ABSTRACT

To selectively remove selector butts on selector jacks and provide a program on the jacks, in accordance with a pattern, a pattern reading means provides control signals which are decoded, synchronized with mechanical transport of the jacks in front of a hammer. The hammer is mechanically moved to a cocked position at which it can strike a butt, striking movement of the hammer being permitted, or inhibited, in accordance with the read information from the pattern, by means of an electrically operated latch, and, when movement is permitted, opening of the latch to thereafter permit striking movement of the hammer by previously stored force, for example a spring, to effect striking of selected butts in accordance with the pattern.

9 Claims, 8 Drawing Figures
KNITTING MACHINE SELECTOR JACK BUTT REMOVAL APPARATUS

CROSS REFERENCE TO RELATED APPLICATION


The present invention relates to apparatus to automatically program the presence, or absence of selector butts on selector jacks for knitting machines, and more particularly for circular knitting machines, in accordance with a certain Jacquard pattern which the machine is to knit.

Jacquard pattern to control circular knitting machines lend themselves, by means of modern electronic reading and other input-output equipment, to automatic, electronic programming. For reference to electronic control of knitting machines, and more particularly circular knitting machines, "Electronics in Knitting," published by the Knitted Outerwear Association, New York, New York 1972 may be noted.

Electronic control of knitting machine permits ready adaptability of the machine to a wide variety of patterns without the time consuming and complicated process of manually removing selector butts on selector jacks which control the Jacquard selector mechanisms of the knitting machines. Personnel to operate such electronically machine is, however, not readily available and personnel trained in the complicated mechanical art of properly operating knitting machine is frequently not ready to be capable of likewise maintaining and programming electronically controlled machines.

It is an object of the present invention to provide an intermediate unit which converts, automatically, an electronically readable pattern to a selector jack pattern on standard selector jacks which can be used with mechanically controlled knitting machines. The apparatus, therefore, permits use of the mechanical controls, and knitting machines which are familiar to most operators, while simultaneously enabling the knitter to have available the flexibility of electronically controlled patterning or programming, by providing an electronically controlled selector butt programming apparatus.

It has previously been proposed to automatically break away selector butts of selector jacks, and in one form of such apparatus, as described in application U.S. Ser. No. 236,897 filed Mar. 22, 1972, now U.S. Pat. No. 3,747,191, assigned to the assignees of the present invention, break-off hammers are disclosed, equal in number to the selector butts, to punch out the pattern desired in a single operation. This apparatus requires a separate break-out hammer for each butt; since these butts are comparatively strong, and the break-off force is considerable, supplying a separate tool for each butt is expensive. It is, therefore, a further object of the present invention to provide an electronically controlled apparatus which can, automatically, read a pattern and command a break-off tool, while the jack is moved with respect thereto, to selectively break away butts, or not, as controlled by the pattern.

SUBJECT MATTER OF THE PRESENT INVENTION

Briefly, a pattern reading means is provided which derives sequential electrical control signals representative of a textile pattern. A typical reader may be a photoelectric scanner which scans a standard pattern, laid out in a raster. The output from the pattern reading means is a signal which is decoded, to determine whether a selector butt of a selector jack is to be removed in a predetermined position. Selector jacks are fed sequentially in a predetermined path and a removal hammer or the like, is moved in a cocked position, from which, depending on the output signal derived from the decoder, it is released by a sear, or not. The feed movement of the jack itself is synchronized with the movement of the release of the hammer, as well as with the release control thereof, so that, depending on the pattern read by the pattern reader, the hammer will be released to strike a predetermined butt, in a predetermined position on the jack, or not.

In one form of the invention, the jack is fed by means of a threaded spindle which carries along a carriage, engaging a jack to be fed, so that the carriage is moved a predetermined step, for example the distance of one butt from the next, upon one revolution of the spindle (or any other selected fractional angle). The spindle is connected to a shaft with a cam, and sensing switches sense the rotational position of the spindle to provide one of the synchronizing signals, namely the position of a butt before the hammer. The shaft, likewise, may carry a cam which is used to cock the hammer, the cam being formed with an abrupt notch which acts as a sear, the hammer being struck forward sharply against a butt by a spring wound up when the hammer is cocked by engagement with the cam. To prevent the hammer striking, a latch is provided which, when the hammer is to strike, is electrically disabled. In accordance with another feature of the invention, return of the spindle is obtained by reversing the direction of the drive motor, to obtain a very rapid reverse; during such reverse, the hammer is, of course, held in a position disengaging it from the cam and the sear. Synchronism between the hammer operating elements, and control cams on the apparatus is provided by connecting the spindle, providing forward transport of the jack, as well as the cams, by a positive drive engagement, such as a sprocket belt.

