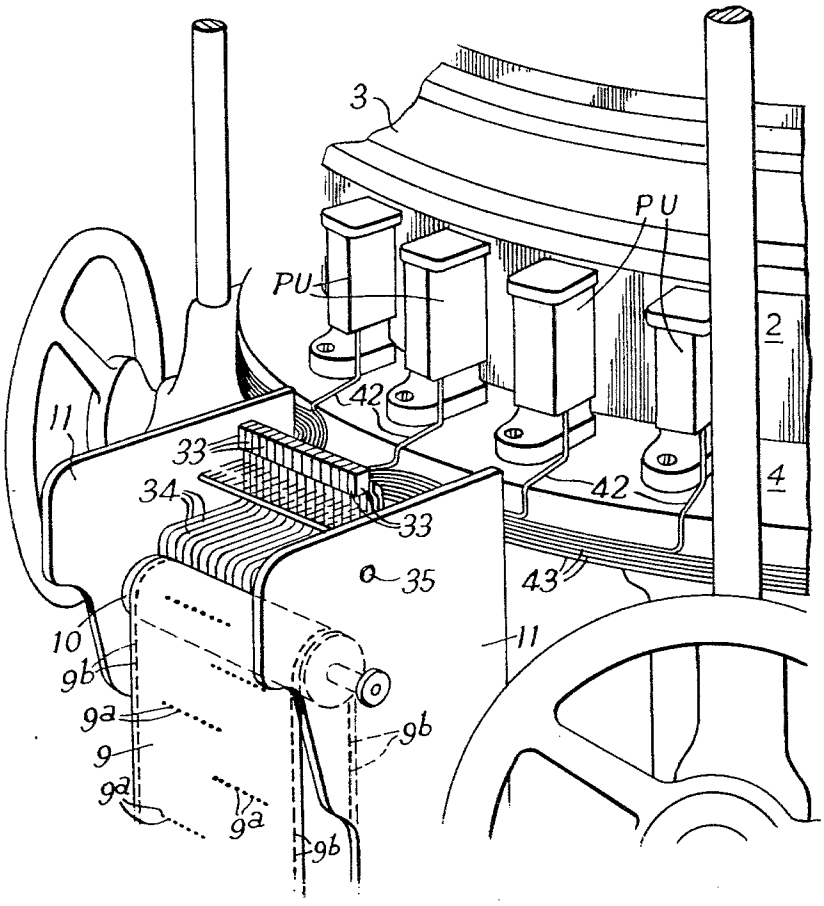
Jan. 18, 1966 E. L. FARMER 3,229,482

PATTERNING MECHANISM FOR KNITTING MACHINES

Filed April 7, 1964 7 Sheets-Sheet 1

Fig. 1.



PATTERNING MECHANISM FOR KNITTING MACHINES

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Fig. 2.

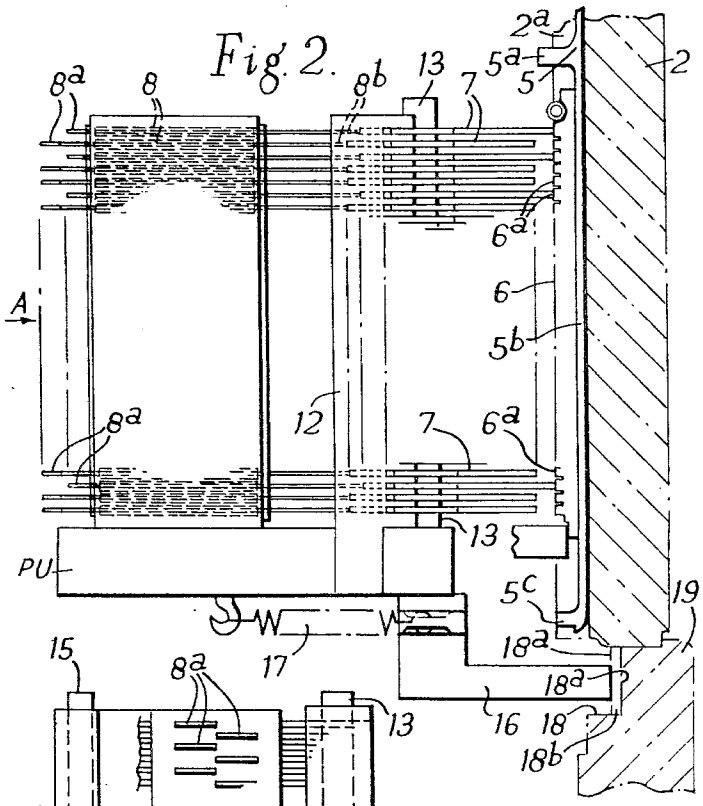

Fig. 3.

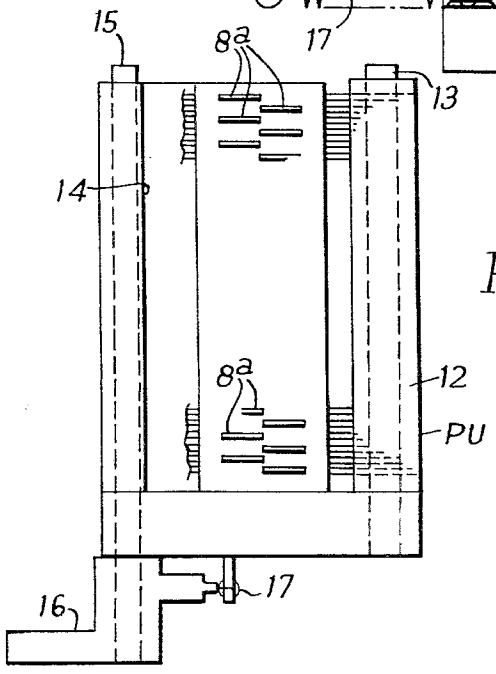

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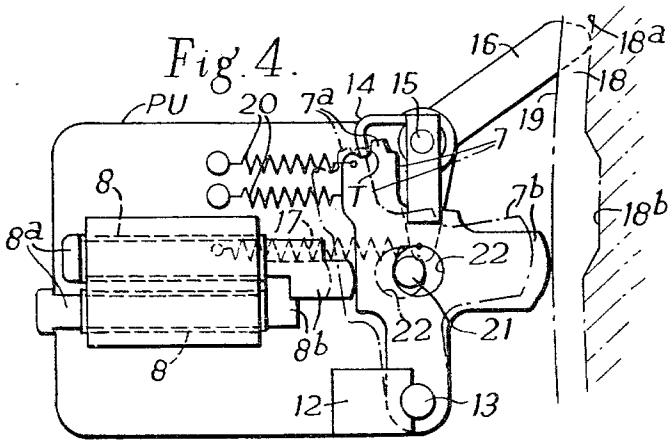
Fig. 4.



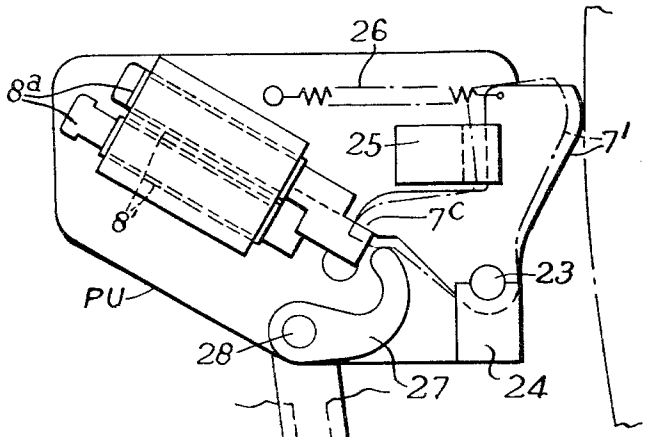


Fig. 5.

