

[54] **CONTROL ARRANGEMENT FOR A FLAT KNITTING MACHINE**

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[57] **ABSTRACT**

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A multiplicity of electrically actuated operating elements in a flat knitting machine is controlled by punched cards having only a limited number of tracks and a corresponding reading station in which sensing switches generate control signals in response to card movement. A system of logic elements is arranged in a circuit between the sensing switches and the operating elements in such a manner that control signals generated by the relatively few switches cause an entire group of operating elements, more numerous than the sensing switches, to be actuated either simultaneously or in timed sequence.

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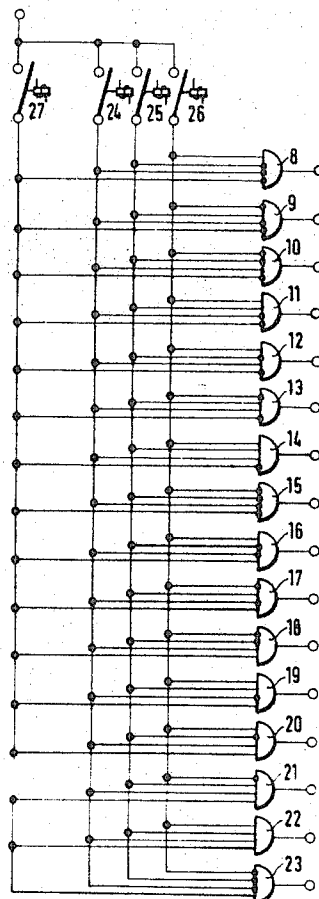
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4 Claims, 8 Drawing Figures



