Dec. 13, 1966 J. A. SCHAEDER ETAL 3,290,898

PATTERN CONTROL ARRANGEMENT FOR CIRCULAR KNITTING MACHINE

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FIG. 1

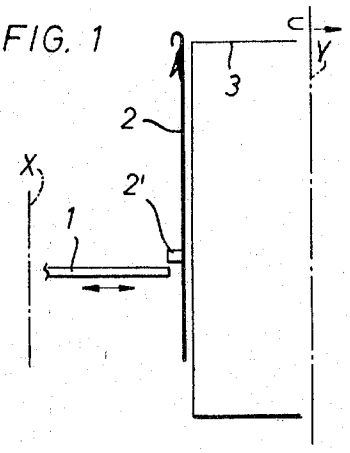


FIG. 1a

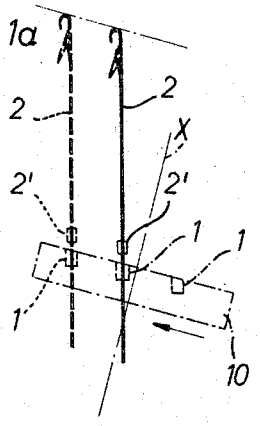


FIG. 2

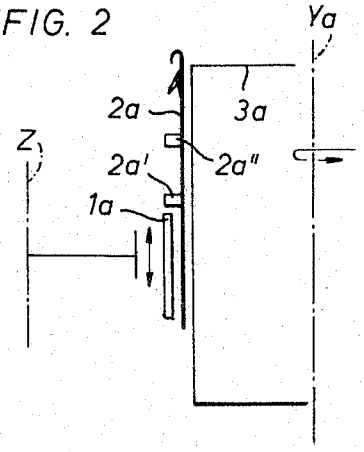
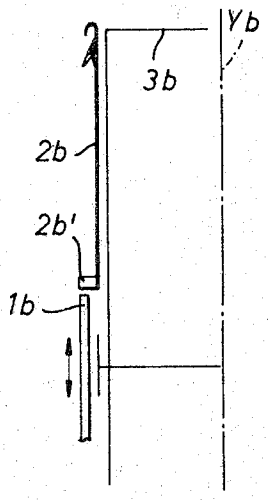


FIG. 3



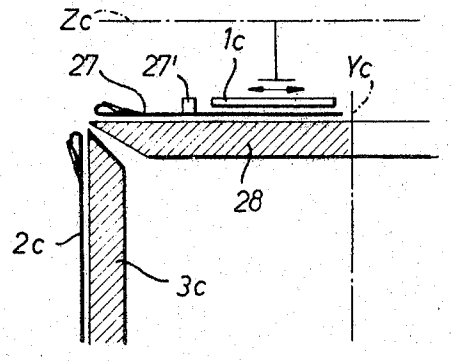


FIG. 4

Inventors
Johann Albrecht Schaeder
Richard Schmidt
by Richard J. Striker
Atty

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FIG. 5

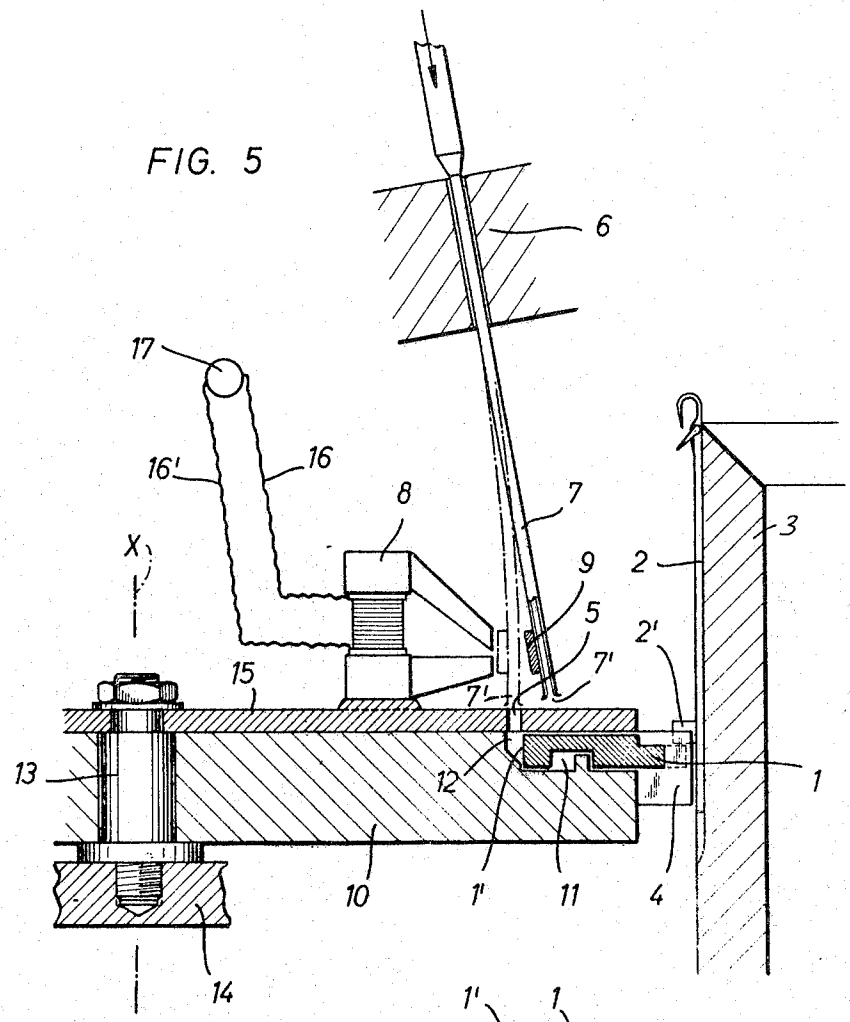
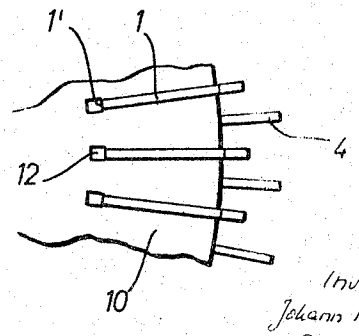


