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Kinkelin

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[54] **APPARATUS FOR CONTROL OF NEEDLE PUSHERS**

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[52] **U.S. Cl.** .... **66/50 R**

[51] **Int. Cl.** **D04b 15/78**

[58] **Field of Search** .... 66/50 R, 50 B, 25, 75, 66/36 A, 36 B, 154 A; 335/277

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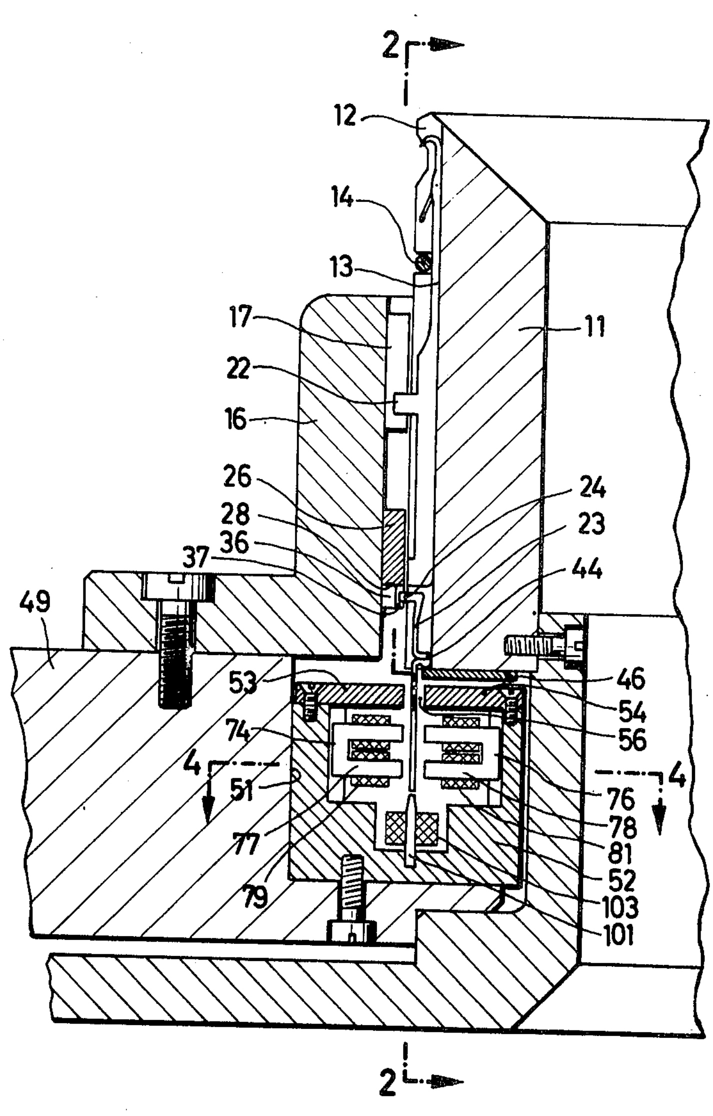
Primary Examiner—Wm. Carter Reynolds

[57] **ABSTRACT**

The needle pushers in a knitting machine push the knitting tool to different vertical knitting positions, i.e. rest, tuck and knitting. The needle pushers are magnetically pivoted in accordance with the knitting pattern by an arrangement of electromagnets and permanent magnets along a guide channel. The needle pusher is held in the selected pivoted orientation by a multichannel path divider which follows the magnet chamber along the guide channel. Depending upon the angle of pivot, a combination of cams for the needle pusher and the knitting tool will move the knitting tool to the desired knitting position for the desired time.