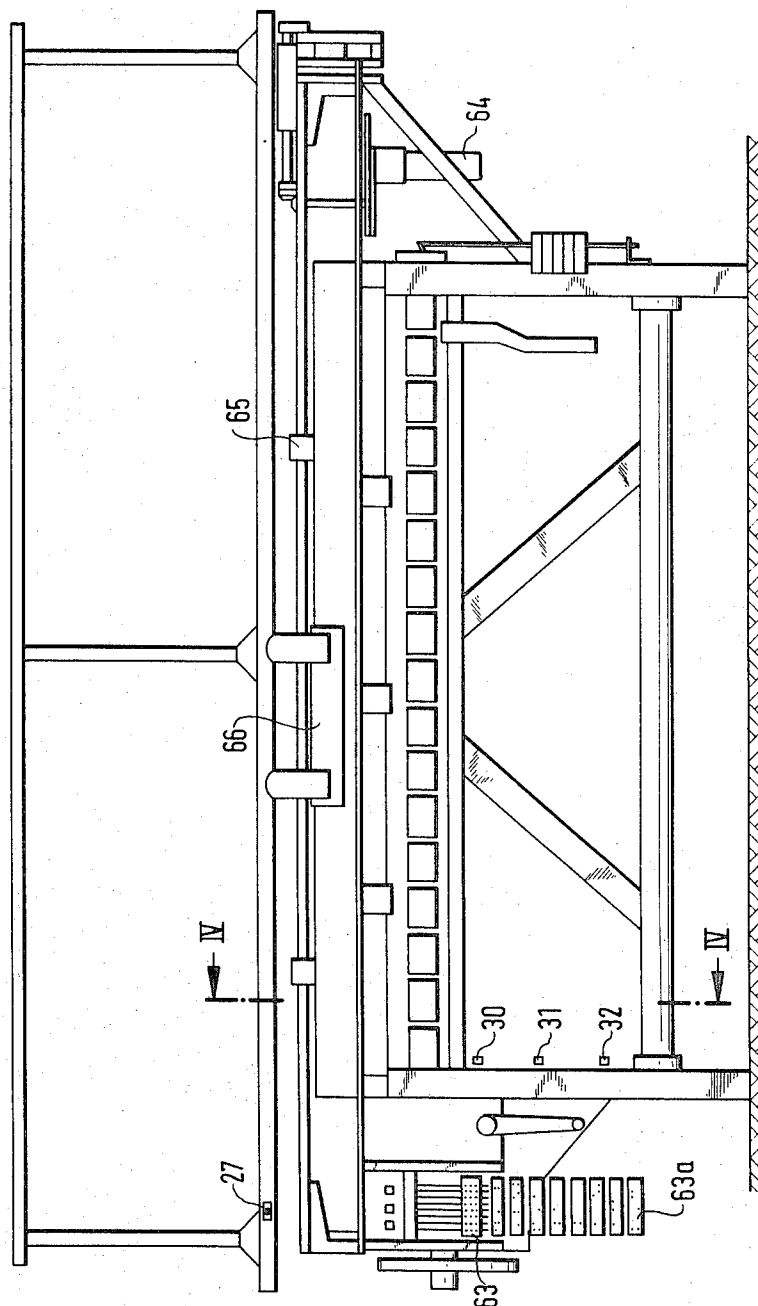


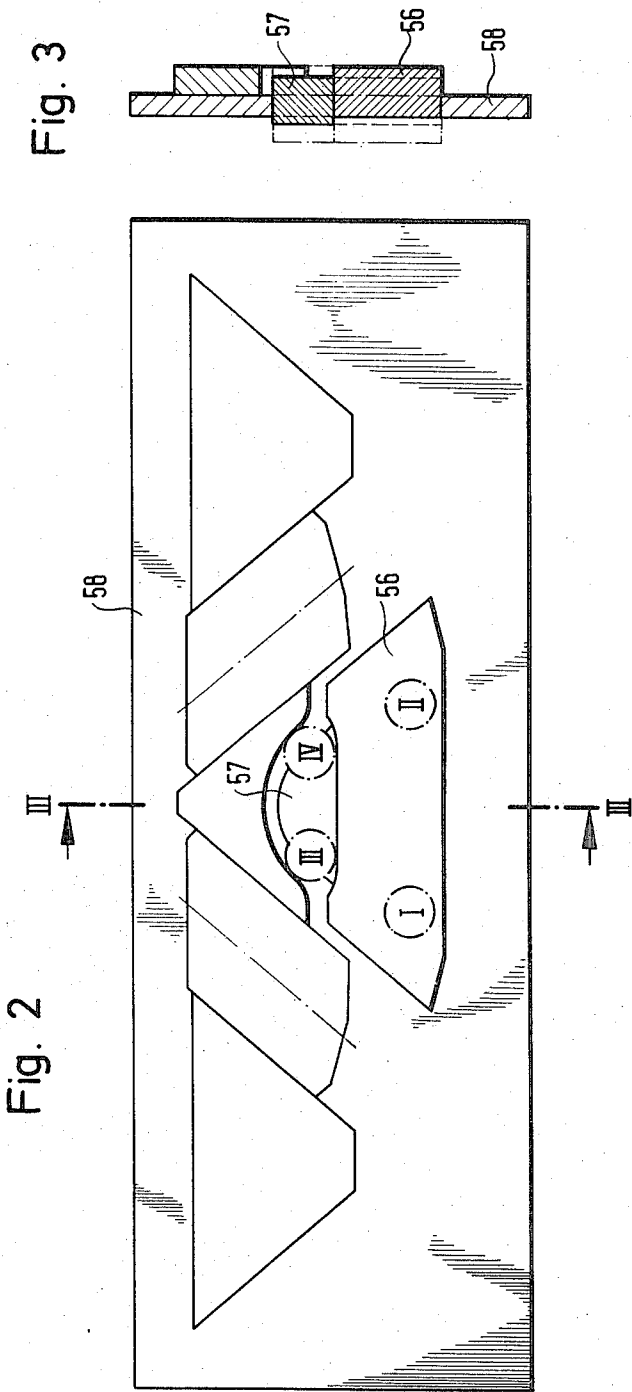
Fig. 1

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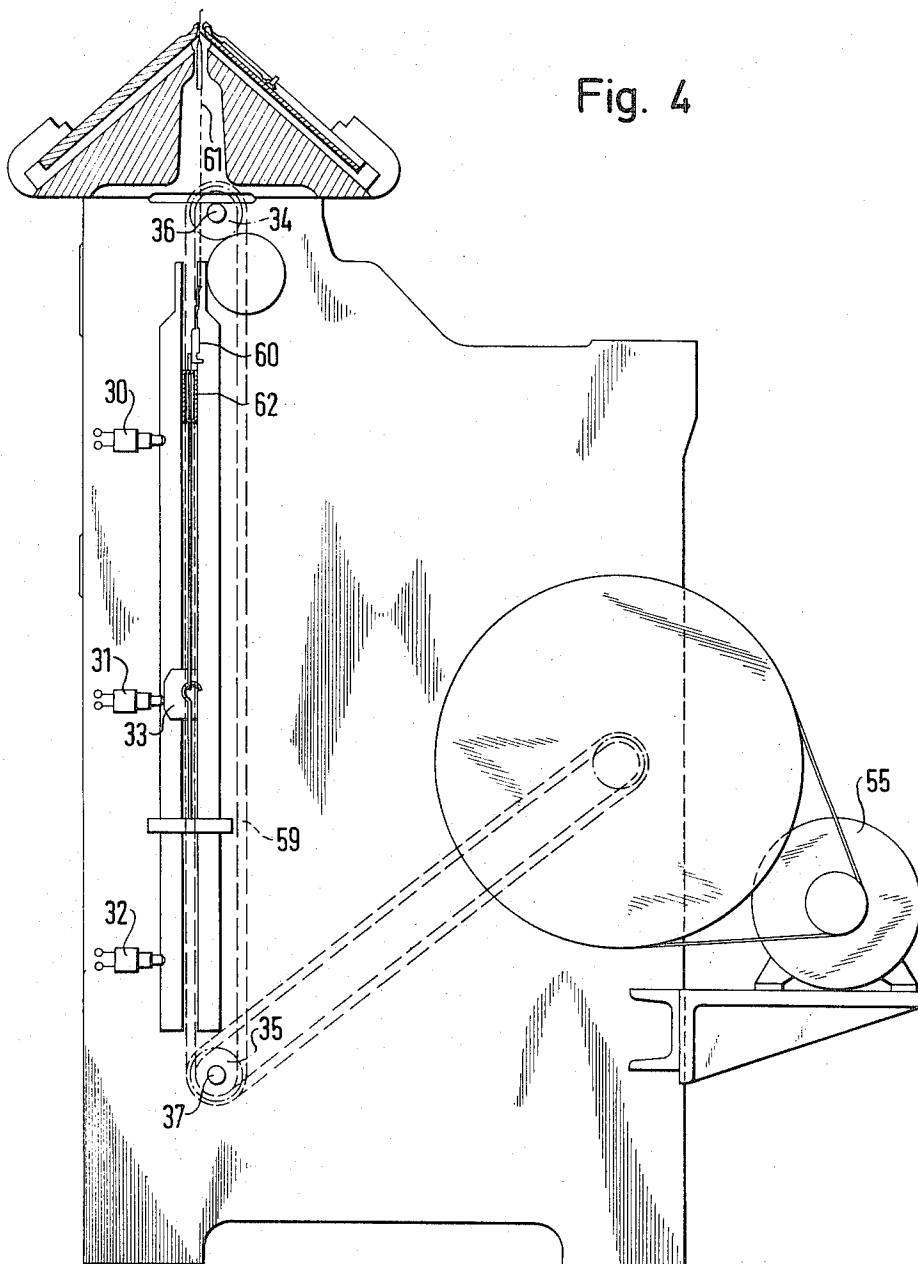
