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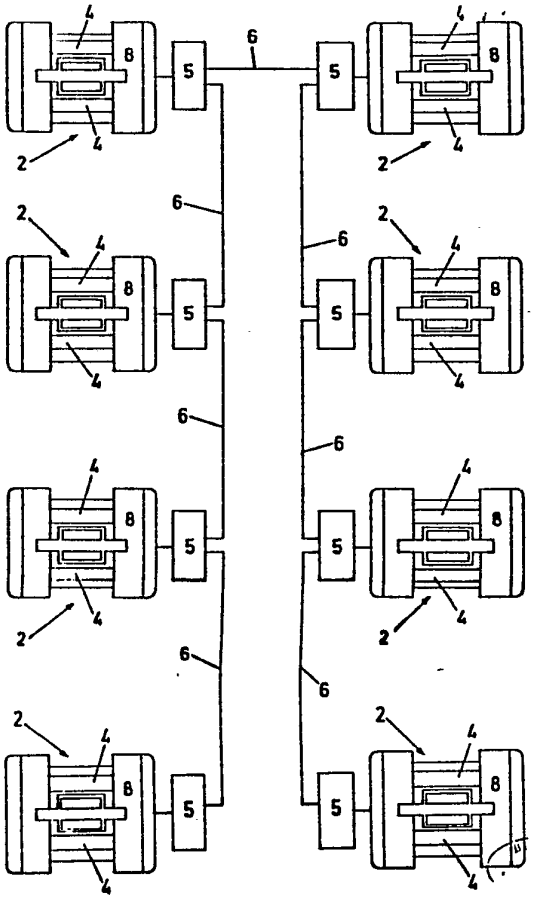
(54) Title: METHOD FOR CONTROLLING STRAIGHT BAR KNITTING MACHINES

(57) Abstract

Method for controlling straight bar knitting machines comprising electronically interconnecting a plurality of mechanically separate straight bar knitting machine units (2). The units generate an "action complete" signal indicative of the completion of a cycle. The action complete signal is utilised so as to ensure that the machines re-start each time in that pre-programmed manner although the individual cycle times may differ. Preferably the units each have analogously arranged microprocessor controls and the action complete signal of each unit gives rise to the presence of an internal "ready to run" signal and the absence of an external "inhibit" signal preventing start up of an adjacent unit, the arrangement being such that only when all "inhibit" signals are absent, start up of the units occurs.



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TITLE:

Method for controlling straight bar knitting machines

DESCRIPTION:

Field of invention

The invention relates to methods for controlling straight bar knitting machines.

Background of invention

There is no earlier information on the control of a number of independent straight bar knitting machines from a common or shared control mechanism. Existing multi-section machines have used electronic control mechanisms to synchronise a variety of control mechanisms working on electronic, electromechanical, pneumatic and mechanical principles. Switches for indicating cam shaft angles, solenoids, rams, cam shafts, racking mechanisms, bluff and prop mechanicams for controlling racking, shogging mechanisms and truck shogging mechanisms are all present on existing multi-section knitting machines.

At the completion of a garment, when plain knitting has finished, the multi-section machine undergoes a "turn-around sequence" to bring all mechanisms and components to the position for starting up. The "turn-around" is effected by a clock-control which advances at a

predetermined speed and actuates the appropriate mechanism and components in the desired sequence.

It is an object of the invention to control a number of independent straight bar knitting machine units so as to synchronise their operation. It is a further object of the invention to enable individual units to be de-activated whilst knitting proceeds on other units.

It is a further object of the invention to use a large number of standardised control mechanisms for a wiee variety of control functions so as to facilitate the interfacing of independent straight bar knitting machine units with a microprocessor control mechanism and reduce manufacturing costs.

Summary of invention

According to this invention there is provided a method for controlling straight bar knitting machines comprising electronically interconnecting a plurality of mechanically separate straight bar knitting machine units, starting all the units in a pre-programmed manner, deriving an action-complete signal at least at the termination of knitting an article and arresting any units after an appropriate action complete signal to enable all units to start once more in that pre-programmed manner.

Preferably the units are started simultaneously although they could be phased to start one after the other in a predetermined sequence.

