connection with the selecting operation for the first color. To bring the cams into operation in this manner, a ratchet wheel 112 for each cam is mounted on a stud 113 threaded into a wall of housing 92, and this wheel is engaged by a spring pressed pawl 114 mounted on a plate 115 having a slot 116 through which the studs 113 pass. The plate extends out beyond the ends of the housing and is provided at its ends with adjustment screws 117, and as the carriage 92 advances to the end of its movement in either direction, one or the other of the adjustment screws strikes a fixed part of the frame and shifts the plate 115. During the movement of the plate to the left (Figure 7), the pawls 114 carried by the plate advance their ratchet wheels 112 by one tooth. Each ratchet wheel is provided with a cam projection 118 on its inner face, the cam projections of the two ratchet wheels being 180° apart, and each projection is arranged to engage a lug 119 attached to the bell crank of a cam 109a, 109b. When a projection engages the lug of its associated cam, the cam is moved to its operative position in which its end extends through the opening in the partition 104, and in this position, the cam engages the tails of all levers in the lines 106, 108 and restores these levers to their initial position as the carriage 92 advances. By forming the ratchet wheels 112 with six teeth, each cam comes into action every six traverses of the carriage 92, and since the lugs 118 on the ratchet wheels are 180° apart, one or the other of the cams is active every three traverses of the carriage 92.

The supply of current to the electromagnet 99 is controlled by a pattern sheet 120 bearing a representation of the pattern to be reproduced in areas of different kinds, such as in contrasting colors, and the sheet illustrated carries a pattern including a circular figure 121 which may be grey, a rectangular figure 122 which may be green, and a background 123 which may be black. The sheet is mounted on a roller 124 which is advanced with

a stepwise rotation, one step for each three traverses of the carriage 92, and the pattern is scanned by a scanning mechanism which includes a housing 125 mounted on block 94 and movable across the pattern sheet in synchronism with the housing 92.

The scanning mechanism includes a source of light 126 within the housing 125 and directing a beam upon the surface of the sheet, and the beam reflected from the sheet strikes a photoelectric cell 127. Three different electric circuits including the cell are provided, and these circuits plus the cell and source of light may be considered as constituting three different scanning means. The circuits have different constants such that when the cell is in one circuit it will react to grey, when the cell is in the second circuit, it will react to both grey and green, and when the cell is in the third circuit there is no reaction of the cell to any of the colors.

The cell is connected in series with a source of current 128 and a resistor 129, the one terminal 129a of which is connected to the grid of an amplifier tube 130. The cathode of the tube is connected to the positive terminal of a source of potential here shown as made up of three batteries 131a, 131b, and 131c, connected in series. Corresponding terminals of these batteries are connected, respectively, to contacts 132a, 132b, 132c, of a switch 132 having a moving contact arm 133, the arm being connected to the terminal 129b of the resistor. The grid-cathode voltage of the tube consists of the algebraic sum of the voltage drop across resistor 129, which constitutes the signal input to the tube, and the voltage between the positive terminal of battery 131a and the moving contact arm 133. The value of the grid-cathode voltage, therefore, depends on which of the stationary contacts, the arm engages at a particular time.

The plate of tube 130 is connected through a resistor 134 to the positive terminal of a source 135, the negative terminal of which is connected to the positive terminal of battery 131a and to the cathode of the tube. The grid of a second amplifier tube 136 is connected to one terminal of resistor 134 and to the plate of tube 130 and the cathode of tube 136 is connected to the other terminal of resistor 134, the positive terminal of source 135, and the negative terminal of a source 137. The positive terminal of source 137 is connected through electromagnet 99 to the plate of tube 136.

In the operation of the scanning mechanism in connection with a pattern sheet having control areas thereon of three different kinds, such as three different colors, the photoelectric cell current has one or another of three different values depending upon the control area being scanned at a particular instant. Similarly, the voltage across resistor 129, which constitutes the signal input to the amplifier tube 130, has three different values which may be considered to correspond to the respective colors on the pattern sheet. The effect of these voltages on the selector depends upon the setting of the switch 132; thus, if the three voltages across resistor 129 are assumed to have relative magnitudes of +1, +2, and +3, respectively, and battery 131a has a voltage of −2, it will be apparent that when the arm 133 of switch 132 is engaged with contact 132a, the grid-cathode potentials of tube 130, will be respectively, −1, 0 and +1. The tube used is one having sharp cut-off characteristics, as, for example, at a grid-cathode potential of −1, and, accordingly, no current will flow through the tube when control areas of the first color are being scanned, but will flow when the areas are of the second and third colors. If the arm 133 is engaged with contact 132b and battery 131b has a voltage of −1, the total counter-voltage applied by the batteries 131a, 131b will be −3, and the grid-cathode potentials will then be −2, −1, and 0. In this case, current will flow through the tube only when the third color is being scanned. If the arm 133 is engaged with contact 132c and the battery 131c has a voltage of −1, the total counter-voltage applied by the three batteries will be −4, and in that case, no current will flow through the tube 130.