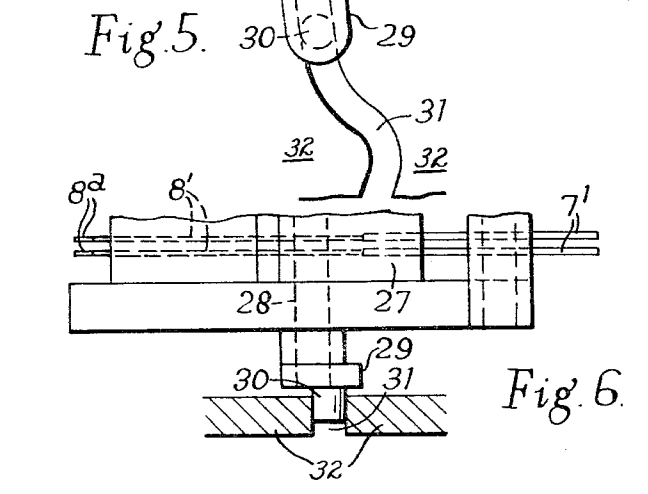


Fig. 6.

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Fig. 7.

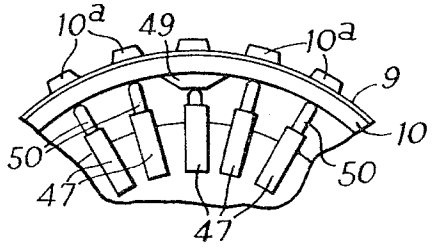

Fig. 8.

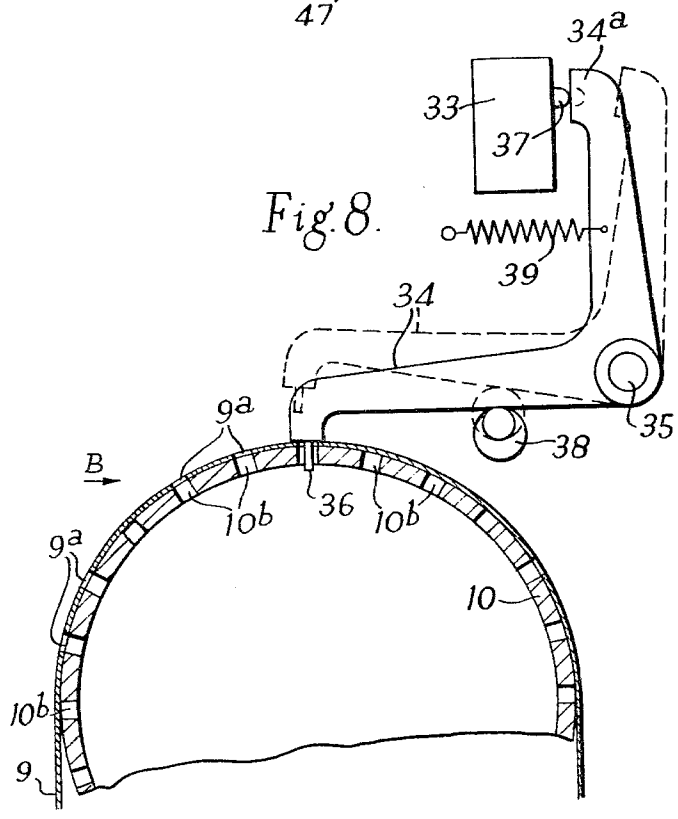

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Fig. 9.

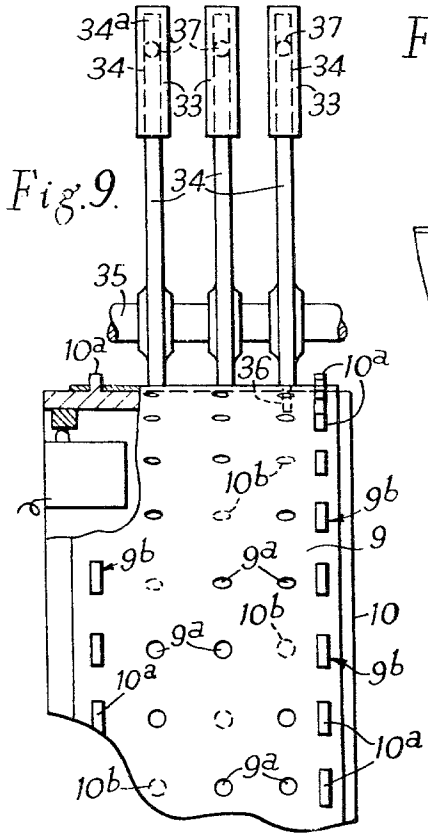


Fig. 11.

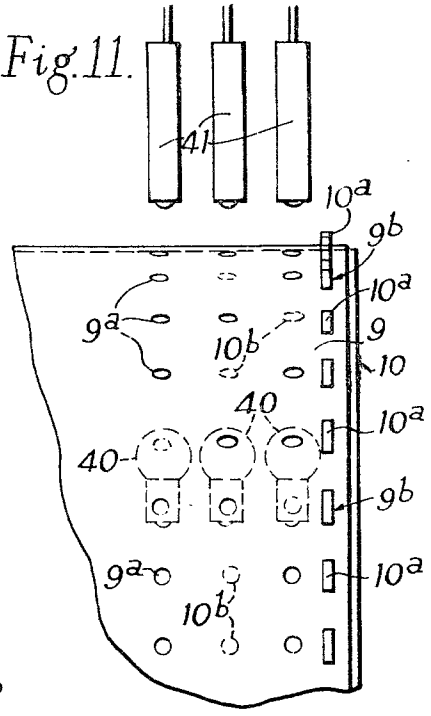
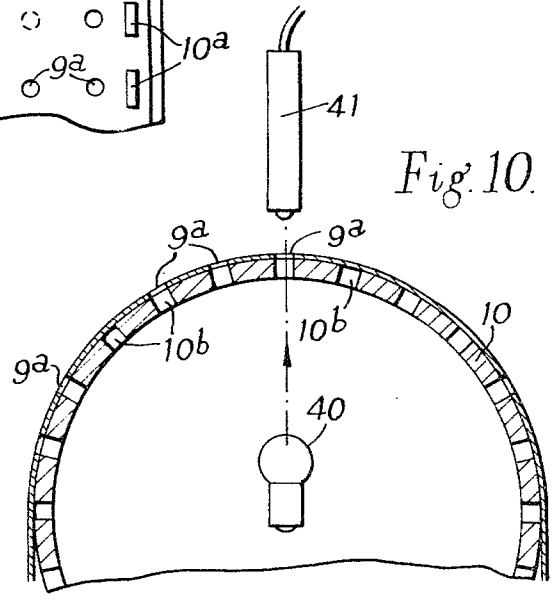


Fig. 10.