FIG. 5a



Inventors
Johann Albrecht Schaeder
Richard Schmidt
by
Michael J. Striker
Atty

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FIG. 6

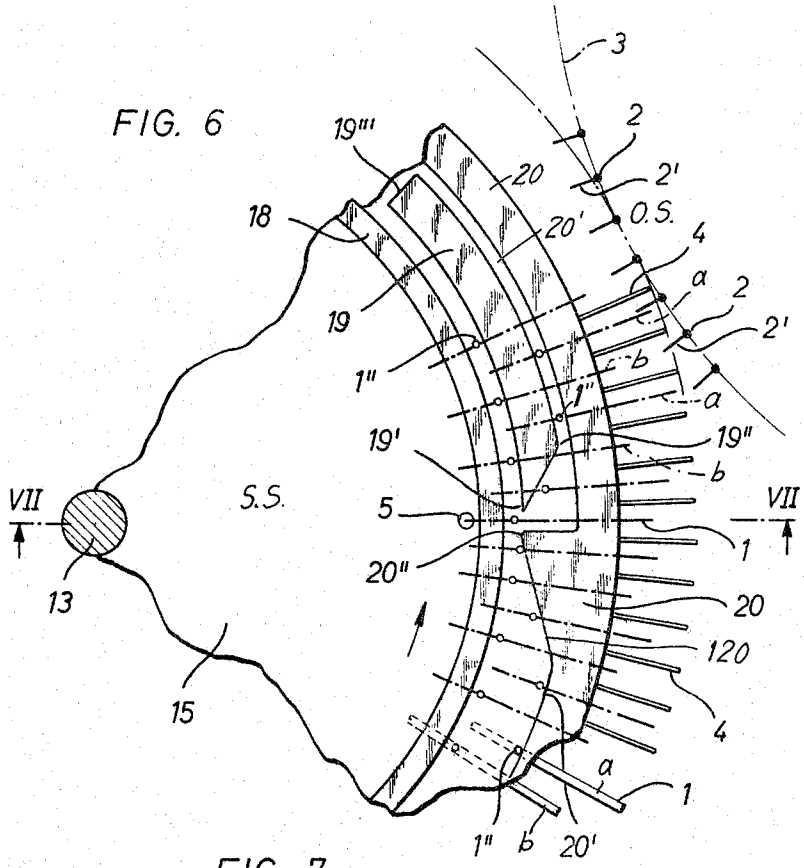
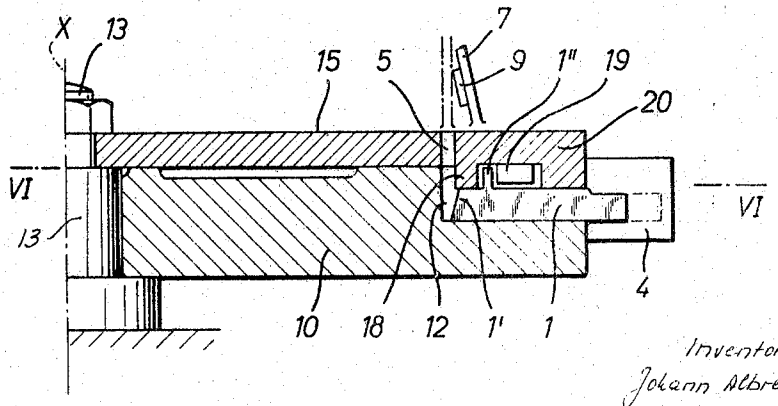


FIG. 7



Inventors
Johann Albrecht Schaeder
Richard Schmidt

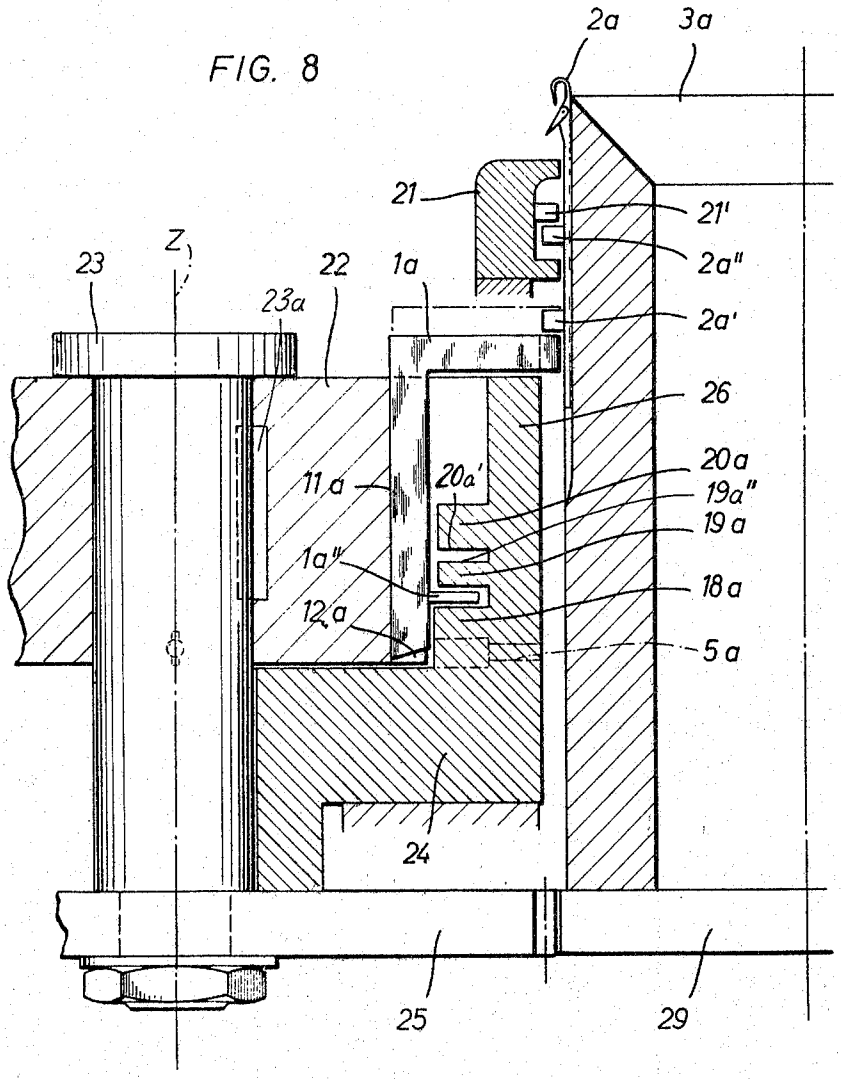
by
Michael S. Striker
Atty

Dec. 13, 1966 J. A. SCHAEDER ETAL 3,290,898

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FIG. 8



Inventors
Johann Albrecht Schaeder
by
Richard J. Striker
Atty

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FIG. 9

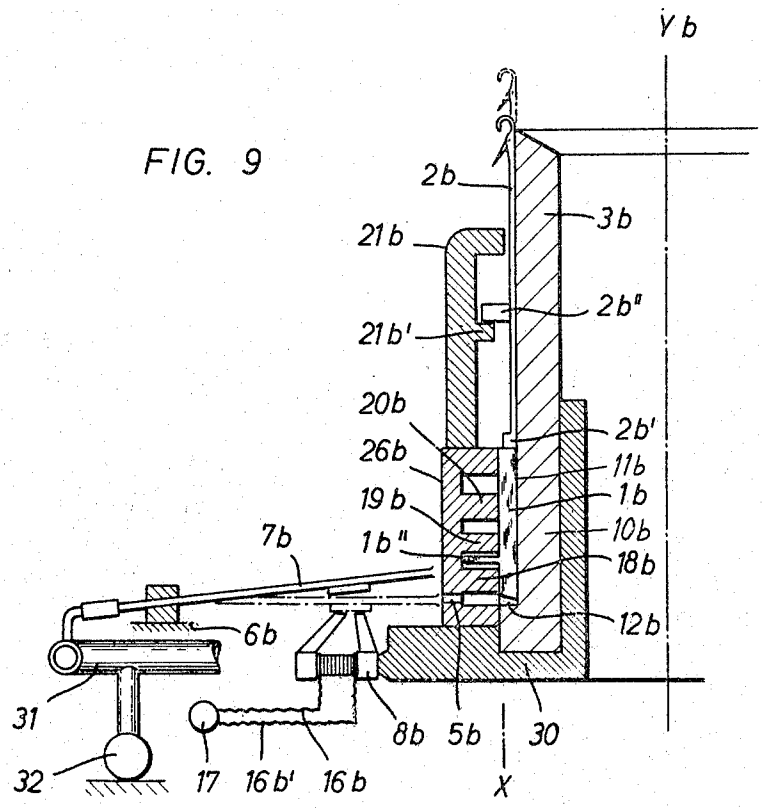
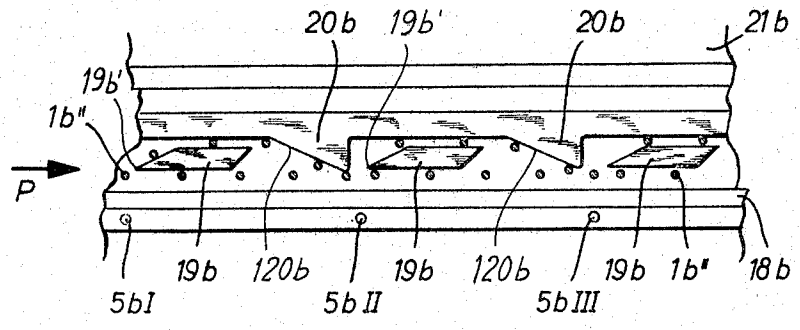