24 Claims, 9 Drawing Figures



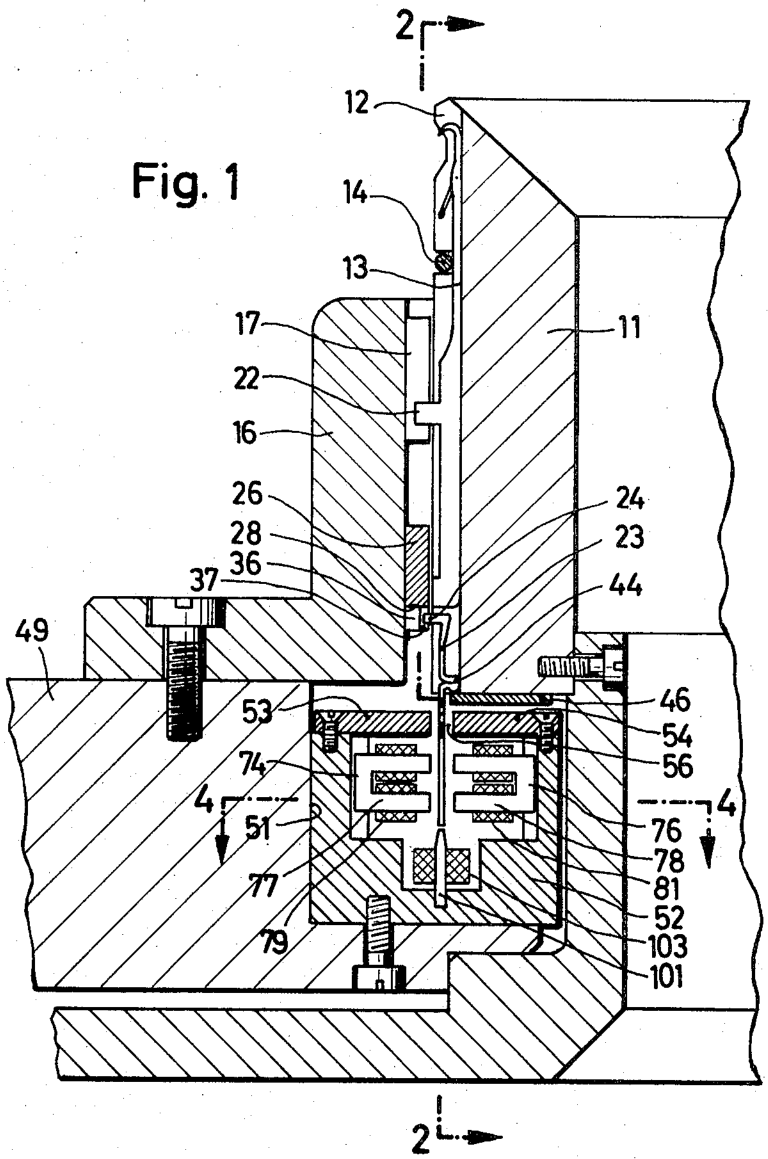

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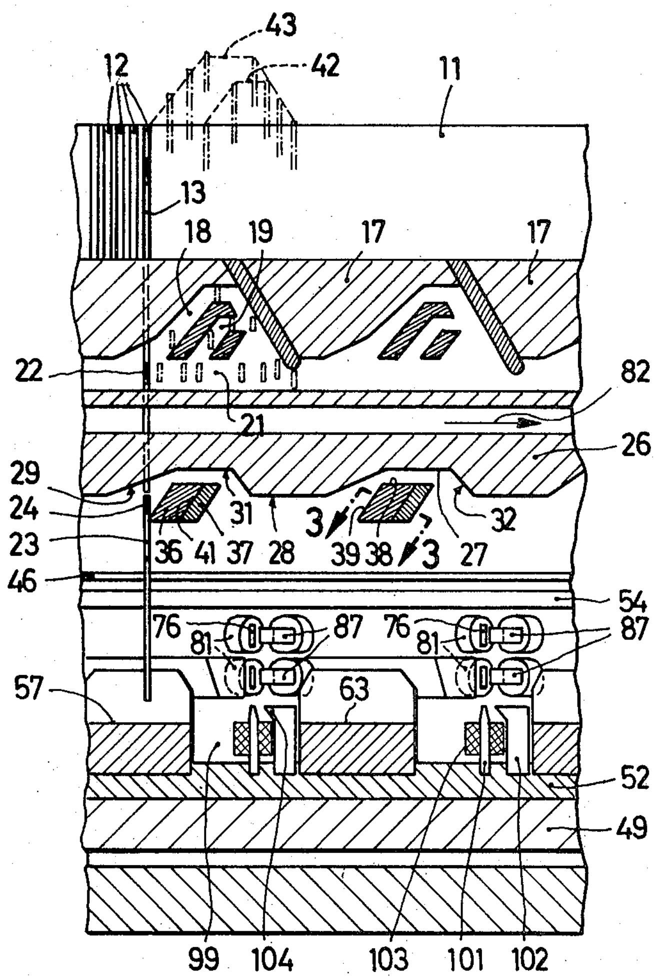
Fig. 1

