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Zamarco et al.

[11] **3,867,820**

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[54] **ELECTRONIC APPARATUS FOR CONTROLLING THE NEEDLES IN KNITTING MACHINES**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **66/154 A,** 66/50 R, 66/75

[51] **Int. Cl.** **D04b 15/66,** D04b 7/24

[58] **Field of Search** ..... 66/154 A, 154 R, 75, 50 R

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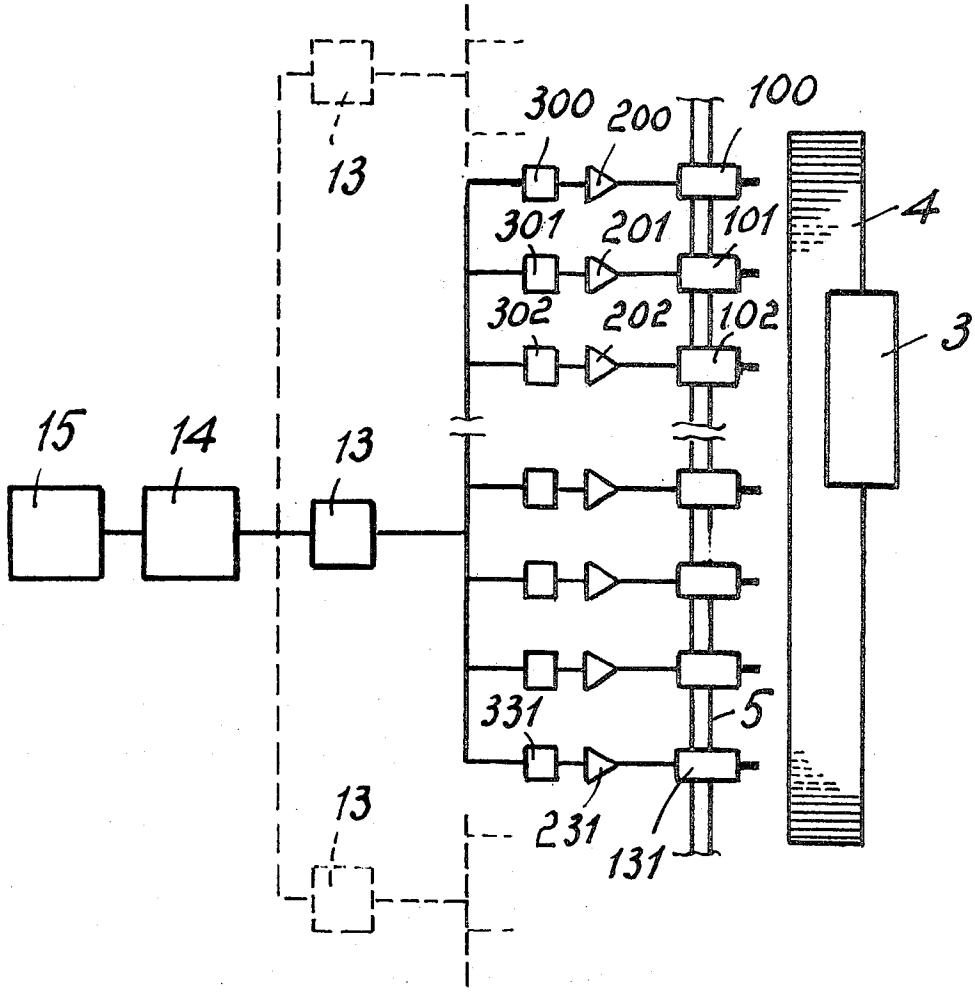
[57] **ABSTRACT**

An electronic apparatus for the programming and individual control of the needles of knitting machines, particularly of the flat bed type, comprising a plurality of actuator elements of electromagnetic type, disposed at regular intervals near the needles, for moving them from a working position into a non-working position or vice versa, a support for said actuator elements mounted mobile in a to-and-fro manner near the needles so as to make each of the actuator elements scan a series of adjacent needles, drive means for moving said support, and an electronic programmer for controlling the actuator elements according to a predetermined sequence, during the to-and-fro strokes of said support.