Thus using the invention, straight bar knitting

machines can be arranged on a factory floor so as to make the best use of available space, maximuse access for repair and maintenance and enable additional units to be incorporated or removed having regard to production requirements. Especially where small units are used, the overall arrangement can provide the same output as large known multi-section arrangements (having say 6 or 12 knitting sections) without the attendant inflexibility and requirement for large floor areas. At the same time, the operative can still service the machines to remove finished articles etc. by hand or automatically.

Preferably each unit provides a plurality of action-complete signals at vital stages of operation and a final one of said action complete signals being used for any arresting of the unit that may be necessary, the other of said action complete signals being used to detect any fault and arrest the unit until the fault is corrected. Thus mechanisms similar to those used for synchronous re-starting can be used to supervise operation of the units to obtain feed-back. Vital stages occur when a certain action must be completed to ensure continued safe operation of the knitting machine.

Preferably the final one of said action complete signals is given at the end of a turn around sequence for each unit to its starting condition, ready for knitting a first course. An arrest signal could be given at an early stage of turn around as long as knitting has been completed and is not interrupted but machines may become dis-synchronised before re-starting during the remainder of the turn-around sequence.

Advantageously a means is provided for electronically disconnecting a unit which fails to give a final action complete signal and for permitting the remaining units to proceed. Thus advantage is taken from the ease of connecting the different units to operate in synchronism in order to permit one unit to stand idle for repairs whilst the other units are productive. This is not possible on a multi-section straight bar knitting machine where repairs on one section necessitate the arrest of all the sections. Preferably therefore the number of sections per unit is kept small such as two in a back to back arrangement so that the production lost for repair and maintenance is small.

Conveniently the action complete signal or signals are derived from a solid-state pressure sensitive device to reduce the number of moving parts and reduce cost. Advantageously the action to be detected is initiated electronically and the initiation of the action enables the solid state pressure sensitive device so that spurious arrest signals are reduced. A simple, yet reliable and easily controlled arrangement is provided by having the action complete signal or signals derived from a solid-state pressure sensitive device. The microprocessor may be centralised or accommodated in individual units as set out in the claims.

DRAWINGS

Figure 1 shows a plan view of one form of a knitting installation controlled by the method of the invention; and

Figure 2 shows another form of knitting installation controlled by yet a further method according to the invention.

Description of example of invention

With reference to Figure 1 and Figure 2, a number of straight bar knitting machine units are arranged parallel to each other.

Each unit 2 has two knitting sections 4 arranged back to back as described in the West-German Offenlegungsschrift 2,900,876. There is a supply of compressed air, electricity etc. Each unit incorporates a microprocessor for controlling the mechanical components of the unit and guards 8 for drive components.

The processor receives as inputs:

A a predetermined desired knitting program from memory, part of which cannot be altered as the steps concerned are essential for the satisfactory execution of a knitting operation, part of which may be variable at the behest of an operator to alter the size or shape or decorative patterning (if any) of a garment piece. The program includes a succession of individual steps described in more detail later on but known per se. Movement from some steps to subsequent steps is conditional upon:

B signals from an action-sensing system which form a "read" part of the processor-mechanical component interface.

In other words the action sensing system includes detectors for establishing that certain programmed steps have been completed or that the machine is in an appropriate mechanical condition for the next step to take place. The timing of the execution of the program depends on a programmable "demand" speed

of operation but the "true" timing may vary as a result of drag, inertia etc. Where the true timing has to govern operation the input signals B are utilised.

The process has as outputs:

C instruction or GO signals for an electro--pneumatic actuating system which through appropriate servo mechanisms initiate certain mechanical actions;

D enabling signals for those elements of the action sensing system necessary to monitor the progress of the programmed step just about to be executed.

The programm provides for the following main steps:

I turnaround sequence
II rib knitting sequence
III plain sequence

The main variations controlled by the operative are: a the setting of the steps which determines the length of the course; b the extent and frequency of narrowing or widening; and c the number of courses knitted.

Each sequence subdivides into subsidiary steps. During turnaround there are firstly a number of steps necessary for removing the previously knitted garment piece and secondly a number of steps preparatory to the knitting of the garment.