Fig. 2



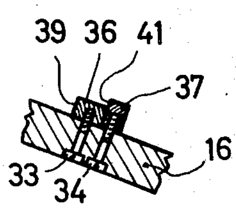


Fig. 3

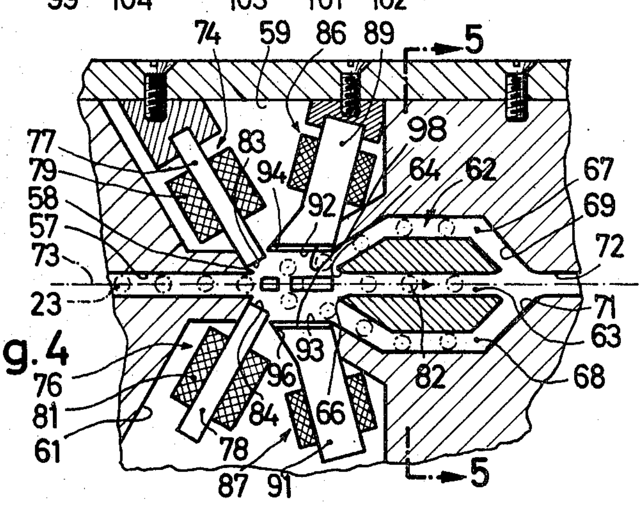


Fig. 4

Fig. 5

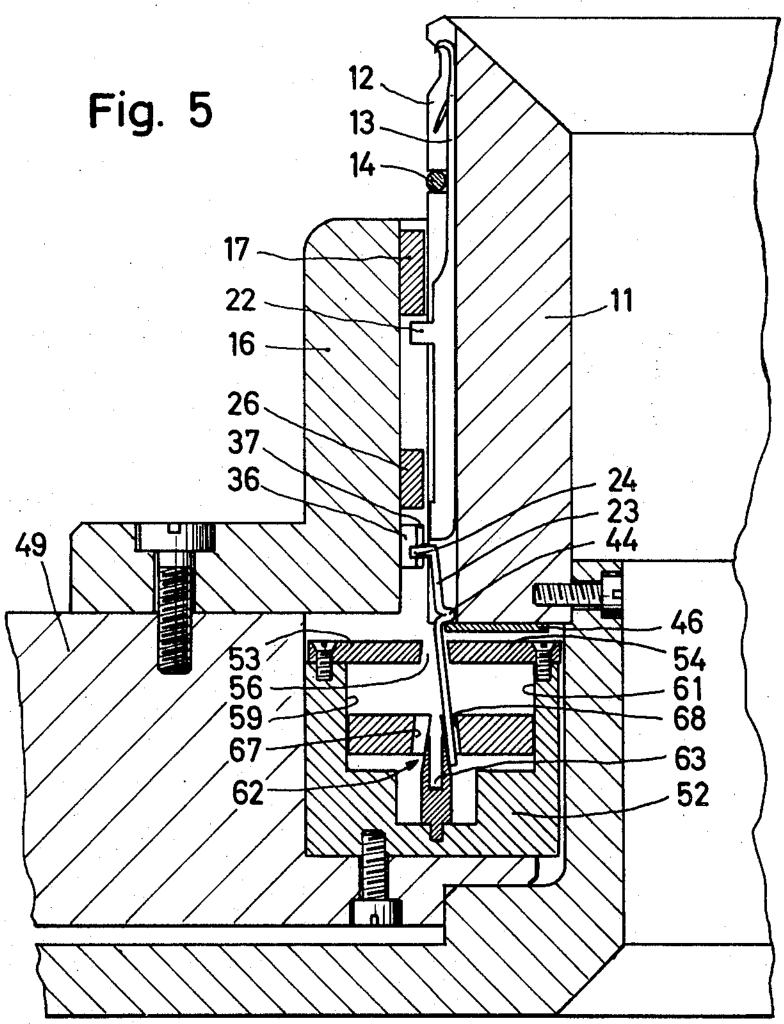

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Fig. 6

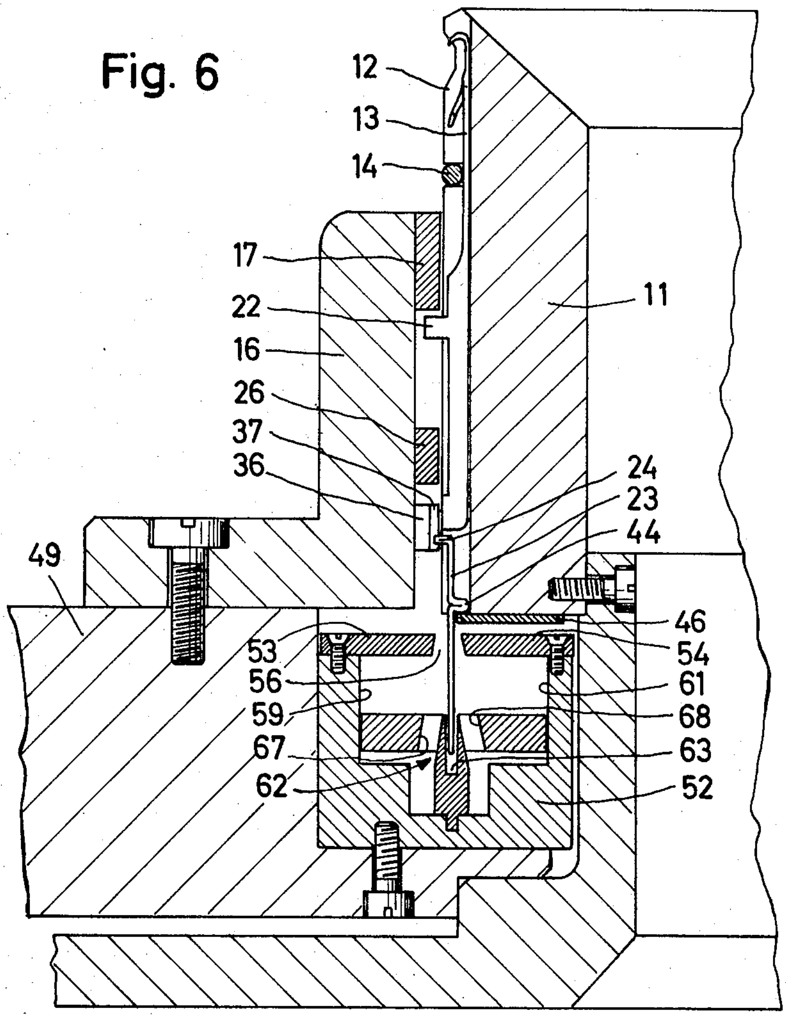
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Fig. 7

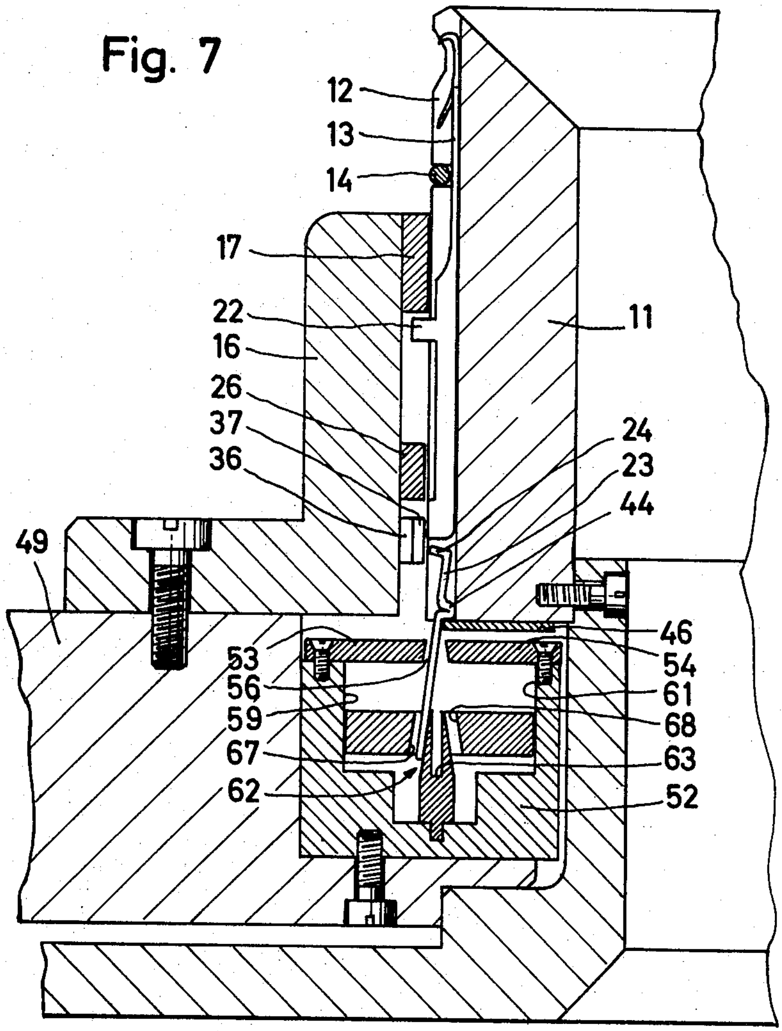
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Fig. 8