FIG. 10



Inventors
Johann Albrecht Schaeder
Richard Schmidt

by Richard J. Striker

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3,290,898

PATTERN CONTROL ARRANGEMENT FOR CIRCULAR KNITTING MACHINE

Johann A. Schaeder, Merzhausen, near Freiburg im Breisgau, and Richard Schmidt, Stuttgart-Vaihingen, Germany, assignors to Franz Morat G.m.b.H., Stuttgart-Vaihingen, Germany

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Claims priority, application Germany, Jan. 13, 1964, M 59,516
20 Claims. (Cl. 66—50)

The present invention relates to a pattern control arrangement for knitting machines, and more particularly to a pattern control arrangement using the pressure of a fluid, such as air, for setting selected needle-influencing elements to an operative position in which they influence needles of the knitting machine to move to knitting positions in accordance with a predetermined pattern.

The pattern control arrangement of the invention is particularly advantageously applied to circular knitting machines of the type having a cylinder with vertical grooves in which needles are mounted, and a dial having radial grooves for another set of needles, and rotating in synchronism with the cylinder about a common main axis.

Circular knitting machines of this type have stationary cams cooperating with butts of the dial needles and cylinder needles to advance or retract the same. In order to knit patterns, means are provided at a plurality of knitting stations located around the needle cylinder for operating only selected needles to move to a knit position, whereas other needles which are not selected will not advance so far.

A pattern wheel may be provided at each knitting station for selecting at a selecting station certain needles for operation, whereupon the selected needles are effective at an operating station to influence the needles. In the U.S. Patent 3,079,775, a pattern control arrangement is disclosed in which electromagnetic means shift resilient or pivoted levers which control the needle influencing elements. Cam means cause movement of the shifted levers to an operative position in which the needle influencing elements are also shifted to an operative position, and other cam means cause the return of the intermediate levers to an inoperative position before they arrive again at the selecting station where the electromagnetic means are located.

However, the provision of intermediate levers between the electromagnetic means and the needle influencing elements has certain disadvantages, and it is one object of the present invention to provide a pattern control arrangement for a knitting machine in which the position of the needle influencing members is directly controlled.

Another object of the present invention is to move selected needle influencing members by fluid pressure towards, or to the operative position in which the elements are capable of controlling needle movements.

Another object of the invention is to provide pneumatic means for directly operating the needle influencing elements to cause movement of the same to an operative, needle influencing position.

Another object of the invention is to provide control means, preferably pneumatic means, which are capable of extremely rapid inertia free operation, so that a very high number of needle influencing elements can be selected within a given period of time.

Another object of the invention is to provide a pattern control arrangement of simple construction which reliably operates even at very high knitting speeds.

Another object of the invention is to provide pattern control arrangements which can be controlled by program control means to automatically select needles for operation in such a manner that a predetermined pattern determined by the program control means is knitted.

With these objects in view, the present invention relates to a pattern control arrangement, preferably for a circular knitting machine of the type comprising cylinder needles and dial needles respectively mounted on a needle cylinder and dial which rotate about a common vertical axis.

One embodiment of the invention includes carrier means, which may be provided on a pattern wheel at each knitting station, or which may form part of the knitting cylinder, and which turn during each revolution past at least one selecting station and at least one operating station at the respective knitting station; a plurality of needle influencing elements carried by the carrier means for rotation therewith and for movement relative thereto between inoperative and operative positions; control means including fluid pressure means, for example an air nozzle, located at the selecting station for causing movement of selected needle influencing elements toward, or to the operative position; and fixed cam means acting on the needle influencing means.

In one embodiment of the invention, an air nozzle moves each selected needle-influencing element to an intermediate position in which it is engaged by cam means and moved to the operative position before arriving at the operating station where the needle influencing element in the operative position influences the needle, for example raises the same to the knit position. Return cam means are disposed between the operating station and the selecting station and return the selected needle influencing elements from the operative position to the inoperative position so that the same can be again selected, or not selected, at the selecting station.

Several embodiments of the invention employ pattern wheels at several knitting stations, each pattern wheel including a carrier for the needle influencing elements, and a stationary cover having an opening at the selecting station. An air nozzle can be moved by electromagnetic means between an inoperative position, and a selecting position in which the nozzle blows into the respective opening to shift a needle influencing element passing through the selecting station to the operative position. When the nozzle is in the inoperative position, the air is discharged from the nozzle into the atmosphere.

An electromagnetic means which causes movement of the nozzle between the inoperative and selecting position, is controlled by program controlled means so as to be energized when selection of a needle is desired, and to be de-energized when the respective needle is not to be selected when passing through the selecting station. The energized electromagnetic means moves the nozzle to the selecting position, and the nozzle is preferably resilient, or resiliently mounted, so as to automatically return to the inoperative position when the electromagnetic means is de-energized by the program controlled means.

Another embodiment of the invention has an annular carrier means which forms part of the needle cylinder and rotates with the same. The needle-influencing elements are directly aligned with corresponding cylinder needles, and are shifted by the pressure of air provided by a plurality of air nozzles arranged around the carrier and needle cylinder at corresponding knitting stations. Preferably, cams are provided for moving a selected and partly moved needle influencing element fully to the operative position, and other cam means are provided for returning the selected needle-influencing elements from the operative position to the inoperative position before arriving at the next selecting station at the next following knitting station. Consequently, in this embodiment a

plurality of advancing control cams, and a plurality of return cams are provided, corresponding to the number of knitting stations of the circular knitting machine.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary schematic side view illustrating an embodiment of the invention in which each pattern wheel is turnable about an axis slanted to the axis of the needle cylinder;

FIG. 1*a* is a fragmentary schematic front view of the embodiment of FIG. 1;

FIG. 2 is a fragmentary schematic side view illustrating another embodiment of the invention in which each pattern wheel turns about an axis parallel to the axis of the needle cylinder;

FIG. 3 is a fragmentary schematic side view illustrating another embodiment of the invention in which an annular carrier rotates about the axis of the needle cylinder in synchronism with the same;

FIG. 4 is a fragmentary schematic sectional view illustrating another embodiment in which each pattern wheel is turnable about an axis parallel to the axis of dial and needle cylinder of a knitting machine, and control needle-influencing elements cooperating with the dial needles;

FIG. 5 is a fragmentary sectional view illustrating the embodiment of FIGS. 1 and 1*a*;

FIG. 5*a* is a fragmentary plan view illustrating a detail of the embodiment of FIG. 5;

FIG. 6 is a fragmentary schematic plan view illustrating a modified embodiment according to FIGS. 1 and 1*a*;

FIG. 7 is a fragmentary sectional view taken on line VII—VII in FIG. 6;

FIG. 8 is an axial sectional view illustrating the embodiment of FIG. 2;

FIG. 9 is an axial sectional view illustrating the embodiment of FIG. 3; and

FIG. 10 is a fragmentary schematic developed view taken on line X in FIG. 9.