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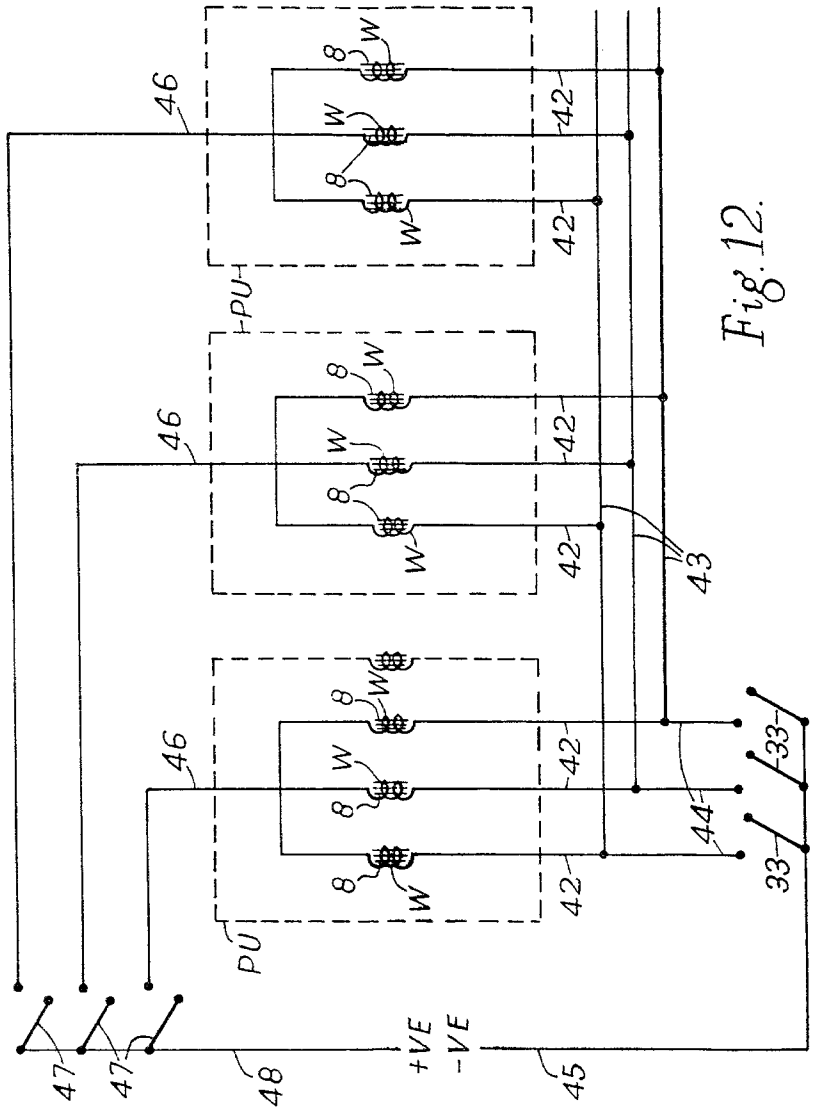

Fig. 12.

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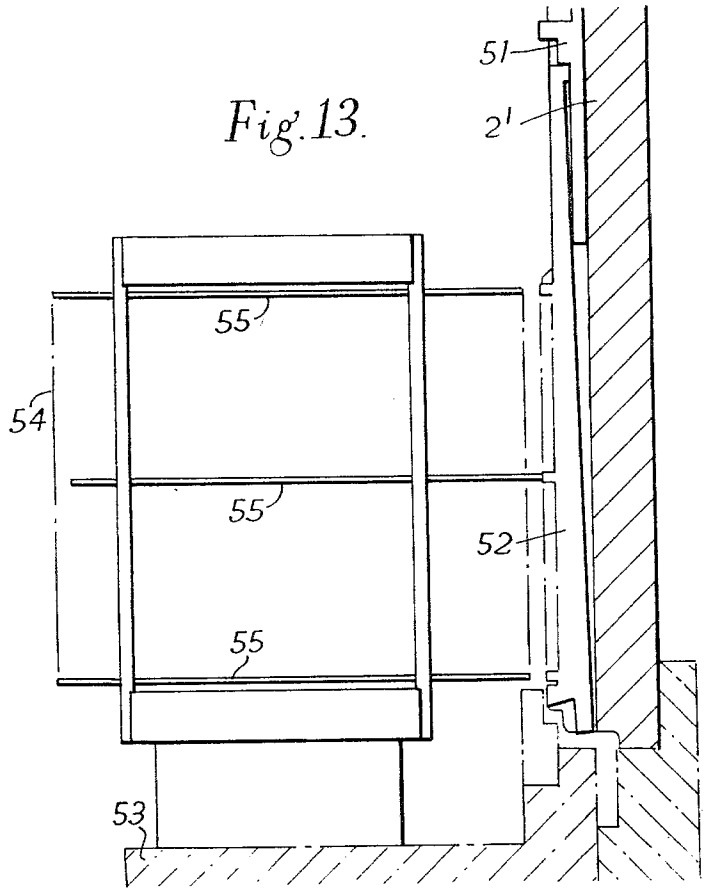
Fig. 13.



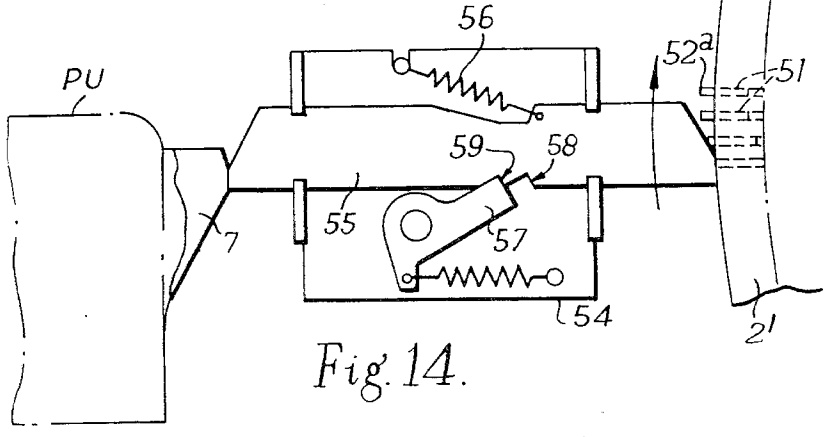


Fig. 14.

United States Patent Office

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PATTERNING MECHANISM FOR KNITTING MACHINES

Ernest L. Farmer, Leicester, England, assignor to Wildt Mellor Bromley Limited, Leicester, England, a British company

Filed Apr. 7, 1964, Ser. No. 357,945
Claims priority, application Great Britain, Apr. 10, 1963, 14,261/63
17 Claims. (Cl. 66—50)

This invention relates to knitting machines, more particularly circular knitting machines, and has reference to mechanism applied to such a machine for initiating, effecting or influencing selective actuation of knitting instrumentalities in the production of patterns and various patterning effects, according to requirements.

Thus, although broadly speaking, the patterning mechanism of this invention may be designed to determine selective actuation of, say, sinkers or analogous instruments, it is primarily the intention that it shall initiate or effect selective actuation of needles, in a cylinder or in a dial, such actuation being either direct, or through the medium of sliders or jacks of any convenient character, e.g. rocking jacks or spring jacks.

The invention, moreover, is concerned exclusively with multi-feed knitting machines equipped with one or more patterning units for determining selective actuation of knitting instrumentalities at each of two or more or all of the feeds, and in this regard appertains solely to patterning mechanism of the kind comprising, in combination, at least one patterning unit including a bank of individually movable selector members selectively operable for the purpose of in turn initiating, effecting or influencing selection of desired needles, and an associated stack of actuators for selectively actuating the said members and means for controlling selective activation of the actuators, according to knitting requirements.

Heretofore, in a patterning mechanism of this kind comprising a plurality of circumferentially spaced patterning units at the relevant feeds, a separate control has commonly been provided for motivating each patterning unit.

The primary object of the present invention is to provide, in a circular multi-feed knitting machine, a generally improved form of patterning mechanism of the kind referred to herein.

A particular object of the invention is to provide, in such a machine, a patterning machanism of the kind herein referred to in which a single improved and particularly sensitive and efficient control is provided for sequentially motivating and controlling at least two or more of the patterning units.

Another aim is the provision, in such a patterning mechanism, of a single central program control for selectively influencing the actuators of all of a plurality of stacks seriatim.