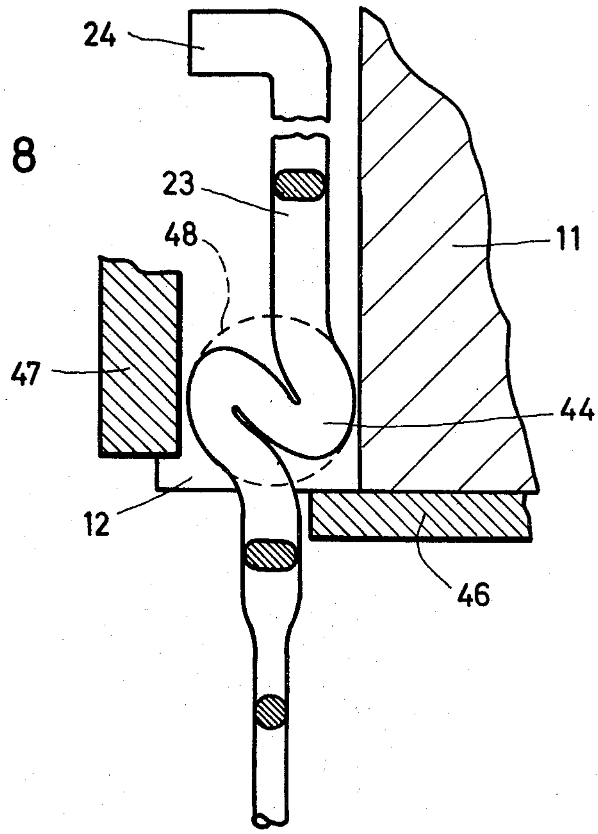
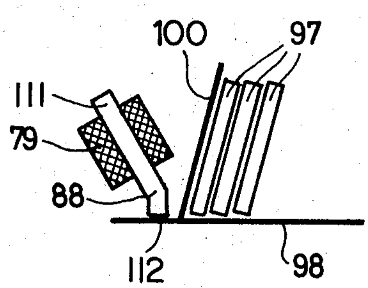


Fig. 9



APPARATUS FOR CONTROL OF NEEDLE PUSHERS

The invention relates to an apparatus for the control of needle pushers for knitting tools of machines producing knitted fabrics, with grooves which are provided in the needle bed and in which both the knitting tools and the needle pushers are movable to and fro, and with a covering part which covers the grooves and which is also provided with the knitting tool cam and the needle pusher cam, and with pivot bearings for the needle pushers, and with a needle pusher foot which is provided on the needle pusher and which engages the needle pusher cam when the needle pusher has been pivoted into one position but not when it has been pivoted into the other, and with an electro-magnet mounted to the side of the lower magnetizable part of the needle pusher and acting on this latter and energizable in accordance with the patterns, and with a magnet situated underneath the said electro-magnet and generating a constant magnetic field and guiding the needle pusher over a certain traject.

An apparatus of this kind has become known from U.S. Pat. No. 3,283,541, FIGS. **6** and **7**. In this apparatus the needle pushers can as a general principle only be moved into two positions, whereas there are three customary positions, i.e. the position of rest, the tuck position and the knitting position. In the known apparatus the knitting tool, e.g. a knitting needle, can only be moved into two of these three positions.

In the known apparatus the lower zones of the needle pushers have to be moved against one pole piece surface of a U-type permanent magnet. This pre-alignment is effected by means of a guide rail against which the lower portions of the needle pushers first make impact. This leads to friction and to vibrations which first undergo no damping. The lower portions of the needle pushers then make impact against a pole piece surface specially ground for the purpose. This renewed impact, in its turn, once again causes friction and vibrations. The latter mean that the lower zones first of all fly against the pole pieces surface, then move away from it in virtue of their resilience, with a certain amplitude, are re-attracted, move away with a smaller amplitude, and so forth. As magnetic forces decrease in proportion to the cube of the distance, the permanent magnet must have a considerable attractive force. This latter, in its turn, necessitates electrical excitation for the permanent magnet, which thus requires a winding. This leads not only to a constant consumption of current but also to a loss of space. The high forces needed cannot be produced by means of known types of ferrite magnet, which do not require any supply of energy.

As the lower portions of the needle pushers must in any case rest against one of the two pole piece surfaces, the latter are subjected to considerable abrasion. It is perfectly possible that the structures concerned become hot as a result of the friction and thus change their magnetic properties or lose them altogether for practical purposes. It is also known that the magnetic properties may be destroyed by mechanical impacts taking place at a high frequency. The use of a bar magnet, which saves space, is fundamentally impracticable. The two poles **15** and **16** exert on the pusher **10** a resultant force which differs according to its position. The force emanating from the pole **16** is at its maximum at the narrowest point. If the electro-magnet **6** is energized it can only attract the pusher with the difference in force and not with its full force. As it is only the force difference that is available, in addition to which friction has to be overcome, the maximum selective frequency is comparatively low. Furthermore, an air gap is indispensable, as otherwise the pushers resting against the pole piece **16**, if the electro-magnet **6** were not energized, would only slide along the pole piece surface **16** or pole piece surface **15** as a result of chance circumstances.

Furthermore, the holding force is unfortunately at its maximum in the narrowest part and decreases with the distance of the pusher from the said part. It would be more favourable if conditions were the exact converse.