In accordance with a feature of the invention, the reader is connected to a storage device, and the content of the storage device — as decoded — is compared with the angular position of the cam which controls the butt-striking hammer to ensure synchronization of output signals to release the butt-striking hammer, or not, in dependence on the information read by the reading unit. To accommodate jacks of different sizes, and of different butt widths, the drive mechanism is made with interchangeable drive wheels of different diameters, matched to the translatory path the jack is to take, thus easily adapting the apparatus to a wide variety of types and sizes of jacks.

The apparatus further includes, in accordance with a feature of the invention, a feedback circuit which monitors the operation of the hammer, that is, if the hammer has moved into interfering position with a butt, thus breaking off a butt, this position is monitored and a signal provided which can control an output-input de-
The butts 21 of the jacks 10 are broken off by means of a hammer 7, which is journaled in a hammer housing 11 (FIGS. 2–4), secured to the machine table 1. The butts 21 severed by hammer 7 from the jacks 10 are collected in tray 22, for disposal, re-melting or sale as scrap.

Hammer 7 is rotatably journaled on a shaft 23 secured in hammer housing 11. The hammer 7 is secured to, preferably unitary with an upper lever arm 29, a lower shorter lever arm 28, and an approximately right-angled projection lever stub 27. Lever stub 27 is located immediately adjacent a cam disk 12, rotatable with a horizontal shaft 13. Lever 13 is, in turn, journaled in bearings 70, 71 (FIG. 5), which are secured to the machine table 1. The cam disk 12 has an approximately spirally extending cam track 41, and a steep shoulder-like jump 42. Cam disk 12 engages the lever stub 27.

The long arm 29 carries the hammer head 26, extending at approximately right angles from lever arm 29. At its forward face it is narrowed, having a width roughly that of the smallest butt 21 to be expected in use, or slightly narrower. At the side opposite the impingement end of hammer head 26, hammer 7 is elastically retained by a compression spring 43 which, at its other side, is retained in a counter bearing, secured to the machine table 1. The counter bearing includes a spring end disk 73, secured in a suitable bore of a spring housing 44. Spring housing 44 is attached to machine table 1, for example by screws, by welding or in any other suitable manner (not shown). The bias of spring 43, and, thus, the force with which the hammer 7 will impinge against a butt 21 can be adjusted by changing the position of set screw 45 in spring housing 44; the set screw is locked in place by means of a counter nut 46, and bears against the spring disk 73.

Hammer 7, when in the position of FIG. 2, and beyond the penetration position through a butt 21, bears against an elastic cushion 25 secured to a shoulder 24. The elastic cushion decreases the noise of operation of the machine, and acts as a general damping mechanism to also decrease vibration.

A support bracket, secured to plate 5 by suitable means (not shown) extends downwardly, beyond the lower region of the lower level arm 28. A double-armed control lever 38 is journaled, roughly in the middle, over a bolt 39. The control lever 38 is linked to the armature of a solenoid 20, likewise secured to depending bracket 6. Upon energization of the coil of solenoid 20, lever 38 is tipped in counterclockwise direction about the fulcrum formed by bolt 39, counter the force of a compression spring 40, the other end of which is secured in a holding bracket 47 attached to bracket 6. Movement of lever 38 in clockwise direction is limited by a pin 48 secured to bracket 6.

The free arm 28 of hammer 7 ends in a terminal hook 49, which can fit into a similar hook-like end portion 38a of lever 38. If the hammer 7 is moved in the position shown in FIG. 3, and solenoid 20 is deenergized, spring 40 will press the lever 38 in clockwise direction and the hook end 38a can engage behind the hook end 49 of hammer 7 (FIG. 3). This locks the hammer 7 in position, regardless of the position of the cam disk 12, and prevents movement of the hammer into impinging or interfering position with respect to a butt 21 on a jack 10 when the disc 12 has rotated to such an extent that the stub 27 on hammer 7 could drop behind the
abrupt change in the spiral configuration of the cam on disk 12, as seen in FIG. 2. The hook end 49, at the side facing the lever 38, is formed with an inclined surface 49a which roughly matches the degree of inclination of the outer surface of the hook end 38a on lever 38, to form inclined sliding surfaces which permit the hammer 7, as it is moved from the position of FIG. 2 into the position shown generally in FIG. 3, to press downwardly against the hook end 38a and permit the hook end 38a of lever 38 to snap behind the hammer hook end 49. The lever 38 thus does not inhibit movement of the hammer 7 in counter-clockwise direction.