According to this invention, electro-magnetic actuators are employed, and a control for the, or each, stacks of these actuators comprises a relatively thin and flexible strip or band which is movable at a speed related to, or in time with, the rotary motion of the circular knitting machine and has formed therein dispositions of holes predetermined in accordance with the pattern it is desired to produce in the knitwear, the apertured and unapertured portions of the movable control strip or band being designed to influence the operation of switch means arranged in circuitry incorporating the electro-magnetic actuators, and the selector members in the bank associated with the aforesaid stack of electro-magnetic actuators being individually adapted for co-operation with a common element which latter is so formed and movable,

in time with each successive selection of the said selector members of the bank, as to effect or assist in effecting a positive separation of the selected from the unselected members and to firmly hold the selected members in their operative positions until the next succeeding selection of the said members.

To permit of the next selection of the selector members in the, or each, bank the associated common element is withdrawn from the previously selected members to release these for return to their inoperative positions.

In the application of the invention to a multifeed circular knitting machine of the revolving cylinder type, a plurality of circumferentially spaced stationary patterning units are provided, these units, preferably one to each feed, being suitably grouped around the rotary cylinder, and a single control strip or band is provided for selectively influencing the electro-magnetic actuators of the spaced stacks seriatim.

Where, as may be, the invention is applied to a stationary cylinder machine, then only one stationary patterning unit will be provided, and this will be used for selectively actuating seriatim a plurality of stacks of movement-transmitting members grouped around the cylinder and arranged to rotate in unison with the rotary cam box of the machine, the movement-transmitting members of each stack in turn passing by the bank of selector members in the single patterning unit and functioning to transfer the selection of the said selector members to the knitting instrumentalities concerned.

But whereas in a revolving cylinder machine each of the plurality of stacks of electro-magnetic actuators is selectively controlled only once per revolution of the machine, in a stationary cylinder machine the single stack of such actuators must be similarly controlled by a number of times per revolution corresponding to the total number of stacks of movement-transmitting members revolving with the cam box.

Although in a revolving cylinder machine the stacks of electro-magnetic actuators of a number of the patterning units less than the total number of such units provided in the machine may be incorporated into one group of circuits including switch means influenced by a single apertured control strip or band, it will be assumed for convenience in the following further description without, however, any limitation in this respect, that selective actuation of the electro-magnetic actuators of all the patterning units in the machine, allocated one to each feed, will be controlled from only one centralised control band or strip.

It will also be assumed in the following further description that the stack or stacks of electro-magnetic actuators and the corresponding bank or banks of selector members are vertically disposed and adapted for initiating, effecting or influencing selective actuation of needles in a cylinder.

In order that the invention may be more clearly understood and readily carried into practical effect, specific constructional examples of the improved patterning mechanism as applied to a circular multi-feed knitting machine will now be described with reference to the accompanying drawings, wherein,

FIGURE 1 is a perspective view of a portion of the knitting head of a circular rotary cylinder machine, showing a few of the patterning units grouped thereround and a single centralised control band or strip for influencing the corresponding stacks of electromagnetic actuators,

FIGURE 2 is a side elevation of a patterning unit of one form included within the scope of the invention, this unit being shown adjacent to a vertical section of a portion of the rotary machine cylinder,

FIGURE 3 is a further elevation of the same as seen in the direction of the arrow A in FIGURE 2,

FIGURE 4 is a plan view of the same unit showing selector members in selected and un-selected positions,

FIGURE 5 is a plan view, corresponding to FIGURE 4, illustrating a particular form of patterning unit which it is preferred to incorporate into the improved patterning mechanism,

FIGURE 6 is a side elevational view of the said preferred form of unit and also in section, a cam track for operating a presser lever common to all of the electro-magnetic actuators and selector levers in the said unit, as and for the purpose hereinafter to be described,

FIGURE 7 represents a fragmentary portion of the hollow control drum of the machine, and depicts a few of a circular series of micro-switches arranged at fixed locations therein,

FIGURE 8 is a diagram showing one of a series of mechanically operated levers which are controlled by the control strip or band and are arranged selectively to operate further micro-switches included in the circuitry incorporating the electro-magnetic actuators,

FIGURE 9 is a front view of the drum, the control strip or band and the levers as seen in the direction of the arrow B in FIGURE 8,

FIGURES 10 and 11 are two views corresponding to FIGURES 8 and 9 respectively illustrating an alternative in which photo-electric switch-influencing means are provided,

FIGURE 12 is an electrical circuit diagram incorporating the solenoids of the electro-magnetic actuators, and

FIGURES 13 and 14 are two views corresponding to FIGURES 2 and 4 respectively illustrating a modified arrangement of the improved patterning mechanism applicable to a circular knitting machine of the stationary cylinder type.

Like parts are designated by similar reference characters throughout the drawings.

In FIGURE 1, the rotary machine cylinder is indicated at **2** and the relatively stationary cam box or shell at **3**. The numeral **4** indicates an annular plate from which the cam box **3** is supported.

In the specific example illustrated, the rotary cylinder **2**, in which independently slidable latch needles (not shown) are mounted, also contains spring jacks such as **5**—one beneath each needle for controlling the same, according to patterning requirements. These jacks are accommodated within a downward extension of the cylinder, and each of them is furnished, with a main operating butt **5***a* and a spring extension **5***b* provided at its lower end with a bottom butt **5***c*. Normally, the extensions **5***b* are outwardly inclined away from the backs of the cylinder grooves or tricks **2***a* in which the jacks **5** are located, with the bottom butts **5***c* projecting outwardly from the cylinder surface for action upon a relevant jack raising cam or cams. Raising of a predetermined jack may serve to dispose its main operating butt **5***a* in the range of other cams. In front of each springy extension **5***b* and located within the same groove or trick **2***a* as the corresponding jack, is a jack selector **6**. Each such selector is provided with a butt **6***a* at a predetermined height. Initially, each selector **6** may be formed with a full complement of superimposed frangible butts predetermined ones of which are judiciously broken off to provide the butt layout necessary to produce the desired pattern. Whenever a selector **6** is selectively pressed inwardly to the position shown in FIGURE 2, it also presses in the underlying jack extension **5***b* as a consequence of which the corresponding bottom butt **5***c* is withdrawn into and buried in the cylinder **2** so that the relevant jack **5** remains down, i.e. is not raised, all as well known to those acquainted with the art concerned.

Secured upon the top of the annular plate **4**, and grouped around the rotary cylinder **2**, one to each feed of the machine, are stationary patterning units PU each including a bank of selector members in the form of pivoted levers **7** selectively operable for the purpose of influencing selection of desired needles, through the medium of the jacks **5** and their selectors **6**, and an associated stack of electro-magnetic actuators **8** for actuating the selector levers **7**.

For controlling selective activation of the electro-magnetic actuators **8** of the various patterning units PU, according to knitting requirements, there is provided a single, centralised control strip or band **9** mounted upon a drum **10**. As shown in FIGURE 1, this drum **10** is mounted for rotation, in time with the rotary motion of the machine cylinder, between two spaced side frame members **11**. The nature of the control strip or band **9** and of the drum **10** upon which it is mounted will be hereinafter fully described.

The superimposed selector levers **7** in each bank are mounted in a comb **12** adapted to maintain heightwise separation of the levers, each of the latter being formed at its free end with a tapered nose **7***a* and intermediate its ends with a suitably profiled neb **7***b* for action upon jack selector butts **6***a* disposed at the corresponding height. It will accordingly be appreciated that in the form of the invention illustrated in FIGURES 2 and 3, the selector levers **7** are intended for action upon such butts **6***a*, although it is possible to visualise an embodiment in which the said operating butts are provided directly upon needles, sliders or jacks, i.e. without the interposition of any elements between the nebs on the selector levers **7** and the relevant operating butts.