If the U-type electro-magnet, energized in accordance with a pattern, has attracted a needle pusher, the lower zone of the latter short-circuits the field of the electro-magnet. A subsequent needle pusher to be deflected in the same direction no longer encounters the same field conditions as its predecessor, and the only way of countering this defect would be to actuate the energized magnet with a higher current whenever the subsequent needle pusher had to be attracted. This, however, would render the electrical circuit more complicated.

As the needle pushers **10** are of rectangular cross section, it is practically impossible to lock them mechanically in the position which they have assumed as a result of the selection, because their flat side would make impact with the entrance to the interlocking device, thus causing considerable mechanical damage.

The purpose of the invention is to indicate an apparatus which avoids all the above drawbacks and nevertheless provides a three-position selection system for the knitting tool, within only a moderate space, leaving the designer largely free to decide whether to make use of small inexpensive ferrite magnets or more expensive electro-magnets, if he wishes to produce a constant field.

The invention enables this object to be achieved as a result of the fact that the needle pusher can be moved into different positions in accordance with the three positions of the knitting tool, that it can be moved to two lateral different vertical levels by the needle pusher cam consisting of two parts, that a guide channel is provided for the lower portion of the needle pusher and is slightly wider than the said portion and takes a largely straight course and enters a magnet chamber widening in the direction of movement of the needle pusher, that immediately following the said entry and on both sides thereof the respective pole piece surfaces of a first and a second electro-magnet energizable in accordance with a pattern are provided, that these electro-magnets are followed by a third and fourth magnet respectively, that these magnets produce a constant magnetic field symmetrical to the central surface of the guide channel, that underneath the lower zone of the needle pusher a fifth magnet is provided which likewise produces a field symmetrical to the central surface of the guide channel, that the magnet chamber is followed by a three-channel path-divider of which the central channel forms the straight continuation of the guide channel and of which the two side channels forming an arc commence on the two sides of the central channel and re-combine with the said control channel beyond the path-divider and that as viewed from the top the fifth magnet is situated in the connecting line between the guide channel and the central channel.

Further advantages and characteristics of the invention will emerge from the following description of preferred examples thereof. The diagrams in the drawing are as follows:

FIG. 1: a radial section through a needle cylinder and the adjacent portions of a circular knitting machine.

FIG. 2: a section along the line 2—2 of FIG. 1.

FIG. 3: a section along the line 3—3 of FIG. 2.

FIG. 4: a section along the line 4—4 of FIG. 1, special attention being drawn to the fact that FIG. 4 is drawn on a scale 2:1.

FIG. 5: a section along the line 5—5 of FIG. 4, with the needle pusher in a certain position.

FIG. 6: a section similar to that shown in FIG. 5, with the needle pusher in a second position.

FIG. 7: a section similar to that shown in FIG. 5, with the needle pusher in a third position.

FIG. 8: an enlarged lateral view of a another form of the pusher in the raised position.

FIG. 9: a schematic plan view of an alternative magnet arrangement.

A circular knitting machine has a needle cylinder **11** in the outer casing of which grooves **12** are cut in an axial direction and contain longitudinally displaceable knitting needles **13**. Among other things, a radial ring **14** inserted in a peripheral groove prevents the knitting needles **13** from falling out. In the manner already known the needle cylinder **11** is driven by means not shown in the drawing. A cam casing **16**, integral with the frame, is provided, with cams **17** on the side opposite to the needle cylinder **11**. As in systems already known, each cam has three channels **18, 19** and **21**, corresponding to the positions "tuck", "knit" and "rest". Each knitting needle **13** is provided with a foot **22**. According to which of the channels **18, 19** and **21** is entered by the foot **22**, the needle either knits, tucks or remains at rest. If the knitting needle **13** is lifted up, it is a decisive factor, as may be seen from FIG. **2**, at what moment it is lifted, as the channel **18** leads to a higher position than the channel **19**.

In the grooves **12**, underneath the knitting needles **13**, the upper zone of knitting pushers **23** is likewise situated. One needle pusher **23** corresponds to each knitting needle **13**. The said pusher represents the control device for the knitting needles **13** and thus provides the control force by which the knitting needle **13** is lifted. The needle pushers **23** can thus be far finer and lighter in weight than the knitting needles **13**. Each knitting pusher has a foot **24** at the top, which points in the same direction as the foot **22**. For the feet **24** the cam casing **16** integral with the frame is provided with a knitting pusher cam **26**, likewise integral with the frame. Needless to say, as many of these cams are provided within the circle of the cam casing **16** as required. A needle pusher cam **26** surrounds, aligned in a suitable manner with the relevant cam **17**, an upper contact surface **27** which comprises a horizontal zone **28**, a zone **29** ascending at a slight angle, a horizontal zone **31** and a zone **32** descending at a considerable angle, as shown in FIG. **2**. The contact surface **27** represents the upper boundary for the feet **24**. Underneath two diamond-shaped lugs **37** and **36** are screwed to the cam casing **16** with screws **33** and **34**. Their upper and lower boundary surfaces are in alignment and situated horizontally. The upper boundary surfaces **38** form, in conjunction with the zone **31**, a horizontal channel. The front side of the lug **36** forms a first lifting surface **39**, proceeding obliquely upwards, for the foot **24**, while the lug **37** is provided with a corresponding lifting surface **41**. As may be seen from FIG. **3**, the lug **37** is higher than the lug **36**, so that the lifting surface **41** extends outwards to a greater distance than the lifting surface **39**.

For the foot **24** this means that it does not draw the needle pusher **23** upwards when it has been pivoted the whole of the way into the groove **12**, which corresponds to the position shown in FIG. **7**. If the needle pusher **23** occupies a position such as shown in FIG. **1**, which also corresponds to FIG. **6**, then the foot **24** moves onto the lifting surface **41**, which means that the needle pusher **23** is lifted at a later moment, likewise raising the knitting needle **13** at a later moment, the said needle thus entering the channel **19**. The upper zone of the knitting needle **13** therefore performs a movement in accordance with the broken line **42** in FIG. **2**.