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Fig. 4

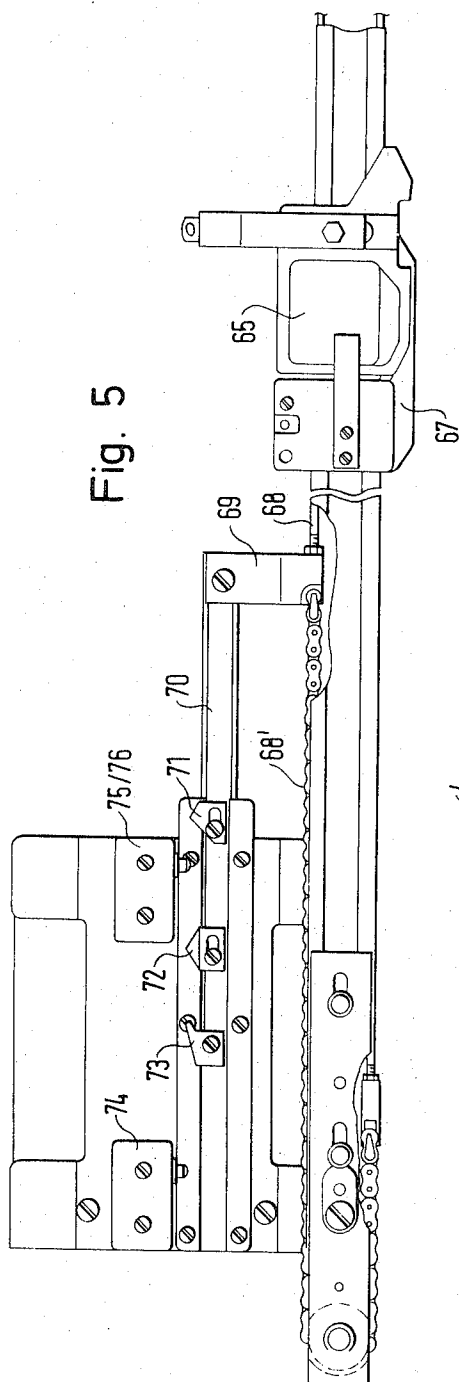
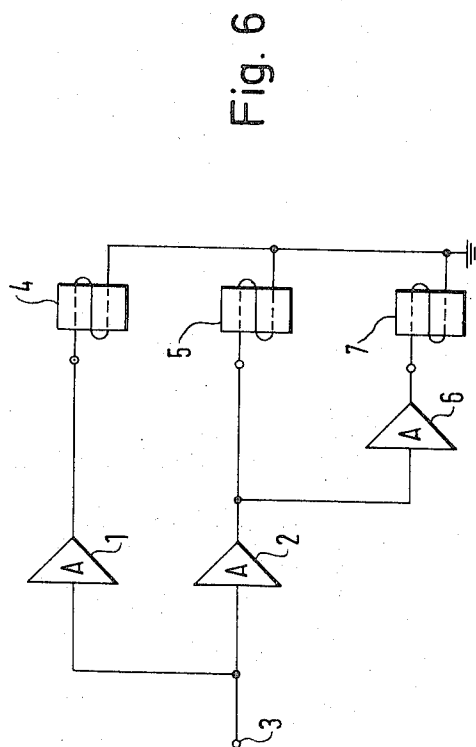