Jacks 10 are transported horizontally in front of hammer 7, as best seen in FIG. 5, by means of the carrier pawl 14, secured to a cross slide or carriage 15. Pawl 14 can swing about a vertical axis, as seen in FIG. 5, whereas carrier 15 can slide along a pair of slider rods 17, 17. The guide rods 17 are held in terminal bearing blocks 16, 19. The latch 14 is so arranged that upon movement towards the right in FIG. 5, the latch 14 cannot swing towards the left, and thus will carry a jack along upon movement of the carriage to the right; upon retrace of the carriage toward the left, however, the latch can deflect out of the way, against pressure of a small spring (for example a spiral spring within, or above carriage 15, not shown) to slip against the next jack, and grip the next jack upon reaching its end position.

A spindle 18 is located between the two guide rods 17, 17, journalized in the two end bearing blocks 16, 19, connected to the carriage block 15 by means of a spindle nut 15a (FIG. 2). Spindle 18 extends with at least one end beyond the bearing blocks, as shown beyond bearing block 16. The projecting end carries three sprocket belt pulleys 36, 62, 64, fixed against rotation with respect to the spindle. Sprocket pulley 36 is connected by means of a sprocket belt 60 to the sprocket pulley 35 of a reversible electric motor 31, suitably secured below the machine table 1 (FIG. 5). Sprocket pulley 64 of spindle 18 is connected by means of a sprocket belt 60 with sprocket pulley 37 secured in connection to transmitting connection, for example by means of a key to the cam shaft 13. Sprocket pulley 62, secured to spindle 18 has a different diameter than sprocket pulley 64. It is associated with a sprocket pulley 63 secured to cam shaft 13. Providing two sprocket pulleys 62, 63 permits, upon transfer of the sprocket belt 60a, a different transmission ratio between the spindle 18 and the rotation of cam shaft 13.

The sprocket belts 60a, and the sprocket pulleys provide slip-less mechanically exactly synchronized transmission of rotation between spindle 18 and the cam shaft 13. Thus, the rotation of cam disk 12 is synchronized with the rotation of spindle 18 and hence the linear translatory movement of carriage 15. The pulleys 62, 64 and 37, 63 may also be made interchangeable for other sets of pulleys, if desired.

Referring again to FIG. 2: a bracket 50 is secured to the housing 11 for the hammer assembly, and a magnet 32 is attached to bracket 50. Magnet 32 has an armature 33 which is connected to a bolt 65, the axis of which is aligned with the short lever arm 28 of hammer 7. The free end of the bolt 65, at the other end of the armature 33, is surrounded by a compression spring 34, bearing on the one hand against the housing of magnet 32 and on the other against a nut-counternut combination 31, the spring 34 bearing between the housing and the nuts returning the armature 33 in the position shown in FIG. 2, when the magnet is deenergized.

Operation: In starting position, carriage 15 is in its left limit position (FIG. 5) close to the bearing block 16. The carrier pawl 14 engages behind the end face of a jack 10 in the blank jack magazine, or tray 8. The cam track 41 of cam disk 12 bears against the lever stub 27 of hammer 7. Magnet 32 is deenergized. Magnet 20 is energized. The compression spring 40 holds the lever 38 in contact with pin 48, so that lever 38 will be in the position of FIG. 2.

When motor 31 is energized in forward direction (as will be explained), so that belt 16 drives spindle 18 in a direction to move carriage 15 and thus carrier pawl 14 to the right (FIG. 5), pawl 14 will engage behind the uppermost jack 10 from the tray 8 and move the jack in the path between the jack holder 2 and the guide bracket 3. Simultaneously, sprocket belt 60a will drive cam shaft 13 in the direction of the arrow shown in FIGS. 2 and 3. Hammer 7 will be tipped backwardly from the position shown in FIG. 2 about its shaft 23 in a position corresponding to that of FIG. 3. The slide surface 49a of the shorter lever portion 28 of hammer 7 will slide against the matching surface of the lever 38, lever 38 will be deflected downwardly, countering the action of spring 40, and the hook portion 38 of lever 38 can catch behind the hook portion 49 of the hammer lever 28.