Finally, if the needle pusher **23** is pivoted the whole of the way to the left by its foot **24**, as shown in FIG. **1**, which corresponds to a position such as shown in FIG. **5**, then the foot **24** reaches the lifting surface **39**, the needle pusher **23** is lifted far sooner and correspondingly thrusts the knitting needle **13** upwards at an earlier moment, as a result of which it enters the channel **18** and moves upwards in accordance with the line **43**.

The pivot bearing used consists of the bent part **44** of the needle pusher **23**, which part, as shown in FIG.**1**, may be bent outwards towards the right, U-shaped and pressed flat. From this zone onwards the entire needle pusher **23** is pressed flat and hardened and thus better adapted to the shape of the groove **12**. The bent part **44** rests on the upper edge of a supporting plate **46** which is screwed against the needle cylinder **11** from below and which partly closes the grooves **12** from below. In front of the lower zone of the grooves **12** and on a level with the bent part **44** a ring **47** is also provided, which is shown in FIG. **8** and which constitutes an outer boundary and rotates together with the needle cylinder **11**. As shown in particular in FIG. **8**, the grooves **12** are thus sufficiently wide open at the bottom and the needle pushers **23** are nevertheless mounted sufficiently securely. The construction of the hardened bent part **44** as shown in FIG. **8**, in the form of an S, is to be preferred to that shown in FIG. **1**, because if it is produced from circular material and the bent part **44** takes the form of an S-bend, this provides, after it has been pressed flat, a form which in the main portions is largely similar to the circle **48** shown in broken lines in FIG. **8**. The needle pushers **23** will thus not be lowered or raised merely by the tilting action, a thing which always occurs if the bent parts are only orientated towards one side. The circular material with substantially circular cross section used as the starting material has a diameter of about 0.8–1 mm. FIG. **8** shows the needle pusher **23** in a raised but not pivoted position, similar to that shown in FIG. **6**.

The S-wise flat configuration **44** as shown in FIG. **8** is approximately circular in its overall contour and forms part of the pivot bearing. The needle pusher is pressed flat and hardened from the circular zone **48** upwards as far as the foot **24**.

The cam casing **16** is screwed onto a solid ring **49** which is integral with the frame and which is provided inside and at the top with a rectangular recess **51.** This recess **51** contains the device for actuating the needle pushers **23.** This includes a supporting ring **52** covered from the top by covering plates **53** and **54** which leave a sufficiently large slit **56** between them, so that that zone of the needle pushers **23** which is situated underneath the bent part **44** has sufficient room to pivot. The supporting ring contains a guide channel **57** by which the lower zones of the needle pushers **23** are guided along a straight path with only very little clearance. Needless to say, this guide channel **57** in the case of circular knitting machines, is not "straight" but is curved in accordance with the diameter of the needle cylinder **11.** As the needle pushers **25** move along an almost linear path for the performance of the present task, even at high rotation speeds and with needle cylinders of small radii, the drawing does not indicate curvatures of this kind. As may be seen from FIG. **4,** the guide channel **57** terminates in an obtuse angle at **58** and gives place on both sides to a salient **59, 61.** The salients **59** and **61** contain the magnets, to be described in due course. They continue in the form of a path-divider **62** of which the central channel **63** forms a continuation of the guide channel **57.** The central channel **63** is provided in the front with a funnel **64** which, as shown in FIG. **4,** is strictly limited and sharply converges at its frone edge **66.** The channel **63** is of exactly the same width as the guide channel **57,** except for the zones corresponding to the funnel. To the right and to the left of the channel **63** side channels **67** and **68** are provided which lead into the salients **59** and **61** on both sides of the edge **66** of the funnel. The side channels **67** and **68** take a curved course. In the drawing these are shown approximately by straight pieces of which the first leads the lower zones of the needle pushers **23** away from the channel **63** in a linear direction, while the second leads parallel to the channel **63** and the third again leads to the rear end of the channel **63.** Needless to say, the side channels **67** and **68** could be curved to a greater extent. The straight piece must nevertheless be provided, inasmuch as the foot **24** is connected with the lifting surfaces **39** and **41.** The walls **69** and **71** of the side channels **67** and **68** again form one common funnel for the channel **63** likewise, so that the lower zones of the needle pushers **23** can continue in a further guide channel **72.** The guide channel **57** and the channel **63** define a central plant **73** (FIG. **4**). Symmetrically with this latter are two electro-magnets **74** and **76** which can be energized in accordance with the pattern and of which the yokes **77** and **78** are bent U-wise and bear windings **79** and **81.** The current flowing through these windings **79** and **81** when the system is actuated takes a rectangular course and is constant current. The best results have been obtained with constant current actuating systems. It is, of course, only technically possible to obtain an ideal constant current up to a certain extent. The results as regards the actuating frequency with constant voltage are less satisfactory. The electro-magnets **74** and **76** could also consist of bar magnets, against which a magnetizable object vested with greater force than in the case of a U-shaped magnet. A U-shaped magnet, however, offers the advantage that a greater atractive force is available, at a given distance, than in the case of a bar magnet.

As may be seen from FIG. **4,** the electro-magnets **74** and **76** are inclined between 30°–80° and preferably at about 60° in relation to the direction of motion. The pole piece surfaces **83** and **84** are symmetrical to the central surface **73** and perpendicular to the yoke **77** and **78.** The pole piece surfaces **83** and **84** commence, as shown in FIG. **4,** a few fractions behind the point **58,** so that, with the needle pushers **23** flying past, they will be both sufficiently close and sufficiently far away to ensure that in normal operation the needle pushers **23** will not make impact on the pole piece surfaces **83** and **84.** To some extent the said pole piece surfaces **83** and **84** are also parallel with the trajectory of the lower portion of the needle pushers **23.** Needless to say, all the parts, with the exception of the yokes **77, 78** and the lower zones of the needle pushers **23,** are amagnetic, so that they do not weaken the magnetic field.