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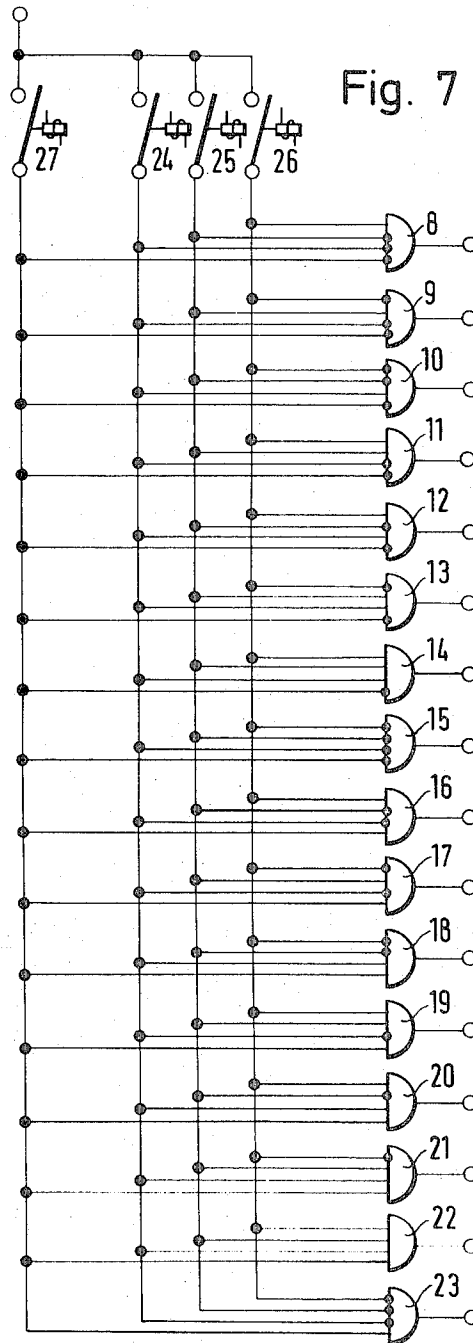