Let it be assumed that the jack 10, being moved by the pawl 14 past the hammer 7, should have a butt 21 removed therefrom. At approximately the angular position of cam 12 which is shown in FIG. 3, magnet 20 is energized by the control system, as will be explained. At this position of the cam disk 12, the cam disk 12 by engagement with stub 27 has depressed the stub to such an extent that the hook 49 has a slight distance to the right from the hook portion 38a of lever 38 (see FIG. 3). Thus, release of the holding arrangement between the engaging hooks 49, 38a, does not involve sliding force, and magnet 20 can readily attract its armature and move lever 38 in the position shown in FIG. 3, thus releasing hammer 7. The only force necessary in the magnet 20 is that to overcome the force of spring 40, since movement of the lever 38 is carried out at a period of time in which the hook 49 on the hammer is already slightly to the right of the hook portion 38a, as clearly seen in FIG. 3.

Hammer 7 is further tipped in counter-clockwise direction by the cam disk 12, against the force of spring 43, until its stub 27 suddenly drops off the shoulder 42 of the cam track 41, releasing the hammer, which is thrown by the force of the spring 43 towards the stub 24, the hammer portion 26, in the path, breaking out a butt 21 from the jack 10 which, otherwise, is supported against bracket of jack guide head 3.

The longitudinal movement of the carrier 15 and the rotary movement of cam disc 12 are so synchronized by means of sprocket belt 60a, that the stub 27 is released by the shoulder 42 of the cam disk at the instant in which a butt 21 is in interfering position with the hammer head 26 as it strikes forward.

Let it be assumed that, for a different knitting operation, a butt 26 should not be removed. The control magnet 20 then is not energized at the time that the cam disk 12 is approximately in the position shown in FIG. 3. The lever 38 will thereafter remain in the position shown in FIGS. 2 and 4, and the hook 49 will engage
the hook end 38a on lever 38, and prevent drop-off of the lever stub 27 as the cam disk 12 continues to rotate. When the cam disk 12 has again rotated in the position of FIG. 3, then, upon the next revolution, a new butt 21 will be in the striking movement of the hammer head 26 which, as previously described, can be either broken out (by energization of magnet 20 and consequent release of the hammer head 26) or be retained (by non-energization of magnet 20).

When all butts 21 of the jack 10 have been carried through the path of the hammer 26, and the completely prepared jack 10 has been moved by pawl 14 into the reception magazine or tray 9, carriage 15 is returned to the left starting position to carry the next jack 10 from the new-jack tray 8 to the programming apparatus and into the reception tray 9.

To return the carriage 15, motor 31 is changed in its direction of rotation to reverse, so that spindle 18 will rotate in reverse direction, to move the carriage 15 backwardly. The pawl 14 can deflect, so that its return motion is not inhibited. The speed of the motor 31 may be higher for the return motion. Cam shaft 13 is coupled to spindle 18 and cam shaft 13 likewise moves backwardly. To prevent engagement of the stub 27 on hammer 7 with the cam disk 12, and to prevent blocking of rotation of the cam disk 12 by the shoulder 42, magnet 32 is energized simultaneously upon reversal of motor 31, so that bolt 65 moves into the position shown in FIG. 4 in which the bolt 65 pushes the lever arm 28 to a limiting position at the right, in counter-clockwise direction, thus moving stub 27 out of the path of motion of the cam disk 12, to permit free rotation of the cam disk 12 in reverse direction, as indicated by the arrow in cam disk 12.

As soon as carriage 15 has reached the left starting position, a control, such as a limit switch, stops the motor and reverses its direction of rotation to forward direction, and at forward speed, while simultaneously deenergizing magnet 32. The return spring 34 moves bolt 65 back into the starting position in accordance with FIG. 2, and remains out of operation with respect to hammer 7 until the next return movement of the carriage 15.

Motor 31, controlling magnet 20, return release magnet 32, and reciprocating motion of the carriage 15 is controlled by a control system, basically shown in FIG. 6.