As shown in FIG. **4,** the electro-magnets **74** and **76** are at the same level, so that in the longitudinal direction only minimum space is required. If those electro-magnets **74** and **76** were offset in relation to each other in the longitudinal direction, then the space required would be far greater. The same applies to the subsequent permanent magnets **86** and **87.**

In order to enable the pole piece surfaces **83** and **84** to be adapted more satisfactorily to the direction of flight of the needle pushers **23** and also to enable the windings **79** and **81,** which require a certain amount of space, to be placed in a less inconveninet position, the yokes **111** can be provided with a bent part **88** preceding the pole piece surfaces **112,** as shown in FIG. **9.**

According to FIGS. **2** and **4** the permanent magnets **86** and **87** are provided with a winding and take the form of a U-shaped magnet. Their yokes **89** and **91** are inclined between 100°–130° and preferably at an angle of 110° in respect of the direction of motion **82.** Their permanent magnet field is symmetrical in respect of the central surface **73,** so that in this position the field intensities cancel each other out. Their pole pieces **92** and **93** are approximately parallel to the central surface **73** and are at a greater distance from the latter than the pole piece surfaces **83** and **84.** Between these four pole piece surfaces, therefore, a magnet space is defined which is practically closed by the fins **94** and **96** pointing towards the yokes **77** and **78.** The side channels **67** and **68** commence immediately after the pole piece surfaces **92** and **93.**

The permanent magnets **86** and **87** could be replaced by plate-shaped ferrite magnets **97,** which act as bar magnets and are stepped, so that they simulate the trajectory still more satisfactorily. FIG. **9** also shows the magnetic screen **100,** the plastic foil **98** likewise being shown therein. This plastic foil **98** not only protects the pole piece surfaces and reduces the friction if a needle pusher happen to impact thereon. The plastic foil **98** also serves to maintain a certain minimum distance between the pole piece surfaces and the needle pushers **23,** so that the latter can never completely short-circuit the magnetic field.

The permanent magnets **97** are stepped in alignment with the longitudinal direction of the needle pushers **23** and are inclined at an angle of between **100°** to **130°** and preferably approximately **110°** in respect to the direction of motion **82** providing, in effect, a fin pointing towards the yoke **111.** Their pole piece surfaces are stepped approximately in accordance with the trajectory of the needle pushers. The yoke **111** is bent U-wise and bears winding 79. Yoke 111, behind its bent part 88 is inclined in relation to the direction of the needle pushers at between 30° to 80° and preferably at about 60°. Its pole piece surface 83 is cut perpendicularly to it.

On the base of the magnet chamber 99 there are two further magnets 101 and 102, both constructed as bar magnets. The magnet 101 bears a winding 103 and is situated immediately underneath the electro-magnets 74 and 76, as shown in FIG. 2. The magnet 102 is a permanent magnet and has a fin 104 pointing towards the left. The magnets 101 and 102 are situated underneath the lower end of the needle pusher 23, as clearly shown in FIG. 1, and thus do not surround it to the side. The flux path of magnets 101 and 102 occurs at each magnet from one pole to the other pole. The magnets 101 and 102 are immediately followed by the central channel 63 of the path-divider 62. The magnets 101 and 102 can be replaced by a ferrite permanent magnet, which may be made up of individual magnet plates.

The apparatus mainly operates as follows: if neither of the electro-magnets 74 and 76 is actuated, the lower zone of the needle pusher 23 is not caused to change the direction of its flight through the magnet chamber 99 and will enter the central channel 63. It is additionally stabilized in this trajectory by the magnets 101 and 102. Owing to the symmetry of the arrangement the permanent magnets 86 and 87 exert no influence. The trajectory of the lower portions of the needle pushers 23 can be actively stabilized by passing a current through the winding 103 at the appropriate moment. The stabilization by means of ferrite magnets, however, is fully sufficient. In accordance with the central position of the needle pusher 23 the knitting needle 13 moves along the line 42.

If the electro-magnet 74 or 76 is energized, the symmetry of the fields in the magnet chamber 99 is disturbed and the lower portion of the needle pushers 23 moves towards the pole piece surface 83 or 84 as the case may be. After passing through these pole piece surfaces 83 and 84 the permanent magnets 86 and 87 increase the deflection tendency, so that the lower zones of the needle pushers 23 enter one of the side channels 67 and 68. The knitting needle 13 is then actuated accordingly.

In the example shown the deflection of the needle pushers 23 in the zone of the foot 24 covers a distance of three-tenths mm. The invention operates satisfactorily when actuated with an constant current of 1 ampere, a rotation speed of 18 r.p.m., a needle cylinder diameter of 28 inches and 18–22 needles per inch. The needle pushers 23 weigh about one-fourth grammes. Selection frequencies of about 1 kc are obtainable.

If the knitting needle 13 only has to be controlled so as to reach one of two positions, the third possibility of the control system is dispensed with. The permanent magnets 101 and 102 are then omitted, as is likewise the channel 63, and this version provides the same results as that having three channels.

The constant current for the electro-magnets 76 and 74 could be increased in accordance with the rotation speed of the needle cylinder 11, so that at a higher rotation speed a higher constant current would likewise be available. This object could be achieved, for example, with the current of a tacho-alternator. It is nevertheless simpler and more economical if use is made of the highest current required and if at lower speeds it is accepted that the constant current need not in itself be so high.

It has been found that still better results are obtained if the plastic foil 98 is replaced by a very narrow strip of hardened metal, arranged horizontally between the pole surfaces of the electro-magnet 76 and those of the permanent magnets 87. If this strip is positioned in the middle it has practically no influence on the magnetic field and is nevertheless able to serve its purpose. This narrow strip has the same function as the plastic foil 98 and prevents the needle pushers 23 from making impact on the pole piece surfaces and magnetically short-circuiting the magnets.