In any event, any appropriate conventional layout of operating butts may be provided in conjunction with the complete circular set of patterning units PU. For example, the layout of the jack selector butts **6***a* may consist of circumferentially spaced diagonally or obliquely extending parallel lines of the butts arranged right around the cylinder **2**. For a layout of this nature the selector levers **7** of each bank may be of progressively longer lengths, or at least the profiled nebs **7***b* on the levers will require to be so relatively offset with respect to one another as to provide a diagonally or obliquely extending line of such nebs. Or similar lines of butts may be alternately reversely inclined around the cylinder to provide a geometrical (mirror reverse) butt layout, again all as well known to those acquainted with the art.

Where, as will usually be the case, there is, in each bank, a comparatively large number of relatively thin selector levers **7** spaced fairly close together, in the manner shown in FIGURES 2 and 3, it may be found necessary or desirable to dispose the corresponding number of electro-magnetic actuators **8** in the associated stack in some suitable staggered relation like that clearly shown in FIGURE 3. This is because the actuators in at least some cases, and however midget in character, will nevertheless usually be of somewhat greater thickness than the corresponding selector levers **7**. That is to say, by offsetting some of the actuators **8** in each stack with respect to the remainder, the whole stack, notwithstanding the thickness of the actuators, can be readily reduced to the same height as the corresponding bank of selector levers **7**.

In accordance with an important feature of the invention, each of the electro-magnetic actuators **8** in each stack—there being one such actuator to each selector lever **7** of the corresponding bank—consists of a midget solenoid of push type, spring return, the armature **8***a* of which is in the form of a slender pin or, as shown, flat blade having its inner end **8***b* directed towards the back edge of the relevant pivoted selector lever **7**. The armature **8***a* is surrounded by and extends axially through a winding which is encased in a small casing of comparatively flat cross-section. Momentary closure and subsequent opening of relevant switch means in the electrical circuitry hereinafter to be described, as determined by means controlled by the centralised control strip or band

9, will so energise and thereupon immediately de-energize the solenoid 8 as to effect first a rapid projection and then an immediate retraction of the armature 8*a* thereof. But in being so projected, the slender inner end 8*b* of the armature 8*a* will sharply act edgewise upon the corresponding selector lever 7 so as to select it by swinging it about the vertical pivot pin 13 from its inoperative position indicated in chain lines in FIGURE 4 into its operative position indicated in full lines in the same figure in which operative position it will act upon jack selector butts 6*a* disposed at the same height. If, however, any solenoid 8 in a stack is not so energized and de-energised during selective operation of the selector levers 7 in the relevant bank, then the corresponding selector lever will not be kicked and will thus remain unselected in its inoperative position. Consequently, each time the selector levers 7 of any one patterning unit PU are selectively operated, some of them will be "selected" and the remainder will be "un-selected" in the senses just described, as determined by selective energisation and de-energisation of the stack of solenoids 8 of the unit—in turn controlled by apertured and un-apertured portions of the control strip or band 9.

In carrying out a further aspect of the invention already broadly described herein, there is provided for cooperating with the tapered noses 7*a* at the free ends of all the pivoted selector levers 7 of each bank a common catch 14 of blade-like form (see FIGURES 3 and 4) which, immediately following each selection of the said levers, is quickly moved fowards into a V-shaped trough T (FIGURE 4) opened up between the rear and the front edges of the tapered noses 7*a* of the selected and the unselected levers respectively, the catch 14 in this position serving to positively separate the selected from the unselected levers 7 and also to securely lock the latter in their respectively operative and inoperative positions. Immediately prior to a re-selection of the selector levers 7 in the manner already described, however, the common blade-like catch 14 must be automatically withdrawn to free the selector levers 7.

The blade-like catches 14 of the respective patterning units PU may, if desired, be automatically operated seriatim by mechanical means. For example, in the illustrated arrangement, each such catch is vertically disposed and extends the full height of the relevant bank of selector levers 7, being directed edgewise with respect to the tapered noses 7*a* thereof. The catch is mounted upon a vertical spindle 15 which at its lower end is secured in a pivoted lever 16 controlled by a spring 17. The free end of this catch-operated lever 16 is arranged to be permanently in contact with a rotary edge cam 18*a* constituted by the back of a rabbet 18 formed in the outer face of a ring 19 attached to the bottom of the rotary cylinder 2. In the edge of the cam 18*a* is formed a suitably shaped and dimensioned recess 18*b*, the idea being that so long as un-recessed edge portions of the cam 18*a* are in contact with the free end of the catch-operating lever 16, the catch will be securely held, against spring action, in the aforementioned V-shaped trough T opened up between the tapered noses 7*a* of selected and un-selected levers 7, whereas whenever the said free end of the catch-operating lever is permitted to drop under the spring influence into the recess 18*b* in the cam edge, the catch will be momentarily withdrawn from engagement with the tapered noses 7*a*, thereby temporarily freeing the selector levers for re-selection.

Each time the selector levers 7 of each bank are so released, the previously selected levers must be automatically moved back from their operative into their inoperative positions and this movement may be effected mechanically by means of springs 20 (FIGURE 4).

Instead of being mechanically operated, the catch-operating lever 16 may be automatically operated by electromagnetic means. In this case the catch 14 may be attached to or linked with the armature of a solenoid which may be wired into an electrical circuit in the manner hereinafter to be described.

In either event the operative and inoperative positions of the selectors levers 7 of each bank are determined by a vertical abutment pin 21 common to all of such levers in said bank. This pin extends through circular holes 22 which are formed in the levers and are of a diameter substantially exceeding that of the pin. Thus, each time a lever 7 is selected and moved into its operative position one side of the hole 22 in the lever will come into contact with the outermost side of the abutment pin 21 which determines the said operative position. On the other hand, each time the lever is released to return to its inoperative position the opposite side of the hole 22 will come up against the innermost side of the pin.

The preferred construction, arrangement and operation of a patterning unit PU, however, will now be described with reference to FIGURES 5 and 6. In this further example, the selector levers 7′ are mounted to turn about a vertical pivot pin 23 and are separated and guided by means of two combs 24 and 25 arranged as in FIGURE 5. Tension springs 26 bias the levers 7′ towards their inoperative positions indicated in chain lines. In this case, a common element in the form of a presser lever 27 is associated both with the selector levers 7′ and the electromagnetic actuators 8. This common presser lever 27 is mounted to turn about the axis of a vertical spindle 28. As will be seen, the said lever is of curved form in transverse cross-section and extends the full height of the complete bank of selector levers. At its lower end the spindle 28 extends beneath the patterning unit PU and has rigidly attached thereto a short arm 29. At its free end this arm carries a downwardly extending pin 30 which is arranged to work in a cam track 31 formed in a part 32 rotating together with the machine cylinder 2. The operation of this preferred form of the patterning unit is such that prior to each successive selection of the pivoted selector levers 7′ the common presser lever 27 is automatically turned anti-clockwise (as viewed in plan in FIGURE 5), with the result that not only will all of the selector levers 7′ in the bank be turned about the pin 23 into their operative (full line) positions, but also all of the electro-magnetic actuators 8′ in the associated stack will be pushed back into their inoperative positions. The solenoids 8′ are each of the push type and the armatures thereof are not returned by springs but by cams (not shown). Then, at the instant of selection, desired ones of the electro-magnetic actuators (solenoids) 8′ will be momentarily energised whilst the remainder of said actuators are not so energised, and at the same time the common presser lever 27 will be swung back to its original position in a clockwise direction. The result is that the momentarily energised actuators 8′ will be projected forwards and follow the tip of the clockwise turning lever 27, these selected actuators remaining in their projected positions and engaging the tails 7*c* of the corresponding, i.e. selected, levers 7′ to hold and lock the latter in their operative positions. On the other hand, the unselected actuators 8 which are not energised will remain in their retracted positions to which they were previously pushed by the common presser lever 27, thereby enabling the tails 7*c* of the unselected levers 7′ in the bank to follow the tip of the lever 27. Consequently, whilst the selected levers 7′ are locked by the energised actuators 8 in their operative positions, the un-selected levers 7′ will be permitted to fall back into the inoperative positions under the influence of their springs 26. Thus, in this particular example, the selected electromagnetic actuators and the common presser lever 27 cooperate in effecting a separation of the selected from the un-selected levers 7′, and the selected levers are held in their operative position by the corresponding actuators 8′.