The butts 21 of jacks 10 are broken out in dependence on a predetermined pattern, which the knitting machine is to knit, using the pattern jacks 10, prepared in accordance with this program. This pattern is drawn on a so-called pattern raster 57, which carries colored markings in the x-direction and the y-direction, as well known. It is an advantage of the present invention that, standard, well known technology can be used, for example as described in "Double Knit Fabric Manual" particularly pages 45 et seq. and page 104 et seq., see also FIG. 10 (published by Knitted Outerwear Association, New York).

The markings of the raster or pattern 57 are converted into electrical signals by a well known x-y reader 51. They are scanned in the x-direction and the y-direction, the reader providing output signals characteristic of the colored markings on the pattern 57 (FIG. 6), which are applied by means of line 51a to an electronic storage device or memory 52. Memory 52 delivers the electrical signals, characteristic for the colored markings of the pattern 57, over line 52a in timed synchronism to a control and decode unit 53. The control and decode unit 53 has an output line 53a on which electrical pulses are provided to command operation of the hammer 7 to strike, or not to strike, relative to each butt of the jack which is carried by the carrier pawl 14 past the hammer 7. The signals from line 53a are applied to unit 54 which, generally, includes the apparatus shown in FIGS. 2-4 and further includes synchronizing elements, so that the signals on line 53a will arrive at the proper time for command of the magnet 20 controlling operation of the hammer 7.

A monitor and input-output element 55 is provided which checks that the pattern butts 21 of jacks 10 are broken out by hammer 7 really as commanded in accordance with the markings on the pattern 57. The monitoring unit 55 thus checks the operation of the hammer control and synchronization element 54. Monitoring unit 55 is connected to the control and decode unit over a line 53c and to the hammer control and synchronization unit over a line 54a. Line 54a transmits signals having characteristics which indicate the operation of the hammer 7, and monitor unit 55 converts these signals into suitable output signals for a printer unit which prints the representation of the operation of the hammer, in a similar X-Y raster, to provide a control or monitoring pattern 56, corresponding to the pattern which was actually made by the hammer 7. To check the operation, it is therefore only necessary to compare the command pattern 57 with the monitor or control pattern 56. Any errors will immediately become apparent and it is then only necessary to pick out the specific jack and to replace it with a jack 10 having properly broken-out butts 21.

The basic construction of the electronic circuit of the monitoring and decoding unit 53 is seen in FIG. 6. The basic circuit of the hammer control and synchronization unit 54 is shown in FIG. 8. Obvious details, such as intermediate amplifiers, buffers, and the like have been omitted since they do not affect the understanding of the operation of the circuit. Memory 52 may be a customary magnetic core memory, a drum memory, or any other suitable commercial electronic memory device.

The controller and decoder 53 includes an AND-gate 80 and an amplifier 81. Electrical signals, read by reader 51 and transferred through memory 52 over line 52a are applied to AND-gate 80. A synchronization signal is applied over a line 53b from hammer control unit 54 to the controller and decoder, likewise applied to AND-gate 80. The output of the AND-gate 80 is connected over intermediate amplifier 81 with the output line 53a of unit 53. The synchronization signal is likewise transmitted over line 52b to memory 52 to synchronize reading of the memory. The synchronization signal is likewise transmitted over line 52c to the reader 51.

A microswitch 58 (FIG. 5) engaging a cam disk 30 secured to cam shaft 13 provides synchronization signals representative of the angular position of the cam shaft 13. The microswitch 58 has an operating element 58a, which rides on the circumference of the cam disk 30 secured, for example, beyond the bearing 71 (FIG. 5). Switch 58, itself, is suitably secured beneath the table 1. The cam disk 30 has an approximately spiral cam track with a notch 30a which, when pin 58a drops in the notch, operates the switch.
Switch 58 may, alternatively, be mounted as seen in FIG. 2 to engage the track 41 of disk 12 directly. Thus, a separate cam disk 30 need not be used. In this embodiment, the arrangement is made that the pin 58 has a ramp 42 and the shown ramp 42 may be formed with a slightly inclined edge, just enough to permit the small travel of switch pin 58 to ride thereover but not enough to interfere with snapping action of the hammer. The switch operation is so set that it occurs approximately at the position shown at 83, FIGS. 2, 3, of curve track 41.

