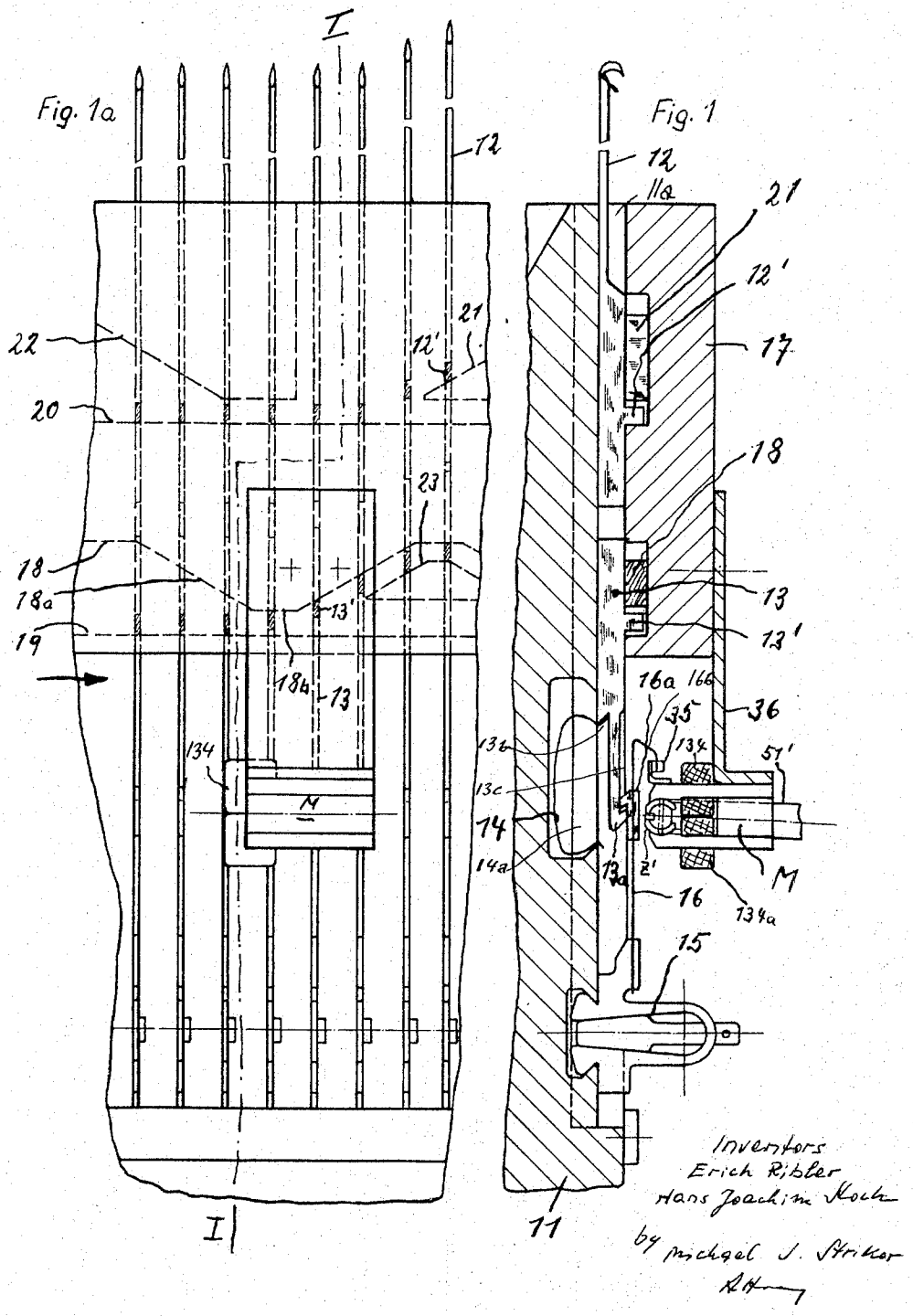
Jan. 30, 1968 E. RIBLER ETAL 3,365,916

SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

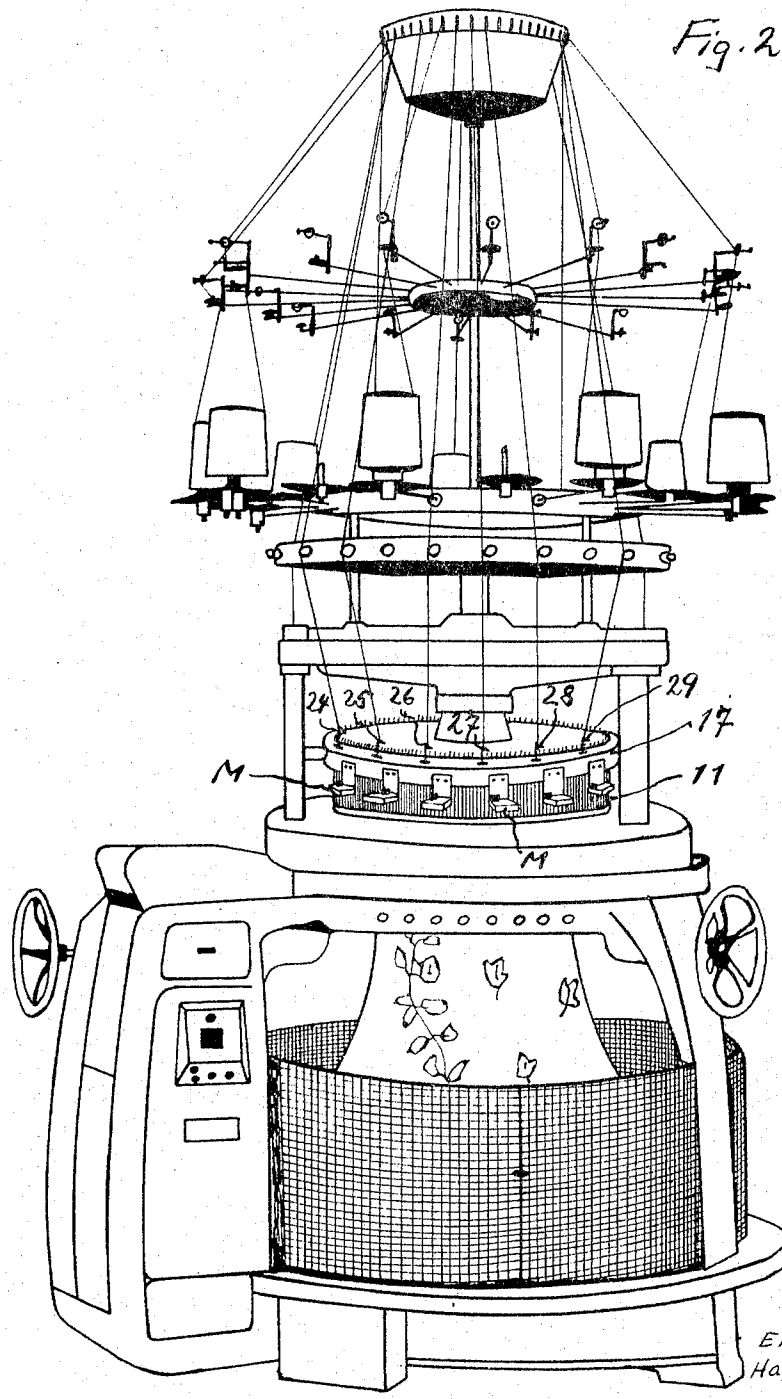
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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 2



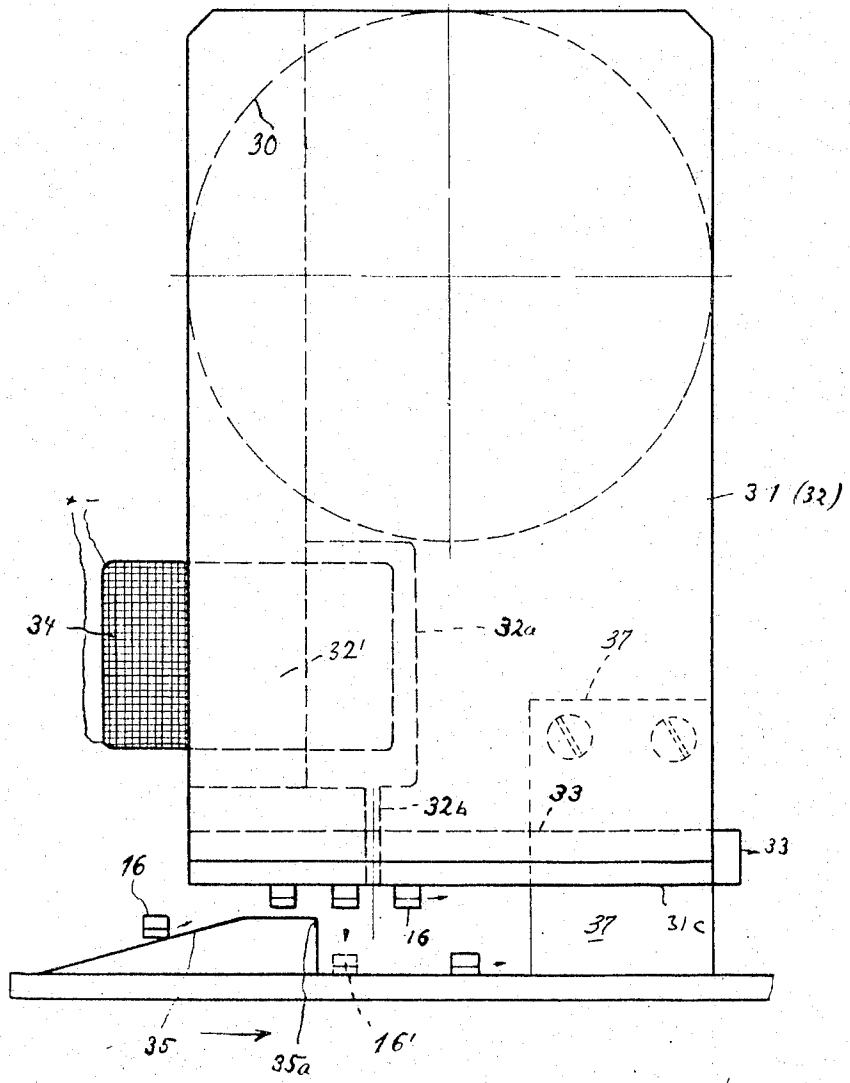
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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 3



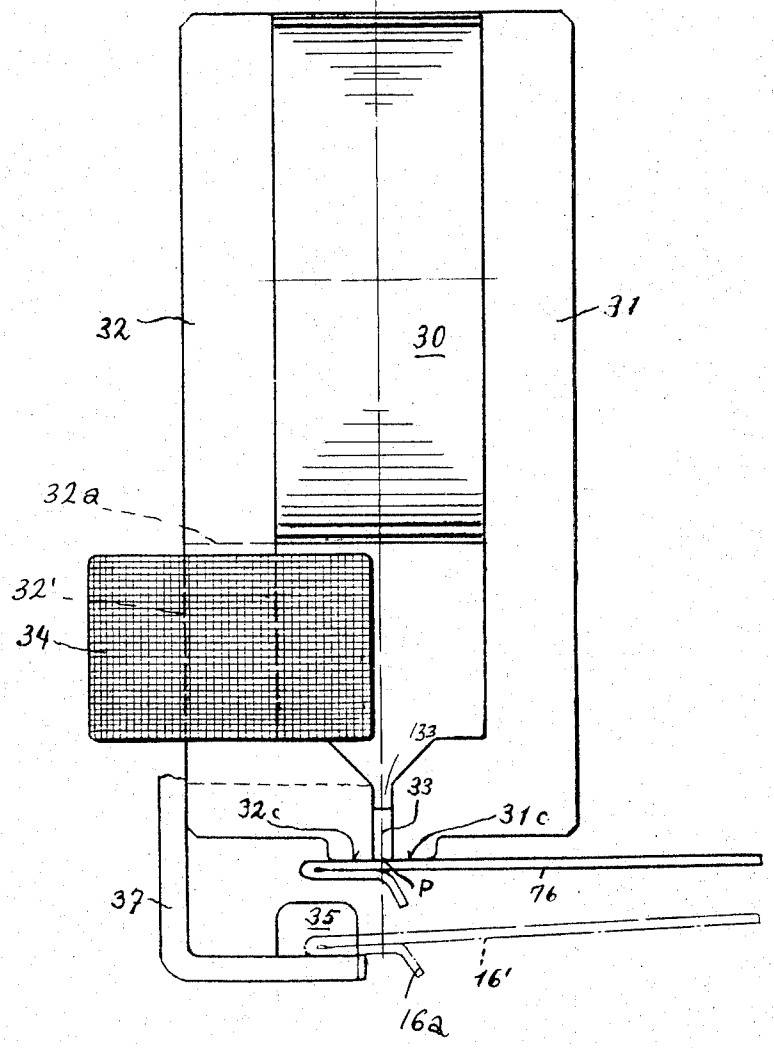
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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

Filed March 2, 1965 24 Sheets-Sheet 4

Fig. 3a



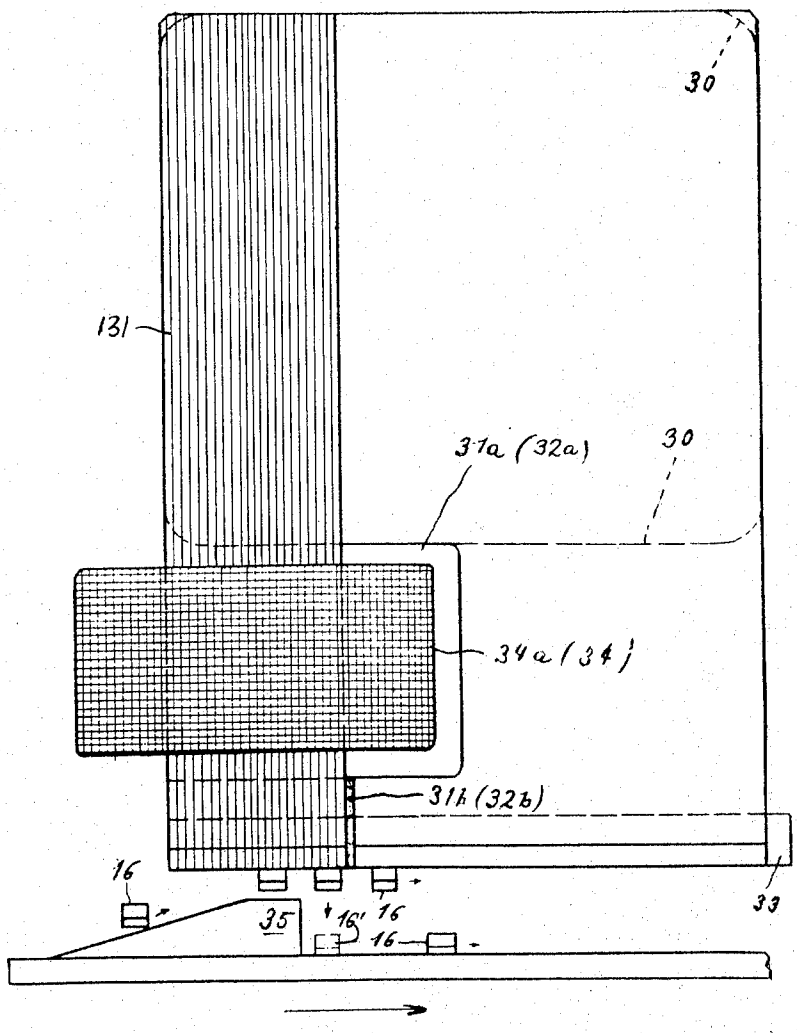
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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 4



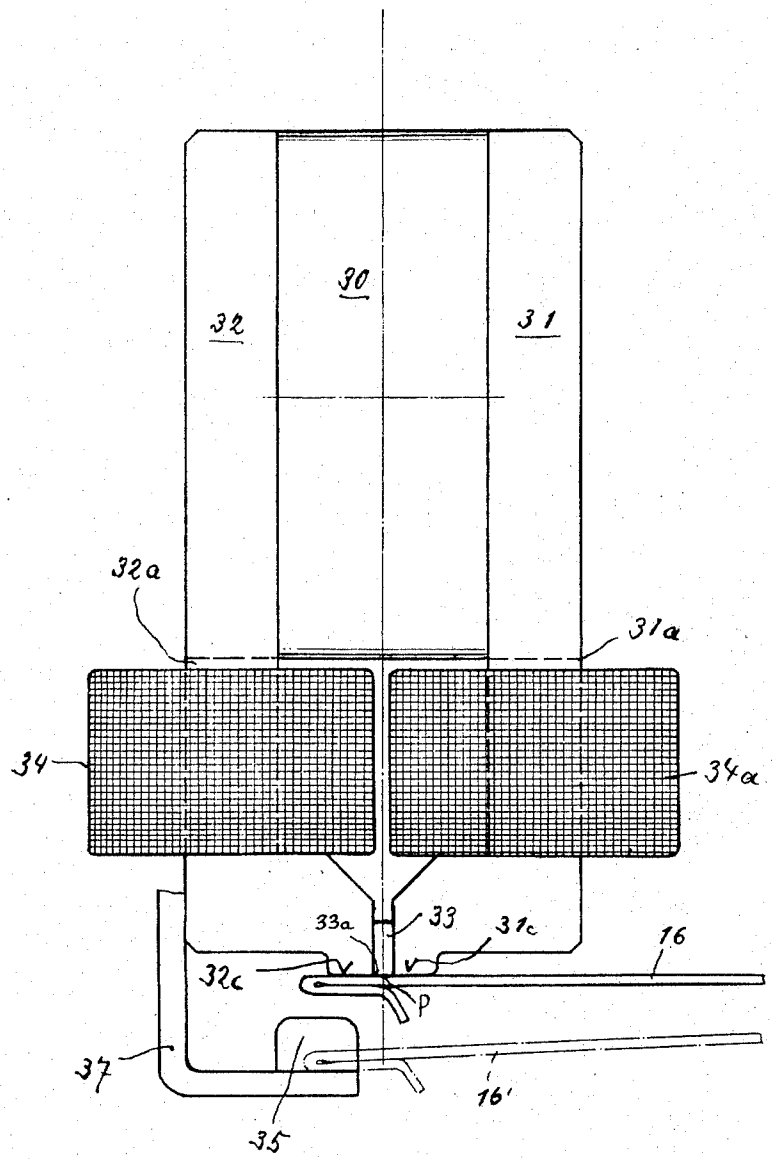
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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 4a