Referring now to the relatively thin and flexible control strip or band 9 which is movable in time with the rotary motion of the machine, this may conveniently consist of a web of reinforced paper, card or film similar

to that provided in any conventional jacquard patterning system, the said web, punched with holes 9*a* in predetermined positions, being mounted upon the control drum 10 which is adapted to be driven either continuously, through the medium of gearing, or intermittently through a rack wheel, a geneva motion or the like driven by or from the machine. At its opposite ends the control drum 10 is furnished with circular series of uniformly spaced teeth 10*a* adapted to engage with correspondingly spaced holes 9*b* formed in the longitudinal edges of the web 9 of paper, card or film.

Conveniently, the control drum 10 is of hollow cylindrical form, and has formed, right through its wall, holes 10*b* which are disposed in straight and axially extending parallel rows, there being as many rows of such holes as there are numbers of web or card-retaining teeth 10*a* at each end of the drum and the rows being circumferentially spaced to correspond with the teeth spacing. The holes 9*a* judiciously punched in the control web 9 of paper, card or film at predetermined points are also arranged in straight rows to correspond with the holes 10*b* machined in the cylindrical drum 10. That is to say, punched holes 9*a* at predetermined points in each row in the paper, card or film 9 register and are congruent with the corresponding holes 10*b* of the relevant axial row formed in the drum 10; thus, across each of the axially extending, uniformly spaced lines on the paper, card or film 9 coincident with a complete axial row of holes 10*b* in the drum there will be interspersed apertured and un-apertured portions of the web—the apertured portions registering with holes in the drum and the un-apertured portions covering such holes, all in accordance with conventional "jacquard" practice.

The idea is that each axial row of interspersed holes 9*a* and un-apertured portions in and of the control strip or band 9, shall determine the selective operation of a corresponding series of switches such as 33 (FIGURES 1, 8 and 12) arranged in that part of the complete circuitry relating to one only of the stacks of electro-magnetic actuators 8'. It is accordingly the primary intention that of this series of switches 33 there shall be one for each of the selector levers 7 or 7' in the particular bank correspnding to the said stack of actuators.

The axial rows of interspersed holes 9*a* and unapertured portions in and of the control strip or band 9 may advantageously determine the selective operation of the corresponding series of switches 33 through any appropriate switch-influencing means. Consequently, each time a complete row of holes 10*b* in the control drum 10 (some of which holes are covered and others are left un-covered by the control strip or band 9, according to patterning requirements) comes opposite to the switch-influencing means, predetermined ones of the aforementioned series of switches 33 will be momentarily closed to energize the relevant electro-magnetic actuators 8 and so either kick selected selector levers 7 of the associated bank from their inoperative into their operative positions (FIGURES 2, 3 and 4) or simply hold and lock selected levers 7' in their operative positions to which they have previously been moved by the presser lever 27 (FIGURES 5 and 6), whilst the remaining switches 33 of the said series will not be operated and the corresponding un-selected levers will, therefore, either remain in or return to their inoperative positions, as the case may be.

As successive rows of holes 10*b* in the control drum 10 progressively pass by the switch-influencing means, by virtue of the continuous or intermittent rotation of the drum, successive re-selection of the series of switches 33 controlling momentary energization of the electro-magnetic actuators 8 in successive stacks around the machine will be effected.

In the specific arrangement illustrated in FIGURES 8 and 9 mechanically operated switch-influencing means are provided. Thus, as will be seen, there are arranged adjacent to the single control drum 10 one set of individually operable, spring-influenced switch-operating levers 34. These levers 34 are so spaced apart on a spindle 35 about which they are free to turn that there is one such lever in line with each of a complete axial row of holes 10*b* in the drum 10. At one end each switch-operating lever 34 is formed with a down-turned slender portion, or is provided, as shown, with a downwardly directed pin 36, disposed in alignment with the relevant control drum hole 10*b* in the row. The opposite end of each lever 34 is formed with an upwardly directed nose-like protuberance 34*a* for action on the spring-controlled plunger 37 of one of a straight line of the switches 33 which are micro-switches. A small rotary cam 38, common to all the switch-operating levers 34 of the set, is arranged for action on the undersides of the latter—in opposition to the springs 39 influencing the same (see FIGURE 8). The cam 38 rotates in a suitably timed relation with the continuous or intermittent rotary motion of the control drum 10. The arrangement is such that the cam 38 as it continuously rotates alternately lifts the appropriate switch-operating levers 34 against their springs 39 to ensure that the slender portions or pins 36 of all the levers of the set are held withdrawn from holes 10*b* in the drum 10, thereby freely permitting the next increment of turning movement of the latter, and then releases all of the said levers so that those which are permitted to do so will move down under the spring action (by virtue of the slender portions or pins 36 of those levers entering holes 9*a* in the control strip or band 9) to move their nose-like protuberances 34*a* into contact with the plungers 37 of the corresponding micro-switches 33 whereas the slender portions or pins 36 of the remaining switch-operating levers will be held up by un-apertured portions of the control strip or band 9 so that the nose-like protuberances 34*a* of such remaining levers will be held back clear of the relevant micro-switch plungers 37.

In the alternative arrangement illustrated in FIGURES 10 and 11, however, photo-electric switch-influencing means are provided. In this case, a single light-radiating tube, or a single row of individual light bulbs such as 40, one to each hole of an axial row in the control drum 10, is located within the latter and on the outside of the same there is provided a row of photo-electric cells 41 each wired up to one of a series of appropriate switches (not shown). This alternative arrangement is, therefore, such that each time an axially extending row of holes 10*b* in the drum 10 is brought opposite to the row of photo-electric cells 41, those cells which are then in line with holes 9*a* in the control strip or band 9 will be activated by the light permitted to shine therethrough to effect a momentary operation of the relevant switches, whereas those photo-electric cells 41, which are opposite to un-apertured portions of the said strip or band will be masked from light as a consequence of which the remaining switches will not be operated.

Turning now to the electrical circuitry, one convenient arrangement of this is depicted in FIGURE 12 and is as follows:

One end of the winding W of each of the solenoids 8 in each stack is connected by a wire 42 to one of a series of circumferentially extending bus-wires 43 by means of which all of the stacks are series-connected. These bus-wires 43, the number of which thus correspond to the number of selector levers in each bank, are arranged beneath the annular plate 4 (see FIGURE 1). A wire 44 is in turn tapped off each of the bus-wires 43 and is connected to one side of a micro-switch 33 the opposite side of which is connected to the negative side 45 of a source of electrical energy, e.g. a so-called power pack. As previously implied there is thus a number of these micro-switches 33 corresponding to the number of solenoids 8 in each stack and hence to the number of selector levers 7 or 7' in each bank. The said micro-switches 33 are fixed and arranged in a straight row adjacent to the

switch-influencing means. The opposite end of the winding W of each of the solenoids 8 in each stack is connected to a single common wire 46 which leads to one side of one of a second series of micro-switches 47, the opposite side of each of which is connected to the positive side 48 of the source of electrical energy. Thus, in the second series of micro-switches 47 there is also one per patterning unit PU. The micro-switches 47 of the second series are arranged in a circle at fixed locations within the hollow control drum 10 and are spaced apart circumferentially to correspond with the spacing of the axially extending rows of holes 10*b* in the said drum (see FIGURE 7). Projecting radially inwards from the inner surface of the wall of the hollow drum 10 is a protuberance 49 which is disposed in the path of the plungers 50 of the micro-switches 47 of the second series. Thus, each time, during continuous or intermittent rotation of the drum, this protuberance 49 moves over the plunger 50 of a micro-switch 47 the positive side of the source of electrical energy will be connected to the solenoids 8 of the corresponding stack, the micro-switches 33 of the first series being simultaneously selectively operated so that those solenoids of the stack corresponding to the momentarily closed micro-switches 33 of such first series will be energised either to project the revelant selector levers 7 from their inoperative into their operative positions (FIGURES 2, 3 and 4) or to lock the selected selector levers 7' in their operative positions (FIGURES 5 and 6), as aforesaid. Consequently, as the control drum revolves, in time with the rotation of the machine cylinder 2, selections of knitting instruments will be successively effected by the patterning units PU at the feeds seriatim.