1 Claim, 5 Drawing Figures



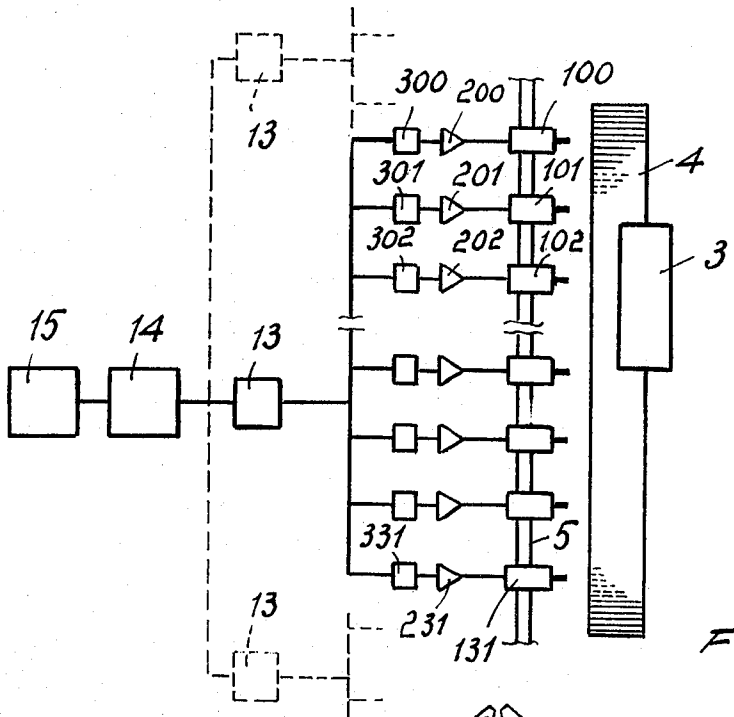
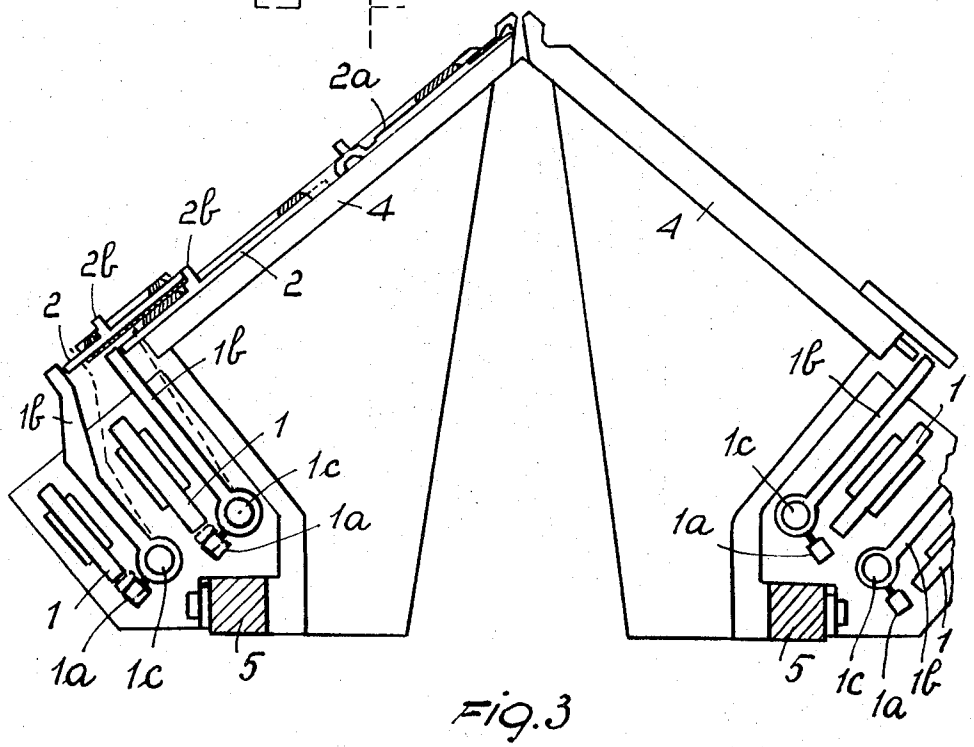

300
200
100
13
301
201
101
4
302
202
102
3
15
14
13
5
331
13
231
131

Fig. 1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2b
4
2b
2
2
1b
1b
1
1c
1a
1
1a
1c
5
4
1b
1
1c
1a
5
1c
1a
1b
1