Plate current of tube 130 passing through resistor 134 will make the grid of tube 136 sufficiently negative to cut off its plate current. Therefore, tube 136 only supplies current to electromagnet 99 when no current is flowing through tube 130. When switch arm 133 is engaged with contact 132a, current will flow through tube 130 while the second and third colors are being scanned but on the first color, tube 130 will be cut off. Accordingly, tube 136 which is biased by tube 130 passes current energizing electromagnet 99 only when the first color is scanned. And similarly when the switch arm is engaged with contact 132b, the electromagnet will be energized when control areas of the first and second colors are being scanned. When the arm 133 is on contact 132c, no current flows through tube 130 and the electromagnet receives current continuously from tube 136.

With the Ruinnet frame, the levers 89 associated with the needles which are to knit stitches of the first color are moved out of operative position by cam action just prior to the operation of selecting the needles to knit stitches of the second color. Accordingly, although in the second selecting operation, the selector is energized to select levers of needles for knitting stitches of both the first and second colors, the selector is effective only with respect to the levers of needles to knit the second color. In the third operation of the frame, all the needles which have not knitted stitches of the first and second colors are to knit stitches of the third or ground color. The electromagnet is then continuously energized so that the stud of its armature cams all the remaining levers 89 into effective position.

The movable arm 133 of switch 132 is shifted from one stationary contact to the other by suitable means in timed relation to the operation of the knitting frame. This movement occurs between successive traverses of the pattern sheet for scanning purposes.

As previously pointed out, the differences in the reaction of the scanning means to the different kinds of control areas on the pattern sheet may be obtained by the use of photoelectric cells of different characteristics, or by using the same kind of cells in different circuits. Another expedient that may be employed for the purpose involves the use of light beams of different kinds, and such differences in the beams may be obtained either by using light sources of different kinds or by employing light filters of different kinds. A scanning mechanism in which filters are used is illustrated in Figure 9, this mechanism being of a form suitable for use in a flat bed knitting frame.

The mechanism illustrated in Figure 9 includes a drum 138 on which is mounted a pattern sheet 139 bearing a representation of a pattern having a background of one kind, figures, such as the

rectangular figure 140, of a second kind, and figures, such as the circular figure 141, of a third kind. The drum 138 is advanced with a step by step movement and, in each period of rest, it is traversed three times by the scanning mechanism which includes a housing 142 mounted on rods 143 and moved back and forth parallel to the axis of the drum by appropriate means. Within the housing is a light source 144 from which a beam is directed through a passage 145 upon the sheet, and rays reflected from the sheet pass through passages 146 containing different light filters 147*a*, 147*b*, respectively, to photoelectric cells 148, 149. Similar elements of the cells are connected in parallel through a line 150 to an amplifier 151 supplied with current through power lines 152, and the other elements of the cells are connected, respectively, to stationary contacts 153*a*, 153*b* of a switch which includes a blank contact 153*c* and a movable contact arm 154. Amplified current is supplied from the amplifier through lines 155 to the electromagnet 156 of a selecting device similar to that employed in the control mechanism illustrated in Figures 4 to 8, inclusive. This selecting mechanism includes an armature in the form of a lever 157 pivoted at 158, one end of the armature lying adjacent to the electromagnet while the other end is acted on by a spring 159 and carries a stud 160.

The movable arm 154 of the switch is mounted on a shaft 161 having a gear 162 meshing with a gear 163 on a shaft 164, provided with a ratchet wheel 165, the shaft 164 being mounted in a suitable support 166 attached to the carriage 142. A pair of pawls 167*a*, 167*b* are mounted on the fixed part of the knitting frame in position to engage the ratchet wheel 165, and at the end of each traverse of the carriage 142 relative to the pattern sheet, the ratchet wheel 165 is engaged by one or the other of the pawls and advanced one tooth. This causes the arm 154 to shift from one of the contacts 153*a*, 153*b*, 153*c* to the next.