Referring now to the drawings, in the embodiment of FIGS. 1, 1*a*, 5, 5*a*, 6 and 7, a needle cylinder **3**, and a dial, not shown, rotate about a common vertical axis Y with a circular set of cylinder needles **2** which have butts **2'**. A series of pattern wheels are disposed around needle cylinder **3** at circumferentially spaced knitting stations, each pattern wheel rotating about an axis X which is slanted at a small acute angle to the main axis Y, as best seen in FIG. 1*a*. Each pattern wheel has a rotary carrier **10** supporting a set of needle-influencing elements **1**, commonly referred to as "jacks" for radial movement in the direction of the arrow in FIG. 1 between an inoperative position and an advanced operative position cooperating with a butt **2'** of a needle **2** to raise the needle to the knitting position due to the inclination of carrier **10** and axis X to the vertical direction of movement of the cylinder needles **2**.

Referring specifically to FIG. 5, a carrier **10** is mounted for rotation about a shaft **13** defining the axis X, which is slanted to the main axis of the needle cylinder **3**, as explained above, although in the view of FIGS. 1 and 5 axis X appears to be parallel to the needle cylinder axis. Carrier **10** supports a set of circumferentially spaced projecting teeth **4** meshing with the butts of the needles **2'** so that carrier **10** rotates in synchronism with the needle cylinder **3**. Radial grooves are provided in carrier **10** staggered in relation to teeth **4**, and needle-influencing elements **1** are mounted in these grooves for radial movement between a retracted position shown in solid lines in FIG. 5, and an advanced operative position shown in broken lines located at an operating station directly below butts **2'** of cylinder needles **2** to raise the same to a knit position, as explained with reference to FIG. 1*a*, and is well known to those skilled in the art.

Inwardly of each needle-influencing member, a pressure chamber **12** is formed in carrier **10** which has a rectangular configuration, as best seen in the plan view of FIG. 5*a*, and is closed by a part of the respective needle-influencing element **1**. The grooves **11** in which the needle-influencing elements **1** are shiftable in radial direction, and the pressure chambers **12** are closed by a stationary fixed cover **15** which is secured to the stationary shaft **13** about which carrier **10** rotates. Consequently, each pressure chamber **12** successively moves under an opening **5** provided in cover **15**, and this opening **5** is disposed at a selecting station at which control means are provided for shifting selected needle influencing elements from the inner inoperative position to outer operative position. A tubular resilient nozzle **7** is mounted on a stationary support **25**, and has a lower discharge end **7'** which in the normal inoperative position of nozzle **7** is located spaced from opening **5** in radial direction. Pressure air is supplied to the nozzle, as indicated by an arrow at the upper end of the same, so that air normally flows out of the discharge end **7'** without having any effect in the illustrated inoperative position of the nozzle.

The movable armature **9** of electromagnetic means **8** is secured to the lower end of the nozzle **7** so that when electromagnetic means **8** is energized, the resilient resistance of nozzle **7** will be overcome, and nozzle **7** be moved to the position illustrated in chain lines in which the discharge opening **7'** registers with the opening **5** in the stationary cover **15** so that air is blown into any pressure chamber **12** which, during rotation of carrier **10**, is located underneath and in communication with the single opening **5** in cover **15**.

Electromagnetic means **8** is connected by wires **16**, and **16'** to a schematically indicated program controlled means which, for example, is controlled by a program tape to cause energization of electromagnetic means **8** in accordance with a preselected pattern. For example, whenever the shifting of a selected cylinder needle **2** to the knit position is desired, an impulse will be given by program controlled means **17** to electromagnetic means **8** when a needle-influencing element **1** correlated with the respective cylinder needle **2**, passes through the selecting station at which nozzle **7** is located.

The arrangement is similar to the embodiment of FIG. 6, which will be described hereinafter, and in which an opening **5** is located at a selecting station, while needle influencing elements **1** in the advanced operative position at an operating station OS with the butts **2'** of cylinder needles **2** on needle cylinder **3**.

During rotation of carrier **10** caused by the meshing engagement between teeth **4** and butts **2'** of the cylinder needles, each pressure chamber **12** will successively move to a position located at the selecting station and aligned with opening **5**. If electromagnetic means **8** has received an impulse from program controlled means **17**, it is energized and holds nozzle **7** in a position aligned with opening **5** so that pressure air is blown through opening **5** into the respective pressure chamber **8** whereby the respective needle-influencing element **1** is operated in the manner of a piston to move outwardly in the radial groove **11** to the operative position shown in broken lines in FIG. 5. When carrier **10** continues its rotation, a needle influencing element **1** in the operative position will pass at the operating station O.S. under the butts of a needle and raise the same to a knit position.

When a pressure chamber **12** arriving under opening **5** at the selecting station is associated with a needle-influencing element which is not to be selected, no impulse is received by electromagnetic means **8**, and nozzle **7** remains in its normal inoperative position so that no pressure is produced in the respective pressure chamber **12**,

and the respective needle influencing element 1 remains in its inner inoperative position. When such a needle influencing element arrives at the operating station, it does not project far enough to engage the butt of the respective correlated cylinder needle 2, and consequently the respective cylinder needle will not be raised to the knit position. By a suitable selection of needle influencing elements by the program controlled means 17, a fabric having a specific desired pattern is produced. A needle 2, which was not raised by a needle influencing element 1, may be engaged by a stationary cam surrounding needle cylinder 2 and be raised to the tuck position.

After the needle influencing elements 1 have passed through the operating station, and preferably shortly before they again arrive at the selecting station, they are engaged by a stationary cam, not shown in FIG. 5, which is advantageously secured to the stationary cover 15, and engages needle influencing elements 1 which are in the operative advanced position due to a previous selection, and moves the same gradually back to the inoperative inner position by an inwardly inclined cam face. A return cam operating in this manner is shown at 20 in FIG. 6 as will be described hereinafter.

In the embodiment of FIG. 5, the needle influencing elements are moved all the way from the inoperative position to the operative position by the pressure of the air discharged by nozzle 7 into the pressure chambers 12. This arrangement is suitable for machines working at a comparatively low speed since the discharge opening of nozzle 7 and opening 5 must communicate with each pressure chamber 12 sufficiently long to accomplish the movement of the needle influencing element to the operative position. In very rapidly operating modern circular knitting machines, 600 needles must be selected in each second, and consequently the selecting operation must be performed in $\frac{1}{600}$ of a second.

For circular knitting machines which operate at such a high speed, the embodiment of FIGS. 6 and 7 is preferred.

Referring now to FIGS. 6 and 7, the carrier 10 is mounted for rotation about the fixed shaft 13, which carries a stationary cover 15, as described with reference to FIG. 5. Needle-influencing elements 1 are mounted in corresponding radial grooves of carrier 10 for movement between a retracted inoperative position shown in solid lines in FIG. 7 and in advanced position shown in chain lines. The needle influencing elements 1, which are schematically indicated in FIG. 6, alternate with teeth 4 which mesh with needle butts 2' in the region of the operating station O.S. to rotate carrier 10 in synchronism with the rotation of needle cylinder 3. Some needle influencing elements 1 are shown in FIG. 6 in the advanced operative position *a*, and other needle-influencing elements 1 are shown in the retracted inoperative position *b*. Needle influencing elements in the operative position *a* will be located to engage the butts 2' of correlated needles 2 and to raise the needles to the knit position.