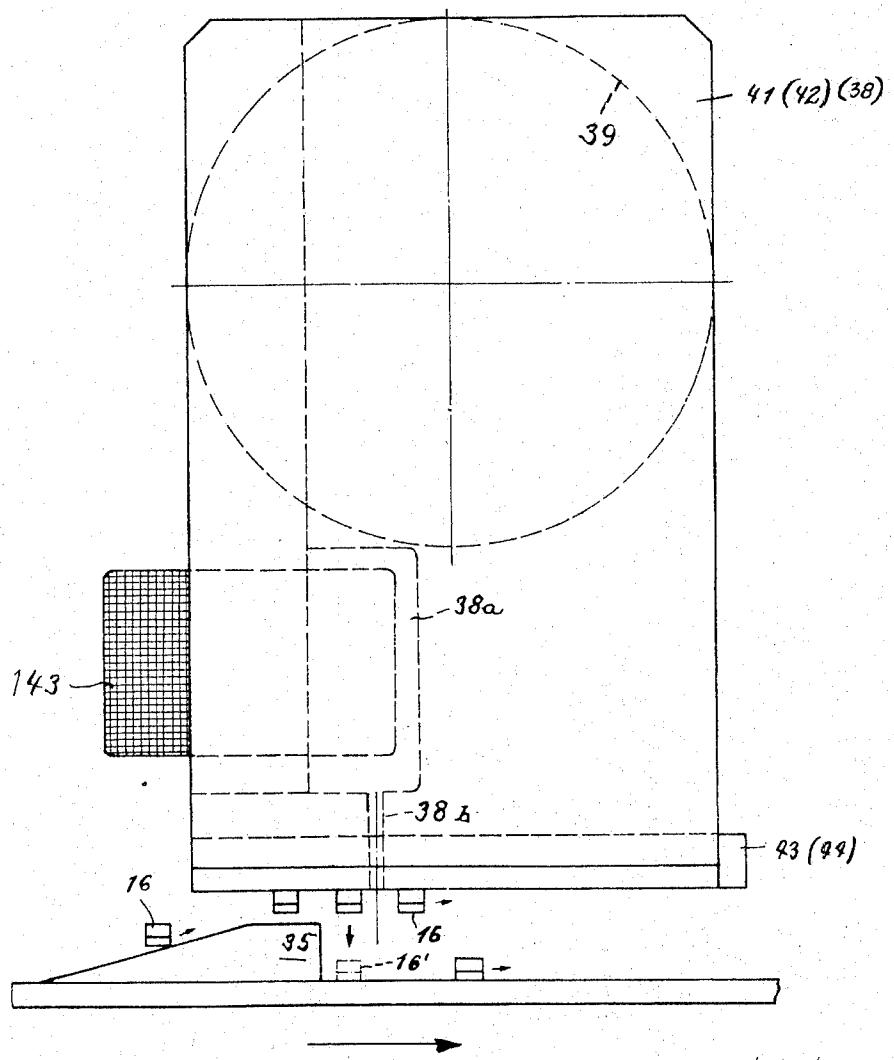


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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 5

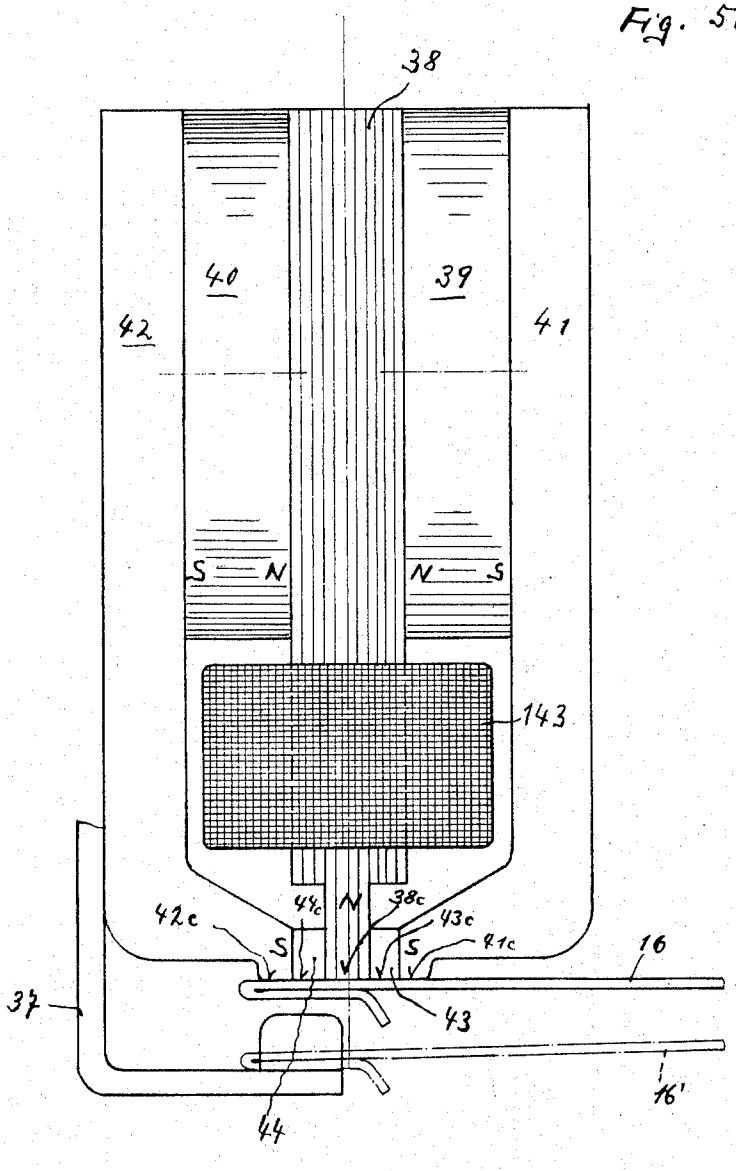


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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 5a



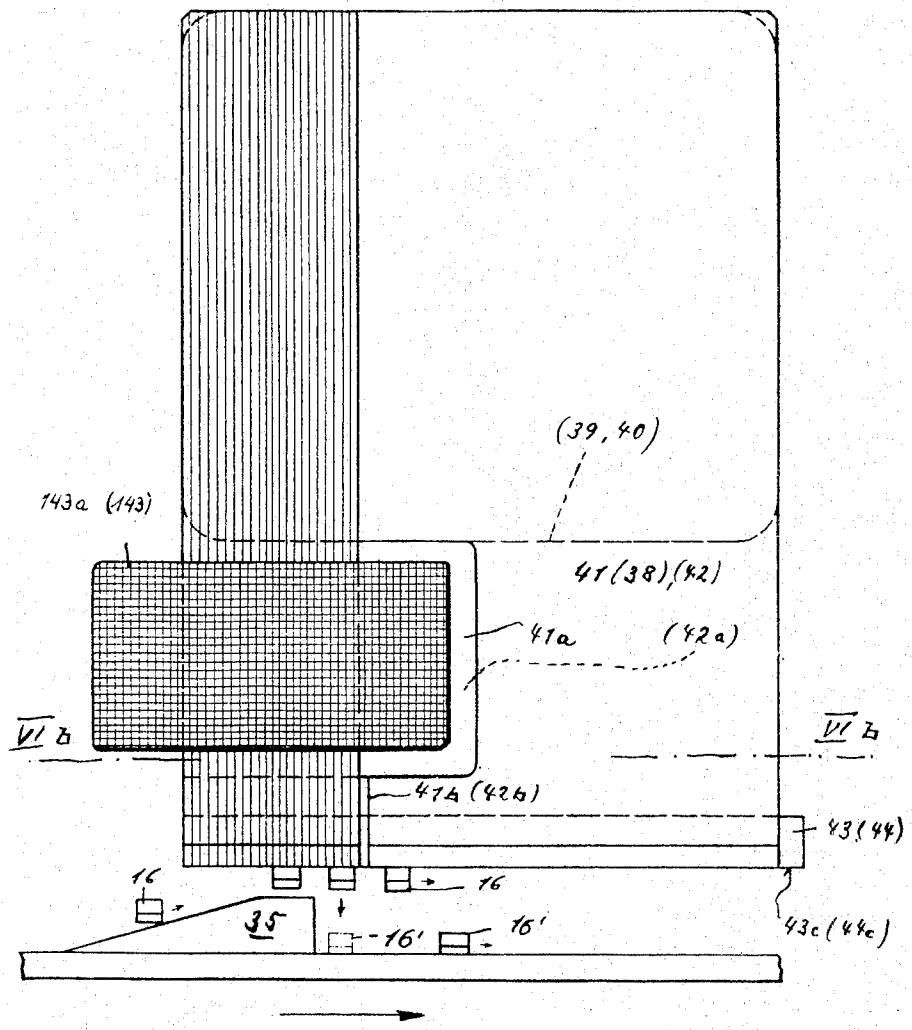
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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 6



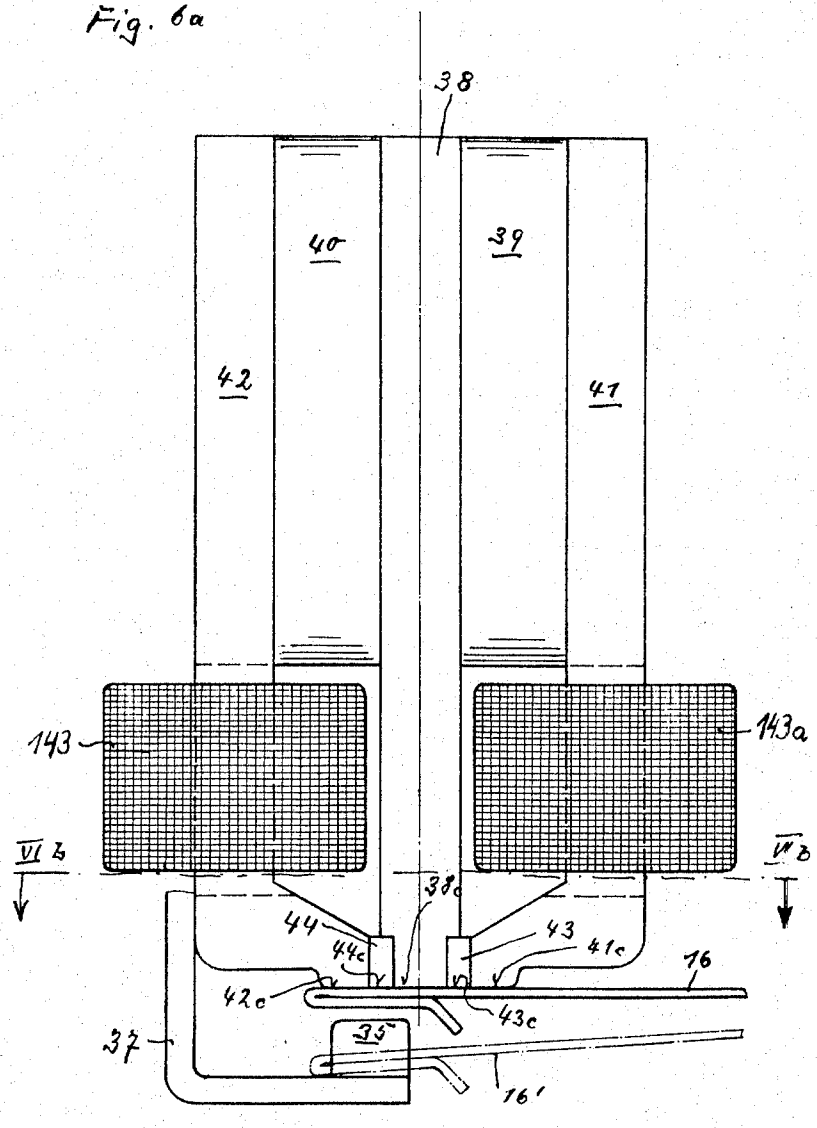
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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 6a

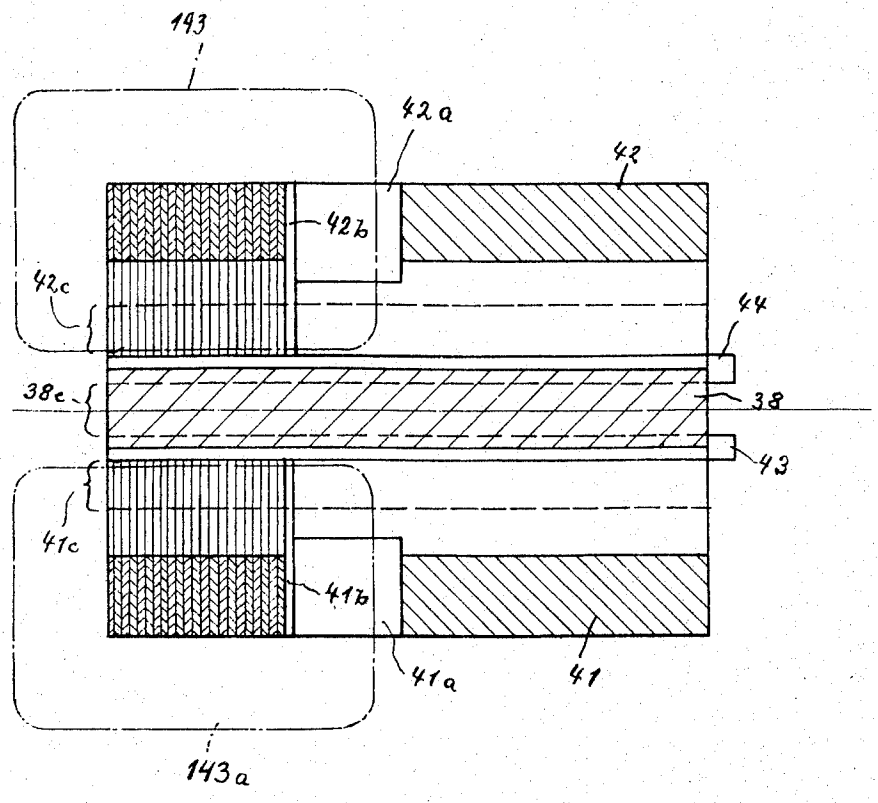


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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 6 a



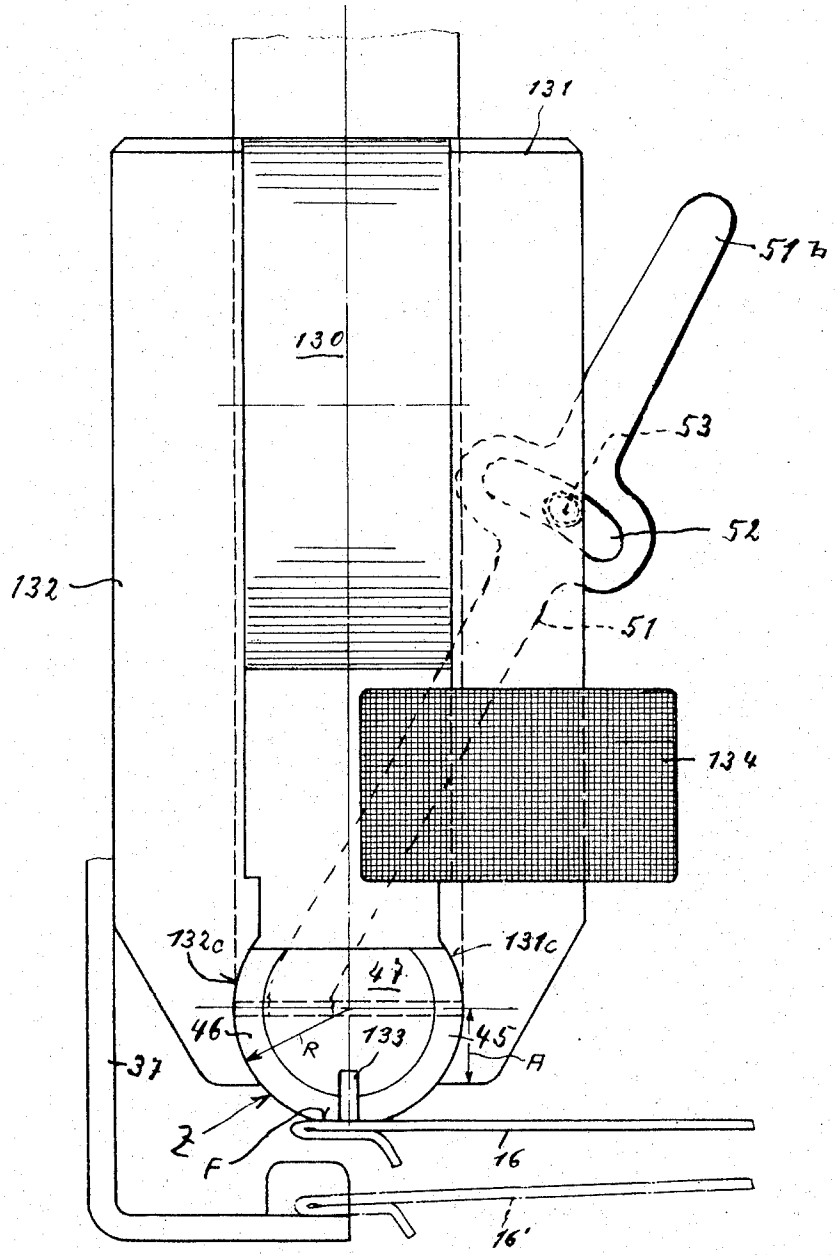
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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 7