Turnaround:

1. Cam shaft stopped in exactly correct position for turnaround to commence using cam shaft angle transducer;

2. Selvedge screw resets stops to starting

width using angle transducer on selvedge screws to give a confirmatory action complete signal to initiate the next step;

3. Draw off roller racking drive disengaged and confirmed by pressure sensor to initiate next step;

4. Draw off roller rotates by means of electric motor to remove garment piece from knitting area. This is confirmed by photosensor which triggers the next step;

5. Yarn cutting and clamping units collect and severs yarn. A pressure sensor initiates the next step;

6. Draw off roller raised for passing of hook-up bar confirmed by pressure sensor which sets off the next step;

7. Hook up bar is set to start position. This is confirmed by pressure sensor which permits the next step;

8. The frame needle bar locking system is disengaged. This is confirmed by pressure switch to start next step;

9. Select splitting latch which pulls needles into half gauge for rib knitting. This is confirmed by sensors which in this cases provides the action complete signal used to resynchronise the different units. The preceding action complete signals have no resynchronising function and are used solely to advance safely from one turnaround step to another without clock control;

10. Machines restart.

Rib knitting sequence:

1. Knit hook up courses;
2. Knit rib set up course;
3. Knit welt and knit programmable number of

courses.

4. Transfer stitches for plain knitting.

Plain sequence:

1. Start garment piece;
2. Knit programmable number of courses.
3. Stop knitting garment piece.

The system incorporates solid-state pressure sensitive microswitches; light sensors; air flow sensors; sensor for detecting a particular shaft position. These components are essentially of the ON-OFF type and do not signal any intermediate positions.

A vital part of the system is a cam shaft angle transducer on the main cam shaft which provides a continuous series of signals indicative of the cam shaft angle to synchronise the actuation of a certain component with a particular overall machine condition. Apart from sequence of operations, the program also provides a signal for controlling the machine speeds. The true speed may however differ from the speed demanded by the program. The timing of many operations is hence determined by reference to the main cam shaft angle which hence determines the absolute time at which a particular event occurs. The cumulative time for executing the programm can vary from machine to machine as a result of differences in the true speed without interfering with the synchronisation of operations on a particular machine.

The electro-pneumatic system contains pneumatic pistons for operating props for levers, latches,

bluffs, mechanical dog clutches, shogging forks on rods and also pneumatic clutches, auxiliary motors such as motors of the "pancake" type and re-set motors. The result is that functions exercised by mechanical components in exact synchronisation with main cam shaft rotation on known types of machine, can now be duplicated by parts of the electro--pneumatic control system on machines according to the invention but without the in-built security of operation and exact mutual timing possible with positive mechanical control.

Operation

The program initiates the operation of the valves etc in response to the cam shaft angle transudcer, controlling the various actuation-system components just ahead of the actual desired stage of the cycle at which a change is desired so that by the time device i.e. ram has responded, the prop, bluff or truck is operated at the right time. The micro-precessor then awaits a signal from a component of the action sensing system such as a pressure sensitive device and only permits continued knitting if the action complete signal is delivered at the appropriate time.

Thus whole or part of the knitting of a garment can be completed using controls which, although the actuation is not as positive as with mechanical direct actuation, nevertheless do not endanger the machine.

When the garment has been completed, after knitting for example a rib border, plain widened part and plain narrowed part, the machine is "turned around" that is to say the welvedge stops are returned to their start

position, the hook up rollers and hook up bar are operated ready to receive a set up course. A pressure sensitive device then gives a final action-complete signal which is in effect a turn around complete signal.

Machine coordination

With reference particularly to Figure 1, the knitting of a garment piece with rib cuff etc may take for example 6 minutes. Each of the units operates at a slightly different speed depending on friction, tolerances etc so that, if machines were started simultaneously the final "turnaround complete" signal from the different units might be out of phase by as much as 30 seconds. This difference would increase if the different units were to restart without any synchronisation.

The microprocessors of the different machines are connected by lines 6 and contain a counter which records the "turnaround complete" signal of the unit interconnected by the lines 6. The counter causes the drives (under guard 8 in Figure 1) to be arrested after the "turnaround complete" signal until the counter counts eight such signals. At that time the counter causes the microprocessor to initiate the knitting of a subsequent article.

Individual counters may be re-set to enable the number of machines connected by lines 6 to be reduced to take a machine out of action for maintenance.

The installation thus functions in a manner equivalent to a 16 section straight bar knitting machine as far as an operator is concerned with knitting starting and

ending at approximately the same time. An operative can thus control a number of such installations in the same way as he used to control a number of multi-section straight bar knitting machines going from one to the other to check the individual sections.