The examples of the invention so far described have all been applied to a circular knitting machine of the rotary cylinder type. As previously mentioned, however, the invention may also be applied to a multifeed circular knitting machine wherein the machine cylinder is stationary and the cam box revolves. In this case, only one stationary patterning (i.e. selector) unit is provided and this is adapted to co-operate with a plurality of stacks (one to each feed) of individually slidable and spring-influenced pressers, each stack comprising as many pressers as there are selector members in the single stationary bank, and the said stacks being grouped around and arranged to revolve in unison with the rotating cam box for the purpose of transmitting movements from the selected selector members to jack selectors or equivalent instruments in the stationary cylinder. Such an arrangement is diagrammatically illustrated in FIGURES 13 and 14 wherein the stationary cylinder is indicated at 2'. In this case the said cylinder is equipped with needle-operating jacks 51 and corresponding selectors 52 having patterning butts 52*a*. The single stationary patterning unit is indicated at PU and is of a form similar to each of the plurality of patterning units applied to a revolving cylinder machine. That is to say, the single unit PU comprises a bank of selector members and a corresponding stack of electro-magnetic actuators therefor combined with means for effecting or assisting in the separation of the selected from the unselected selector members at each successive selection of the same. Mounted on a component 53 which rotates in unison with the cam box are a number of stacks 54 of presser slides 55, these stacks—one to each feed—being suitably grouped around the stationary cylinder 2'. There are as many superimposed presser slides 55 in each stack 54 as there are pivoted selector members 7 in the single stationary patterning unit. As will be seen in FIGURE 14 each slide 55 is controlled by a tension spring 56, and there is provided in association with all the slides a common spring-loaded catch 57. This catch engages in one of two recesses 58 and 59 in each presser slide 55 to hold the latter either forwards in its selected position or in a rearward inoperative position. Any suitable means are provided to effect automatic release of the catch 57 between successive selections, to release relevant presser slides 55 in each stack 54 in turn and thereby enable all such slides to be inoperative preparatory to a fresh selection. As will be appreciated, instead of the selector members 7 acting directly upon butts of the jack selectors as in the case of a revolving cylinder machine, they act upon said butts (in the arrangement illustrated in FIGURES 13 and 14) through the medium of the intermediate presser slides 55 which simply function as movement transmitters.

I claim:

1. In a circular multi-feed knitting machine, in combination: a cylinder; selectable knitting instrumentalities in said cylinder; at least one patterning unit for determining selective actuation of said instrumentalities at each of a plurality of feeds, said patterning unit including a bank of individually movable selector members selectively operable for the purpose of influencing selection of desired instrumentalities; an associated stack of electro-magnetic actuators for selectively actuating said selector members; a flexible control web for controlling the said stack of actuators, said web being movable at a speed related to the rotary motion of the machine and having formed therein dispositions of holes predetermined in accordance with a desired pattern; switch means which are arranged in electric circuitry including the electro-magnetic actuators; means which are adapted to influence said switches and are in turn influenced by the apertured and un-apertured portions of the movable control web; and a common element which is movable in time with each successive selection of the said selector members of the bank and is adapted to bring about a positive separation of the selected from the unselected selector members and to hold the selected members in operative positions to which they are movable at appropriate times, the said common element being automatically withdrawn from selected members at appropriate times to release the latter for return to their inoperative positions.

2. A combination according to claim 1, wherein the selector members are in the form of pivoted levers each having a neb for action upon the knitting instrumentalities and are mounted in at least one comb adapted to maintain separation of said levers.

3. A combination according to claim 1, wherein needle actuating jacks are accommodated within the cylinder, and in association with said jacks there are provided jack selectors furnished with butts arranged to be acted upon by the selector members.

4. A combination according to claim 2, which includes a pivoted presser lever common to all the selector levers in the bank and all the electro-magnetic actuators in the associated stack; and a rotary component for automatically operating said presser lever, the operation of the latter being such that when it is turned in one direction, prior to a selection of the selector levers it pushes all of the latter into their operative positions and all of the electro-magnetic actuators into their inoperative positions, whereas whenever, at an instant of selection, the said presser lever is turned in the opposite direction, energized actuators are permitted to move forward to hold corresponding selector levers operative and non-energized actuators will remain back and permit the relevant selector levers to move back into their inoperative positions.

5. A combination according to claim 2, wherein each of the selector levers of the said patterning unit is formed at its free end with a tapered nose, and there is provided for co-operation with all said noses of the unit a common catch and means for operating the same, the operation being such that following each selection of the levers the catch is moved into a V-shaped trough opened up between opposed edges of the tapered noses of the selected and the un-selected levers respectively, the catch in this position positively separating the selected from the unselected levers and also to lock these levers in their respectively operative and inoperative positions.

6. A combination according to claim 5, wherein the catch extends the full length of the said bank of selector levers and is directed edgewise with respect to the tapered noses thereof, said catch being mounted on a spindle which is rigid with a spring-controlled pivoted lever arranged permanently in contact with a rotary edge cam driven from a rotary component of the machine.

7. In a circular multi-feed knitting machine in combination: a rotary cylinder; selectable knitting instrumentalities in said cylinder; a plurality of stationary patterning units grouped around said cylinder for determining selective actuation of said instrumentalities at each of a plurality of feeds, each of said patterning units including a bank of individually movable selector members selectively operable for the purpose of influencing selections of desired instrumentalities; and an associated stack of electro-magnetic actuators for selectively actuating said selector members; a flexible control web for selectively influencing the electro-magnetic actuators of the several stacks seriatim and in such a way that each stack is so influenced only once per revolution of the machine, said web being movable at a speed related to the rotary motion of the machine and having formed therein dispositions of holes predetermined in accordance with a desired pattern; switch means which are arranged in electric circuitry including the electro-magnetic actuators; means which are adapted to influence said switches and are in turn influenced by the apertured and un-apertured portions of the movable control web; and, in association with each patterning unit, a common element which is movable in time with each successive selection of the selector members of the relevant bank and is adapted to bring about a positive separation of the selected from the unselected selector members and to hold the selected members in operative positions to which they are movable at appropriate times, the said common elements being automatically withdrawn seriatim to release appropriate members of the relevant patterning units for return to their inoperative positions.