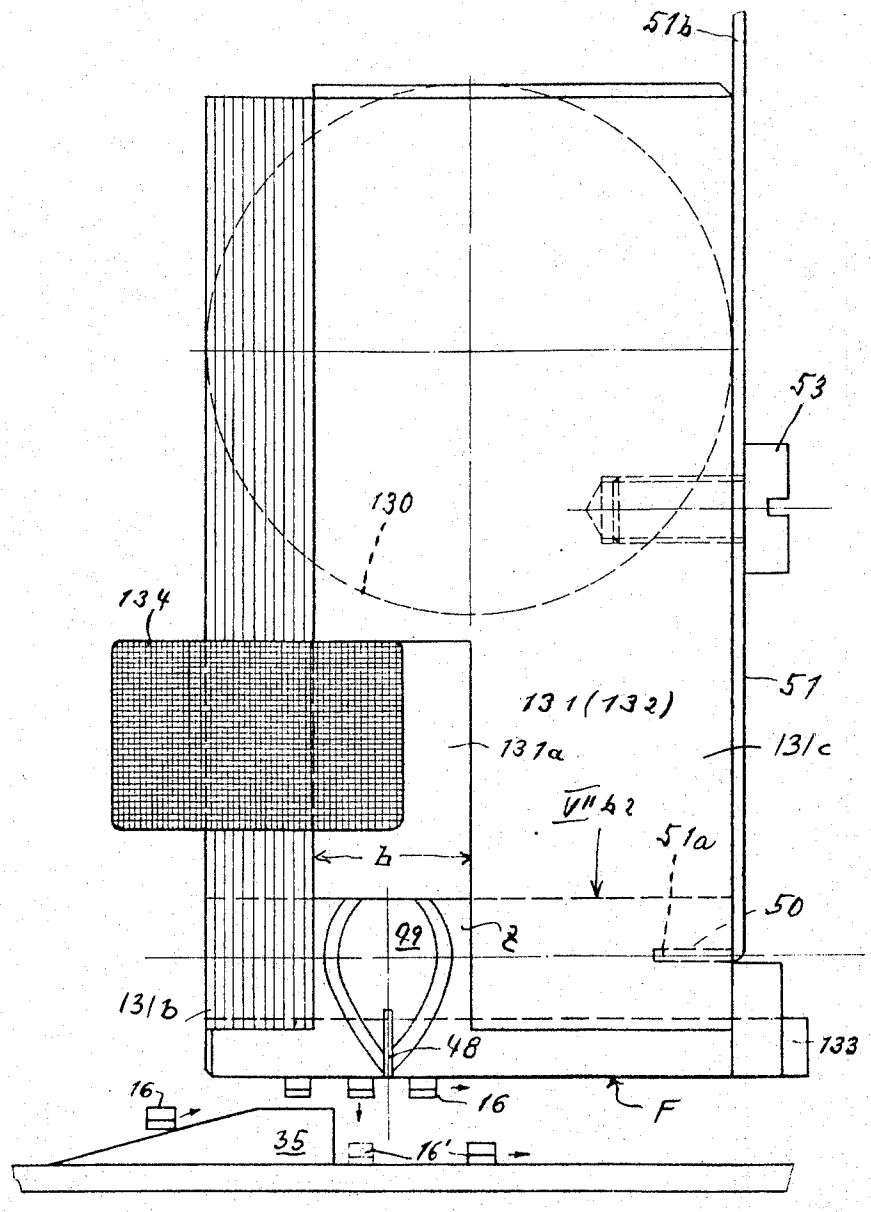
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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 7a



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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 7b1

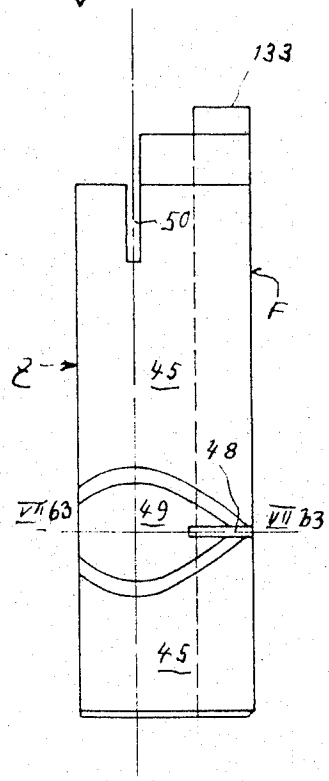


Fig. 7b2

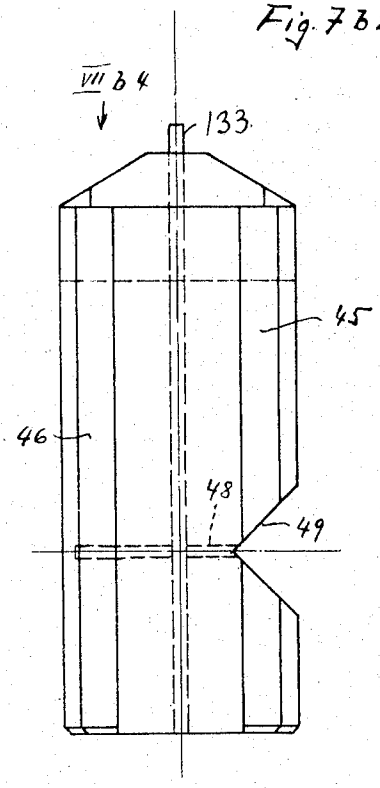
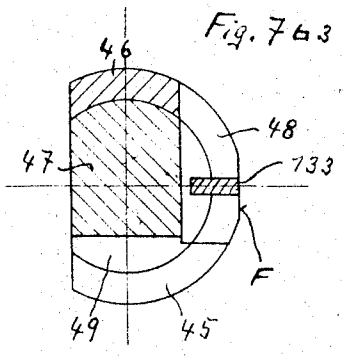


Fig. 7b3



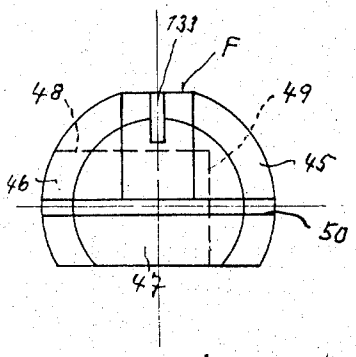


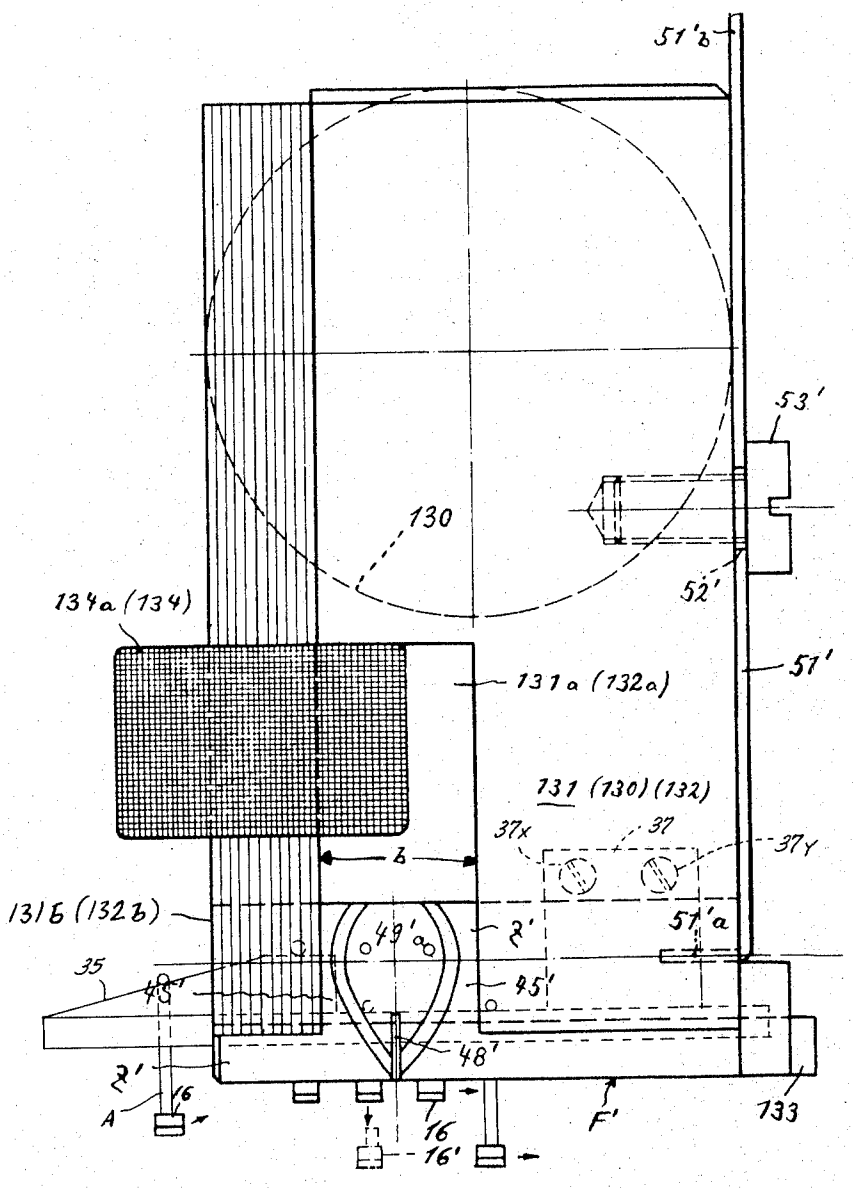
Fig. 7b4

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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 8

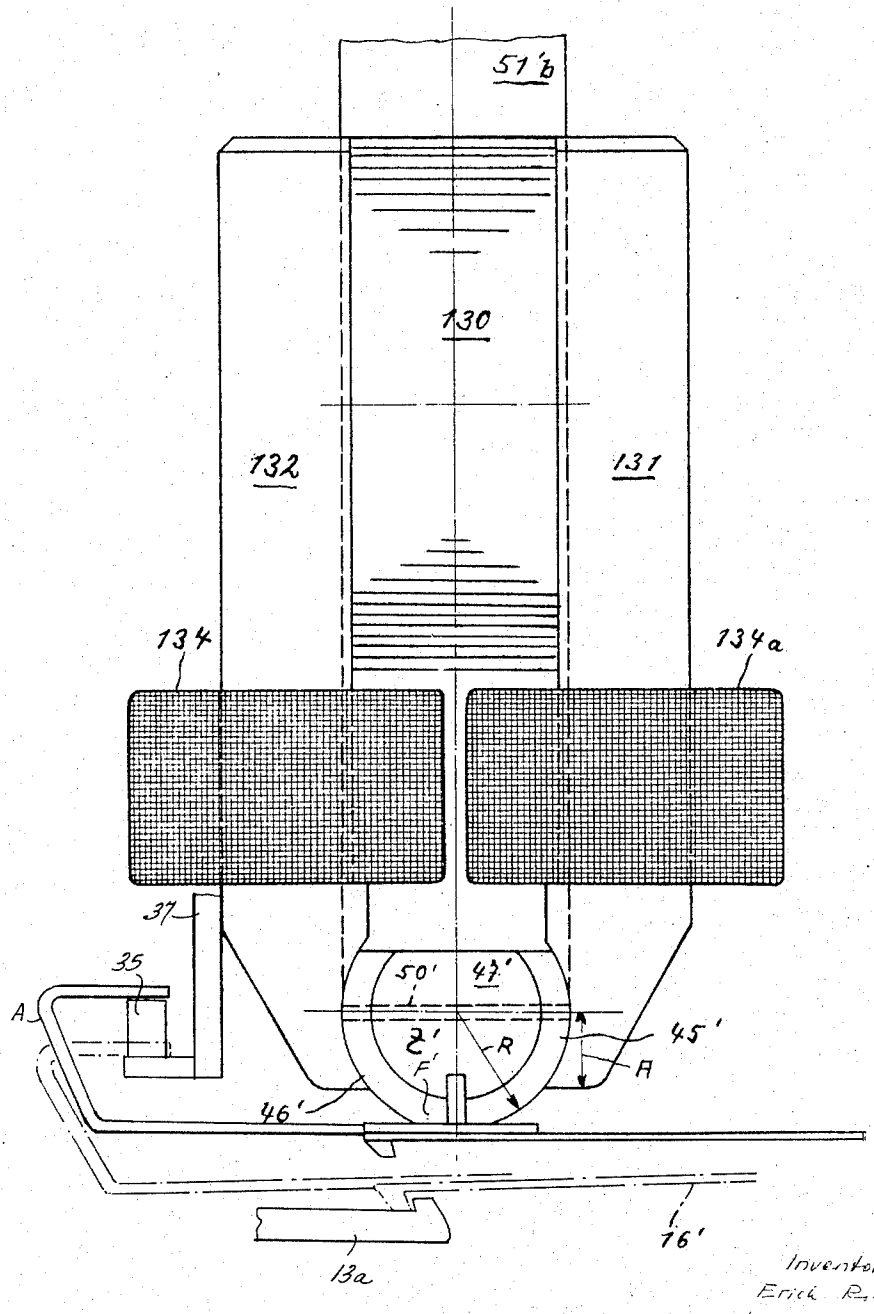


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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 8a



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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 8b1

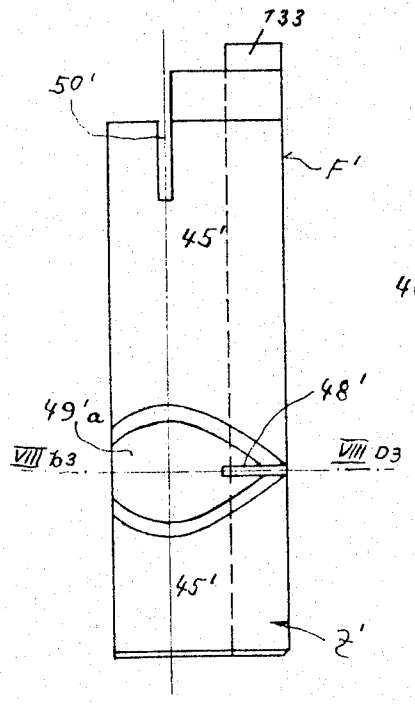


Fig. 8b2

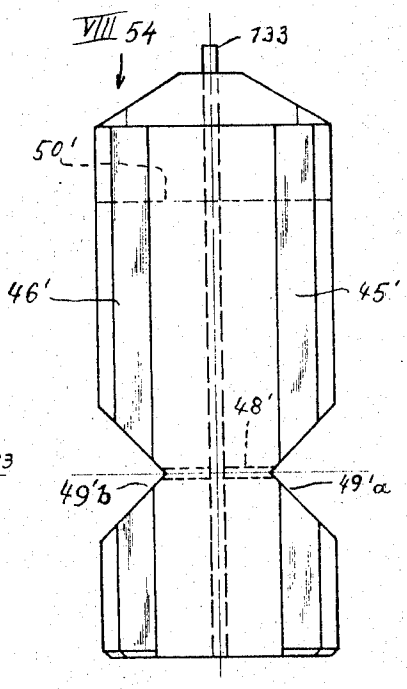


Fig. 8b3

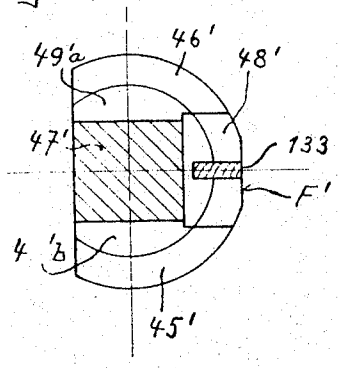
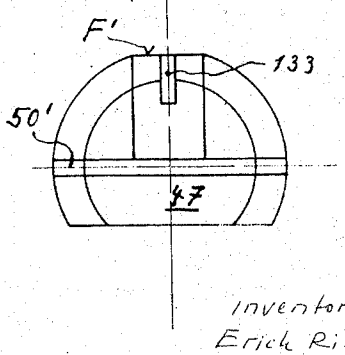