The selection frequency could also be increased if the electro-magnets 74 and 76 were replaced by several such electro-magnets, each having their own windings and "staggered" in the direction of motion 82. Each single electro-magnet would then have to be actuated separately, largely at the speed at which the needle pushers 23 fly. The successive actuation could be effected, for example, by a slide register of which the individual elements assume, at the speed at which the needle pushers 23 fly, the state required for the actuation.

What is claimed is:

1. Apparatus for the control of needle pushers for knitting tools of a knitting machine comprising:

a needle bed having grooves therein,

knitting tools moveable to and fro in the grooves,

needle pushers having lower magnetizable portions having substantially circular cross-sections and moveable to and fro in the grooves for moving the knitting tools,

means covering at least a portion of the grooves and provided with knitting tool cam means and needle pusher cam means,

the needle pusher cam means and knitting tool cam means causing the needle pushers to move the knitting tools,

the needle pushers being moveable into different positions in accordance with different positions of knitting tool,

the needle pusher cam means having two camming surfaces for moving the needle pushers to two lateral different positions along the grooves,

pivot bearing means for pivoting the needle pushers,

needle pusher foot means on the needle pushers for pivotably engaging the needle pusher cam means except when the needle pushers have been pivoted into one of a plurality of pivot positions.

guide channel means for the lower portion of the needle pusher which is slightly wider than said lower portion,

said guide channel means having a central plane taking a substantially straight course and opening into a magnet chamber which widens in the direction of flight of the needle pushers,

first and second electromagnet means in the magnet chamber having pole pieces close to the opening to the guide channel and on both sides thereof, positioned to magnetically select by deflecting said lower magnetizable portions of the needle pushers and pivot said needle pushers with high selection frequency without contacting said lower magnetizable portions of the needle pushers in their flight path at normal working speeds, the electromagnet means being energizable in accordance with a predetermined knitting pattern, for causing the needle pushers to pivot,

third and fourth magnet means following the first and second electromagnet means in the magnet chamber and producing a constant magnetic field symmetrical to the central plane of the guide channel means and positioned to magnetically influence the trajectory of said lower magnetizable needle pusher portions without contacting said lower magnetizable needle pusher portions in their flight path at normal working speeds,

covering foil means which cover the pole piece surfaces of said third and fourth magnet means,

multi-channel path-divider means for the lower portion of the needle pushers following the magnet chamber,

said first and second electromagnetic means and said third and fourth electromagnetic means being symmetrically located with respect to the central course of said guide channel means.

2. Apparatus in accordance with claim **1** comprising fifth magnet means in the magnet chamber beneath the lower portion of the needle pusher which produces a magnetic field symmetrical to the central plane of the guide channel means for guiding the needle pusher over a certain traject, and

said multi-channel path divider means having a central channel means which forms the continuation of the guide channel and a pair of side channels commencing from each side of the central channel and re-combining therewith,

the fifth magnet means being situated in the magnet chamber and being in alignment with the guide channel means and the central channel.

3. Apparatus in accordance with claim **1,** in which the third and fourth magnet means comprise permanent magnets.

4. Apparatus in accordance with claim **2,** in which the fifth magnet means comprises a permanent magnet preceded by an electromagnet.

5. Apparatus in accordance with claim **1,** in which the first and second electromagnet means comprise U-shaped magnets having pole surfaces aligned with the longitudinal direction of the needle pusher.

6. Apparatus in accordance with claim **3,** in which the third and fourth magnet means are bar magnets having pole surfaces aligned with the longitudinal direction of the needle pusher.

7. Apparatus in accordance with claim **4,** in which the fifth magnet means comprises a bar-shaped electromagnet and bar-shaped permanent magnet.

8. Apparatus in accordance with claim **1,** in which the first and second magnet means are inclined in relation to the direction of motion of the needle pushers.

9. Apparatus in accordance with claim **8,** in which the angle of inclination is between 30°–80°.

10. Apparatus in accordance with claim **9,** in which the angle of inclination is approximately **60°**.

11. Apparatus in accordance with claim **1,** in which the fourth and third magnet means are inclined in relation to the direction of motion of the needle pushers.

12. Apparatus in accordance with claim **11,** in which the angle of inclination is between 100°–130°.

13. Apparatus in accordance with claim **12,** in which the angle of inclination is approximately **110°**.

14. Apparatus in accordance with claim **1,** in which the pole piece surfaces of the first and second magnet means are cut perpendicularly to the yoke of the magnet.

15. Apparatus in accordance with claim **1,** in which the pole piece surfaces of the third and fourth magnet means are cut approximately in accordance with the trajectory of deflected lower magnetizable portions of the needle pushers and have fin means pointing to the first and second adjacent magnet means.

16. Apparatus in accordance with claim **1,** in which the first and second electromagnet means are closely followed by the third and fourth magnet means.

17. Apparatus in accordance with claim **1,** in which a magnetic screen is provided between the first and second electromagnet means and the third and fourth magnet means.

18. Apparatus in accordance with claim **1,** comprising means for actuating the first and second electromagnet means with constant current.

19. Apparatus in accordance with claim **18,** in which said means actuates with a magnitude of constant current of one ampere.

20. Apparatus in accordance with claim **19,** in which said means actuates with the same constant current required for the maximum operating speed also for lower operating speeds.

21. Apparatus in accordance with claim **2,** in which the central channel is funnel-shaped in the front and the outer edge of the funnel is pointed.

22. Apparatus in accordance with claim **1,** in which the needle pusher has its foot at its upper end.

23. Apparatus in accordance with claim **1,** in which the needle pusher comprises a zone which is of a S-wise, flat configuration and approximately circular in its overall contour, the said zone being hardened and forming part of the pivot bearing.

24. Apparatus in accordance with claim **23,** in which the needle pusher is flat and hardened from the circular zone upwards as far as the foot.

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