A monitoring switch 59 is associated with hammer 7, and acting against short lever arm 28. It is secured by means of a small bracket 59b on housing 11. Switch 59 provides an electrical signal over line 54a to an AND-gate 90 in monitor unit 55. The other input of the AND-gate is connected to the output of amplifier 81 in the control unit 53, over line 52c. The signals derived from switch 59 are characteristic of the operation of the hammer 7. Operation of the hammer 7 should occur only when the hammer moves in the position shown in FIG. 2, that is, when a butt 21 is to be broken out from a jack 10. The output of the AND-gate 90 controls an output printer 91, which effects generation of the control of monitor pattern 56.

Return of the carriage 15 at the terminal points, that is, close to the end blocks 16, 19 can be commanded by limit switches or the like, which are located on the end blocks 16, 19, and contacted by the carriage 15. These end switches, not shown in FIG. 5, provide limit signals characteristic for the left or right end position of carriage 15. Referring now to FIG. 8, which includes, highly schematically, the functionally necessary portions of the hammer and hammer command unit 54, a transfer element 200 changes state upon receiving a signal from one of the limit switches, to change the direction of rotation of the motor 31 (for example by changing the polarity of the field winding of the motor). The transfer element 200 may be, for example, a bistable flip-flop, a two-position type latching relay, or the like operating in a double-throttle mode.

A counter 100 (FIG. 8) is connected to the switch 58 to count the number of signals which are derived therefrom and representative of the number of revolutions of cam shaft 13. When a predetermined count is reached, corresponding to the number of butts on the jack, plus such counts as are representative of the terminal end of the jacks, indicating that the carriage has reached its limit position, a pulse is obtained from counter 100 and applied to transfer switch unit 200. The transfer switch 200 then would include an AND-gate; upon sensing both that the requisite number of pulses have been received and that the carriage is at a limit position, the AND-gate then controls the transfer switch. A check is thus obtained that both the mechanical operation is proper (operation of the limit switch) and that the electrical system is functioning (operation of counter and pulses from cam shaft 13). If such check is not necessary, then either the electronic counting arrangement, or the limit switches, may be omitted. Upon return movement of the carriage, the counter will then count backwards and when it reaches a count stage of 0, will provide another pulse to again cause changeover of transfer switch 200.

Operation of electrical and electronic circuitry: Let it be assumed that carriage 15 is in its left limiting position (FIG. 5), and pawl 14 engages the upper jack 10 in the tray 8. Counter 100 (FIG. 8) has been set for a fixed value, corresponding to the number of butts 21 and the length of the terminal ends of the jack. Upon energization of the unit by a suitable main switch (not shown) input-output unit 51 (FIG. 5) begins to scan a line of the pattern 57. Signals representative of the color markings in the pattern 57 are transmitted over line 51a to memory 52. Simultaneously, motor 31 is started and the carriage 15 travels to the right (FIG. 5), pawl 14 carrying the uppermost jack towards the right and towards the path in which hammer 7 is located. The sprocket belt 60, moving with spindle 18 drives cam shaft 13, so that cam disk 12 rotates in synchronism with the translatory movement of carriage 15 and hence of jack 10. At each revolution of cam disk 12, line 53b will have a synchronizing pulse appear thereon, which is transmitted over line 52b to memory 52 and 52c to reader 51. The reader, and memory 52 are therefore synchronized with the rotation of cam disk 12, and thus with movement of the hammer 7 and feed movement of the carriage 15. Line 52a will then transmit from memory 52, upon each revolution, a signal representative of the color representation of the pattern 57, the signal being applied to AND-gate 80 in unit 53, amplified by buffer amplifier 81 and applied to line 53a, in order to command the control solenoid 20. Solenoid 20 will only then have a command signal applied thereto when the second input to AND-gate 80, connected to synchronization line 53b, likewise has a signal thereon. The hammer will then operate, as previously described, and strike a butt to punch out a butt at the appropriate position. If, at a predetermined position, the butt 21 should remain, that is should not be struck off, then memory 52a will not transmit a signal to the AND-gate 80 at the time a synchronizing signal appears at line 53b, so that the AND-gate 80 remains blocked, and magnet 20 deenergized. As a result, lever 38 (FIG. 2) and its hooked end 38a remains in engaged position with the hooked end 49 of lever 28 of hammer 7, so that the stub 27 cannot drop off the edge 42 of cam track 41, and hammer 7 is held in cocked position.