Fig. 8b4

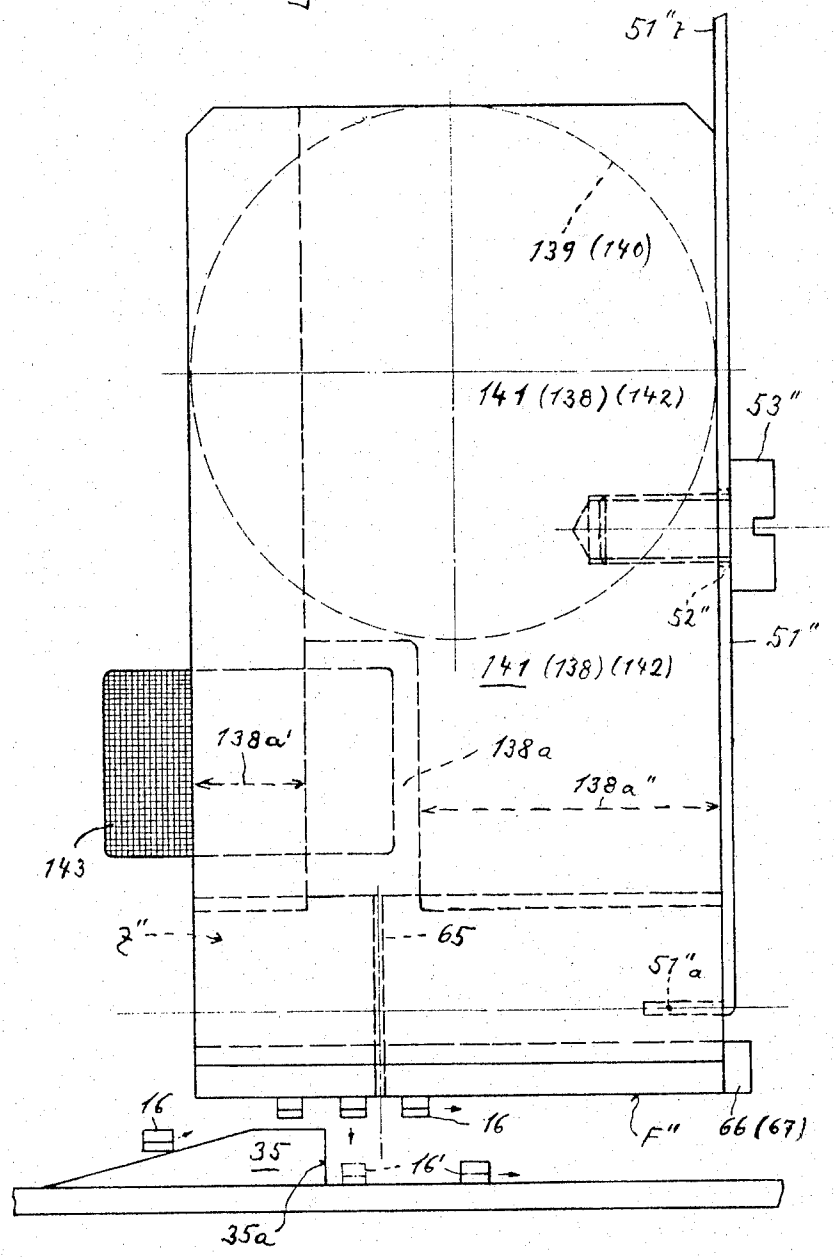


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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 9

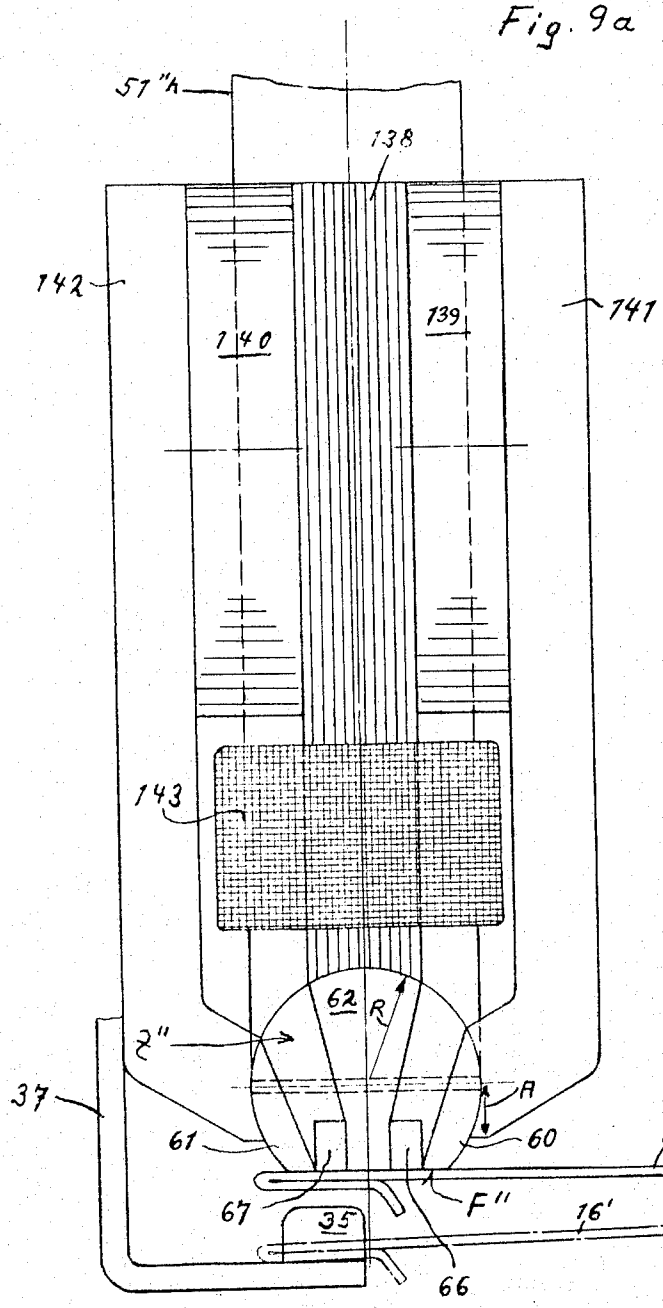


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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 9a



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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 9b1

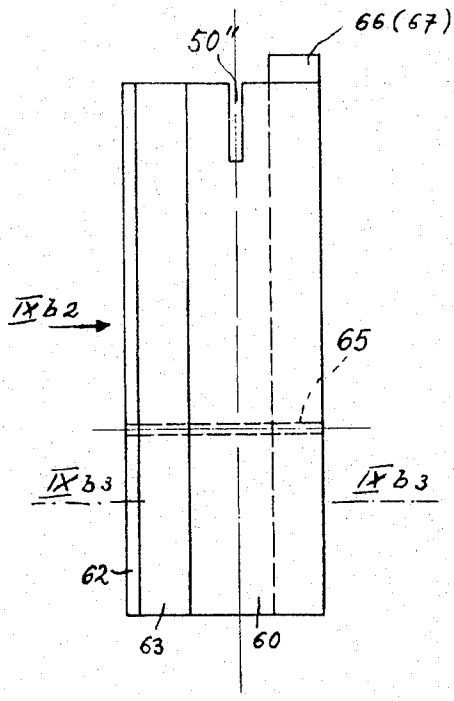


Fig. 9b2

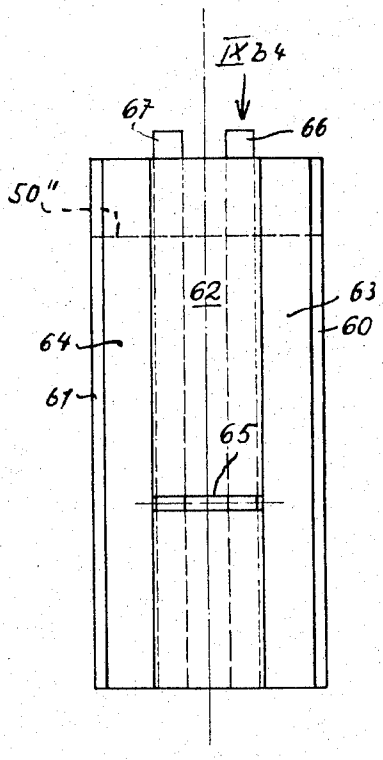


Fig. 9b3

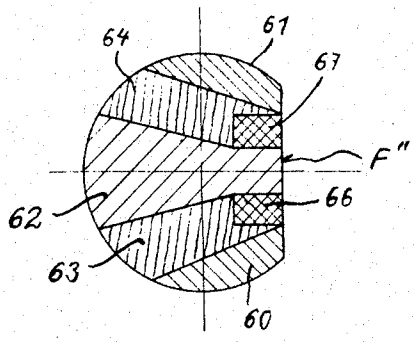


Fig. 9b4

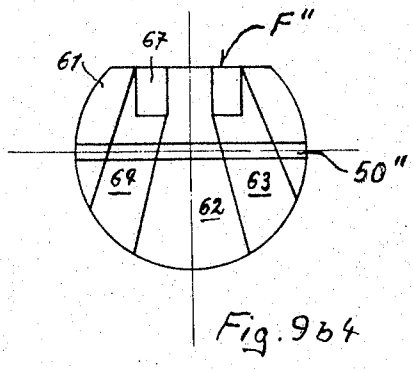


Fig. 9b4

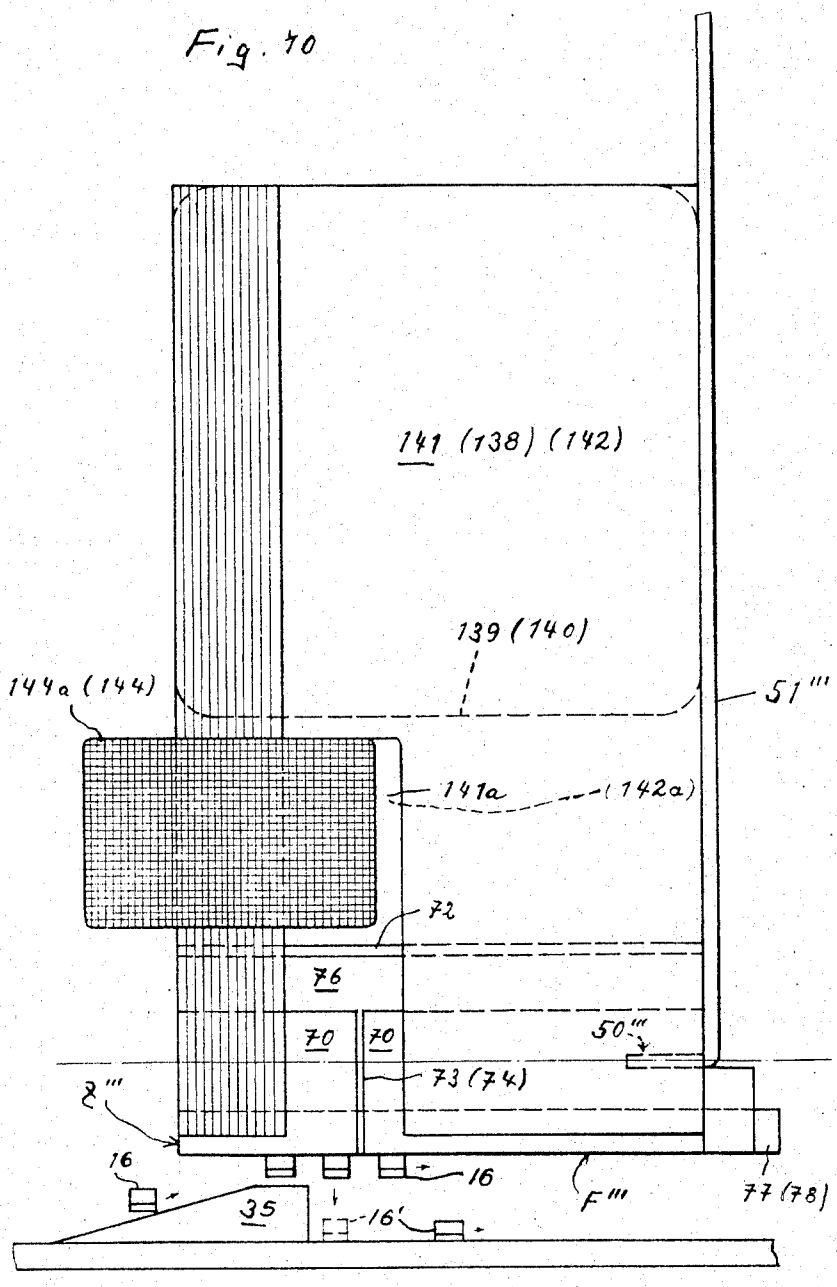
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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 70

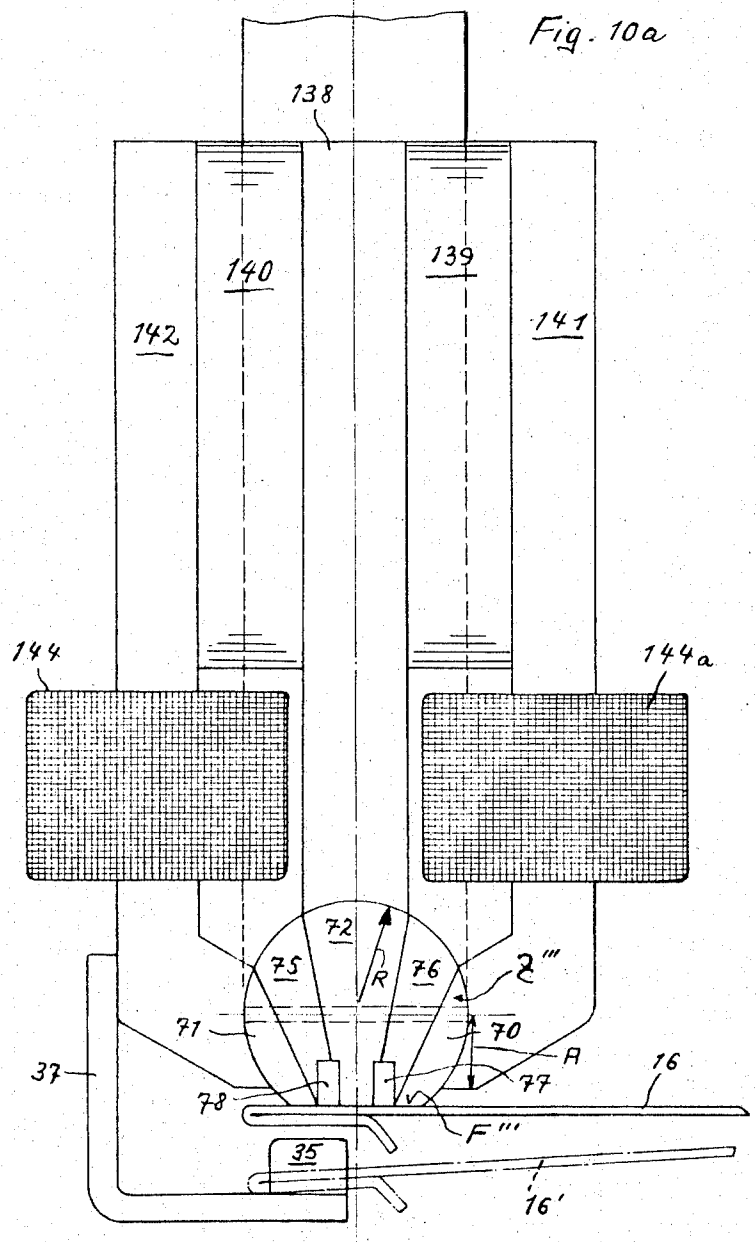


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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

Filed March 2, 1965 24 Sheets-Sheet 22

Fig. 10a



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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Fig. 10 b 1

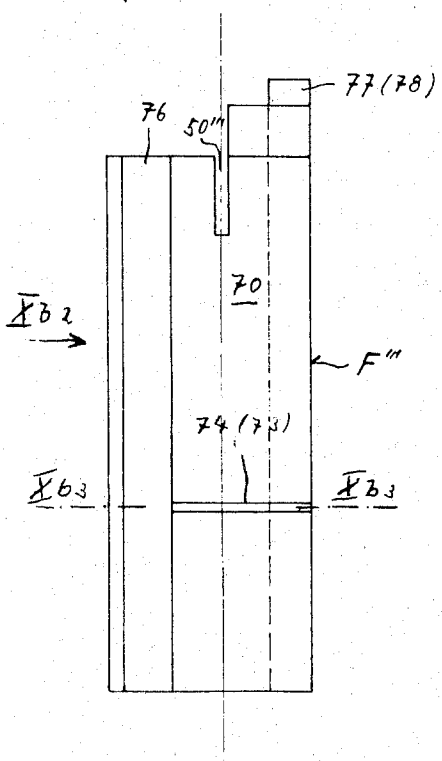


Fig. 10 b 2

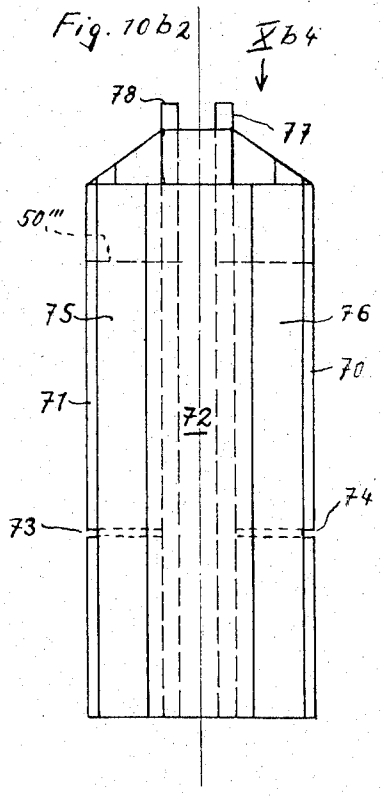


Fig. 10 b 3

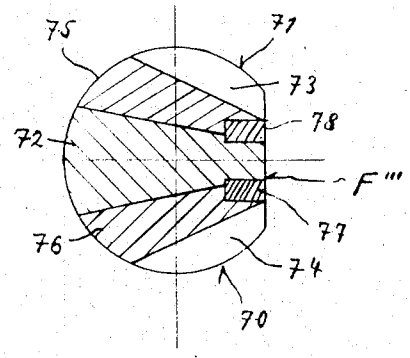
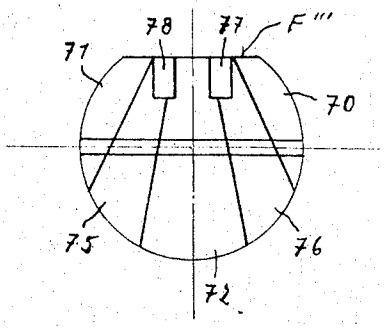