At the same time the installation is much more attractive in that the units need not be accurately aligned, can be shipped and installed as complete assemblies, and their number increased or decreased. Also repairs and maintenance do not involve the loss of production from all the units in the installation.

Thus in spite of an apparent disadvantage resulting from the cam shaft timed step-by-step control program which permits the machines to operate dis-synchronously with respect to each other and replaces the cumbersome, bulky prior art mechanical control system, it is believed that the invention uses the action-complete signals inherent in the step-by-step control to maintain overall coordination of the machines overall and to permit in addition flexible installations in which a machine unit can be deactivated without influencing other units in a way not possible so far.

With reference to Figure 2, the same benefits can be obtained using a preferred arrangement in which lines 20 interconnect the different units in a doubled loop. The last sensor to operate during the turn-around sequence is arranged to cause the associated microprocessor to issue an internal "CLEAR TO RUN" signal for that unit and also an external "INHIBIT" signal for transmitting to the next unit

in the loop i.e. the one towards the last unit 2 in the loop in which the loop is doubled back.

In order to start running, the respective micro-processors require the presence of a "CLEAR TO RUN " signal and the absence of an "INHIBIT" signal. All other conditions prevent start up of the machine. When all machines are "CLEAR TO RUN" and have no "INHIBIT" effect on adjacent units, an external "CLEAR TO RUN" or "START UP" signal passes from the last unit in the loop along the return leg of the doubled loop to start up operation of all units and remove all signals or cause all signals to be ignored. The last unit 2 thus fulfills a special function but each unit 2 is capable of fulfilling that function.

The result is the system will operate regardless of the number of machines in the loop. Machines can be disconnected and by-passed by the loop. No counters need to be re-set. At the same time additional software and hardware is kept to a minimum.

CLAIMS:

1. A method for controlling straight bar knitting machines comprising electronically interconnecting a plurality of mechanical separate straight bar knitting machine units, starting all the units in a pre-programmed manner, deriving an action-complete signal at least at the termination of knitting an article and arresting any units after an appropriate action complete signal to enable all units to start once more in that pre-programmed manner.

2. A method according to claim 1 in which the units are started simultaneously.

3. A method according to claim 1 or claim 2 in which each unit provides a plurality of action-complete signals at vital stages of operation and a final one of said action complete signals being used for any arresting of the unit that may be necessary, the other of said action complete signals being used to detect any fault and arrest the unit until the fault is corrected.

4. A method according to claim 3 in which the final one of said action complete signals is given at the end of turn around of each unit to its starting condition, ready for knitting a first course.

5. A method according to claim 4 in which a means is provided for electronically disconnecting a unit which fails to give a final action complete signal and for permitting the remaining units to proceed.

6. A method according to any of the preceding claims in which the units comprise from 1 to 4

knitting sections arranged side-by-side or back to back.

7. A method according to any of the preceding claims in which the action complete signal or signals are derived from a solid-state pressure sensitive device.

8. A method according to claim 7 in which the action to be detected is initiated electronically and the initiation of the action enables the solid state pressure sensitive device.

9. A method according to claim 7 or claim 8 in which the action to be detected is initiated by an electronically controlled valve of a pneumatic ram device.

10. A method according to claim 9 in which a majority of control functions is effected by electronic valve actuated pneumatic ram devices so as to facilitate interfacing with a microprocessor control.

11. A method according to claim 10 in which each knitting machine unit has a microprocessor control connected to the electronical valves and the pressure sensitive devices to control the knitting operation or part thereof on each unit and the microprocessor is further connected to other such microprocessor units to pool the final action-complete signals and enable eacn unit to be arrested until the slowest moving unit has caught up.

12. A method according to claim 10 in which each unit

has a microprocessor control connected to the electronic valves and the pressure sensitive devices to control the knitting operation or part thereof and each microprocessor is further contacted to a central overall control unit to receive the final action-complete signals and arrest each unit until the slowest moving unit has caught up.

13. A method according to any of claims 1 to 5 in which the units each have analogously arranged microprocessor controls and the action complete signals of each unit gives rise to the presence of an internal "ready to run" signal and the absence of an external "inhibit" signal preventing start up of an adjacent unit, the arrangement being such that only when all "inhibit" signals are absent, start up of the units occurs.