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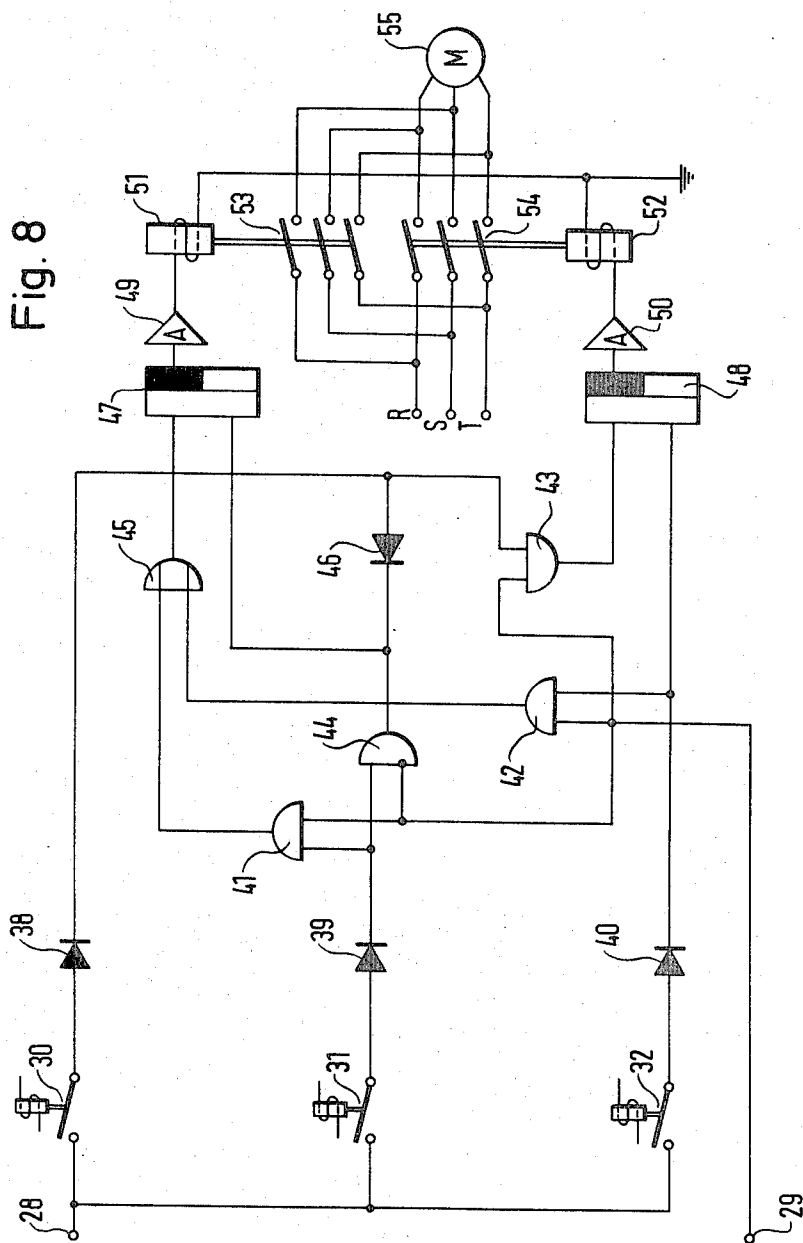


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CONTROL ARRANGEMENT FOR A FLAT KNITTING MACHINE

This invention relates to flat knitting machines, and particularly to a control arrangement for such a machine.

It is known to equip a flat knitting machine with a reading station through which punched cards pass in the form of a chain, normally an endless chain. Most punched cards presently employed are equipped with four rows of 13 punch positions so that as many as 52 individual operating functions may be controlled. Mechanical sensors are usually used to actuate yarn changing devices and to change the configuration of movable cam assemblies.

The available choice of 52 control functions is not adequate for modern knitting machines, and attempts have been made to use cards providing spaces for 120 to 125 punched holes, and corresponding sensing devices. The latter, however, are complex and unwieldy, and the larger cards are not stiff enough unless made of heavier material than was employed earlier, an undesirable feature. The instances of malfunctioning and corresponding fabric defects have been found to increase in number with the number of tracks on the cards.

The object of the invention is the provision of a control arrangement for a knitting machine, more specifically a very complex flat knitting machine, in which the machine is controlled by a small punched card or by an equivalent other multiple-track record carrier scanned by sensing devices in a reader, but which is not narrowly limited in the number of different operating elements and their functions that can be controlled.

With this object in view and others, as will hereinafter become apparent, the invention has a reading arrangement whose sensing elements generate sequential control signals in response to respective tracks of records on a carrier arranged for movement relative to the reading arrangement. Circuitry which connects the sensing elements to the electrically actuated operating elements of the knitting machine includes a logic system which responds to control signals generated by a small number of sensing elements for actuating the operating elements as a group more numerous than the sensing elements.

Other features, additional objects, and many of the attendant advantages of this invention will readily be appreciated as the same becomes better understood by reference to the following detailed description of a preferred embodiment when considered in connection with the appended drawing in which:

FIG. 1 shows a flat knitting machine equipped with the control arrangement of the invention in front elevation;

FIG. 2 illustrates a portion of a cam box in the machine of FIG. 1 in bottom plan view;

FIG. 3 shows the device of FIG. 2 in fragmentary section on the line III—III;

FIG. 4 shows the machine of FIG. 1 in fragmentary section on the line IV—IV;

FIG. 5 shows a part of the machine of FIG. 1 in front elevation on a larger scale; and

FIGS. 6 to 8 are circuit diagrams of respective portions of the control arrangement in the machine of FIG. 1.