Fig. 3

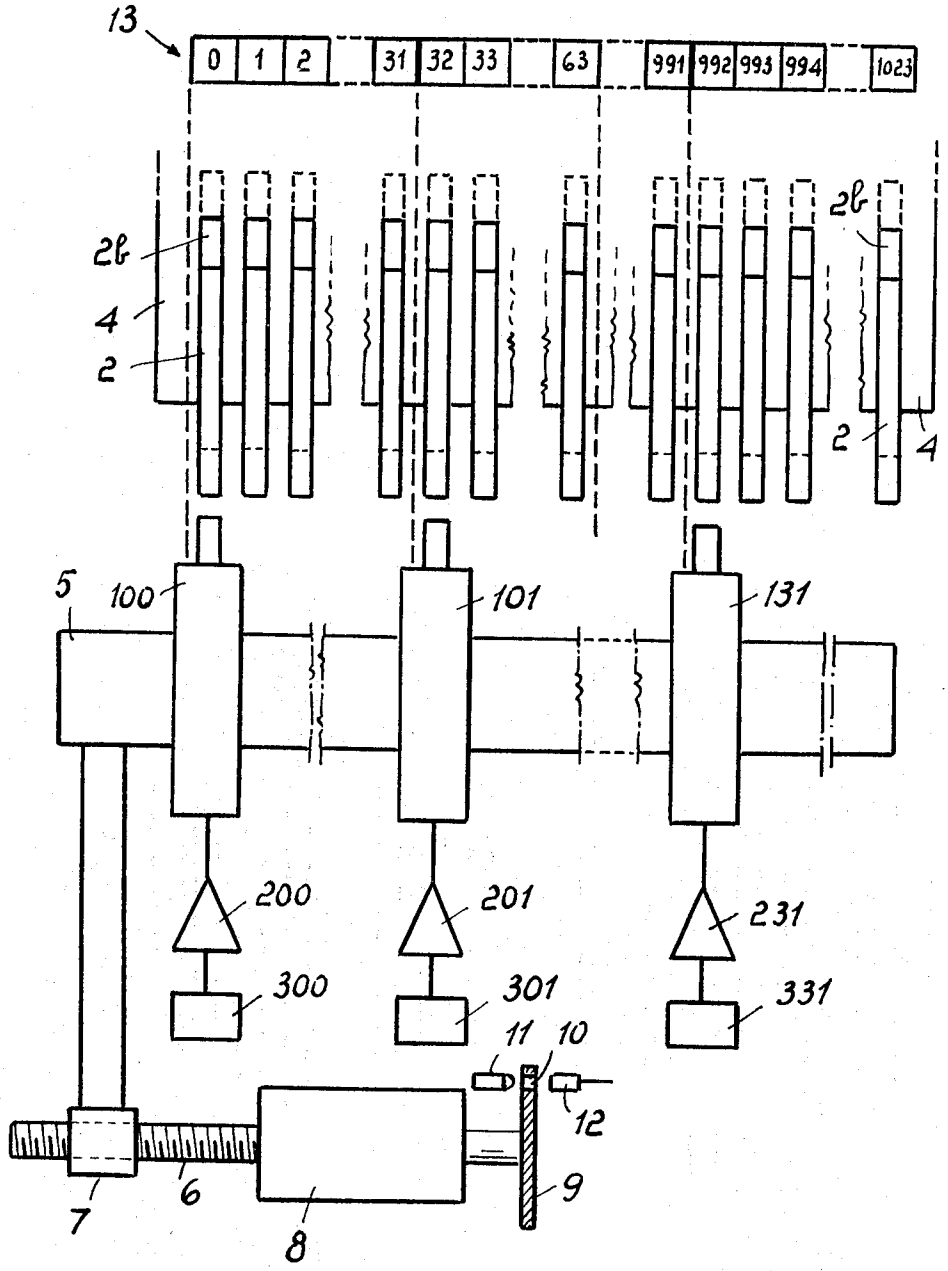
13
0
1
2
31
32
33
63
991
992
993
994
1023
2b
4
2
5
100
101
131
200
201
231
300
301
331
11
10
12
9
7
6
8