Fig. 10 b 4



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SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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FIG. 11a

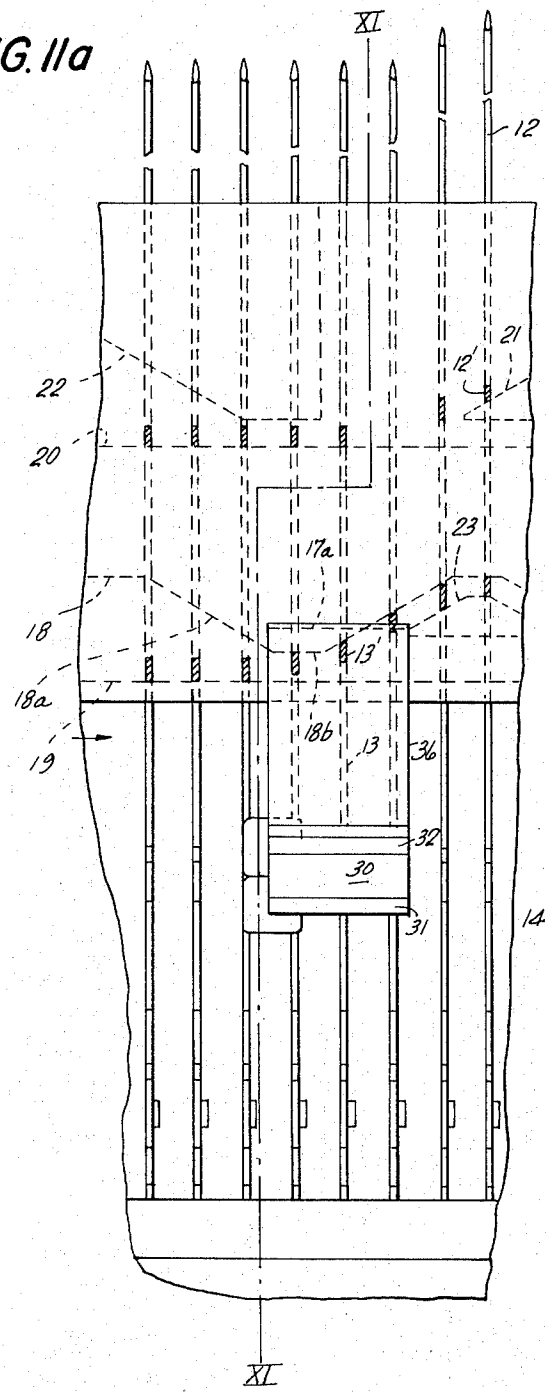
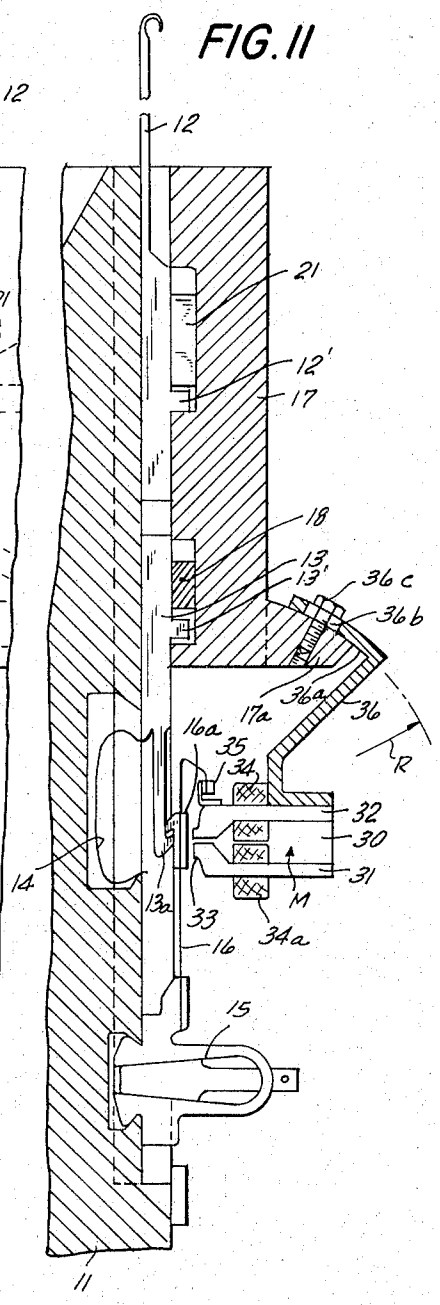


FIG. 11



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United States Patent Office 3,365,916 Patented Jan. 30, 1968

3,365,916

SELECTOR MAGNET ARRANGEMENT FOR KNITTING MACHINES

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Filed Mar. 2, 1965, Ser. No. 436,614
32 Claims. (Cl. 66—50)

ABSTRACT OF THE DISCLOSURE

The spring biased jacks of a circular knitting machine are normally locked by locking means and released by a permanent magnetic field, unless the same is counteracted by the magnetic field of a winding which is energized and deenergized in accordance with the desired knitting pattern.

The present invention relates to a selector magnet arrangement for knitting machines, and more particularly to a selector magnet which is used for the pattern control apparatus for a knitting machine, such as a circular knitting machine.

Different types of circular knitting machines are known, for example one cylinder machines, interlock machines, and machines having a set of cylinder needles mounted on a needle cylinder and a set of dial needles mounted on a rotary dial.

Machines of this type have stationary cam boxes in which cam tracks for the butts of the needles are provided. When a track portion is located in a plane perpendicular to the axis of the needle cylinder, the needles do not perform an axial movement. However, the track includes rising and descending track portions which cause the respective needle to move in axial direction to a knit position or to a tuck position and then withdraw the needle to knock the old loop over the newly formed loop.

In order to knit a patterned fabric, it is necessary to select needles which are to be moved to the knit position or to the tuck position, while non-selected needles continue to move with the needle cylinder, or with the dial, in an inoperative position.

It is known to use electromagnetic means for carrying out the selection required for knitting a particular pattern. Due to the high speed of modern knitting machines, the electromagnetic selectors must be capable to perform, for example, 500 selecting operations per second, corresponding to 500 needles passing the selector magnet in each second. It has been proposed to provide cams and cam tracks for guiding the needles, or needle influencing jacks, before and after the selecting station so that the electromagnetic selector means performs the selection by shifting a needle influencing element to one or the other cam track in accordance with the desired needle operation. In one construction, an easily shiftable lever is moved by a stationary cam to a position of readiness before arriving at a knitting station, is first held directly before the selector station by a permanent magnet, and is then moved by a selector magnet between two positions for engagement by two different cam tracks. The selection is carried out by energizing or de-energizing the selector magnet which has a soft iron core which becomes non-magnetic when the selector magnet is de-energized.

In some constructions, the shiftable lever is a resilient rod which is tensioned in the position of readiness, and is maintained in the tensioned condition if the selector magnet is energized, while assuming an untensioned position when the selector magnet is not energized at the moment in which the resilient rod passes the selector magnet. In accordance with the position assumed by the resilient rod, it will follow one or the other cam track and cause shifting of a jack and of a needle only when moving along one of the cam tracks.

In other known constructions, the selection is carried out by compressed air discharged from a nozzle which is shifted between an operative and an inoperative position by a selector magnet.

In accordance with another selector arrangement, a spring acts on a jack which controls a corresponding needle, and the jacks and needles are guided by cam tracks, one of which urges the jack to again tension the spring. A locking means is provided for locking each jack when the corresponding needle is to remain inoperative which is accomplished since the locked jack cannot be shifted by the spring. The locking means is controlled by a selector magnet which shift the same between a locking position, and an inoperative position permitting movement of the jack with the corresponding needle under the action of the tensioned spring.

In other selector arrangements, the selector magnet is part of a pattern wheel, and shifts jacks between operative and inoperative positions. The pattern wheels are mounted on the machine at the knitting stations in a position in which the axis of rotation of the pattern wheel is slanted to the axis of the needle cylinder, so that needles whose butts are engaged by operative jacks of the pattern wheel are raised, whereas needles cooperating with retracted and inoperative jacks of the pattern wheel are not raised.

When pattern wheels are used, each jack of a pattern wheel must be in the correct position selected by the selector magnet before the respective jack arrives at the selector station while turning with the pattern wheel.

In another construction, a pattern wheel or cylinder is provided at each knitting station in a position in which its axis of rotation is parallel to the axis of the knitting cylinder. The jacks of the pattern wheel move in axial direction for shifting corresponding needles of the knitting cylinder. The jacks of theh pattern cylinder are shifted by corresponding cams, and a selection is carried out by a selector magnet which operates locking means for locking selected jacks so that the same cannot be shifted by springs acting on the same. Although the above described selector mechanisms are different in many ways, they have in common that the selection proper is carried out by a selector magnet which has a soft iron core and is either energized or de-energized to produce, respectively, a magnetic force or no magnetic force so that the respective control element which is controlled by the selector magnet, is either attracted by the selector magnet, or assumes a normal position of rest which is not influenced by the de-energized selector magnet. Selector arrangements of this type are provided at the knitting stations of a knitting machine not only for the cylinder needles, but also for the dial needles.

It is one object of the invention to improve all the above described selector arrangements, as well as any other selector arrangement for a knitting machine which employs a selector magnet for effecting the selection of knitting needles in accordance with a predetermined pattern by influencing the position of a needle control means.

Another object of the invention is to provide an extremely simple and efficient selector magnet which is capable of carrying out the necessary selection at very high speed, and any number of selections per second which may be required by a high-speed knitting machine.

Another object of the invention is to use as selector

magnet, a permanent magnet instead of the energizable and de-energizable electromagnetic selectors of the known pattern control arrangements for knitting machines.

Another object of the invention is to provide a pattern control arrangement for a knitting machine with a permanent selector magnet whose permanent flux is counteracted by the temporary flux produced by an energizable winding thereon.

Another object of the invention is to provide a permanent selector magnet with magnetizable pole shoes so that the flux in the pole shoes can be counteracted by the action of an energized winding thereon.

Another object of the invention is to make at least part of the pole shoes adjustable for adjusting the position of a surface on the pole shoes along which selected needle control means slide.

Another object of the invention is to form the surface on which the needle control means slide, partly of a hard unmagnetizable body for example consisting of a mineral, such as sapphire which is located in a gap between two pole shoes.

Another object of the invention is to counteract the permanent magnetic flux only in a leading portion of the pole shoes so that the portion of the pole shoes trailing in the direction of movement of the needle control means remains permanently magnetic for holding selected needle control means.

With these objects in view, the present invention relates to a selector magnet arrangement which is part of the pattern control apparatus of a knitting machine. One embodiment of the invention comprises rotary carrier means, which may be part of the needle cylinder, of the dial, or of a pattern wheel of a knitting machine; a series of needle control means supported on the carrier means for rotation therewith and for movement thereon between a normal position and a displaced position; and stationary selector magnet means having magnetizable pole shoe means located in the region of the carrier means.

In accordance with the preferred embodiment of the invention, the selector magnet means includes a permanent magnet for producing a permanent magnetic flux in the pole shoe means, and a winding adapted to be energized in accordance with a knitting pattern and being constructed and arranged to at least partly demagnetize the pole shoe means, when energized.

Since the pole shoe means are successively passed by the needle control means during rotation of the carrier means, the needle control means are attracted by the permanent flux and tend to assume the displaced position thereof in which the corresponding needle is controlled to assume, for example, a knit position. However, when the winding is energized, a magnetic flux counteracting the permanent flux produced by the permanent magnet develops in the pole shoe means, so that a needle control means passing the pole shoe means is not attracted and remains in the normal position when the winding is energized.

In the constructions according to the prior art electromagnetic selector magnets are energized for producing a magnetic flux, and de-energized to produce no flux when the respective needle control means is not to be selected. Electromagnetic means are also used for holding the control means before and after the selection, and are continuously energized for this purpose.

The use of electrically controlled magnets in pattern control apparatus of knitting machines has the disadvantage that the needle control means which are held in attracted condition by the selector magnet, or by the holding magnet, are immediately released when the main switch of the knitting machine is opened so that the needle control means assume another position corresponding to non-election. As a result, an error is introduced into the knitted pattern of the fabric whenever the machine is stopped.

It is consequently another object of the invention to

provide a selector magnet for a knitting machine with a permanent magnet producing a permanent flux so that selected needle control means attracted by the selector magnet remain in the attracted displaced position when the knitting machine is disconnected from a source of voltage.

A related object of the invention is to prevent errors in the knitted pattern by maintaining a permanent magnetic flux in the selector magnet when the knitting machine is disconnected from the source of voltage.

In constructions according to the prior art, a permanent magnet leads the selector magnet in the direction of the movement of the needle control means, and holds the needle control means in a preliminary position toward which each needle control means is guided by a corresponding cam track.

In accordance with the present invention, a permanently magnetic portion of the pole shoe means trails the leading portion of the pole shoe means which can be demagnetized by the energized winding. Preferably, a cam is provided for moving the needle control means toward the leading portion of the pole shoe means so that a lesser magnetic force is required for attracting selected needle control means.

In the preferred embodiment of the invention, the needle control means are resilient elements which tend to remain in a normal position, and have to be resiliently tensioned by the magnetic force to assume the displaced selected position. The resilient needle control elements are preferably shiftable in a plane which is perpendicular to the end faces of the pole shoe. During the movement of the carrier, selected locking means slide on a surface of the pole shoe means in the region of a gap which, in accordance with the present invention, is filled by a sapphire providing a smooth surface along which selected needle control means slide.

In another embodiment of the invention three pole shoes are provided which form two gaps respectively filled with two sapphires. The winding may be provided on the center pole shoe, or on one or both of the outer pole shoes.

In another embodiment of the invention, the pole shoe means include two or three legs having part-circular bearing surfaces on which a pole shoe member of generally cylindrical shape is mounted for turning movement. The pole shoe member has portions of magnetizable material forming continuations of the magnetizable pole shoe legs so that the magnetic flux passes through the pole member in which the gap, or gaps are provided, filled with an unmagnetizable mineral material, such as sapphire. In this region, the slide surface for attracted and selected needle control means is provided, and by turning the pole shoe member, the position of the slide surface can be exactly correlated to the position of the attracted needle control means.

In the embodiments of the invention in which no turnable and adjustable pole shoe member is provided, the entire selector magnet can be angularly adjusted for aligning the slide surface with the displaced needle control means. In the embodiment of the invention in which only the leading portions of the pole shoe means are demagnetized by a winding while the trailing portions of the pole shoe means remain permanently magnetized for holding selected needle control means, the pole shoe member is divided by a suitable cutput to prevent magnetic flux to pass therethrough between the leading and trailing portions of the pole shoes.