Referring initially to FIG. 1, there is seen a flat knitting machine having two straight needle beds in a V-arrangement, better seen in FIG. 4, but not directly relevant to this invention which is concerned with the automatic controls for the knitting machine.

At the core of the control arrangement is a reader 63 for punched cards 63a which are linked in a chain, as is conventional with Jacquard cards, and move over the reader during knitting. Apertures in the cards are arranged in eight columns in the direction of card movement and control eight switches, not themselves seen in FIG. 1.

A carriage 66 is moved forth and back in a horizontal path by the main drive mechanism of the machine and may take yarn guides 65 along in a known manner. The path of the yarn guides is controlled by an electric motor 64, as will presently be described in more detail. The carriage 66 operates limit switches 27 at the ends of its stroke, only one limit switch being shown. Additional limit switches 30, 31, 32 are spaced vertically on the machine frame for cooperation with a drawing-off comb, as will be described with reference to FIG. 4.

The carriage 66 supports a cam box partly illustrated in FIGS. 2 and 3. The cam box includes a plate 58 on which the knitting cams are mounted, as is known in itself. Some of the cams may be moved between a fully operative position, a semi-retracted position, and a fully retracted position, as illustrated in FIGS. 2 and 3 with reference to a lower needle lifting cam 56 and an upper needle lifting cam 57. As shown in fully drawn lines in FIG. 3, the lower cam 56 is set in the operative position, and the upper cam 57 in the semi-retracted position. The other two positions of each cam are indicated in FIG. 3 in broken and chain-dotted lines.

The cams 56, 57 are moved between their several positions by means of setting electromagnets I, II, III, IV mounted behind the plate 58, as indicated in FIG. 2 and omitted from FIG. 3. Non-illustrated return springs normally hold the cams in the operative positions. When the magnet I is energized, it shifts the cam 56 to the semi-retracted position. The magnet II, when energized, fully retracts the cam 56. The magnets III, IV operate the upper cam 57 in an analogous manner. Each cam 56, 57 may therefore be shifted between its three positions independently of the other cam.

FIG. 4 illustrates the drawing-off mechanism of which only the switches 30, 31, 32 were seen in FIG. 1. The switches are operated by a switch actuating cam 33 on an endless link chain 59 trained over vertically spaced sprockets 34, 35. Shafts 36, 37 connect the sprockets 34, 35 with another identical set of sprockets and a link chain on the other side of the knitting machine frame. A bar 62 extends horizontally over the width of the machine between the two chains and provides a carrier for a comb 60 of drawing-off hooks, as is known in itself, for example, from British Pat. No. 991,975. The shaft 37 is driven by a reversible electric motor 55.

The manner in which the motor 55 positions the comb 60 in proper timed sequence with other operating steps of the knitting machine will presently be described.

During knitting, the stroke of each yarn guide 65 is limited by stops 67, as is shown in FIG. 5 for one side of the knitting machine, the arrangement of the stops being generally as disclosed in my U.S. Pat. No. 3,364,703. The illustrated stop 67 is mounted on a push

rod 68 connected to the motor 64 (FIG. 1) by a chain 68'. A transverse arm 69 connects the rod 68 and the chain 68' to a cam carrier rail 70 on which switch operating cams 71, 72, 73 are fixedly mounted in adjustable positions. The cams cooperate with two microswitches 74, 75 spaced in the direction of movement of the yarn guide stop 67, and a third microswitch 76 which, in the view of FIG. 5, is obscured by the switch 75.

The width of the knitted fabric is determined by the length of the yarn guide stroke which, in turn, is set by the motor 64 acting on the rod 68. The range of safe stop adjustment toward the left, as viewed in FIG. 5, is limited by engagement of the cam 73 with the switch 74, the switch being arranged in the energizing circuit of the motor 64 to deenergize the motor when engaged by the cam 73. Movement of the illustrated stop 67 toward the right is similarly limited by the cam 72 acting on the switch 76. The cam 71 and the switch 75 normally cooperate for setting the width of the knitted fabric.

The circuitry associated with the switches 74, 76 and the motor 64 operates in such a manner, known in itself, that the motor 64 cannot be energized except in a direction to move the cam 73 toward the right from the engaged switch 74, and to move the cam 72 toward the left from the engaged switch 76.