A pressure chamber 12 is located inwardly of each needle influencing element 1 and communicates with the opening 5 when carrier 10 moves the respective needle-influencing element 1 and pressure chamber 12 past the selecting station S.S. At this selecting station, an opening 5 is provided in the stationary cover 15, and cooperates with a resilient tubular nozzle 7 which is operated by the armature 9 of electromagnetic means, not shown in FIGS. 6 and 7. The program control means 7, the electromagnetic means 8 with armature 9, and the mounting on nozzle 7 corresponds exactly to the illustration of FIG. 5, so that these parts are omitted in FIG. 7 for the sake of simplicity.

It will be understood that whenever a command impulse is given by the program controlled means 17, an electromagnetic means 8 will be energized to move its armature 9 to a position in which nozzle 7 registers with opening 5 to blow pressure air into the respective pressure chamber 12 which passes through the selecting station. The lower surface of stationary cover 15 has a downwardly projecting cam 20 which includes a triangular projecting portion bounded by radial shoulder located in the region of the selecting station and of opening 5, and an inwardly slanted cam face 120 which merges into a circular cam face 20' extending around the carrier 10. The needle influencing elements 1 have slanted inner ends 1' and projections 1'' which cooperate with cam 20. A ring-shaped projection 18 of cover plate 15 slidingly engages the inner ends of needle influencing elements 1 to seal the pressure chambers 12 so that pressure air supplied by nozzle 7 cannot flow into the wide space between the sealing projection 18 and the cam 20.

Another cam 19 is secured to the lower surface of cover plate 15 and has a part-circular configuration, terminating in radial end face 19''. Cam 19 has a pointed end 19' located at the selecting station in the region of opening 5, and a slanted end face connecting the pointed end 19' with a circular cam face 19'' which defines a circular gap with the inner cam face 20' of cam 20. During knitting operations, needle cylinder 3 rotates carrier 15 in the direction of the arrow due to the meshing engagement between teeth 4 and needle butts 2'. Some of the needle influencing elements 1 are in the outer position *a*, and some needle influencing elements are in the inner position *b* when approaching the slanted cam face 120 of cam 20. Irrespective of the position of needle influencing elements, the projection 1'' will be guided by cam face 120 to the innermost inoperative position, and most needle-influencing elements will not be in the inner position since the centrifugal force tends to drive the needle influencing elements outward toward cam face 1''.

In every event, every element 1 arriving at the selecting station S.S. in a position radially aligned with opening 5 will be in the inner inoperative position shown in solid lines in FIG. 7. In accordance with the command impulse given by the program controlled means 17, electromagnetic means 8 may be energized and move nozzle 7 to a position aligned with opening 5 so that air is blown into the respective pressure chamber 12 located at the selecting station aligned with opening 5 whereby the respective element 1 is driven outwardly. However, it is not necessary to move the respective element 1 all the way to the outer operative position *a*, since a small outward displacement of a selected needle influencing element 1 will place the respective projection 1'' in a position located slightly outwardly of the pointed end 19' of cam 19 so that during further rotary movement of carrier 10 the respective selected element 1, and more particularly its projection 1'' will be engaged by the slanted cam face of cam 19 and gradually move to the outer operative position in which projection 1'' is located in the gap between the outer circular cam face of cam 19 and the inner circular cam face 20' of cam 20.

Other elements 1, which are not selected at the selecting station, are not subjected to air pressure, since nozzle 7 remains in the inoperative position spaced from opening 5, so that the projection 1'' of the non-elected elements 1 will continue to move with carrier 10 along a circular path inwardly of cam 19. When any needle-influencing element 1 has been moved beyond the end 19'' ' of cam 19, the non-selected elements may be moved by centrifugal force to an outer position, but this is immaterial since after each element 1 has been moved through approximately 340°, its projection 1'' engages the inwardly slanting cam face 120 and is moved back to the inner inoperative position to be ready for a possible selection at the selecting station.

It will be understood that very little time is required for moving a selected element 1 from the innermost position in outward direction to an intermediate position located in the region of the slanted cam face of cam 20 so that the carrier 10 can rotate at a far higher speed than in

the embodiment of FIG. 5 since nozzles 7 have to communicate with opening 5 only so long as is required for moving the respective selected element 1 a very small distance in radial direction, as compared with the movement of the selected element 1 from the inner position to the outer operative position in the embodiment of FIG. 5. Sufficient time is available for moving a selected element 1 by cam 19 to the outer operative position, since for this cam action, all the time required for any selected element to move from the selecting station to the operating station is available, and as will be apparent from FIG. 6, it is not necessary to use the entire angular distance between the selecting station and the operating station for the movement of a selected element 1 by cam 19 to the outer operative position. Only the operation at the selecting station must be very fast, since in high speed circular knitting machines, only 1/600 of a second is available for the selection. In the embodiment of FIG. 6, the selection is carried out by moving a selected element 1 the small distance required for placing its projection 1'' outwardly of the pointed end 9' of cam 19.

The principle of the invention can also be applied to knitting machines of the type illustrated schematically in FIG. 2, and provided with pattern wheels as best seen in FIG. 8. While in the embodiment of FIGS. 5 and 6, the needle influencing elements 1 are moved in radial direction on the carrier of the pattern wheel, the needle influencing elements 1*a* of the embodiment of FIG. 8 are moved in axial direction between a lower position and a higher operative position for raising the cylinder needles 2*a* to the knit position. A needle cylinder 3*a* supports needles 2*a* for movement in axial direction, and is surrounded by a cam cylinder including a cam 21' which is adapted to engage the butts 2*a*'' to raise the needles to the knit position after raising by the element 1*a*. Each needle has a lower butt 2*a*'' cooperating with needle-influencing elements or jacks 1*a* which are mounted for axial movement in a carrier 22 which is secured to a shaft 23 by a key 23*a* and rotates with the same. Gears 25 and 29 are respectively secured to shaft 23 and to needle cylinder 3*a* so that carrier 22, and all needle-influencing elements 1*a* rotate in synchronism with the needles 2*a*. FIG. 8 is a section at the operating station at which the horizontally projecting heads of elements 1*a* are located under butts 2*a*' of correlated needles 2*a*.

Each element 1*a* has an axially extending guide portion guided in a narrow slot 11*a* of carrier 22 for movement in axial direction, but also for turning movement with carrier 22.

An annular sealing projection 18*a* projects inwardly from the cylindrical wall 26 into close proximity with an outer circular surface of carrier 22. The vertical portions of needle influencing elements 1*a* which are located in grooves 11*a*, are shorter than grooves 11*a* and have a slanted lower end face so that a small portion at the lower end of each slot 11*a* is left free and serves as a pressure chamber. The pressure chambers are circumferentially spaced about the periphery of carrier 22, and are sealed from each other by the inner surface of the annular sealing projection 18*a*, which also seals all pressure chambers 12*a* to prevent a communication in between the same and the space formed between the upper portion of cylindrical wall 26 and the carrier (in which space cams 19*a* and 20*a* are located. A duct 5*a* having an outer portion of cylindrical cross section and an inner portion of rectangular cross section penetrates the cylindrical wall 26 of the stationary cover member 24 as indicated in chain lines in FIG. 8, but actually opening or duct 5*a* is located at a selecting station spaced 90° from the section illustrated in FIG. 8, and consequently appears as a circle in broken lines at the center of shaft 23 in FIG. 8.