Fig. 2

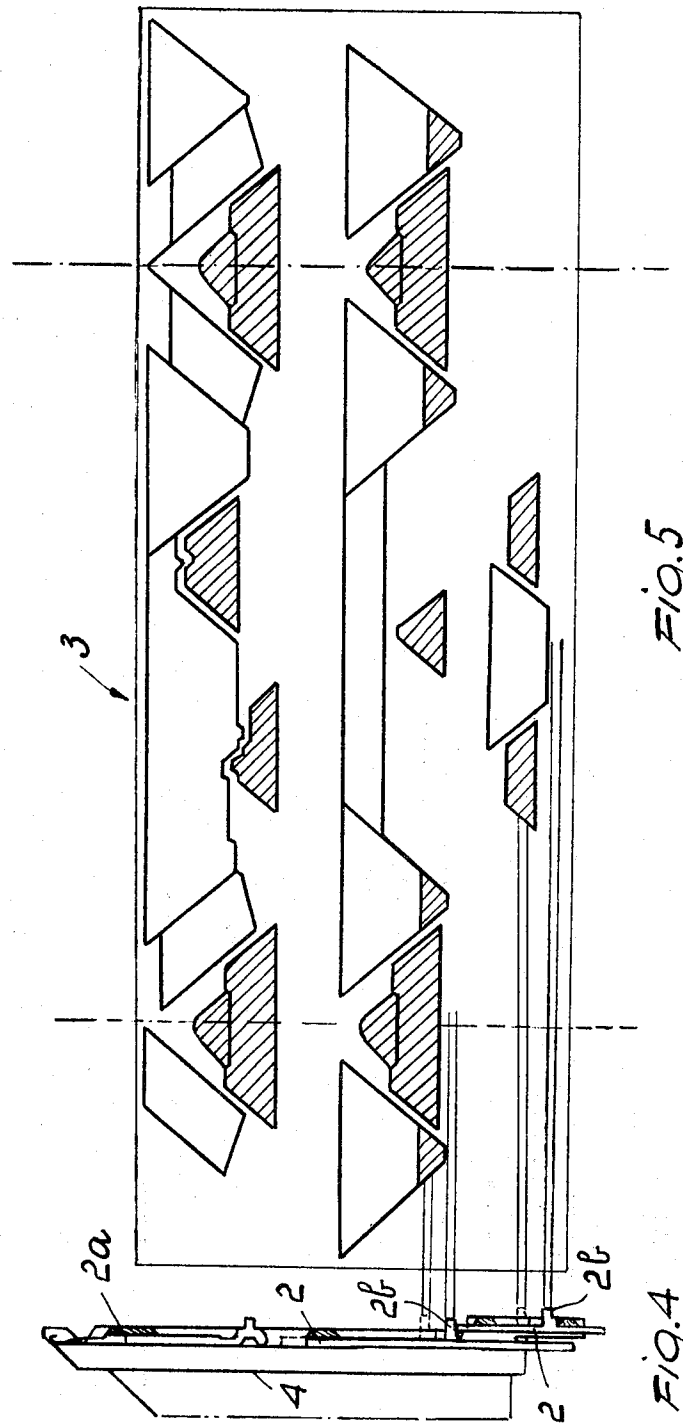

Fig.5

Fig.4

ELECTRONIC APPARATUS FOR CONTROLLING THE NEEDLES IN KNITTING MACHINES

BACKGROUND OF THE INVENTION

The present invention relates to an electronic apparatus for the programming and individual control of the needles of knitting machines, particularly of the flat bed type.

The individual control of the needle, i.e., the possibility of prearranging for each stroke whether an individual needle comes into operation or not, enables a knitted Jacquard fabric of any type to be obtained on knitting machines and is hence of great interest.

Considering the case of flat bed knitting machines as a particularly interesting typical but not limiting example, the individual control of the needle in these machines is resolved mechanically by "Jacquard" type devices consisting of rods which contain holes in positions corresponding with each needle which is not to come into operation, and solid portions in positions corresponding with the needles which are to come into operation.

The rods control the needles by way of members commonly called sinkers.

There are either one or two sinker assemblies, operated by respective sets of holes and solid portions in said rods, according to whether the machine is of the single or double feed type. The entire assembly may be doubled if it is required to independently operate the needles on both needle beds. Even though the control takes place in parallel over the entire needle bed, the foregoing known system is fairly slow and the programming cost high, because of which in practice programmes are used which are repeated over a limited number or rods. The programming and programme substitution require the attention of specialised personnel.

An attempt has been made to use electronic programming, but up to now this has been possible only on knitting machines which provide a certain limited sequence of operations by the control of the cams of the carriage, but without it being possible to control the needles individually.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an individual control device for the needles, based on electronic programming.

Another important object of the invention is to provide an electronic apparatus by means of which it is possible to programme knitting machines using the time available for the normal overstrokes of the machine, and without giving rise to idle time.

Another object of the invention is to provide an apparatus in which the mechanical side does not deteriorate with time and is hence of high reliability.

Another object of the invention is to provide an apparatus the length of which does not extend greatly beyond the needle beds.