As is not explicit shown in the drawing, but conventional in itself, the rear needle bed of the illustrated knitting machine may be shifted longitudinally, that is, right or left in FIG. 1, by several needle spacings, and the front needle bed may be shifted angularly to vary the spacing of the needle bed edges. The machine is equipped with solenoids operating against the restraint of return springs, as described above with reference to FIGS. 2 and 3, for shifting one needle bed longitudinally and for tilting the other. Other adjustments are operated in the illustrated machine by electric motors or electromagnets where manual setting of operating elements was conventional heretofore, and the necessary mechanical and electromechanical devices will be obvious from the preceding description of FIGS. 1 to 5.

The control circuits which are opened and closed in response to movement of the cards 63a over the eight available switches of the reader 63 permit a number of operations much greater than eight to be performed simultaneously and in proper timed sequence.

The circuit illustrated in FIG. 6 has an input terminal 3 in circuit with the switches in the reader 63, as will presently be described, and connected to inputs of two amplifiers 1, 2. The amplifiers operate respective magnets 4, 5 in unison and simultaneously operate a relay 7 through an additional amplifier stage 6. The magnet 4 operates a cam element other than the needle lifting cams 56, 57 in an analogous manner. The magnet 5 moves one of the needle beds, and the relay 7 operates the motor 64 for the yarn guide stops 67. The non-illustrated cam and needle bed are thus adjusted simultaneously with the stops 67, as is often desirable.

The needle lifting cams 56, 57 and other movable cam elements are operated by the selector circuit seen in FIG. 7 in which 16 logic elements 8 to 23 are gate circuits having each four input terminals respectively connected to the limit switch 27 shown in FIG. 1 and to three switches 24, 25, 26 in the card reader 63. By way of example, the gate circuit 11 is arranged in such a manner that it releases an output signal only when the

switches 24, 27 are closed while the switches 25, 26 are open. Other combinations of the switch positions permit an individual output signal to be released by each of the gate circuits 8-23. The output terminals of eight gate circuits are connected with the magnets I, II, III, IV for energizing and deenergizing the magnets in response to the movement of the cards 63a over the reader 63, whereas eight additional outputs are available for other control functions.

The switches 27, which are operated in response to the forth-and-back movement of the carriage 66 close the associated circuit when the carriage reaches the end of its stroke on the left side of the machine, and open the circuit when the carriage reaches its right terminal position. An entire group of functions normally needs to be changed when the direction of carriage movement is reversed, and the circuit of FIG. 7 is well adapted to such operation.

Whereas the circuit shown in FIG. 6 simultaneously energizes several operating elements of the knitting machine, the circuit of FIG. 7 energizes each member in a group of operating elements individually, the group having more members than switches needed for making the selection. The circuit shown in FIG. 8 causes a fixed sequence of operations to take place in response to consecutive signals from the reader 63 reaching its input terminal 29.

The three switches 30, 31, 32 illustrated in FIGS. 1 and 4 can connect a voltage source 28 through respective diode rectifiers 38, 39, 40 to first input terminals of AND gate circuits 41, 42, 43. The second input terminals are connected to the input terminal 29. The two input terminals of an OR gate circuit 45 are connected to the output terminals of the gate circuits 41, 42, and the output terminal of the gate circuit 45 is connected to one input of a bistable multivibrator 47 whose other input is connected to the output terminal of a blocking gate circuit 44 whose inputs are connected to the terminal 29 and the diode 39. A diode 46 is interposed between the diode 38 and the output of the gate circuit 44. The two inputs of a bistable multivibrator 48 are connected respectively to the output of the AND gate circuit 43 and the diode 40.

The respective outputs of the two multivibrators 47, 48 are connected through amplifiers 49, 50 to solenoid coils 51, 52 of relays whose contacts 53, 54 respectively connect the motor 55 to a three-phase AC line R, S, T for forward or backward rotation.

The circuit elements shown in FIG. 8 cooperate with the mechanical elements seen in FIG. 4 as follows:

During normal operation of the knitting machine, an operating cycle of the draw-off comb 60 starts in the position illustrated in FIG. 4 in which the switch 31 is closed by the cam 33, and the comb 60 is at the approximate center of its stroke. When a control pulse is received by the input terminal 29 from the card reader 63, the pulse is transmitted by the gate circuits 41, 45 to the multivibrator 47 which functions as a storage element. The resulting output signal is amplified and fed to the relay coil 51 which attracts its armature. The motor 55 is started in a direction to move the cam 33 and the comb 60 upward. Because of the storage properties of the multivibrator 47, this movement continues even though the switch 31 is opened, and the pulse at the terminal 29 may have decayed.