At the selecting stations, a nozzle operated by an electromagnetic means between the inoperative position and a position aligned with opening 5*a* is provided. The arrangement corresponds to the constructions described with reference to FIG. 5, and is not illustrated in FIG. 8. It will be understood that air blown by the pressure nozzles into opening or duct 5*a* at the selected station, will enter the respective pressure chamber 12*a* passing through the selecting station, and will move the respective element 1*a* upwardly, at least a small distance as explained with reference to FIG. 6. A control cam 19*a* corresponding to cam 19 of the embodiment of FIG. 6, and the return cam 20*a* corresponding to the return cam 20 of FIG. 6 are provided on the inner surface of the cylindrical wall 26 of cover member 24. The configuration of cams 19*a* and 20*a* corresponds exactly to the configuration of cams 19 and 20 shown in FIG. 6, except that the circular lines bounding the cams will have their centers at the axis Z of shaft 23 and will be located in planes perpendicular to the axis Z. The cam face 20*a*' has a downwardly extending slanted cam face near the selecting station, and a vertical shoulder directly before the selecting station represented by opening or duct 5*a* in FIG. 8. Cam 19*a* has an upper cam face 19*a*' with an upwardly slanting end face on the other side of the selecting station, as described with reference to FIG. 6. The shape of cams 20*a* and 19*a* corresponds to the shape of each of the cams 19*b* and 20*b* illustrated in FIG. 10.

During operation of the machine, each pressure chamber 12*a* successively arrives in a position communicating with the opening or duct 5*a* at the selecting station, and when the electromagnetic means receives an impulse from the program controlled means, the nozzle is moved to a position registering with opening 5 and blows air into the respective pressure chamber 12*a* so that the respective element 1*a* is slightly raised until its projection 1*a*'' is located above the pointed ends of cam 19*a* and raised along the slanted cam face of the same until arriving at the horizontal cam face 19*a*'' which holds the respective element 1*a* in the raised operative position shown in dash and dot lines in FIG. 8. During such movement butt 2*a*' of the respective correlated needles 2*a* is engaged from below, as shown in FIG. 8, and raised so that butt 2*a*'' is engaged by the stationary cam 21' which holds the respective needle in the knit position until the needle is again lowered to cooperate with a needle-influencing element provided in the next following pattern wheel. The elements 1*a* which are not selected, and are not subjected to air pressure and raised, do not influence the needles at the operating station since they pass below butts 2*a*', and the needles 2*a* remaining in the lower position are engaged by a cam, not shown, on member 21 which raises the respective needles to the tuck position.

The embodiments of FIGS. 5, 6 and 8 concern circular knitting machines in which a pattern wheel is provided at each knitting station, each pattern wheel providing a selecting station where the selection of certain needles is determined, and an operating station where the respective needles are raised.

In the embodiment of FIGS. 9 and 10, the pattern wheels are replaced by a single pattern device including an annular carrier forming part of the needle cylinder, or being secured to the same, and a ring-shaped cover operating with the annular carrier to provide a plurality of pairs of selecting and operating stations.

Referring now to FIGS. 9 and 10, a needle cylinder 3*b* is driven to rotate about a vertical main axis Y and is provided with axially extending peripheral grooves in which cylinder needles 2*b* are mounted for vertical movement. The lower portion 10*b* of the needle cylinder is constructed as a carrier for needle-influencing elements 1*b*, and is provided with a set of vertical grooves 11*b* which respectively register with the grooves in which needles 2*b* are mounted so that each needle-influencing element 1*b* abutts the foot portion 2*b*' of a needle 2*b*. Consequently, the same number of needle-influencing elements and needles is provided in the embodiment of FIGS. 9 and 10, whereas in the previously described embodiments, each of the carriers of the several pattern wheels supported a set

of needle-influencing elements whose number was smaller than the number of the controlled needles.

The carrier portion **10***b* of needle cylinder **3***b* is mounted for rotation in a circular stationary support **30** so that the butts **2***b*'' cooperate with cam means **21***b*' of the cam cylinder **21***b*. Intermediate the cam cylinder and support **30**, a cover ring **26***b* is fixedly mounted on support **30** so that the needle cylinder and needle influencing elements **11***b* move along the inner circular surface of ring **26***b*. A cam cylinder **21***b* is secured to ring **26***b* and has an inner cam **21***b*' cooperating with butts **2***b*'' of needles **2***b*. A circular knitting machine of this general type is disclosed in the U.S. Patent 2,158,536.

The needle-influencing elements **1***b* are shorter than the slots **11***b* in which they are mounted, and consequently a pressure chamber **12***b* is formed at the lower end of each slot **11***b* between the walls of the slot and the slanted lower end of the respective needle-influencing element **1***b*.

The ring **26***b* has a number of circumferentially spaced radical ducts **5***b* with outer portions of circular cross sections, and inner portions of rectangular cross sections corresponding to the shape of slots **11***b*. During rotation of the needle cylinder with carrier **10***b*, each pressure chamber will be successively aligned with one duct **5***b*, then be closed by the inner surface of ring **26***b*, and then again register with the next duct **5***b*. A circular sealing projection **18***b* slidingly engages the outer surface of carrier portion **10***b* and also elements **1***b* so that the pressure chambers are sealed from the cavity formed above sealing projection **18***b* between rings **26***b* and carrier **10***b*. The number of ducts **5***b* corresponds to the number of knitting stations, and a resilient nozzle **7***b* is mounted at each knitting station on a support **6***b* movable between the inoperative position shown in solid lines in FIG. 9, and the selecting position shown in chain lines in which the nozzle is located at the level of the ducts **5***b*. All nozzles **7***b* are connected to a circular supply pipe **31** which is connected to a compressor **32**. Consequently, pressure air will flow at all times through nozzles **7***b* and will be dissipated into the atmosphere when a nozzle is in the inoperative position, but will be blown through ducts **5***b* into a pressure chamber **12***b* crossing ducts **5***b* while the nozzle is in the selecting position. An electromagnetic means **8***b* has an armature secured to nozzle **7***b*, and is energized through conductors **16***b* and **16***b*' by a program controlled means **17** in which, for example, a tape is sensed to produce combined signals in accordance with a predetermined pattern which is to be knitted. Whenever a command impulse passes to an electromagnetic means **8***b*, the nozzle **7***b* is moved to the selecting position, and the pressure air entering pressure chamber **12** effects movement of the respective needle-influencing element **1***b* to a higher position whereby the respective needle **2***b* is raised.

For machines operating at low speed, it would be possible to accomplish the movement of the needles **2***b* to the knit position by air pressure alone, but in the embodiment of FIGS. 9 and 10, the air pressure moves each needle influencing element only a small distance in upward direction, while the movement of the needle influencing element to the high operative position in which the needle is further raised is accomplished by cams **19***b* in a manner similar to the previously described embodiment. However, since ring **26***b* provides all selecting stations, a corresponding number of control cams **19***b* for raising the needle influencing members, and return cams **20***b* for returning the needle influencing members to the lower position must be provided. In the fragmentary developed view of FIG. 10, three selecting stations **5***b*I, **5***b*II, **5***b*III are represented by the ducts **5***b*, and it will be seen that a control cam **19***b* and a return cam **20***b* is associated with each selecting station. Control cam **19***b* has a pointed end in the region of the respective selecting station, followed by a slanted surface which is adapted to engage projections **1***b*'', schematically shown by circles in FIG. 10, which are raised by the air pressure above the level of the pointed end of **19***d*', and to guide the respective projection during movement of the needle-influencing member with a needle cylinder in direction of the arrow P relative to ring **26***b* and cam **19***b* until the respective projection **1***b*'' arrives at the horizontal upper cam face of the respective cam **19***b*. During further turning of carrier **10***b*, the projections of raised needle influencing elements will be engaged by the downwardly slanted cam surface **120***b* of the return cam **20***b* and gradually returned to the normal lower position.