14. A method according to any of the preceding claims in which a plurality of action complete signals are generated so as to synchronise all units at a number of stages during the knitting of an article.

15. An installation of straight bar knitting machine units operating in accordance to any of the preceding claims.

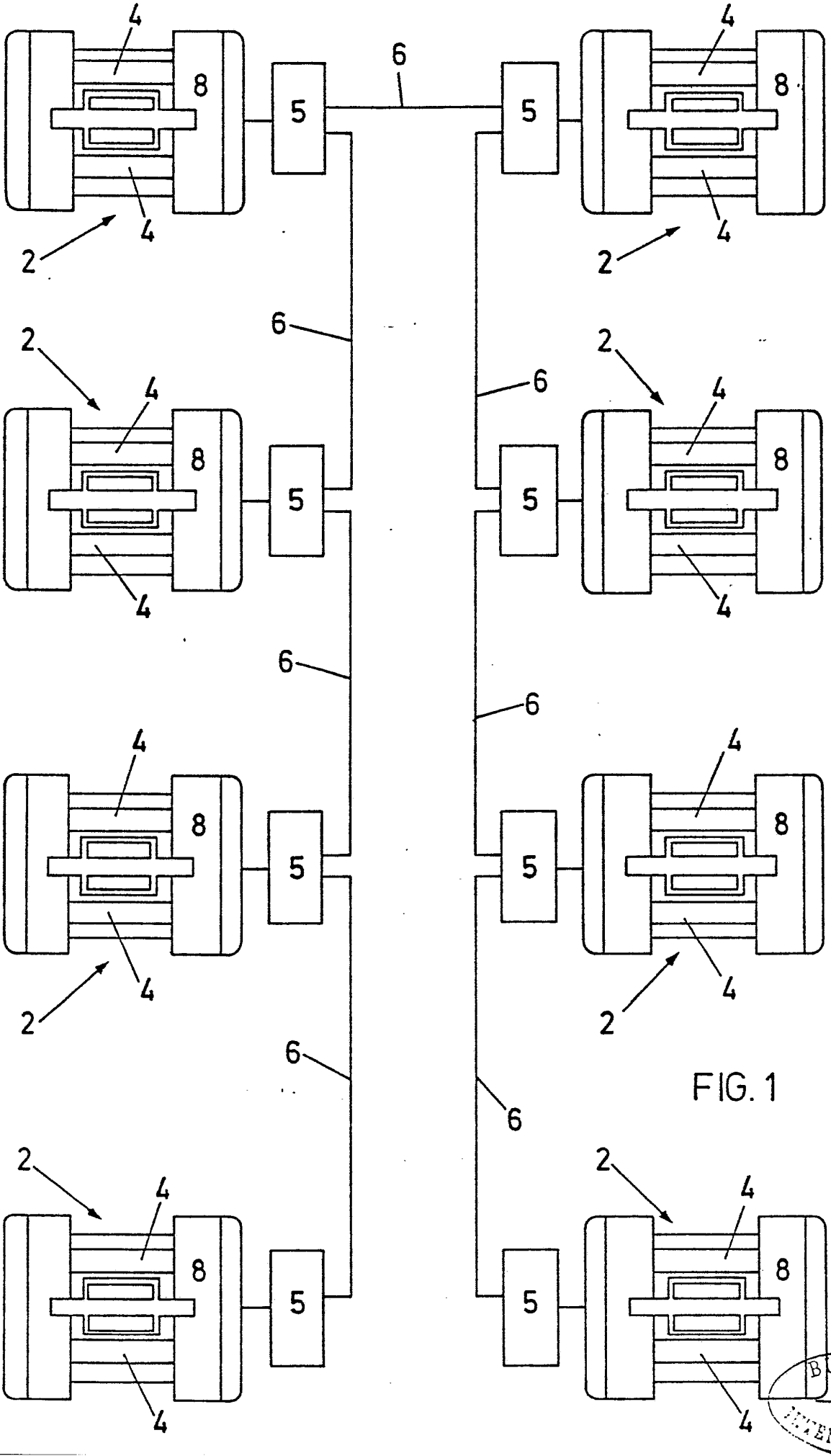

FIG. 1

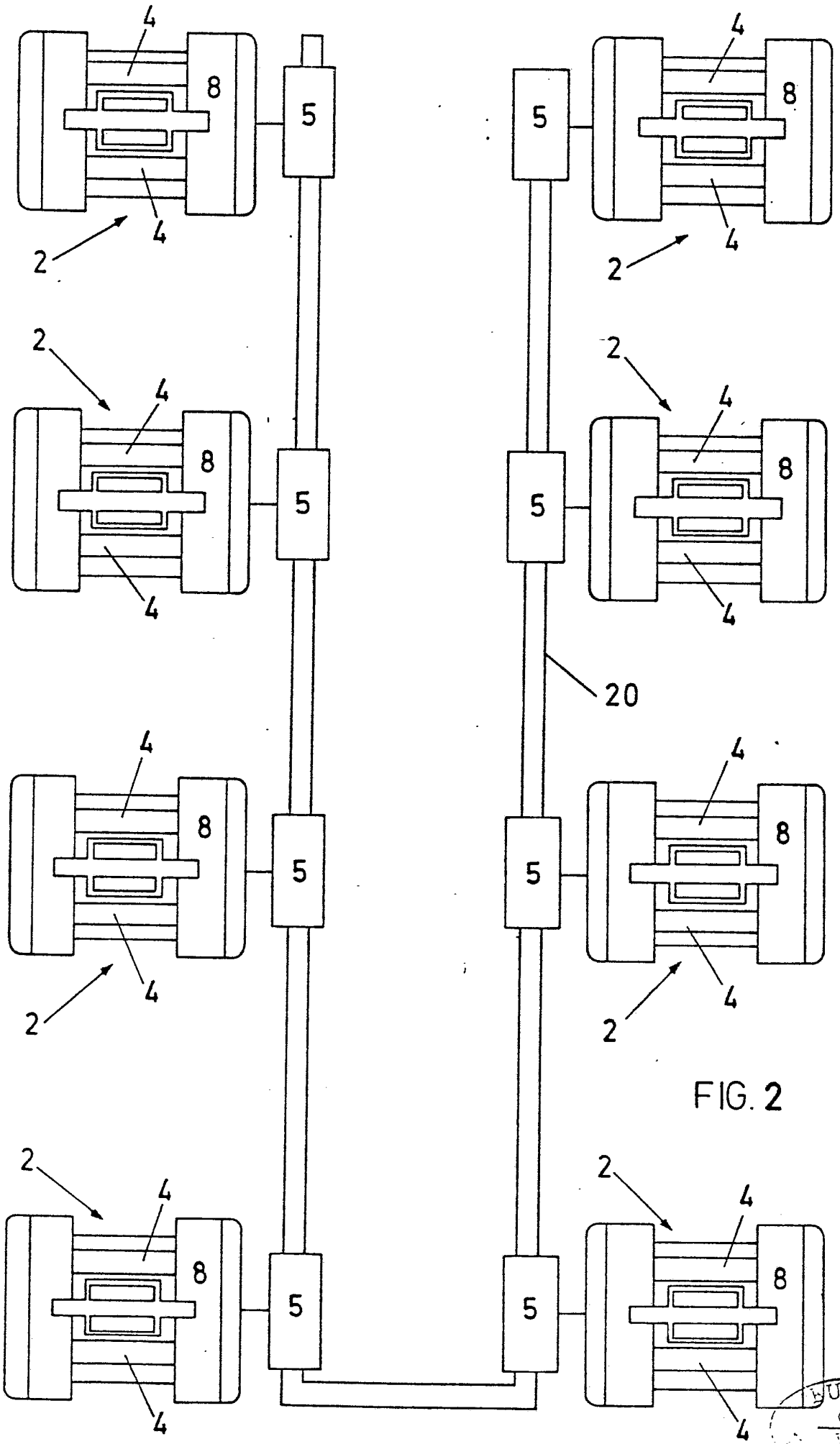

FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 80/00151

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl.[3] D 04 B 15/99

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
Int.Cl.[3]	D 04 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	US, A, 4031718, published June 28, 1977 see column 1, lines 14-46 and column 2, lines 49-57, Luth	1
A	US, A, 3940953, published March 2, 1976 see column 1, lines 12-55, Elitex	1

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"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [3]	Date of Mailing of this International Search Report [3]
23rd December 1980	8th January 1981
International Searching Authority [1]	**Signature of Authorized Officer [20]**
European Patent Office	G.L.M. Kruydenberg

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