When the upper limit switch 30 is closed by the ascending cam 33, the clearing input of the multivibra-

tor 47 receives a signal through the diodes 38, 46. The coil 51 is deenergized, and the motor 55 is stopped. Upon receipt of the next pulse from the switch terminal 29, the AND gate 43 transmits a signal to the multivibrator 48, and the motor 55 is started by the contacts 54 to lower the comb 60. The downward movement continues after the cam 33 passes the switch 31 because the latter is not connected with the clearing input of the multivibrator 48. The motor 55 is stopped when the switch 32 is closed in the lowermost position of the comb.

The next pulse received from the switch terminal 29 produces an output signal from the AND gate 42, and the motor 55 is energized, as described above to raise the comb 60. When the switch 31 is then closed by the cam 33, a signal is transmitted by the gate circuit 44 to the clearing input of the multivibrator 47, and the motor 55 is stopped in its starting position.

The stitches of a starting course are knitted on the hooks of the comb 60 when the comb is in its topmost position, and the remainder of the fabric 61 is knitted in the usual manner as the comb 60 descends. The direction of movement of the comb 60 is reversed from its lowermost position when knitting is completed, and the comb is raised to its starting position to relax the tension in the fabric and to permit its removal from the knitting needles. The comb then rises as the next cycle begins.

While the input terminals 3 and 29 in FIGS. 6 and 8 may be connected directly to terminals of switches in the card reader 63, they are preferably connected to output terminals of gate circuits 8 to 23 in FIG. 7 which are not otherwise employed, and such an arrangement permits a maximum of operating elements in the knitting machine to be controlled by a card reader having a minimum number of switches, and a correspondingly small number of control tracks on the cards 63a or other record carriers which are scanned by a reader 63.

The switch elements of the reader, of which only the switches 24, 25, 26 are seen in the drawing, are preferably gas-filled reed contacts to improve the reliability of the control arrangement. They are operated by permanent magnets on plungers actually engaged by the cards 63a. Optical scanning devices including light sources and photoelectric cells have been used successfully in closely analogous reading arrangements and may be substituted for the illustrated arrangement in an obvious manner. The control signals may be generated also in response to changes in the inductance or capacitance of circuits, as record carriers such as cards provided with metallic dots move over suitable pick-up elements.

Other changes and variations of the present invention are obviously possible in the light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a flat knitting machine having a plurality of electrically actuated different operating elements including

setting means for setting a needle cam, shifting means for shifting a needle bed, adjusting means for adjusting a yarn guide stop, positioning means for varying the vertical position of a drawing-off comb, reading means, a multiple-track record carrier arranged for movement relative to said reading means, said reading means including a plurality of sensing means respectively associated with the tracks of said record carrier for generating sequential control signals in response to the record of the associated track during said movement, and circuitry connecting said sensing means to said operating elements, the improvement in said circuitry which comprises:

- a. logic means including a plurality of gate circuits, each gate circuit having a plurality of inputs connected to a group of respective ones of said sensing means different from the group of sensing means connected to each other gate circuit, the number of said gate circuits being substantially greater than the number of said sensing means, each sensing means being common to a plurality of said groups;
- b. first actuating means for simultaneously actuating said shifting means and said adjusting means, said actuating means being connected to the output of a first one of said gate circuits for operation in response to control signals simultaneously generated by the sensing means of the group of sensing means associated with said first gate circuit;
- c. second actuating means for actuating said positioning means, said second actuating means being connected to the output of a second gate circuit for operation in response to control signals simultaneously generated by the sensing means of the group of sensing means associated with said second gate circuit; and
- d. third actuating means for actuating said setting means, said third actuating means being connected to the output of a third gate circuit for actuation in response to control signals simultaneously generated by the sensing means of the group of sensing means associated with said third gate circuit.

2. In a machine as set forth in claim 1, said record carrier including a chain of connected punched cards.

3. In a machine as set forth in claim 1, said first actuating means including an amplifier and a relay interposed in series between said first gate circuit and each of said shifting means and said adjusting means.

4. In a machine as set forth in claim 3, said machine including a carriage moving back and forth between two terminal positions during operation of said machine, and a switch operated by said carriage when said carriage approaches one of said terminal positions, one of said gate circuits having an additional input connected to said switch for receiving a signal therefrom when said switch is operated by said carriage, said one gate circuit having an output connected to one of said actuating means for operating the same in response to signals simultaneously received from said switch and from the associated group of said sensing means.

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