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 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 axial sectional view of a portion of a needle cylinder and cam box of a circular knitting machine taken on line I—I in FIG. 1*a*;

FIG. 1*a* is a fragmentary front view of the cam box and of the needle cylinder of a circular knitting machine provided with a selector magnet arrangement in accordance with the embodiment of the invention shown in FIGS. 8 and 8*a*;

FIG. 2 is a perspective view of a circular knitting machine of the type including a plurality of knitting and selector stations and provided with the selector magnet arrangement according to the present invention;

FIG. 3 is a top view, and FIG. 3*a* is a side view of a first embodiment of the invention;

FIG. 4 is a top view, and FIG. 4*a* is a side view of a second embodiment of the invention;

FIG. 5 is a top view, and FIG. 5*a* is a side view of a third embodiment of the invention;

FIG. 6 is a top view, FIG. 6*a* is a side view, and FIG. 6*b* is a cross-sectional view taken on lines VI*b*—VI*b* in FIGS. 6 and 6*a*, and illustrating a fourth embodiment of the invention;

FIG. 7 is a side view, and FIG. 7*a* is a top view of a fifth embodiment of the invention;

FIG. 7*b*1 is a top view, FIG. 7*b*2 is a side view taken in the direction of the arrow VII*b*2 in FIG. 7*a*, FIG. 7*b*3 is a cross-sectional view taken on line VII*b*3—VII*b*3 in FIG. 7*b*1, FIG. 7*b*4 is an elevation taken in the direction of the arrow VII*b*4 in FIG. 7*b*2 and illustrating an adjustable pole shoe member used in the embodiment of FIGS. 7 and 7*a*;

FIG. 8 is a top view, and FIG. 8*a* is a side view of a sixth embodiment of the invention;

FIG. 8*b*1 is a top view, FIG. 8*b*2 is a side view, FIG. 8*b*3 is a cross-sectional view taken on line VIII*b*3—VIII*b*3 in FIG. 8*b*1, and FIG. 8*b*4 is an elevation taken in the direction of the arrow 8*b*4 in FIG. 8*b*2 illustrating a pole shoe member used in the embodiment of FIGS. 8 and 8*a*;

FIG. 9 is a top view, and FIG. 9*a* is a side view of a seventh embodiment of the invention;

FIG. 9*b*1 is a top view, FIG. 9*b*2 is a side view, FIG. 9*b*3 is a cross-sectional view taken on line IX*b*3—IX*b*3 in FIG. 9*b*1, and FIG. 9*b*4 is an elevation taken in the direction of the arrow IX*b*4 in FIG. 9*b*2 illustrating a pole shoe member used in the embodiment of FIGS. 9 and 9*a*;

FIG. 10 is a top view, and FIG. 10*a* is a side view of an eighth embodiment of the invention;

FIG. 10*b*1 is a top view, FIG. 10*b*2 is a side view taken in the direction of the arrow 10*b*2 in FIG. 10*b*1, FIG. 10*b*3 is a cross-sectional view taken on line X*b*3—X*b*3 in FIG. 10*b*1, and FIG. 10*b*4 is an elevation taken in the direction of the arrow X*b*4 in FIG. 10*b*2 illustrating a pole shoe member used in the embodiment of FIGS. 10 and 10*a*;

FIG. 11 is a fragmentary axial sectional view of a portion of a needle cylinder taken along line XI—XI in FIG. 11*a* and illustrating a portion of a needle cylinder and cam box of a circular knitting machine provided with a selector magnet arrangement in accordance with the embodiment of the invention shown in FIGS. 4 and 4*a*; and

FIG. 11*a* is a fragmentary front view of the knitting machine shown in FIG. 11.

Referring now to the drawings, and more particularly to FIGS. 1 and 1*a*, a needle cylinder **11** has axial channels **11***a* in which cylinder needles **12** are guided for axial movement. Needle influencing jacks **13** are mounted in channels **11***a* to cooperate with associated needles **12**. Each jack has a hook portion at its lower end forming a recess **13***b* at the inner edge of the jack, and a recess **13***c* at the outer edge of the jack.

Recess **13***b* is engaged by a curved leaf spring **14** located in a recess **14***a* of the needle cylinder **11** and urging

the respective jack **13** upward in axial direction to cooperate with the lower end of the corresponding needle.

Each jack **13** cooperates with a resilient control element **16** which has a hook shaped projection **16***a* engaging hook portion **13***a* and projecting into recess **13***c* in the normal position of the control elements **16**. All control elements **16** are mounted on an annular carrier means **15** which surrounds the needle cylinder.

When the control element **16** engages hook portion **13***a* in the position illustrated in FIG. 1, the force of spring **14** cannot move jack **13** upward, since the same is locked by the control element **16**. This is the normal position of the needle control means **13**, **16** in which the corresponding needle **12** will not be raised by jack **13**. However, when the resilient control element **16** is moved by the magnetic force of a selector magnet M to a displaced position releasing hook portion **13***a*, spring **14** will urge the respective jack **13** upward for moving the corresponding needle **12** upward to a knit or tuck position.

In the embodiment illustrated in FIG. 1, the control element **16** has at the upper end a hook-shaped portion **16***b* cooperating with a cam **35** which rises in circumferential direction as shown, for example, in FIGS. 8 and 8*a* for moving the control elements **16** toward selector magnet M while control elements **16** travel with carrier means **15** and the rotating needle cylinder **11** toward a selector magnet M.

A bracket **36** supports a selector magnet M at each knitting station of the circular knitting machine on a cam box **17**, as also shown in FIG. 2. The inner circular surface of cam box **17** confronts the outer peripheral surface of needle cylinder **11** in which the channels **11***a* for needles **12** and jacks **13** are provided uniformly spaced from each other, as best seen in FIG. 1*a*. Cam tracks and cams for the butts **12'** of needles **12** and for the projections **13'** of jacks **13** are provided at the inner surface of cam box **17**.

Jacks **13** urged upward by the corresponding springs **14** engage a cam track formed by the lower edge of a cam **18**. As best seen in FIG. 1*a*, cam **18** has a portion **18***a* which is downwardly slanted and engages butts **13'** to urge jacks **13** down so that springs **14** are tensioned, and in the lowest position of the respective jacks in which butts **13'** engage the cam track portion **18***b*, the resilient control element **16** snaps into recess **13***c* of the respective jack and locks the same in its lowest position. Jacks locked in this manner will move along the track **19** which is located in a plane perpendicular to the axis of rotation of the needle cylinder. However, jacks which are released by control elements **16** after the same have been attracted by selector magnets M, are urged by the respective springs **14** to move upward onto the cam track **23** which during continued rotation of needle cylinder **11** raises the respective selected jacks so that the same engage the lower ends of the corresponding needles **12** and raise the same to a position above the horizontal cam track **20** so that the respective butts **12'** are engaged by the upper cam track of a cam **21** and are further raised to a knit position. The downwardly slanted track of a stitch cam **22** returns previously raised needles to the low position located on track **20**. A corresponding cam arrangement is provided at each knitting and selector station of the knitting machine. The first two needles counted from the left of FIG. 1*a* were not raised at the preceding selector station to cooperate with the respective raising cam **21**, and consequently are located on the low cam track **20**.

It will be seen that control elements **16** lock corresponding jacks when approaching the selector station where selector magnet M is located, and either continue to lock the jacks after the selector station, or are moved by the magnetic force of selector magnet M to a displaced position releasing the respective hook portion **13***a* and permitting the respective spring **14** to raise jack **13** so that

the same acts on the corresponding needle 12 in accordance with the cams provided in the cam box 17.

A corresponding arrangement is described in detail in the copending application Ser. No. 361,310, filed by E. Ribler, particularly in FIGS. 8 and 9. FIG. 2 of the present application illustrates a knitting machine provided with the selector magnet arrangement of the invention, and shows a number of selector magnets M spaced about the periphery of needle cylinder 11 and stationarily mounted on an annular cam box 17 above which a thread supply guide 24 to 29 is provided at each knitting station.

FIGS. 3 and 3*a* illustrate a first embodiment of the invention. A permanent magnet 30 shown to be of cylindrical shape, is mounted between two pole shoes 31 and 32 which are of generally rectangular configuration and have lower portions projecting toward each other to form a gap 133 which is filled by an unmagnetizable mineral body, preferably a sapphire. The bottom surface of sapphire 33 and adjacent surface portions 31*c* and 32*c* of pole shoes 31 and 32 form a continuous surface on which a resilient element 16 slides when transported by carrier means 15 on needle cylinder 11, as described with reference to FIG. 1. Each control element 16 tends to resiliently assume the position 16' in which its hook portion 16*a* engages recess 13*c* of hook portion 13*a* of the corresponding jack 13, not shown in FIG. 3*a*, but as described with reference to FIG. 1.

Hook portion 16*a* of control element 16 is shown different in FIG. 3*a* and in FIG. 1, but the cooperation with the jack is exactly the same. Since in the construction of the control element 16 shown in FIGS. 3 and 3*a*, the upper hook portion 16*b* of the control element of FIG. 1 is omitted, the end of control element 16 directly cooperates with a rising peripheral cam portion 35 stationarily supported by a bracket 37 on the stationary pole shoe 32.

During rotation of needle cylinder 11 and carrier means 15, control elements 16 move in the direction of the arrow in FIG. 3 so that they are successively moved toward surface 32*c*, 31*c* of pole shoes 31, 32 so that they are spaced a small distance from the pole shoe surface and located in the region of the permanent magnetic flux produced by permanent magnet 30, so as to be attracted to the position shown in solid lines in FIG. 3*a*, when selection of the corresponding needles is desired. When a control element 16 is not attracted by the selector magnet 30, 31, 32, as will be explained hereinafter, the resiliently tensioned control element 16 drops over the edge 35*a* shown in FIG. 3 and resiliently snaps into recess 13*c* of the corresponding jack 13, not shown in FIGS. 3 and 3*a*, in the position 16' shown in broken lines.

As best seen in FIG. 3, pole shoe 32 has a rectangular cutout 32*a* which is continued in a narrow air gap 32*b* extending to the surface 32*e*. A portion 32' of substantially square cross section is thus formed in pole shoe 32. A winding 34 surrounds portions 32' and is partly located in cutout 32*a*. Winding 34 is connected to switch means which are controlled by the pattern control arrangement of the knitting machine in a known manner to be energized or de-energized in accordance with the desired pattern to be knitted.

Pole shoes 31 and 32 are made of soft iron or a corresponding magnetizable material. As long as winding 34 is not energized, the magnetic flux produced by permanent magnet 30 passes through the pole shoes 31 and attracts control elements 16 riding on the crest of cam 35 to the positioned illustrated in solid lines in FIG. 3*a* in which the corresponding jacks 13 are released to raise the corresponding needles.

Winding 34 is wound and polarized in such a direction as to produce in portion 32' of pole shoe 32 a flux counteracting the flux produced by permanent magnet 30. The permanent flux may either be reversed, or fully compensated, or only weakened. In any event, if winding 34 is energized, the magnetic force acting on a control element 16 approaching the selector magnet is reduced to such an extent that the spring force of control element 16 is sufficient to hold the respective control element on the crest of cam 35 until it is carried beyond edge 35*a* and resiliently snaps inward to the position 16' engaging the recess 13*c* in jack 13 and locking the same.

It will be seen that only the leading portion of pole shoe 32 taken in the direction of movement of carrier 15 and control elements 16, and located forwardly of the air gap 32*b* will be influenced by winding 34, while the trailing portion of pole shoe 32 located rearwardly of air gap 32*b* is not influenced by the energizing winding 34. Consequently, an attracted and displaced control element 16 sliding on surfaces 31*c* and 32*c*, and on the surface of sapphire 33, will be held by a permanent magnetic flux produced by permanent magnet 30 after passing gap 32*b*. In this manner, it is reliably prevented that a control element 16 resiliently snaps back toward the corresponding jack before the same has been moved upward by spring 14 and has been engaged by the rising cam track 23.

As explained with reference to FIG. 1*a*, all jacks 13 which are not locked by a non-elected control element 16, and which were raised by cam track 23, are again moved downward by cam track 18*a* to tension spring 14 until control element 16, released by the trailing end of surfaces 31*c*, 32*c* and by the lower surface of sapphire 33, again locks the corresponding jacks 13.

As shown in FIG. 3, the trailing end of sapphire 33 projects beyond the trailing ends of surfaces 31*c*, 32*c* so that the stray flux at the trailing ends of pole shoes 31, 32 does not delay or prevent the movement of a released resilient control element toward the locking position shown in FIG. 1. In order to prevent an undesired flux distribution, brackets 37 by which the selector magnets are secured to the cam box, are made of an unmagnetizable material.

During the rotation of needle cylinder 11 and carrier means 15, attracted and selected control elements 16 slide in the direction of the arrow along surfaces 31*c* and 32*c* and on the corresponding flush surface of sapphire 33. In order to assure low friction, and full effect of the magnetic flux, the entire surface 31*c*, 32*c* is to be engaged by the surface of control element 16.

Adjusting means are provided for placing selector magnet 30, 31, 32 in the position shown in FIG. 3*a* in relation to a control element 16, and include mounting means, not shown, for mounting the selector magnet for turning movement about an axis P in surface 31*c*, 32*c* and perpendicularly to the axis of the cylindrical selector magnet 30 as will be described in the reference to FIGS. 4*a* and 11*a*.

The embodiment illustrated in FIGS. 4 and 4*a* cooperates with the needle control elements 16 in the same manner as described with reference to FIGS. 1, 1*a*, 3 and 3*a*. However, in the embodiment of FIGS. 3 and 3*a*, the flux produced by the permanent magnet 30 is counteracted by the flux produced by the permanent magnet 30 is counteracted by the flux produced by winding 34 only in the leading portion of one pole shoe.

In order to obtain a stronger effect of the compensation, two windings 34 and 34*a* are provided on both pole shoes 31 and 32, respectively. Pole shoe 32 has a cutout 32*a*, and pole shoe 31 has a cutout 31*a*, the cutouts being, respectively, extended by airgaps 31*b* and 32*b*.

While in the embodiment of FIGS. 3 and 3*a*, both pole shoes 31 and 32 are made entirely of the magnetizable material, only the leading portions of pole shoes 31 and 32 are made of a magnetizable material, shown to be laminated superimposed sheets 131. When windings 34 and 34*a* are energized in accordance with the desired pattern, the leading portions of both pole shoes are magnetized in opposition to the flux produced by the permanent magnet 30 which is shown to have a rectangular cross section. Consequently, the attracting force still exerted by the leading portion of pole shoe 31 in the embodi-

ment of FIGS. 3, 3*a*, is eliminated in the embodiment of FIGS. 4 and 4*a*, while the flux produced by the permanent magnet in the trailing portions of the pole shoes is fully maintained. The sapphire body **33** projects beyond the trailing edge of surface **31***c*, **32***c* and facilitates the sliding of selected control elements **16** until released by the projecting end of bottom face **33***a* of sapphire body **33**. As in the embodiment of FIG. 3, the air gaps **31***b*, **32***b* prevent the flux produced by the permanent magnet in the trailing portions of the pole shoes to enter the lowest part of the leading portions of the pole shoes when windings **34**, **34***a* are energized to de-magnetize the leading portions of the pole shoes.

In order to assure that the bottom face **33***a* of the sapphire body **33**, and surfaces **31***c*, **32***c* are absolutely parallel with the surface of the control elements **16** sliding thereon, the angular position of the selector magnet is adjustable. FIGS. 11 and 11*a* show an adjustable arrangement incorporating the embodiment of FIGS. 4 and 4*a*, but the selector magnets of the other embodiments may be mounted in the same manner.

The cam box **17** has a projecting portion **17***a* in the region of every selector magnet system. The top surface of the projection is a circular surface having the radius R and a center P located in the surface **33***a*, **31***c*, **32***c*, as also shown in FIG. 4*a*. A selector magnet M is secured to projection **17***a* by a bracket **36** which has a part-circular end portion **36***a* matching the curvature of projection **17***a*. The portion **36***a* has a slot **36***b* through which a screw **36***c* passes into a threaded bore of projection **17***a*. When portion **36***a* is moved along the circular surface of projection **17***a*, the selector magnet is turned about the axis P shown in FIG. 4*a*, and the position of the selector magnet can be adjusted until the surface **31***c*, **33***a*, **32***c* is exactly parallel to the surface of an attracted resilient control element **16**, so that the same will slide on both surface portions **31***c* and **32***c*.

In the embodiment of FIGS. 5 and 5*a*, three pole shoes are provided, and the permanent magnet is divided into two parts **39** and **40** which are respectively located between the outer pole shoes **41**, **42** and the center pole shoe **38**. A winding **143** is provided only on the center pole shoe **38** which is preferably constructed of laminated soft iron. The outer pole shoes **41** and **42** have portions projecting toward each other and forming with a thinner end portion of pole shoe **38**, two gaps in which sapphire bodies **43** and **44** are located. Surface portions **41***c*, **42***c*, **38***c* of the pole shoes, and surface portions **43***c*, **44***c* of the sapphires, are flush and form a continuous slide surface for attracted and selected control elements **16**. The central pole shoe **38** is formed with a rectangular cutout **38***a* communicating with an air gap **38***b* separating the leading portion of pole shoe **38** from the trailing portion of the same. Winding **143** surrounds the part of pole shoe **38** located forwardly of the cutout **38***a*. When during rotation of needle cylinder **11** with carrier means **15**, control elements **16** ride along cam **35** into the proximity of the leading portions of pole shoes **41**, **42** and **38**, they are attracted if winding **143** is not energized, and slide along the sapphires and surfaces **41***c*, **42***c* and **38***c* until released by the trailing projecting ends of sapphires **43**, **44**.

However, when winding **143** is energized, the flux in the leading portion of pole shoe **38** is reversed so that the resilient control elements **16** are not attracted, and snap resiliently over the end of cam **35** inwardly toward the recesses **13***c* of the jacks **13** to lock the same. Attracted and selected control elements **16** are held by the permanently magnetized trailing portions of pole shoes **41**, **42**, **38**, and are released when arriving at the projecting end portion of the sapphires **43**, **44**.

It is preferred to make the leading portion only of the central pole shoe **38** of a laminated material and to provide cutout **38***a* adjacent the laminated material in the solid portion of pole shoe **38** which remains permanently magnetized by permanent magnets **39**, **40** in the same manner as pole shoes **41** and **42**. The embodiment illustrated in FIGS. 6, 6*a* and 6*b* has three pole shoes **41**, **42** and **38** as described with reference to FIGS. 5 and 5*a*, and the sapphires **43** and **44** are arranged in the same manner. In contrast to the embodiment of FIGS. 5 and 5*a*, the central pole shoe **38** does not have a winding or a cutout, and cutouts **41***a*, **42***a* of rectangular configuration connected with air gaps **41***b*, **42***b* are provided in the outer pole shoes **41**, **42**. The leading portions of pole shoes **41**, **42** located forwardly of gaps **41***b*, **42***b* are constructed of laminated soft iron sheets and are surrounded in the region of cutouts **41***a*, **42***a* by windings **143**, **143***a*.