AND-gate 80 additionally ensures synchronization of operation of the hammer with the position of the jack 10 in front of the hammer. When a signal is applied over line 53b representative of a predetermined angular position of cam disk 12, and a signal is derived from memory 52 representative of the fact that a butt is to be removed, a control pulse is then conducted over line 53a to the magnet 20, to tip lever 38 in counterclockwise direction and, upon continued rotation of cam disk 12, permit the hammer 7 to drop off shoulder 42 of the cam and strike a butt with the force delivered by the compressed spring 43 (FIG. 2).

The striking movement of a hammer 7 causes deflection of arm 28, which is engaged with switch 59. Switch 59 is connected by line 54c to the monitor unit 55, energizing AND-gate 90 therein. The other input of the AND-gate 90 is connected by line 53c to the synchronization line 53b so that, upon each rotation of cam shaft 13, a synchronization signal is applied to the AND-gate 90. When both inputs to AND-gate 90 are energized, printer 91 is energized to provide a symbol to be printed on the control or monitor pattern 56, indicative of the fact that hammer 7 has operated. If at any specific rotation of cam disk 12, hammer 7 is not operated since the signal from memory 52 commands a non-
Various changes and modifications may be made in the apparatus. Only one punch-out unit for any number of butts on a selector jack is necessary. The break-away force is adjustable by setting of the compression of spring 43 (FIG. 2). Rather than holding a selector jack stationary in front of a number of hammers which are simultaneously energized, the jack is moved in front of one hammer. Accuracy of operation is ensured by synchronization of movement of the jack in front of the hammer, and hammer operation. Reliability of the apparatus over long operating periods is ensured by independent mechanisms for holding the hammer in non-operated position, and permitting operation of the hammer, that is, by independently controlling the holding of the hammer if it should not operate, in cocked position, by engagement of the hook ends 38a, 49 (FIG. 2), and drop-off of the hammer when it may operate, by the shoulder 42 on the cam track 41 of cam disk 12. Thus, the holding element itself is relieved of strain and reliability of operation under the program is ensured, since the mechanical release of the striking force of the hammer is independent of the mechanism controlling the hammer whether it should strike, or not.

Operation of the machine is rapid. Typical operating speeds are:

For a jack of about 20 cm lengths, feed or transport speed: 4 cm/sec. This corresponds to 900 hammer operations per minute. Total production (including time to return the carriage from its right terminal to its left terminal position: 5 jacks per minute, which corresponds to total time to 600 jacks for a 36-feed knitting machine of 120 minutes.

Reader 91 is coupled to an output-input record unit 56, which, in its simplest form, can be a paper tape punch, a digital magnetic tape recorder-reader, a card punch, or the like. Thus a permanent record in a form different from the input X-Y pattern 57 can be obtained, which can be fed into a similar record reader, to be connected to line 51a in other apparatus instead of a photoelectric reader like reader 51. Photoelectric X-Y readers are more expensive than punched paper tape readers, and thus a pattern once read on a photoelectric reader can be converted by the apparatus readily into a different form, from which sets of selector jacks can be made to duplicate the pattern originally read. The second pattern is then commanded directly by, for example, punched tape. The output record generator 91 may be omitted entirely and reliance be placed on a paper tape, the signals of which can be fed into a tape reader for electrical comparison with the signals applied to memory 52, and determination of congruence, for example by means of an AND-gate which provides an alarm signal in case of mismatch.

The mechanical portions of the specification show the essential operating relationships of the various parts. Such well known expediants, as providing anti-friction means between rubbing, or engaged surfaces, such as cam followers, cam follower rollers, or balls, retention springs, anti-friction bearings to journal the shafts, pawl 14, and the like, have been omitted from the drawing in the interest of clarity, since they are well known in the art and a matter of design.

We claim:

1. Jacquard selector jack programming apparatus, in which the selector jacks have removable selector butts, comprising
a pattern reading means (51) deriving sequential electrical control signals representative of a textile pattern;
control and decoding means (53) decoding said control signal;
means feeding single selector jacks sequentially in a predetermined path;
selector butt removal means (7) having a removal position and a blocked position and located along said predetermined path;
power means (43) effecting movement of said removal means (7) to said removal position;
means (20) controlling movement, or non-movement, of said removal means (7) by the force of said power means;
jack position synchronizing means (12, 58, 130, 13, 63, 64) synchronized with feed of any selector jack over said path and providing an instantaneous jack position signal representative of the position of a jack in said path opposite the butt removal means (7);
the control and decoding means (53) being connected to said movement control means (20) and providing a release signal to permit the power means to move the removal means (7) into removal position if the control signal, as decoded by said control and decoding means, has a characteristic commanding removal of a butt, said control and decoding means inhibiting application of the release signal if a butt removal is not commanded, the butt removal means then remaining in blocked position;
and circuit means connecting the jack position signal to the movement control means (20) to signal that a butt is present before the removal means, and to synchronize operation of said butt removal means and the feed of any jack over said path.
2. Apparatus according to claim 1 wherein the feeding means comprises
a threaded spindle (18) and means (31, 35, 36, 60) to rotate the spindle;
a carriage (14, 15) engaging a jack to be fed, said carriage being mounted for translatory movement on the spindle upon rotation thereof to carry the jack in a rectilinear path;
and the position synchronizing means comprising
a shaft (13) and camming means (12, 30) thereon, switching means (58, 58a) located in engagement with said camming means and operative upon predetermined rotary positions of said shaft, as sensed by said camming means;
and drive means (31, 37, 62, 63) synchronously driving said spindle (18) and said shaft (13).
3. Apparatus according to claim 1 wherein said selector butt removal means (7) comprises
a hammer head (26) having a projecting end movable between a butt clearing and a butt removal position;
a hammer lever (28, 29) journaled for rocking movement between said positions, and carrying said head;
the power means comprises a power spring (43) bearing against the hammer lever;
and the movement control means (20) comprises a holding lever (38), and a solenoid (20) to operate the holding lever, the holding lever (38) being located to be engageable with the hammer lever.
4. Apparatus according to claim 1, further comprising movable power means (31, 12, 13) engaging (41, 27) said selector butt removal means (7) and acting on said removal means in a direction counter the force of said power means (43) to store energy in said power means;
and a sear (41, 42) abruptly disengaging said movable power means from said selector butt removal means (7) and permitting application of stored energy to said removal means if the movement control means has provided a release signal.
5. Apparatus according to claim 4 wherein said butt removal means is movable between a butt clearing and a butt removal position;
the movement control means is located to engage said butt removal means, if butt removal is not commanded, upon release of the sear;
and wherein the jack position synchronizing means provides said jack position signal to the movement control means in advance of disengagement of said movable power means to permit movement of said butt removal means while said butt removal means is engaged by said movable power means and thereby permit free movement of said movement control means between engaged and disengaged position with respect to the removal means.
6. Apparatus according to claim 4 wherein the movable power means comprises
a rotatable shaft (13) and a cam (12) thereon;
the butt removal means comprises a hammer (7, 26) having a control lever (27) engaged by said cam (13, 41), said cam having an abrupt shoulder (42) thereon forming said sear, said cam moving said hammer in a rocking path between forward and rearward limits;
said movement control means (20) comprises a movable hook (38, 38a) located in said rocking path intermediate said forward and rear limits, and a solenoid moving said movable hook between a position interfering with free rocking movement of the hammer, or non-interfering position, depending upon energization of said solenoid;
and wherein said jack position synchronizing means provides said jack position signal to the solenoid when said hammer is in an intermediate position between said limits and clear of said hook to provide for play between said hook and said hammer when the hook is moved upon energization of said solenoid.
7. Apparatus according to claim 4 wherein the movement control means comprises
a rotatable shaft (13) and a cam (12) thereon;
the butt removal means comprises a hammer (7, 26) having a control lever (27) engaged by said cam (12, 41), said cam having an abrupt shoulder (42) forming said sear;
reversible drive means (31) are provided rotating said shaft (13) in two directions of rotation;
and means (32) operative in synchronism with reversal of rotation of said shaft acting on said hammer (7) to lift said hammer away from said cam (12, 41) to prevent interference of said sear shoulder (42) with said hammer upon reversed rotation of the shaft.
8. Apparatus according to claim 7 wherein the disengagement means comprises
a solenoid (32) having electromagnetic operated
plunger means (65), said plunger means bearing
against the hammer (7) in a direction away from
said cam.

9. Apparatus according to claim 1 wherein said butt
removal means is movable between a butt clearing and
a butt removal position;
and said apparatus further comprises electrical
means sensing the position of the selector butt re-
moval means after movement of the power means

has caused the butt removal means to operate, if
commanded to do so by the movement control
means, or movement of the butt removal means
was inhibited;
and means providing an indicated representation of
the sensed position of said butt removal means to
permit comparison of actual butt removal means
operation and commanded butt removal means
operation.

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