In the operation of the device, as the carriage 142 starts at one edge of the pattern sheet, the arm 154 is engaged with one of the stationary contacts, for example, contact 153*a*. The cell 148 is then connected to the amplifier, and the cell current, which varies in accordance with the control areas being scanned, operates through the amplifier to actuate the selecting mechanism. At the end of the first traverse of the pattern sheet by the scanning mechanism, the arm 154 is shifted to the next contact, for example, contact 153*b*, and during the second traverse of the sheet by the scanning mechanism, the cell 149 is in operation. At the end of the second traverse, the arm 154 is shifted to the blank contact and both cells are out of operation.

In the different forms of pattern control mechanism above described, the photoelectric cells react to light reflected from different kinds of areas on the pattern sheet and the differences in the control areas may be obtained by making the areas of different color or by giving them different reflection factors in some other way. Thus, for the latter purpose, the sheet may be of metal having areas which are oxidized, polished, and sand-blasted, respectively, so that the three different kinds of areas reflect light with different degrees of efficiency. Instead of employing a pattern sheet which reflects light, the desired effects may be obtained with a sheet through which light is transmitted with different intensities for the different areas. A control mechanism suitable for use in connection with a light transmitting pattern sheet is illustrated in Figure 10 and it consists of a drum 168 of transparent material carried by a circular support 169 attached to a shaft 170. Mounted on the surface of the drum is a transparent pattern sheet 171 bearing a representation of the design in which the different colors in the figures and background are represented by appropriately shaped areas of coloring matter of different light transmitting power.

Mounted adjacent the drum is a scanning mechanism which includes a housing 172 which is moved lengthwise of the drum, and within this housing is a photoelectric cell 173, which receives light through a passage 174, the light entering the passage being that which has been emitted by a source 175 and has passed through the drum and pattern sheet. The source 175 is mounted on a support 176 which extends into the open end of the drum and is attached to the housing 172. The cell is connected in the usual way to an amplifier 177 which supplies current in accordance with the requirements of the pattern to the electromagnet 178 of a selecting device.

In all forms of the mechanism of the invention, the selectively operable elements of the machine with which the mechanism is employed are controlled in accordance with the requirements of a pattern having control areas of several different kinds thereon, and the mechanism includes a plurality of scanning means which scan the pattern along a single track. In the case of a pattern mechanism employed with a circular knitting frame, the several scanning means operate simultaneously, and scan the pattern along a single helical track. With a flat bed frame, the different scanning means operate at different times, but in a cycle in which all the means operate, the sheet is at rest and all the means scan the same straight track on the sheet. Accordingly, the new control mechanism permits the use of a sheet which carries a representation of the pattern which may be an actual facsimile of the pattern to be produced on the final product, at least with respect to the shape of the design areas thereon. The preparation of a pattern sheet for the new mechanism is, therefore, a simple operation, since it is not necessary to magnify, distort, or otherwise alter the pattern as it appears on the sheet in order to effect the desired control of the machine. Preferably, the same colors are employed on the sheet regardless of those to appear in the product of the controlled machine, and this further facilitates the use of the control mechanism.

When used with ordinary machines, such as circular and flat bed knitting frames of conventional construction, or with looms, the control mechanism will include a scanning means for each of the different kinds of control area on the pattern sheet. Since the Tandler and Ruinnet knitting frames permit the same control to be achieved by the use of one less scanning means than the number of colors in the pattern on the fabric, those frames are preferably employed with the new control mechanism. The utility of the mechanism is not limited, however, to its use in connection with any particular machine, and, similarly, the two knitting frames are not dependent for their use upon control mechanism of the construction herein disclosed.

While the apparatus of the invention has been described principally in connection with the control of a knitting frame producing a patterned fabric containing threads of different colors, it is

to be understood and will be readily apparent that it may also be used in controlling the production of a fabric in which the pattern is formed by knitting stitches of different types. In both cases, the new apparatus determines which of the needles will take part in the knitting of the thread from a particular feed, and the selection of the needles is under the control of a pattern scanned by the means described.

We claim:

1. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet having a single pattern track made up of control areas of different kinds, a plurality of scanning means scanning said track successively, said means reacting differently to the different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one for each kind of control area.

2. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet having a single pattern track made up of control areas of different kinds, a plurality of scanning means scanning said track successively, said means reacting differently to the different kinds of control areas, means for segregating the elements into groups, one for each kind of control area, said means including an electromechanical translating device, and means controlled by said scanning means for supplying current to the device to actuate the latter.

3. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet having a single pattern track made up of control areas of different color, a plurality of photoelectric scanning means scanning said track successively, said means reacting differently to the different kinds of control areas, and means controlled by the scanning means for separating the elements into groups, one for each color of the control areas.

4. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet having a single pattern track made up of control areas of different color, a plurality of photoelectric scanning means scanning said track successively, said means reacting differently to the different kinds of control areas, means for segregating the elements into groups, one for each kind of control area, said means including an electromechanical translating device, and means controlled by the scanning means for supplying current to the device to actuate the latter.

5. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet having a single pattern track made up of control areas of different kinds, a plurality of scanning means scanning said track successively, said means reacting differently to the different kinds of control areas, and means controlled by the scanning means for shifting the elements between operative and inoperative positions and thereby segregating them into groups, one for each kind of control area.

6. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet having a single pattern track made up of control areas of different color, a plurality of photoelectric scanning means scanning said track successively, said means reacting differently to the different kinds of control areas, and means controlled by the scanning means for shifting the elements between operative and inoperative positions and thereby segregating them into groups, one for each kind of control area.

7. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a plurality of scanning means, one less in number than the number of kinds of control areas on the sheet, said means scanning the sheet successively and reacting differently to the different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one group for each kind of control area.

8. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a plurality of scanning means, one less in number than the number of kinds of control areas on the sheet, said means scanning the sheet successively and reacting differently to the different kinds of control areas, means for segregating the elements into groups, one group for each kind of control area, said means including an electromechanical translating device, and means controlled by said scanning means for supplying current to said device to actuate it.

9. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a plurality of photoelectric scanning means scanning said sheet successively, said means reacting differently to the different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one group for each kind of control area.

10. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different light reflecting power, a plurality of photoelectric scanning means scanning said sheet successively, said means reacting differently to light reflected from the different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one for each kind of control area.

11. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds arranged in a single track, a plurality of scanning means scanning said track simultaneously at successive points along it, said means reacting differently to the different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one group for each kind of control area.

12. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds arranged in a single

track, a plurality of photoelectric scanning means scanning said track simultaneously at successive points along it, said means reacting differently to the different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one group for each kind of control area.

13. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds arranged in a track, a plurality of scanning means scanning the track simultaneously at different points along it, said means being one less in number than the number of different kinds of control areas and reacting differently to the different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one for each kind of control area.

14. A pattern control mechanism for use in controlling the operation of a knitting frame containing a plurality of needles and control elements therefor arranged in a circular series, said mechanism comprising a pattern sheet of cylindrical form bearing control areas of different kinds arranged thereon to form a track, a plurality of scanning means simultaneously scanning the track at different points along it, said means reacting differently to the different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one group for each kind of control area, said means including a plurality of selecting devices disposed in spaced relation relative to the circular series of needles, the angular spacing of the scanning means with reference to the pattern sheet being the same as the angular spacing of the selecting devices with reference to the needles.

15. A pattern control mechanism for use in connection with a knitting machine having a plurality of needles arranged in a circular series for rotary movement, said mechanism comprising a cylindrical pattern sheet bearing control areas of different kinds arranged to form a track, a plurality of scanning means scanning the track simultaneously at points spaced along it, said means reacting differently to the different kinds of control areas, means controlled by the scanning means for segregating the elements into groups, one for each kind of control area, said means including a plurality of selecting devices, each controlled by a scanning means, and said devices having an angular spacing with reference to the series of needles which is the same as the angular spacing of the scanning means with reference to the pattern sheet, and means for rotating the pattern sheet and series of needles in synchronism.

16. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet made up of control areas of at least three different kinds arranged in a track, a plurality of photoelectric scanning means scanning said track successively, the number of said scanning means being one less than the number of different kinds of control areas, and said scanning means reacting differently to the different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one group for each kind of control area.

17. A pattern control mechanism for use in connection with a knitting frame having a plurality of needles and actuating elements therefor arranged in a circular series, said mechanism including a pattern sheet having a single pattern track made up of control areas having at least three different light reflecting powers, a plurality of photoelectric scanning means scanning said track simultaneously at different points along it, said means reacting differently to the different kinds of control areas, the number of said means being one less than the number of different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one for each kind of control area.

18. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a plurality of means scanning said sheet successively and containing photoelectric cells, means for causing light beams to be directed from said areas upon said cells, the latter reacting differently to the beam from the different areas, and means controlled by the scanning means for segregating the elements into groups, one group for each kind of control area.

19. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a plurality of means scanning said sheet successively, said means including photoelectric cells, and a plurality of different light sources causing light beams of different kinds to be directed upon said areas and thence upon said cells, said cells reacting differently to the light from the different areas, and means controlled by the scanning means for segregating the elements into groups, one group for each kind of control area.

20. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a plurality of means scanning said sheet successively, said means including photoelectric cells and means of different kinds associated with the respective cells for directing light beams upon the pattern sheet to be reflected to said cells, said cells reacting differently to the beams from different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one for each kind of control area.

21. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a plurality of means scanning said sheet successively, said means including photoelectric cells, means for directing a light beam upon said sheet to be reflected to said cells, and a color filter through which the beam for each cell passes, and means controlled by the scanning means for segregating the elements into groups, one for each kind of control area.

22. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a plurality of means scanning said sheet successively, said scanning means reacting differently to the different kinds

of control areas and each means including a circuit containing a photoelectric cell, said circuits having different constants whereby the cells are of different sensitivity, and means controlled by the scanning means for segregating the elements into groups, one for each kind of control area.

23. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a plurality of means scanning said sheet successively, said scanning means reacting differently to the different kinds of control areas, each means including a circuit containing a photoelectric cell, said circuits having different constants whereby the cells are of different sensitivity, an amplifier tube controlled by said circuits, and means receiving current from the amplifier tube for segregating the elements into groups, one for each kind of control area.

24. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet made up of control areas of different kinds, a plurality of means scanning said sheet one at a time in succession, said means reacting differently to the different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one for each kind of control area.

25. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds arranged in a single track, a plurality of scanning means reacting differently to the different kinds of areas, said means scanning the sheet one at a time in sequence, the number of scanning means being one less than the number of kinds of control areas, and means controlled by the scanning means to segregate the elements into groups, one for each kind of control area.

26. A pattern control mechanism for use in connection with a machine to be selectively actuated, said mechanism comprising a pattern sheet made up of control areas of different kinds, a plurality of means scanning said sheet one at a time in sequence, said means reacting differently to the different kinds of control areas, each means including a photoelectric cell, and a source of light for directing a beam upon said sheet, and therefrom upon the several cells, and means controlled by the scanning means for segregating the elements into groups, one for each kind of control area.

27. A control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a source of light directed upon the sheet, an amplifier tube, a plurality of means responsive to light from the areas on the sheet, each means including a circuit containing a photoelectric cell, the circuits being connected to the tube and varying the grid-cathode potential thereof in accordance with variations in the light from said areas, and electrical means controlled by the tube and operating to segregate the elements into groups, one for each kind of control area.

28. A control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a source of light directed upon the sheet, an amplifier tube, a plurality of means responsive to light from the areas on the sheet, each means including a circuit containing a photoelectric cell, the circuits being connected to the tube and varying the grid-cathode potential thereof in accordance with variations in the light from said areas, a second tube connected to the first tube, the output of the second tube being controlled by the first tube, and electrical means controlled by the second tube and operating to segregate the elements into groups, one for each kind of control area.

29. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a plurality of means for scanning said sheet, each scanning means including a circuit containing a photoelectric cell, the circuits having different constants whereby the scanning means are of different sensitivity and react differently to the different kinds of control areas, and means controlled by the scanning means for segregating the elements into groups, one for each kind of control area.

30. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet bearing control areas of different kinds, a plurality of means for scanning said sheet, each means including a circuit containing a photoelectric cell, the circuits having different constants whereby the scanning means are of different sensitivity and react differently to the different kinds of control areas, means for amplifying the current flowing through said circuits, and means for receiving current from the amplifying means for segregating the elements into groups, one for each kind of control area.

31. A pattern control mechanism for use in connection with a machine having a plurality of elements to be selectively actuated, said mechanism comprising a pattern sheet made up of control areas of different kinds, a plurality of means for scanning said sheet, each means including a circuit containing a photoelectric cell, an amplifier tube, and means for impressing a grid-cathode potential on the tube, said means in the different circuits impressing different potentials whereby the several scanning means react differently to light reflected from the pattern sheet, and electrical means controlled by the tube and operating to segregate the elements into different groups.

WILLIAM S. TANDLER.
DAVID WALKER.