In the description of FIG. 8, reference was made to FIG. 10, and it will be understood that a developed view showing the cams **20***a* and **19***a* of the embodiment of FIG. 8, would represent cam **19***a* similar to a single cam **19***b*, and cam **20***a* with only a single slanted cam face **120***b* since only selecting station is provided for each pattern wheel in the embodiment of FIG. 8.

FIG. 10 shows 22 projections **1***b*''. At the first selecting station **5***b*I, every second needle influencing element is selected and slightly raised by air blown by the lowered nozzle **7***b* into ducts **5***b* and the respective pressure chamber **10** at the moment in which the pressure chamber **30** passes duct **5***b*. Projection **1***b*'' is raised to a position slightly higher than the pointed end **19***b*' and since projection **19***b*'' moves with carrier portion **10***b* and the needle cylinder, it slides along the slanted surface of cam **19***b* to a higher position so that the respective needle is raised. Every second needle influencing element is in a higher position when projections **1***b*'' approach the slanted cam face **120** of return cam **20***b* preceding the next following selecting station **5***b*II, so that all needle influencing elements are in the lower inoperative position when passing duct **5***b* of the second selecting station **5***b*II. At this station those needle influencing elements which were not selected at selecting station **5***b*I, are selected and blown to an intermediate position located above the pointed end **19***b*' of cam **19***b* at the second selecting station so that alternate needles are raised to knit position at the second selecting station, and the selection of needle influencing elements is again reversed at the following selecting station **5***b*III so that a particular pattern is produced by the needles of the knitting machine. Those needle influencing elements which were not raised permit the corresponding needles to remain in a lower position in which butts **2***b*'' are engaged by a cam **21***b*' on the cam cylinder **21***b* which raises the respective needles to the tuck position. However, different patterns can be produced by a different selection, and it is possible to operate the needles which were not selected in a different manner, and the arrangement may be such that selected needles are not raised to the knit position in which event the non-selected needles must be operated by other means to arrive at a desired pattern of the fabric.

The modified embodiment of the invention shown in FIG. 4 in which the dial needles **27** are operated by pattern wheels turning about axes Z*c* parallel to the main axis Y*c* of the dial **28** and of needle cylinder **3***c*, uses a pattern wheel and pneumatic control means as described with reference to FIG. 8. The needle influencing elements **1***c* are moved outwardly in radial direction to an operative position engaging butts **27**' of dial needles **27**. As described with reference to FIGS. 5 and 9 program controlled means operate electromagnet means to shift a flexible and resilient nozzle to a selecting position blowing into a duct of the stationary cover of the respective pattern wheel when the rotary carrier of the needle influencing elements successively places the pressure chambers in the region of the duct. A synchronous rotation of the rotary carriers of the pattern wheels and of the dial is obtained by bevel gears substantially corresponding to the spur gears **25** and **29** of FIG. 8.

It will be understood that each of the elements described above or two or more together, may also find a useful application in other types of knitting machines differing from the types described above.

While the invention has been illustrated and described as embodied in a pneumatic pattern control arrangement for circular knitting machines, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention, and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed and desired to be secured by Letters Patent is:

1. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation, and turning during each revolution past at least one selecting station and operating station; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station; control means including pneumatic means located at the selecting station for causing movement of selected needle-influencing elements to said operative position so that said needles will be influenced when selected needle-influencing elements are at the operating station in said operative position; and return cam means fixedly supported on said support means and acting on the selected needle-influencing elements while the same are moved by said carrier means from said operating station to said selecting station, and being constructed to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station.

2. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation, and turning during each revolution past at least one selecting station and at least one operating station; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station; pneumatic means located at the selecting station for causing movement of selected needle-influencing elements into an intermediate position; control cam means fixedly supported on said support means and located between the selecting station and the operating station and acting on the selected needle-influencing elements while the same are moved by said carrier means from said selecting station to said operating station and being constructed to move said selected elements from said intermediate position to said operative position before each element arrives at the operating station so that said needles will be influenced when selected needle-influencing elements arrive at the operating station in said operative position; and return cam means fixedly supported on said support means and acting on the selected needle-influencing elements while the same are moved by said carrier means from said operating station to said selecting station, and being constructed to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station.

3. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation, and turning during each revolution past at least one selecting station and at least one operating station; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station; control means including pneumatic means located at the selecting station and having a movable nozzle, and operating means connected to said nozzle for moving the same between an inoperative position, and a selecting position causing air pressure on a needle-influencing element passing through the selecting station for causing movement of selected needle-influencing elements to said operative position so that said needles will be influenced when selected needle-influencing elements arrive at the operating station in said operative position; and return cam means fixedly supported on said support means and acting on the selected needle-influencing elements while the same are moved by said carrier means from said operating station to said selecting station, and being constructed to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station

4. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation, and turning during each revolution past at least one selecting station and at least one operating station; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station; pneumatic means located at the selecting station and having a movable nozzle and electromagnetic means including a movable member connected to said nozzle for moving the same between an inoperative position, and a selecting position causing air pressure on a needle-influencing element passing through the selecting station for causing movement of selected needle-influencing elements to said operative position so that said needles will be influenced when selected needle-influencing elements arrive at the operating station in said operative position; and return cam means fixedly supported on said support means and acting on the selected needle-influencing elements while the same are moved by said carrier means from said operating station to said selecting station, and being constructed to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station.

5. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation, and turning during each revolution past at least one selecting station and at least one operating station; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station; pneumatic means located at the selecting station and having a movable nozzle and electromagnetic means including a movable member connected to said nozzle for moving the same between an inoperative position, and a selecting position causing air pressure on a needle-influencing element passing through the selecting station for causing movement of selected needle-influencing elements to said operative position so that said needles will be influenced when selected needle-influencing elements arrive at the operating station in said operative position; program controlled means connected to said electromagnetic means for energizing and deenergizing the same in accordance with a pattern program determining the selection of needles; and return cam means fixedly supported on said support means and acting on the selected needle-influencing elements while the same are moved by said carrier means from said

operating station to said selecting station, and being constructed to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station.

6. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation, and turning during each revolution past at least one selecting station and at least one operating station, said carrier means having a plurality of pressure chambers; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station, each needle-influencing element being partly located in one of said chambers; control means including pneumatic means located at the selecting station for blowing air into selected pressure chambers passing through said selecting station for causing movement of selected needle-influencing elements to said operative position so that said needles will be influenced when selected needle-influencing elements arrive at the operating station in said operative position; and return cam means fixedly supported on said support means and acting on the selected needle-influencing elements while the same are moved by said carrier means from said operating station to said selecting station, and being constructed to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station.

7. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation, and turning during each revolution past at least one selecting station and at least one operating station, said carrier means having a plurality of pressure chambers; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station, each needle-influencing element being partly located in one of said chambers; pneumatic means located at the selecting station for blowing air into selected pressure chambers passing through said selecting station for causing movement of selected needle-influencing elements into an intermediate position; control cam means fixedly supported on said support means and located between the selecting station and the operating station and acting on the selected needle-influencing elements while the same are moved by said carrier means from said selecting station to said operating station and being constructed to move said selected elements from said intermediate position to said operative position before each element arrives at the operating station so that said needles will be influenced when selected needle-influencing elements arrive at the operating station in said operative position; and return cam means fixedly supported on said support means and acting on the selected needle-influencing elements while the same are moved by said carrier means from said operating station to said selecting station, and being constructed to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station.

8. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation, and turning during each revolution past at least one selecting station and at least one operating station, said carrier means having a plurality of pressure chambers; a cover means fixed to said support means and closing said pressure chambers, said cover means having an opening at said selecting station; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station, each needle-influencing element being partly located in one of said pressure chambers; pneumatic means located at the selecting station and including a nozzle movable between an inoperative position and a selecting position located opposite said opening in said cover means for blowing air into a pressure chamber passing through the selecting station, and operating means connected to said nozzle for moving the same between said inoperative and selecting positions so that air pressure produced in selected pressure chambers by said nozzle in said selecting position will cause movement of selected needle-influencing elements to said operative position so that said needles will be influenced when selected needle-influencing elements arrive at the operating station in said operative position; and return cam means fixedly supported on said support means and acting on the selected needle-influencing elements while the same are moved by said carrier means from said operating station to said selecting station, and being constructed to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station.

9. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation, and turning during each revolution past at least one selecting station and at least one operating station, said carrier means having a plurality of pressure chambers; a cover means fixed to said support means and closing said pressure chambers, said cover means having an opening at said selecting station; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station, each needle-influencing element being partly located in one of said pressure chambers; pneumatic means located at the selecting station and including a resilient tubular nozzle having one end secured to said support means and another free outlet end movable between an inoperative position and a selecting position located opposite said opening in said cover means for blowing air into a pressure chamber passing through the selecting station, and operating means connected to said nozzle for moving the same between said inoperative and selecting positions so that air pressure produced in selected pressure chambers by said nozzle in said selecting position will cause movement of selected needle-influencing elements to said operative position so that said needles will be influenced when selected needle-influencing elements arrive at the operating station in said operative position; and return cam means fixedly supported on said support means and acting on the selected needle-influencing elements while the same are moved by said carrier means from said operating station to said selecting station, and being constructed to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station.

10. A pattern control arrangement for a circular knitting machine having a rotary member supporting a set of needles for movement about a machine axis, comprising, in combination, support means; a plurality of pattern wheels respectively located at knitting stations around said axis, each pattern wheel including carrier means supported on said support means for rotation, and turning during each revolution past at least one selecting station and one operating station; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station; control means

including pneumatic means located at the selecting station and having a movable nozzle, and operating means connected to said nozzle for moving the same between an inoperative position, and a selecting position causing air pressure on a needle-influencing element passing through the selecting station for causing movement of selected needle-influencing elements to said operative position so that said needles will be influenced when selected needle-influencing elements are at the operating station in said operative position; and return cam means fixedly supported on said support means and acting on the selected needle-influencing elements while the same are moved by said carried means from said operating station to said selecting station, and being constructed to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station.

11. A pattern control arrangement as set forth in claim **10** wherein each of said carrier means is supported for turning movement about an axis slanted to said main axis.

12. A pattern control arrangement as set forth in claim **11** wherein said rotary member is the needle cylinder of the circular knitting machine.

13. A pattern control arrangement as set forth in claim **10** wherein said rotary member is the dial of the circular knitting machine.

14. A pattern control arrangement as set forth in claim **10** wherein said carrier means rotate about an axis parallel to said main axis, and wherein said needle-influencing elements move parallel to said main axis between said inoperative position and said operative position when moved by said pneumatic control means at said selecting station.

15. A pattern control arrangement for a circular knitting machine having a rotary member supporting a set of needles for movement about a machine axis, comprising, in combination, support means; annular carrier means forming part of said rotary member and supported on said support means for rotation about said main axis and turning during each revolution past a plurality of knitting stations, each of which includes a selecting station and an operating station; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station; control means including pneumatic means located at each selecting station for causing movement of selected needle-influencing elements to said operative position into an intermediate position; and a stationary ring fixed to said support means and surrounding said carrier means, said ring having control cam means located between each selecting station and corresponding operating station in the direction of rotation of said annular carrier means and acting on the selected needle-influencing elements while the same move from the respective selecting station to the respective operating station, and being constructed to move selected elements from said intermediate position to said operative position before each element arrives at the respective operating station, said ring having return cam means located between the respective operating station and selecting station and acting on said selected needle-influencing elements to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station, said selected elements in said operative position being adapted to influence needles at the operating station.

16. A pattern control arrangement for a circular knitting machine having a rotary member supporting a set of needles for movement about a machine axis, comprising, in combination, support means; annular carrier means forming part of said rotary member and supported on said support means for rotation about said main axis and turning during each revolution past a plurality of knitting machines, each of which includes a selecting station and an operating station; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station; control means including pneumatic means located at each selecting station and having a movable nozzle, and operating means connected to said nozzle for moving the same between an inoperative position, and a selecting position causing air pressure on a needle-influencing element passing through the selecting station for causing movement of selected needle-influencing elements to said operative position into an intermediate position; and a stationary ring fixed to said support means and surrounding said carrier means, said ring having control cam means located between each selecting station and corresponding operating station in the direction of rotation of said annular carrier means and acting on the selected needle-influencing elements while the same move from the respective selecting station to the respective operating station, and being constructed to move selected elements from said intermediate position to said operative position before each element arrives at the respective operating station, said ring having return cam means located between the respective operating station and selecting station and acting on said selected needle-influencing elements to return said selected elements from said operative position to said inoperative position before each element arrives at the selecting station, said selected elements in said operative position being adapted to influence needles at the operating station.

17. A pattern control arrangement as set forth in claim **16** wherein said stationary ring and said annular carrier means form a plurality of pressure chambers in said carrier means respectively closed by needle-influencing elements, and wherein said ring has an opening at each selecting station communicating with the pressure chamber passing through the selecting station, and wherein said nozzle at the respective selecting station is located opposite said opening in said selecting position of said nozzle.

18. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation and turning during each revolution past at least one selecting station and operating station, said carrier means having a plurality of pressure chambers; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station, each needle-influencing element being partly located in one of said chambers; and control means including means for discharging a fluid under pressure at said selecting station only into selected pressure chambers passing through said selecting station for causing movement of needle-influencing elements located in selected pressure chambers to said operative position so as to engage and activate correlated needles.

19. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation and turning during each revolution past at least one selecting station and operating station, said carrier means having a plurality of pressure chambers; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station, each needle-influencing element being partly located in one of said chambers; control means including movable nozzle means having an inoperative position and a selecting position for discharging a fluid under pressure at said selecting station only into selected pressure chambers passing through said selecting station for causing movement of needle-influencing elements located in selected pressure chambers to said op-

erative position so as to engage and actuate correlated needles; and program controlled operating means for moving said nozzle means in accordance with a predetermined program between said positions thereof.

20. A pattern control arrangement for a knitting machine, comprising, in combination, support means; carrier means supported on said support means for rotation and turning during each revolution past at least one selecting station and operating station, said carrier means having a plurality of pressure chambers; a plurality of needle-influencing elements carried by said carrier means for rotation therewith, and for movement relative thereto between inoperative and operative positions, and adapted to cooperate in said operative position with needles located at the operating station, each needle-influencing element being partly located in one of said chambers; control means including movable nozzle means having an inoperative position and a selecting position for discharging a

fluid under pressure at said selecting station only into selected pressure chambers passing through said selecting station for causing movement of needle-influencing elements located in selected pressure chambers to said operative position so as to engage and actuate correlated needles; and program controlled operating means including electromagnetic means for moving said nozzle means in accordance with a predetermined program between said position thereof.

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MERVIN STEIN, *Primary Examiner.*

R. FELDBAUM, *Assistant Examiner.*