When both windings are simultaneously energized, the flux produced by the permanent magnets **39**, **40** in the leading portions of pole shoes **41**, **42** is compensated so that control elements **16** approaching surfaces **41***c*, **38***c*, **42***c* on cam **35** are not attracted but snap at the end of cam **35** to the normal position **16'** for locking the corresponding jacks. When windings **44** and **44***a* are not energized, the flux produced by the permanent magnets **39**, **40** attracts control elements **16** to the surfaces **41***c*, **38***c*, **32***c*, and the attracted and thus selected control elements **16** travel with carrier **15** and needle cylinder **11** in the direction of the arrows in FIG. 6 until they pass gaps **41***b*, **42***b* and are held during further movement by the permanently energized trailing portions of pole shoes **41**, **38**, **42**, irrespective of whether the leading portions of pole shoes **41**, **42** are de-magnetized by energized windings **44**, **44***a* for rejecting control elements **16** associated with needles which are not to be raised to a knit position.

As explained with reference to the embodiment of FIGS. 3 and 3*a*, the entire selector magnet is mounted for turning movement so that the relative position between the slide surfaces of the pole shoes and sapphires and the attracted control elements can be adjusted to assure that the sliding control elements engage the surface portions on both pole shoes, or on all three pole shoes. The adjustment of the position of the slide surface of the pole shoes is perfected in the constructions illustrated in FIGS. 7 to 10. The construction of FIGS. 7, 7*a* corresponds substantially to the embodiment described with reference to FIG. 3 inasmuch as a single winding is provided on the leading portion of one pole shoe only.

In the embodiment of FIGS. 7, 7*a*, the pole shoe means include two legs **131**, **132** provided at the ends of a cylindrical permanent magnet **130**. A cutout **131***a* is provided in leg **131** and extends to the lower edge of the same. The width of the cutout is *b*, and the leading portion of leg **131** located forwardly of cutout **131***a*, is made of laminated soft iron sheet material, and surrounded by winding **134**. The laminated leading portion **131***b*, the trailing portion **131***c* rearwardly of cutout **131***a*, and pole shoe **132** have part circular surfaces **131***c* and **132***c* in sliding engagement with a substantially cylindrical pole shoe member Z. Pole shoe member Z has a gap in which a sapphire body **133** is mounted. Pole shoe member Z comprises two curved parts **45** and **46** of magnetizable material in sliding engagement with the legs **131**, **132**, and permeated by the magnetic flux produced by permanent magnet **130**. Members **45** and **46** have flattened surface portions forming together with a surface of sapphire **133**, a slide surface F for an attracted control element **16**.

The magnetizable parts **45** and **46** are separated by a body **47** consisting of a non-magnetizable material, for example brass.

The leg portions **131**, **132** are respectively extended by magnetizable portions **45** and **46** so that the flux produced by the permanent magnet **130** passes through pole shoe member Z so that control elements **16** riding on cam **35** are attracted toward the surface F. When winding **134** is energized, the leading leg portion **131***b* of pole shoe leg **131** is de-magnetized and a control element **16** approaching the leading portions of pole shoe portions **45** and **46** is not attracted. Pole shoe **132**, and the trailing portion **131***c* of pole shoe leg **131** are permeated by a permanent mag-

netic flux produced by permanent magnet **130**, and such flux passes through the trailing portion of pole shoe member Z. In order to separate the leading and trailing portions of pole shoe member Z, a narrow deep air gap **48** corresponding to air gap **32***b* in the embodiment of FIG. 3, is provided, and this air gap communicates with a wide cutout **49** performing the same separating function. The air gap **48** has to be narrow in the region of the slide surface F, so that it is narrower than the corresponding dimension of a control element **16**. In this manner, a control element **16** moving in the direction of the arrow along the slide surface F, is either attracted, at least partly, by the leading parts of pole shoe portions **45**, **46**, or by the trailing parts of the same, while an air gap **48** having a width greater than the width of control element **16** would cause release of an already attracted control element **16**.

Pole shoe member Z has an outer surface with a radius R matching the radius of curvature of surfaces **132***c* and **131***c* so that pole shoe member Z is turnable. A slot **50** is provided at the end of pole shoe member Z, and engaged by the bentover end portion **51***a* of an adjusting lever **51** which has a part-circular slot **52**. A screw **53** threaded into pole shoe leg **31** passes through slot **52**, so that adjusting lever **51** can be turned when screw **53** is loosened, and arrested by screw **51** in a position in which pole shoe member Z has been turned sufficiently to place slide surface F in a position exactly parallel to control elements **16** so that the same slide on slide surface portions of both portions **45** and **46** of pole shoe member Z when attracted by the selector magnet. The end portion **51***b* is adapted to be manually engaged during the adjustment of the angular position of pole shoe member Z and its surface F.

The embodiment illustrated in FIGS. 8 and 8*a* is similar to the embodiment of FIGS. 4 and 4*a* inasmuch as the selector magnet has a pair of pole shoes, each of which is provided with a winding. Rectangular cutouts **131***a* and **132***a* are provided in pole shoes **131** and **132** and extend to the lower edges of the same. The leading portions of the pole shoes are formed by laminated bodies **131***b*, **132***b* of square cross section which are surrounded by windings **134**, **134***a* partly located in cutouts **131***a*, **132***a*.

The lower end of pole shoe legs **131**, **132** have part-circular surfaces supporting a pole shoe member Z' for turning movement. Pole shoe member Z' is shown in detail in FIGS. 8*b*1, 8*b*2, 8*b*3 and 8*b*4. The flux passing through the leading and trailing portions of pole shoes **131**, **132** is continued in curved portions **45'**, **46'** into the region of a gap in which a sapphire body **133** is located as described with reference to the other embodiments. The sapphire body projects from the trailing portion so that during the movement of the carrier **15** with needle cylinder **11**, control elements **16** first slide on the slide face F', and finally slide only at the slide surface of the projecting portion of sapphire **133** from which they resiliently separate to assume the normal position **16'**.

Pole shoe member Z' has a gap **48'** and cutouts **49***a'* and **49***b'* interrupting flux between the leading and trailing portions of pole shoe member Z' so that the leading pole shoe portions **131**, **132***b* are separated from the trailing pole shoe portions in which a permanent flux is always maintained. Pole shoe member Z' has an inner part **47'** consisting of a non-magnetic material so that the flux is concentrated in the region of the surface F' into whose proximity the control elements are guided by the cam **35** in the region of the leading portions of the pole shoes and of pole shoe member Z'. As best seen in FIG. 8*b*3, cutouts **49***a'* and **49***b'* are located on opposite sides of the non-magnetic body **47'** so as to be located in the cutouts **131***a* and **132***a*. While the wider cutouts **49***a'* and **49***b'* obtain a better magnetic separation between the leading and trailing portions of parts **45'** and **46'** of pole shoe member Z', the gap **48'** must be narrow to assure that control elements **16** do not separate from slide surface F' when passing the air gap **48'**.

The trailing end of pole shoe member Z' has a slot **50'** into which the bentover end **51***a'* of an adjusting lever **51'** projects. Adjusting lever **51'** can be turned by handle portion **51***b'* and arrested in displaced positions by a screw **53'** passing through a curved slot into a pole shoe. Lever **51'** preferably consists of a non-magnetizable material.

As explained with reference to the previously described embodiments, the permanent flux produced by the permanent magnet **130** is counteracted by the magnetic flux produced by windings **134**, **134***a* which have to be wound in opposite directions in accordance with the different polarity of the two pole shoes. When windings **134**, **134***a* are not energized, the flux of the permanent magnet passes through the leading and trailing portions of the pole shoe legs into the leading and trailing portions of pole shoe member Z', and pole shoe member Z' is strongly magnetic in the region of the surface F' so that control elements **16** resiliently bent by cam **35** to be located in the proximity of surface F' are attracted and slide on the slide surface F' until reaching the projecting end of sapphire **133** from which they return resiliently to the normal position for locking corresponding jacks. The width of cutouts **131***a*, **132***a* is indicated to be *b*, the radius of the pole shoe member and of the corresponding bearing surfaces of the legs of the pole shoes is R, and the distance between the ends of the pole shoes and the turning axis of pole shoe member Z' is indicated to be A.

The embodiment illustrated in FIGS. 9 and 9*a* is similar to the embodiment of FIGS. 5 and 5*a* inasmuch as two outer poles and a central pole are provided, and that a winding is mounted on the central pole.

A pair of pole shoe legs **141** and **142** are secured to the outer ends of a pair of permanent magnets **139**, **140** between which a third pole shoe leg is secured. The free ends of the pole shoe legs have circular bearing surfaces with the radius R, and a pole shoe member Z'' is mounted on the bearing surfaces for turning movement so that the position of the slide surface F'' relative to control elements **16** can be adjusted by a lever **51''** whose bentover end portion **51***a''* projects into a slot **50''** at the trailing end of pole shoe member Z'', as best seen in FIG. 9*b*1. A screw **53''** passing through a circular slot **52''** arrests the adjusting lever in adjustable positions of pole shoe member Z'' and has a handle **51***b''* for this purpose.

The central pole shoe leg **138** has a cutout **138***a* of rectangular configuration opening at the lower edge of pole shoe leg **138** and thus separating a leading portion of pole shoe leg **138** from its trailing portion, the leading portion extending a distance **138***a'* and a trailing portion extending a distance **138***a''* in the direction of movement of control elements **16**. The winding **143** surrounds the leading portion which is constructed of laminated soft iron sheets in the form of a rectangular prism, and secured to the remaining trailing portion of the central pole shoe leg by screws, not shown.

The curved bearing faces at the ends of pole shoe legs **141**, **142** engage corresponding portions **60**, **61** of pole shoe member Z'' along the entire length of the pole shoes in the direction of travel of the control elements. A central portion **62** of pole shoe member Z'' is divided by a narrow air gap **65** so that portion **62** has a leading portion in the region of, and in contact with the leading portion of the pole shoe leg **138**, and a trailing portion in contact with the trailing portion of pole shoe leg **138**, gap **65** extending into the region of cutout **138**. Between the magnetizable portions **60**, **61**, **62** of pole shoe member Z'', non-magnetizable portions **63**, **64** are inserted, as best seen in FIG. 9*b*3 and FIG. 9*b*4. Portions **63** and **64** have cutouts forming together with the magnetizable central portion **62**, a pair of slots or gaps which are completely filled with sapphire bodies **67**, **66**. A flat slide surface F'' is formed on portions **60** to **64**, and on the sapphires **66**, **67**, permitting sliding of the straight control elements **16** thereon while the magnetic flux passes through the

magnetizable portion **60, 61, 62** if winding **143** is not energized. When a switch controlled in accordance with the pattern to be knitted is closed and winding **143** is energized, the magnetic force produced by the permanent magnet **139** is reversed, compensated, or at least partly compensated so that the spring force of control elements **16** is sufficient to maintain the same on the rising cam **35** when the control elements travel with carrier **15** and needle cylinder **11** from the left to the right as viewed in FIG. 9.

If winding **143** is not energized when a control element **16** arrives at the highest part of cam **35**, it is attracted and slides on surface F'' first along the leading portion of pole shoe member Z'' forwardly of gap **65**, and then on the trailing portion of pole shoe member Z'' along surface F'' while in sliding engagement with the magnetizable portions **60, 61, 62**, and with the sapphires **66, 67** which protect the surfaces of the soft material of portions **60, 61, 62** which otherwise would be soon worn off. If the angular position of pole shoe member Z'' would not be exactly adjusted, the control elements **16** may, for example, slide only on portion **60**, wearing the same off in a short time, but this is prevented by the turnable adjustment of pole shoe member Z'' to a position in which the entire surface F'' including both sapphires is engaged by the moving control elements **16**.

The embodiment illustrated in FIGS. 10 and 10*a* is similar to the embodiment of FIGS. 6 and 6*a* inasmuch as three pole shoes are provided and that two windings are mounted on the outer pole shoes.

A pair of permanent magnets **139, 140** are secured to the three pole shoe legs **138, 141** and **142**. The outer pole shoe legs **141** and **142** are formed with cutouts **141***a*, **142***a* extending to the lower edges of the pole shoe legs **141, 142**, as best seen in FIG. 10. Pole shoe legs **141** and **142** are formed of two parts, the leading parts being made of laminated soft iron material forming square prisms bounding cutouts **141***a*, **142***a*. Windings **144, 144***a* are mounted on the leading portions of pole shoe legs **141, 142** and partly located in cutouts **141***a* and **142***a*. The free ends of all three pole shoe legs are formed with part-circular bearing faces having the radius R, which is also the radius of the substantially cylindrical pole shoe member Z''' so that the same can be turned by a handle **51'''** having a bentover end located in a slot **50'''** at the rear end of pole shoe member Z'''.

Two segment shaped magnetizable portions **70** and **71** of the pole shoe member form continuations of pole shoe legs **141** and **142**, and a central wedge-shaped portion **72** forms a continuation of the central pole shoe leg **138**. Portions **71, 72, 70** are separated by portions **75, 76** of the pole shoe member which are made of a non-magnetizable material, such as brass. Cutouts are formed in portions **72, 75, 76** to receive a pair of mineral bodies **77, 78**, preferably consisting of sapphire, and portions **70, 71, 72** and sapphires **77, 78** are flattened to form a slide surface F''' on which control elements **16** can slide.

All three sapphires are extended at the trailing end of pole shoe member Z''' beyond the same and pole shoe legs **138, 141, 142** so that stray flux has no effect on the separation of the control elements from the sapphire bodies.

Since only the leading portion of pole shoe legs **141, 142** are de-magnetized by energization of windings **144, 144***a*, the leading portions of the pole shoes must be magnetically separated from the trailing portions, which is achieved by cutouts **141***a*, **142***a* for the leg portions, and by narrow gaps **73, 74** in magnetizable portions **70, 71**, as best seen in FIGS. 10*b*1, 10*b*2 and 10*b*3. No air gap corresponding to gaps **73, 74** is provided in the central portion **72** of the pole shoe member, since the central pole shoe leg **138** has no winding and is not divided into leading and trailing portions.

If desired, the air gaps **73, 74**, and corresponding air gaps separating leading and trailing portions which are differently magnetized, may be filled by a non-magnetizable material such as brass in order to improve the rigidity of the structure. As explained with reference to the other embodiments, the slide surface F''' must be parallel to attracted control elements **16**, which is obtained by turning pole shoe member Z''' by means of handle lever **51'''**.

While FIG. 1 illustrates a selector magnet M corresponding to the embodiments of FIGS. 8 and 8*a*, it will be understood that any other embodiment described above may be used as selector magnet in the general arrangement illustrated in FIGS. 1 and 1*a*. Control elements **16** may have bent-over head portions forming hooks as described with reference to the several embodiments of the selector member, or may have an angular portion **16***b* projecting beyond hook portion **16***a* and guided by a cam **35**, as shown in FIG. 1. Such minor structural modifications are interchangeable in the several embodiments of the invention, and it will be understood that the mineral bodies, described to be sapphires, may be diamonds or other hard minerals, or even a hard non-magnetizable material which will not be worn off by the sliding engagement with the moving control elements **16** in attracted positions.

FIGS. 1 and 1*a* have been described to include a rotary needle cylinder with a carrier **15** thereon moving relative to a stationary cam box **17**. It will be understood by those skilled in the art that the arrangement is reversed in machines in which the cam box rotates, and the carrier of the needles is stationary. In constructions of this type, the selector magnet will be secured to the rotary cam box. The invention may also be applied to flat bed knitting machines in which the needle bar reciprocates and the cams are stationary, or in which the cams reciprocate and the needle bar is stationary.

As explained above, the magnetic flux produced by permanent magnets is counteracted by the flux produced by an energized winding on a magnetizable pole shoe or pole shoe portion. The flux produced by the energized winding may just weaken the permanent flux, or compensate the same, or reverse the magnetic flux. In the described embodiments, the resilient force of the control elements which are tensioned by cams **35** will return the control elements to the normal position if the energized winding counteracts the flux produced by the permanent magnet. However, if the pattern control means cause no energization of the respective winding, or windings, the respective control element is attracted and continues to travel on the trailing portion of the pole shoes in which the permanent flux is continuously effective, while the leading portion of the pole shoes may already be de-magnetized by the energized winding and cooperate with another control element.

In the illustrated embodiment, the attracted and elected control elements release jacks which are spring loaded so that the same can start the needle movement to a knitting position. However, the construction of the invention is applicable to other arrangements in which the control elements do not lock other elements, but influence and control the needles in any other way to cause selection of a needle for a knitting operation, or rejection of a needle which is not required for a knitting operation in accordance with the preselected knitting pattern.

Evidently, the selection cannot only be carried out by attraction of a control element, but by non-attraction so that control elements which are not attracted by the selector magnet due to the fact that the winding was energized, cause needles to move to a knitting position, while control elements attracted by the selector magnet while the winding was not energizing, cause the needles to remain in the inoperative low position.

It will be also appreciated that the selector magnet arrangements according to the invention can be used also for controlling the dial needles of a circular knitting machine, and in fact any other set of needles which are controlled by control elements.