8. In a circular multi-feed knitting machine, in combination; a stationary cylinder; selectable knitting instrumentalities in said cylinder; a rotary cam box surrounding said cylinder; a single stationary patterning unit for determining selective actuation of said instrumentalities at each of a plurality of feeds; a plurality of stacks of movement-transmitting members grouped around the cylinder and rotatable in unison with said rotary cam box, each stack of movement-transmitting members in turn passing by the patterning unit and functioning to transfer selections of said members effected by the patterning unit to the knitting instrumentalities; said patterning unit including a bank of individually movable selector members selectively operable for the purpose of influencing selections of desired movement-transmitting members; an associated stack of electro-magnetic actuators for selectively actuating said selector members; a flexible control web for controlling the said stack of actuators, said web being movable at a speed related to the rotary motion of the machine and having formed therein dispositions of holes predetermined in accordance with a desired pattern; switch means which are arranged in electric circuitry including the electro-magnetic actuators; means which are adapted to influence said switches and are in turn influenced by the apertured and un-apertured portions of the movable control web; and a common element which is movable in time with each successive selection of said selector members of the bank and is adapted to bring about a positive separation of the selected from the unselected selector members and to hold the selected members in operative positions to which they are movable at appropriate times; the said common element being automatically withdrawn from selected members at appropriate times to release the latter for return to their inoperative positions, and the electro-magnetic actuators in the single stack being selectively influenced a number of times per revolution of the cam box corresponding to the cam box corresponding to the total number of stacks of movement-transmitting members.

9. In a circular multi-feed knitting machine, in combination: a rotary cylinder; selectable knitting instrumentalities in said cylinder; a plurality of stationary patterning units grouped around said cylinder for determining selective actuation of said instrumentalities at each of a plurality of feeds, each of said patterning units including a bank of individually movable selector members selectively operable for the purpose of influencing selections of desired instrumentalities, and an associated stack of electro-magnetic actuators for selectively actuating said selector members; a flexible control web for selectively influencing the electro-magnetic actuators of the several stacks seriatim and in such a way that each stack is so influenced only once per revolution of the machine, said web being punched with holes in predetermined positions and having spaced apertures in its longitudinal edges; a drum of hollow cylindrical form upon which said web is mounted, said drum being driven from the machine in timed relation therewith and having at its ends circular series of uniformly spaced teeth engageable in the aforesaid apertures, and there being formed right through the wall of the drum holes disposed in straight axially extending parallel rows corresponding in number with the number of web-retaining teeth at each end of the drum, said rows being circumferentially spaced to correspond with the teeth spacing, and the holes punched in the web also being arranged in straight rows to correspond with the holes formed in the cylindrical drum; a series of switches arranged in electric circuitry relating to one stack of electro-magnetic actuators and of which switches there is one for each of the selector members in the particular bank corresponding to the said stack of actuators; means for influencing said switches, each row of interspersed holes in, and un-apertured portion of, the control web determining selective operation of the aforesaid switches through the medium of the switch-influencing means; and, in association with each patterning unit, a common element which is movable in time with each successive selection of the selector members of the relevant bank and is adapted to bring about a positive separation of the selected from the unselected selector members and to hold the selected members in operative positions to which they are movable at appropriate times, the said common elements being automatically withdrawn seriatim to release appropriate members of the relevant patterning units for return to their inoperative positions.

10. A combination as claimed in claim 9, wherein the selector members are in the form of pivoted levers which are controlled by springs and are thereby adapted, whenever released, to move back automatically from their operative into their inoperative positions under the spring action.

11. A combination according to claim 9, wherein there is in each bank a large number of thin selector members spaced close together, and the corresponding electro-magnetic actuators in the associated stack are each of a greater thickness than a selector member, the said actuators being disposed in a staggered relation so that the whole stack is reduced to the same height as the said bank of selector members.

12. A combination according to claim 9, wherein each of the electro-magnetic actuators consists of a midget solenoid the armature of which is in the form of a flat blade having one end directed towards the back edge of the relevant selector member.

13. A combination according to claim 9, which includes a set of individually operable, spring-influenced switch operating levers arranged adjacent to said control drum, there being one such lever in line with each circumferential row of holes in said drum, and each lever having at one end a pin disposed in alignment with the relevant drum holes and at the other end a protuberance; a spindle upon

which the said switch operating levers are mounted for turning movement; a straight line of micro-switches having spring-controlled plungers arranged to be acted upon by the protuberances on the set of switch-operating levers, the said micro-switches being those arranged in the electric circuitry relating to one stack of electro-magnetic actuators; and a rotary cam which is common to all the switch-operating levers and is arranged for action on the undersides of the latter in opposition to the springs influencing the same, this cam rotating in timed relation with the rotary motion of the control drum and functioning to lift relevant switch operating levers clear of the drum to permit turning movement of the latter at appropriate times.

14. A combination according to claim 9, including at least one light source located within the control drum and arranged to shine through drum holes of one axial row at a time; and a row of photocells each wired up to one of the said series of switches, whereby each time an axial row of holes in the drum is brought opposite to the row of photocells, those cells which are in line with holes in the control web will be activated by the light permitted to shine therethrough, whereas those photocells which are opposite to un-apertured portions of the said webs will be masked from light and not so activated.

15. In a circular multi-feed knitting machine, in combination: a rotary cylinder; selectable knitting instrumentalities in said cylinder; a plurality of stationary patterning units grouped around said cylinder for determining selective actuation of said instrumentalities at each of a plurality of feeds, each of said patterning units including a bank of individually movable selector members selectively operable for the purpose of influencing selections of desired instrumentalities and an associated stack of electro-magnetic actuators each in the form of a solenoid comprising a winding through which extends an armature having one end directed towards the back edge of the relevant selector member; a flexible control web for selectively influencing the electro-magnetic actuators of the several stacks seriatim and in such a way that each stack is so influenced only once per revolution of the machine, said web being punched with holes in predetermined positions and having spaced apertures in its longitudinal edges; a drum of hollow cylindrical form upon which said web is mounted, said drum being driven from the machine in timed relation therewith and having at its ends circular series of uniformly spaced teeth engageable in the aforesaid apertures, and there being formed right through the wall of the drum holes disposed in straight axially extending parallel rows corresponding in number with the number of web-retaining teeth at each end of the drum, said rows being circumferentially spaced to correspond with the teeth spacing, and the holes punched in the web also being arranged in straight rows to correspond with the holes formed in the cylindrical drum; a series of switches arranged in electric circuitry relating to one stack of electro-magnetic actuators and of which switches there is one for each of the selector members in the particular bank corresponding to the said stack of actuators; means for influencing said switches, each row of interspersed holes in, and un-apertured portion of, the control web determining selective operation of the aforesaid switches through the medium of the switch-influencing means; and, in association with each pattern unit, a common element which is movable in time with each successive selection of the selector members of the relevant bank and is adapted to bring about a positive separation of the selected from the unselected selector members and to hold the selected members in operative positions to which are they movable at appropriate times, the said common elements being automatically withdrawn seriatim to release appropriate members of the relevant patterning units for return to their inoperative positions.

16. A combination according to claim 15, which includes: a series of bus-wires by means of which all of the stacks of solenoids are series connected; wires connecting relevant bus-wires to appropriate ends of the windings of the solenoids; wires tapped off the bus-wires and connected to relevant sides of the said series of switches; a source of electrical energy to the negative side of which the opposite sides of the said switches are connected, these switches being fixed and arranged in a straight row adjacent to the switch-influencing means; a second series of switches, a corresponding series of common wires each of which latter is connected at one end to one side of one of said second series of switches and at the other end to the end of the winding of the relevant solenoid remote from that aforesaid; there being in the second series of switches one per pattern unit, and the opposite sides of said last mentioned switches being connected to the positive side of the source of electrical energy.

17. A combination according to claim 16, wherein the switches of the said second series are arranged in a circle at fixed locations within the hollow control drum and are spaced apart circumferentially to correspond with the spacing of the axially extending rows of holes in said drum, a protuberance projecting inwards from the inner surface of the wall of the drum being disposed in the path of plungers of the said switches for the purpose herein described.

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DONALD W. PARKER, *Primary Examiner.*

RUSSELL C. MADER, *Examiner.*