Another object of the invention is to provide a programming apparatus which enables the formation of patterns which may be varied at will while permitting high working speeds in knitting machines, and comparable with those obtainable on machines of normal operation without a "Jacquard" device, and moreover with negligible costs of programming and archiving of programmes.

Another object of the invention is to provide an apparatus by means of which it is possible to effect long and considerably complex programmes without any appreciable increase of cost.

These objects are attained by a electronic apparatus for the programming and individual control of the needles of knitting machines, comprising a plurality of actuator elements, preferably of the electromagnetic type, disposed at regular intervals near the needles, for moving them from a working position to a non-working disposition or vice versa, a support for said actuator elements mounted mobile in a to-and-fro manner near said needles so as to make each of the actuator elements scan a series of adjacent needles, drive means for moving said support, and an electronic programmer for controlling said actuator elements according to a predetermined sequence, during the to-and-fro strokes of said support.

BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristics will be more evident from the detailed description of a preferred embodiment of an electronic apparatus for the programming and individual control of needles, applied to a flat bed knitting machine, illustrated by way of example in the accompanying drawing in which:

FIG. **1** is a general diagram of the apparatus according to the invention;

FIG. **2** is an operational diagram of said apparatus;

FIG. **3** is a diagrammatic cross-section of a double-bed knitting machine provided with the apparatus according to the invention;

FIGS. **4** and **5** are a cross-section through a needle bed and a longitudinal section through a carriage, respectively (the carriage is of the type for two feeds).

DESCRIPTION OF THE PREFERRED EMBODIMENT

The apparatus according to the invention controls a maximum number N of needles by k successive operations, by means of h actuators. In the example shown $N = 1{,}024$, $k = h = 32$.

More precisely, each actuator comprises an electromagnet **1** (FIG. 3) and an actuation member composed by a mobile core **1***a* and a lever **1***b* rigid therewith and pivoted at a fixed point **1***c* and adapted to cooperate with the sinkers or jacks **2** co-operating the needles **2***a*. In accordance with known arrangements the sinkers or jacks **2** serve to move the needles **2***a* in their working or non-working positions and are provided with butts **2***b* for engagement with the cams of the carriage **3** (FIG. 5). Furthermore said sinkers or jacks **2** project from the needle bed **4** so as to be operated by the ends of levers **1***b* operated by means of the electromagnets **1**.

As shown diagrammatically in FIG. **2**, for each needle bed and each feed, there are provided **32** electromagnets **100, 101 . . .131** controlled by the same number of amplifiers **200, 201 . . .231,** controlled in their turn by **32** static memories **300, 301 . . .331.**

The electromagnets **100, 101 . . .131** are fixed at regular intervals to an elongated support member such as a bar **5** arranged near the needle bed **4** along substantially the whole length thereof. The electromagnets are spaced from one another along the whole length of the support member by an extent corresponding to that of a group of adjacent needles, in the example shown 32

needles. The bar **5** is moved forwards and backwards in the direction of its length by driving means including a screw **6** and nut screw **7** assembly and an electric motor **8**, the screw **6** being rotated by the electric motor **8**.

To each turn of the screw **6** corresponds a movement for an extent corresponding to a whole number of needles **2***a*. On the screw **6** rotates rigidly a disc **9** provided with holes **10** and associated with a lamp **11** and a photodiode **12** or other equivalent means adapted to provide a synchronism signal (or Strobe signal). With this arrangement it is possible to know the successive positions of the bar **6** and hence of the electromagnets **100**, 101 . . .131 with respect to the sinkers **2**.

In a modification, the movement of the bar **5** supporting the electromagnets may be obtained by means of a step motor with a rack and pinion connection (in this case synchronism signals are not required).

The static memories **300, 301 . . .331** are controlled by a random access memory **13** of 1,024 bits, each bit corresponding to one needle, for example with "ones" for signifying needles working, and "zeros" for signifying needles not working (in FIG. **2** the 1,024 cells of the random access memory **13** are indicated diagrammatically by numbers from zero to 1,023).

The memory **13** is charged by a logic control unit **14** (FIG. **1**) which also decodes the information received from a reader **15** of the magnetic or perforated tape type. This latter is fed with the coded numerical instructions relative to the needles to be put into operation or out of operation at each stroke of the carriage **3** according to the desired knitting pattern.

The instructions to the random access memory **13** may be fed from a central remote unit.