Pattern control arrangements which produce electric

pulses for energizing a winding on a selector magnet, are well known and available in the trade so that those skilled in the art will understand how to energize and de-energize the windings described above in accordance with the desired pattern of the fabric to be knitted.

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 selector magnet arrangement including a winding for compensating the flux produced by a permanent magnet, 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 as new and desired to be secured by Letters Patent is:

1. In a pattern control apparatus for a knitting machine, in combination, carrier means; a series of needle control means supported on said carrier means for movement between a normal position and a displaced position for differently controlling the needles of the knitting machine; resilient means for urging said needle control means into said normal position; and selector magnet means having magnetizable pole shoe means located in the region of said carrier means and being passed by said needle control means during relative movement between said selector magnet means and said carrier means, said selector magnet means including a means for producing a permanent magnetic flux in said pole shoe means for moving needle control means passing said pole shoe means successively to said displaced position against the action of said resilient means, and a winding located in the proximity of said pole shoe means and energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said pole shoe means for counteracting the permanent magnetic flux so that a needle control means passing said selector magnet means remains in said normal position when said winding is energized.

2. An apparatus as claimed in claim **1** wherein said pole shoe means are located outwardly of said needle control means on the side remote from said carrier means.

3. An apparatus as claimed in claim **1** wherein said pole shoe means are located on one side of said needle control means; wherein said carrier means is movable with said needle control means; and comprising stationary cam means, and cam follower means secured to said needle control means for moving the same against the action of said spring means into the proximity of said pole shoe means for attraction by said permanent flux, said cam means being shaped so that said control means are returned by said resilient means to said normal position when said winding is energized and demagnetizes said pole shoe means.

4. In a pattern control apparatus for a knitting machine, in combination, carrier means; a series of needle control means supported on said carrier means each needle control means including a jack, and locking means biassed into a normal position for locking said jack and being movable to a displaced position releasing said jack, and resilient means operating the released jack for controlling the needles of the knitting machine; resilient means for urging said needle control means into said normal position; and selector magnet means having magnetizable pole shoe means located in the region of said carrier means and being passed by said needle control means during relative movement between said selector magnet means and said carrier means, said selector magnet means including a means for producing a permanent magnetic flux in said pole shoe means for moving locking means passing said pole shoe means successively to said displaced position, and a winding on said pole shoe means located in the proximity of said pole shoe means and energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said pole shoe means for counteracting the permanent magnetic flux so that a needle control means passing said selector magnet means remains in said normal position when said winding is energized.

5. In a pattern control apparatus for a knitting machine, in combination, carrier means; a series of needle control means supported on said carrier means for movement between a normal position and a displaced position for differently controlling the needles of the knitting machine; resilient means for urging said needle control means into said normal position; and selector magnet means having magnetizable pole shoe means including a plurality of pole shoes located in the region of said carrier means on one side of said needle control means and being passed by said needle control means during relative movement between said selector magnet means and said carrier means, said selector magnet means including a means for producing a permanent magnetic flux in said pole shoe means for moving needle control means passing said pole shoe means successively to said displaced position, and a winding on at least one of said pole shoes located in the proximity of said pole shoe means and energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said one pole shoe for counteracting the permanent magnetic flux so that a needle control means passing said selector magnet means remains in said normal position when said winding is energized.

6. In a pattern control apparatus for a knitting machine, in combination, carrier means; a series of needle control means supported on said carrier means for movement between a normal position and a displaced position for differently controlling the needles of the knitting machine; resilient means for urging said needle control means into said normal position; and selector magnet means having magnetizable pole shoe means forming a gap located in the region of said carrier means on one side of said needle control means and being passed by said needle control means during relative movement between said selector magnet means and said carrier means, said selector magnet means including a means for producing a permanent magnetic flux in said pole shoe means for moving needle control means passing said pole shoe means successively to said displaced position, and a winding located in the proximity of said pole shoe means and energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said pole shoe means for counteracting the permanent magnetic flux so that a needle control means passing said selector magnet means remains in said normal position when said winding is energized; and a hard unmagnetizable body located in said gap, said pole shoe means and said body forming a continuous surface slidingly guiding needle control means moving in said displaced position with said carrier means.

7. In a pattern control apparatus for a knitting machine, in combination, carrier means; a series of needle control means supported on said carrier means for movement between a normal position and a displaced position for differently controlling the needles of the knitting machine; resilient means for urging said needle control means into said normal position; and selector magnet means having magnetizable pole shoe means forming a gap located in the region of said carrier means and being

successively passed by said needle control means during relative movement between said selector magnet means and said carrier means, said selector magnet means including a permanent magnet for producing a permanent magnetic flux in said pole shoe means for moving needle control means passing said pole shoe means successively to said displaced position, and a winding on said pole shoe means located in the proximity of said pole shoe means and energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said pole shoe means for counteracting the permanent magnetic flux so that a needle control means passing said selector magnet means remains in said normal position when said winding is energized; and a hard sapphire body located in said gap, said pole shoe means and said body forming a continuous surface slidingly guiding needle control means moving in said displaced position with said carrier means.

8. In a pattern control apparatus for a knitting machine, in combination, carrier means; a series of needle control means supported on said carrier means for movement between a normal position and a displaced position for differently controlling the needles of the knitting machine; resilient means for urging said needle control means into said normal position; and selector magnet means having magnetizable pole shoe means located in the region of said carrier means and being successively passed by said needle control means during relative movement between said selector magnet means and said carrier means, said pole shoe means including a first portion leading in the direction of relative movement between said needle control means with said carrier means and said selector means, and a second portion trailing in said direction, said pole shoe means forming an air gap between said portions, said selector magnet means including a means for producing a permanent magnetic flux in said pole shoe means for moving needle control means passing said pole shoe means successively to said displaced position, and a winding on said first portion of said pole shoe means energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said first portion of said pole shoe means for counteracting the permanent magnetic flux so that a needle control means passing said selector magnet means remains in said normal position when said winding is energized, and is attracted to slide on said first and second portions in said displaced position when said winding is not energized.

9. In a pattern control apparatus for a knitting machine, in combination, carrier means; a series of needle control means supported on said carrier means for movement between a normal position and a displaced position for differently controlling the needles of the knitting machine; resilient means for urging said needle control means into said normal position; and selector magnet means having magnetizable pole shoe means including a plurality of pole shoes located in the region of said carrier means and being successively passed by said needle control means during relative movement between said selector magnet means and said carrier means, said selector magnet means including a permanent magnet for producing a permanent magnetic flux in said pole shoe means for moving needle control means passing said pole shoe means successively to said displaced position, and a winding on said pole shoe means on at least one of said pole shoes energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said one pole shoe for counteracting the permanent magnetic flux so that a needle control means passing said selector magnet means remains in said normal position when said winding is energized.

10. In a pattern control apparatus for a knitting machine, in combination, carrier means; a series of needle control means supported on said carrier means for movement between a normal position and a displaced position for differently controlling the needles of the knitting machine; resilient means for urging said needle control means into said normal position; and selector magnet means having magnetizable pole shoe means located in the region of said carrier means and being successively passed by said needle control means during relative movement between said selector magnet means and said carrier means, said pole shoe means including a first portion leading in the direction of relative movement between said needle control means with said carrier means and said selector means, and a second portion trailing in said direction, said pole shoe means forming an air gap between said portions, said selector magnet means including a permanent magnet for producing a permanent magnetic flux in said pole shoe means for moving needle control means passing said pole shoe means successively to said displaced position, and a winding on said first portion of said pole shoe means energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly damagnetizing said first portion of said pole shoe means for counteracting the permanent magnetic flux so that a needle control means passing said selector magnet means remains in said normal position when said winding is energized, and is attracted to slide on said first and second portions in said displaced position when said winding is not energized.

11. In a pattern control apparatus for a knitting machine, in combination, carrier means; a series of needle control means supported on said carrier means for movement between a normal position and a displaced position for differently controlling the needles of the knitting machine; resilient means for urging said needle control means into said normal position; selector magnet means having magnetizable pole shoe means forming a gap located in the region of said carrier means and being successively passed by said needle control means during relative movement between said selector magnet means and said carrier means, said pole shoe means including a first portion leading in the direction of relative movement between said needle control means with said carrier means and said selector means, and a second portion trailing in said direction, said pole shoe means forming an air gap between said portions, said selector magnet means including a permanent magnet for producing a permanent magnet flux in said pole shoe means for moving needle control means passing said pole shoe means successively to said displaced position, and a winding on said first portion of said pole shoe means energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said first portion of said pole shoe means for counteracting the permanent magnet flux so that a needle control means passing said selector magnet means remains in said normal position when said winding is energized, and is attracted to slide on said first and second portions in said displaced position when said winding is not energized; and a hard unmagnetizable body located in said gap, said pole shoe means and said body forming a continuous surface slidingly guiding needle control means moving in said displaced position with said carrier means.

12. An arrangement as set forth in claim 11 wherein said body projects in direction of movement of said carrier means beyond said second trailing portion of said pole shoe means.

13. An arrangement as set forth in claim 11 wherein said pole shoe means include at least two pole shoes forming said gap; and wherein only one of said pole shoes has said first and second portions and said air gap between said first and second portions, and wherein said winding surrounds a part of said first portion of said one pole shoe so that a permanent flux is main-

tained in said second portion and in the other pole shoe when said winding is energized.

14. An arrangement as set forth in claim 11 wherein said pole shoe means include two pole shoes at the ends of said permanent magnet converging in the region of said carrier means to form said gap; wherein each of said pole shoes has said first and second portions, and an air gap between the same; and wherein said winding includes a first coil surrounding a part of said first portion of one of said pole shoes and a second coil surrounding a part of said first portion of the other pole shoe so that a permanent flux is maintained in said second portions of said pole shoes when said coils are energized and counteract the flux in said first portions.

15. An arrangement as set forth in claim 11 and including means supporting at least a part of said pole shoe means of said selector magnet means for adjusting movement for adjusting the position of said continuous surface in relation to said needle control means; and manually operated means connected to said selector magnet means for adjusting the position of said continuous surface.

16. In a pattern control apparatus for a knitting machine, in combination, carrier means; a series of needle control means supported on said carrier means for movement between a normal position and a displaced position for differently controlling the needles of the knitting machine; resilient means for urging said needle control means into said normal position; selector magnet means having magnetizable pole shoe means located in the region of said carrier means and being successively passed by said needle control means during relative movement between said selector magnet means and said carrier means, said pole shoe means including two outer pole shoes, and a central pole shoe forming with said outer pole shoe two gaps, said selector magnet means including a permanent magnet for producing a permanent magnetic flux in said pole shoe means for moving needle control means passing said pole shoe means successively to said displaced position, and a winding mounted on at least one of said pole shoes and on said pole shoe means energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said pole shoe means for counteracting the permanent magnetic flux so that a needle control means passing said selector magnet means remains in said normal position when said winding is energized; and hard mineral bodies in said gaps, said outer pole shoes, said central pole shoe, and said mineral bodies forming a continuous surface slidingly guiding needle control means in said displaced position.

17. An arrangement as set forth in claim 14 wherein said pole shoe means include a third pole shoe located between said pole shoes and forming two gaps with the same; and wherein said unmagnetizable body has two parts located in said gaps.

18. In a pattern control apparatus for a knitting machine, in combination, carrier means; a series of needle control means supported on said carrier means for movement between a normal position and a displaced position for differently controlling the needles of the knitting machine; resilient means for urging said needle control means into said normal position; stationary selector magnet means having magnetizable pole shoe means including leg means having ends located in the region of said carrier means, and a pole shoe member having a gap and being movably and adjustably mounted between said ends of said leg means so as to be successively passed by said control means during relative movement between said carrier means and said selector magnet means, said leg means and said pole shoe member having first portions leading in the direction of said relative movement and second portions trailing in said direction, said selector magnet means including a permanent magnet for producing a permanent magnetic flux in said leg means and said pole shoe member, and a winding mounted on said leading portion of said leg means energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said first portions for counteracting the permanent magnetic flux therein so that a needle control means passing said selector magnet means remains in said normal position while passing said first portions when said winding is energized, and is attracted to slide on said pole shoe member in the region of said first and second portions when said winding is not energized; and a hard unmagnetizable body located in said gap of said pole shoe member and forming with the same a continuous surface slidingly engaged by needle control means in said displaced position.

19. An arrangement as set forth in claim 18 and including a manually operated lever secured to said pole shoe member, and wherein said pole shoe member has part-circular surfaces slidingly engaging matching surfaces of said leg means so that said pole shoe member is turnably mounted on said leg means and can be turned and adjusted by said lever.

20. An arrangement as set forth in claim 18 wherein said pole shoe member has a cutout to interrupt magnetic flux through said pole shoe member between said first and second portions of said pole shoe member.

21. An arangement as set forth in claim 18 wherein said pole shoe means include two outer legs and a center leg, only said center leg having said first and second portions, said winding being mounted on said first portion of said center leg, said legs having free ends formed with part-circular bearing surfaces, and wherein said pole shoe member has part-circular surfaces slidingly engaging said part-circular bearing surfaces so that said pole shoe member is supported on said legs for turning movement between adjusted positions, said pole shoe member including magnetizable portions respectively extending between said legs and said continuous surface and forming two gaps, said unmagnetizable body including two parts respectively located in said gaps.

22. An arrangement as set forth in claim 18 wherein said pole shoe member has a flat face slidingly engaged by said needle control means in said displaced position, said pole shoe member being cylindrical and turnable about an axis for adjusting the position of said flat face relative to the position of needle control means in said displaced position.

23. An arrangement as set forth in claim 18 wherein said pole shoe member has a gap separating said first leading portion from said second trailing portion thereof.

24. An arrangement as set forth in claim 18 and including a mineral body mounted in said gap and forming a continuous surface with adjacent surface portions of said pole shoe member.

25. An arrangement as set forth in claim 18 wherein said pole shoe member is mounted on said leg means for turning movement; and including manually operable adjusting means connected to said pole shoe member for angularly displacing the same; and means for arresting said pole shoe member in turned adjusted positions so that the relative position between said pole shoe member and said control elements in said displaced position can be adjusted.

26. An arrangement as set forth in claim 18 wherein said pole shoe means include two outer legs and a center leg, said outer legs having cutouts separating first leading portions from second trailing portions, said winding including two oppositely wound coils respectively located on said first portions of said outer legs.

27. An arrangement as set forth in claim 18 wherein said leading portion of said leg means is made of laminated soft iron sheets.

28. An arrangement as set forth in claim 18 wherein

said leg means include two legs, one of said legs being formed with a cutout separating a first leading portion from a second trailing portion thereof, said winding being mounted on said leading portion of said one leg.

29. An arrangement as set forth in claim **18** wherein said leg means include two legs on opposite ends of said permanent magnet, each of said legs having a cutout therein forming in the same a first leading portion and a second trailing portion, said winding including two winding parts respectively mounted on said first leading portions of said two legs.

30. In a pattern control arrangement for a knitting machine, in combination, a rotary carrier means; a set of needle influencing jacks supported on said carrier means for rotation therewith and for movement thereon between an inoperative position and an operative position adapted to cause displacement of a correlated needle; a series of control elements supported on said carrier means for rotation therewith and for turning movement between a normal position and a displaced position for causing movement of said needle influencing jacks, respectively, between said inoperative and operative positions; and stationary selector magnet means having magnetizable pole shoe means located in the region of said carrier means and being successively passed by said control elements during rotation of said carrier means, said selector magnet means including a permanent magnet connected to said pole shoe means for producing a permanent magnetic flux in the same for moving control elements passing said pole shoe means successively to said displaced position, and a winding on said pole shoe means energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said pole shoe means and producing a flux counteracting the permanent magnetic flux whereby a needle control element passing said selector magnet means remains in said normal position when said winding is energized and moves to said displaced position when said winding is de-energized.

31. In a pattern control arrangement for a knitting machine, in combination, a rotary carrier means; a set of needle influencing jacks supported on said carrier means for rotation therewith and for movement thereon between an inoperative position and an operative position adapted to cause displacement of a correlated needle; a series of control elements supported on said carrier means for rotation therewith and for turning movement between a normal position and a displaced position for causing movement of said needle influencing jacks, respectively, between said inoperative and operative positions; and stationary selector magnet means including a permanent magnet, at least two pole shoe legs secured to said permanent magnet, and a pole shoe member mounted on said legs for turning movement and having a flat surface slidingly engaged by said control elements in said displaced position, means for turning said pole shoe member to adjust the relative position between said flat face and said control elements, said flat face being located in the region of said carrier means, said pole shoe member including magnetizable portions magnetically connected with said legs and forming a gap; a mineral body in said gap; and winding means on at least one of said legs energizable in accordance with a predetermined knitting program by electric pulses at a polarity for at least partly demagnetizing said one leg and producing a flux counteracting the permanent magnetic flux produced by said permanent magnet whereby a needle control element passing said selector magnet means remains in said normal position when said winding means is energized and moves to said displaced position when said winding means is de-energized.

32. A control arrangement as set forth in claim **31** wherein at least said one leg is formed with a cutout defining a first portion leading in the direction of movement of said control elements and a second portion trailing in the direction of movement of said control elements, said winding means being mounted on said first leading portion and counteracting the permanent magnetic flux in the same when energized; and a narrow gap in said pole shoe member in the region of said cutout dividing at least one of said magnetizable portions of the same into a leading portion and a trailing portion.

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