At the end of each stroke, all needles are taken out of operation by suitable cams provided on the carriage **3** in accordance with known arrangements.

After the carriage **3** has emerged laterally from the needle bed **4**, and is disengaged from the needles, programming by the apparatus according to the invention may take place. The control sequence is the following.

After the motor **8** has been started, the electromagnet **100** arrives in front of the sinker corresponding to position **0**, as shown in FIG. **2**, the electromagnet **101** in front of the sinker **32** and so on until the electromagnet **131** which arrives in front of the sinker **992**. The cells of the memory **13**, indicated by the reference numerals **0, 32** and so on up to **992**, are read and their content stored in the memories **300, 301 . . . 331** respectively.

This operation takes place practically in parallel, the reading time being negligible with respect to the mechanical times.

The static memories which go to "1" control the respective electromagnet by way of the corresponding amplifier, and the sinker is thrust into the working position.

The movement continues, and the electromagnet **100** arrives in front of the sinker corresponding to the position **1**, the magnet **101** in front of the sinker **33** and so on to the magnet **131**, in front of the sinker **993**.

The cells **1, 33 . . . 993** of the memory **13** are read and their contents is stored in the memories **300, 301** . . . 331 respectively. Control of the sinkers takes place in the foregoing manner.

The cycle is repeated and in 32 successive phases the positioning of all needles is obtained, with a movement of the control system corresponding to just 1/32 of the entire stroke.

FIG. **3** shows a preferred embodiment with a V front fitted with electromagnets for operating the sinkers **2** for a two feed machine disposed for selecting the needles individually on both needle beds. In this case, as shown by dashed lines in FIG. **1**, a number of random access memories **13** must be provided equal to the number of feeds per needle beds and suitably connected to respective static memories.

It can be seen that the proposed programming system, which may be defined as of the modular block type, is of an intermediate type between a parallel control and a series control.

This design is particularly advantageous considering that the two types of control mentioned constitute two very unfavourable limiting cases for opposite reasons.

Parallel control requires an actuator for each needle of the machine, so that for normal grades 1,000 actuators must be provided. In fact with the double feed two actuators must be provided per needle. The control logic requires the same number of power controls.

The cost and size of such a parallel control system are very great. The actuation time is very short, in the order of milliseconds. Such a system is not useful because a normal flat bed machine remains out of operation for mechanical reasons for a time of some hundreds of milliseconds at each stroke. On the other hand, series control of the needle requires only one actuator per front and per feed, the actuator being moved along the entire needle bed and hence travelling with the carriage. It must operate a needle during the time in which the carriage travels across the space occupied by the same needle, i.e., possibly only two milliseconds at normal speeds.

Moreover said actuator needs to be operated possibly a thousand times for each stroke. The electronic control is simple but the mechanical problems, above all those relative to lasting properties, are very severe.

It can be noted that with the apparatus according to the invention, because of the freedom of choice of the quantities h and k (or the number of electromagnets and the elementary times) for a given product, it is possible to carry out scanning and control of the needles by the electromagnets during the time available for the normal overstrokes of the machine, without giving rise to idle time.

If h is not very big (for example less than **128**) the cost of the mechanical part is moderate and the cost of the electronic part is not much greater than that of a pure series system.

It should also be noted that the system according to the invention is modular and uses mechanical and electronic parts of usual or substantially usual type, which results in considerable constructural simplification.

The invention so conceived is susceptible to numerous modifications all of which fall within the scope of the inventive idea.

Thus for example the apparatus according to the invention may be adapted with suitable modifications to a circular knitting machine.

We claim:

1. In a knitting machine having a needle bed and a plurality of jacks for operating the needles, a device for the selective control of the needles comprising an elongated support member arranged near said needle bed along substantially the whole length thereof and mov-

able therealong, means for driving said support member, a number of electromagnets arranged on said support member and equally spaced from one another along the whole length thereof by an extent corresponding to that of a group of adjacent needles, a number of actuation members each arranged on said support member proximate to a corresponding electromagnet and each having one end for cooperation with the jacks of a group of adjacent needles, each of said actuation members being operated by a corresponding one of said electromagnets for selectively operating the jacks of a corresponding group of needles and cause the selected needles of said group to move from a non working position into a working position, said support member being reciprocatingly movable for an extent at least corresponding to the distance between two electromagnets thereby causing simultaneous selective operation of the jacks and the needles of each group of needles, the device further comprising an electronic programming unit for energizing said electromagnets according to the operative program during the movement of said elongated support member.

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