(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 163 670 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
05.11.2014 Bulletin 2014/45

(51) Int Cl.:
D03D 47/30 *(2006.01)*

(21) Application number: **08164207.6**

(22) Date of filing: **12.09.2008**

(54) Method for controlling transportation of a weft thread through a shed

Verfahren zur Steuerung des Transports eines Schussfadens durch ein Webfach

Procédé pour le contrôle du transport d’un fil de trame à travers une foule

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR

(43) Date of publication of application:
17.03.2010 Bulletin 2010/11

(73) Proprietor: **Picanol**
8900 Ieper (BE)

(72) Inventor: **Puissant, Patrick**
9820 Merelbeke (BE)

(74) Representative: **Bird, William Edward et al**
Bird Goën & Co
Wetenschapspark Arenberg
Gaston Geenslaan 9
3001 Heverlee (BE)

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Printed by Jouve, 75001 PARIS (FR)

EP 2 163 670 B1

Description

Technical field of the invention

[0001] The present invention relates to a method for controlling transportation of a weft thread through a shed of an air jet weaving machine and to an air jet weaving machine with controlled transportation of the weft thread through the shed of the weaving machine.

Background of the invention

[0002] In weaving machines, more particularly in air jet weaving machines, it is known to use relay nozzles, also referred to as auxiliary nozzles, to assist a weft thread in its transfer through the shed from the insertion side to the opposite side of the shed. The weft thread to be inserted, i.e. the weft yarn or the weft, is inserted in the shed at the insertion side by means of a jet of air, provided from a main jet nozzle. As disclosed in WO2006/077063A1, the main jet nozzle may comprise two serially arranged main jet nozzles, which cooperate to provide the necessary air flow for insertion of the yarn in the shed.

[0003] Relay nozzles can be provided with compressed air, in order to assist the yarn, more particularly the yarn tip, to fly to the opposite side of the shed. The relay nozzles may optionally be grouped in groups of relay nozzles adapted for being simultaneously provided with compressed air, by means of one valve system per group.

[0004] In case the yarn arrives late at the opposite side of the shed, the yarn will be beaten up while it is not properly present along the length of the shed, causing weaving faults. In case the yarn arrives early, it means that some of the relay nozzles may have provided compressed air to the yarn at an inappropriate timing to effectively assist the yarn transfer.

[0005] At the end of the shed, opposite to the insertion side, optionally a stretch nozzle is provided, which may be provided with compressed air when the yarn tip arrives at this opposite side. The stretch nozzle causes the yarn to remain straight in the shed before and during the actual beating-up of the inserted yarn.

[0006] An example of such weaving machine is shown in US4534387.

[0007] US4534387 discloses the air flow rate provided to the relay nozzles to be varied dependent on the kind of weft yarn to be woven in.

[0008] In order to avoid unnecessary consumption of compressed air, timing of the air jets, e.g. by timing of valve systems to open or close, for each of the relay nozzles has been considered. As an example, US3705608 discloses to time the opening and closing of the valve systems for consecutive relay nozzles along the shed of the weaving machine.

[0009] US4445546 discloses to open the relay nozzles upon passage of the yarn tip, and maintain the air jet, however at reduced air flow rate, once the yarn tip has passed. Upon completion of the yarn flight through the shed, all relay nozzles are rendered inoperative simultaneously.

[0010] US4332280 discloses to control the relay nozzles differently during the first insertion of a yarn after machine interruption, as compared to following yarn insertions.

[0011] Timing and air pressure may be varied dependent on the weft yarn take-off speed, as is disclosed in US4673004 and US4458726. An example of such measurement is a calculated average arrival of consecutive weft yarn insertions, e.g. as disclosed in WO2006/114187A1. WO2007/057217A1 discloses to shift the moment of inactivation of the relay nozzles dependent upon measurements on the transported weft yarn.

[0012] US4759392 discloses a weft inserting apparatus of the kind specified in the preamble portion of claim 1. In this apparatus, the air flow rate of the relay nozzles in function of the weft thread is not very well tuned and the amount of compressed air which is consumed during weaving neither.

Summary of the invention

[0013] It is an object of the present invention to improve an apparatus and a method for controlling transportation of a weft through a shed of an air jet weaving machine.

[0014] The above objective is accomplished by a weft-inserting apparatus according to claim 1 and a method for controlling transportation of a weft through a shed of an air jet weaving machine according to claim 3.

[0015] It is an advantage of the present invention that it allows a significant reduction of compressed air consumption during weaving. A saving of an amount of at least 10% of compressed air may be obtained.

[0016] It is an advantage of the present invention that it allows tuning of the amount of compressed air, consumed during weaving, while maintaining the number of weaving interruptions due to inappropriate yarn or thread transfer below an acceptable number of process interruptions.

[0017] It is an advantage of the present invention that it allows tuning of the air flow rate of the relay nozzles in function of the type and properties of the weft thread or weft threads to be inserted.

[0018] It is an advantage of the present invention that it allows tuning of the air flow rate of the relay nozzles in function of weft insertion information measured during the insertion, e.g. tuning in real time.

[0019] The air flow rate is determined by the pressure of the air supplied to the relay nozzles, wherein the pressure of the supplied air to the relay nozzles is determined by the pressure in the air tank and the throttling of this pressure between the air tank and the relay nozzles. With air flow rate is meant the amount of air, this means the air flow, which is blown out of a relay nozzle during a time unit. The air flow is thus determined as the air flow rate multiplied by the blowing time of the relay nozzles.

[0020] Particular and preferred aspects of the invention are set out in the accompanying independent and dependent claims. The above and other characteristics, features and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention. This description is given for the sake of example only, without limiting the scope of the invention. The reference figures quoted below refer to the attached drawings.

Brief description of the drawings

[0021]

Fig. 1 is an overall schematic view of the embodiment of a weft insertion apparatus of an air jet weaving machine, suitable for applying a method according to the present invention.

Fig. 2 is an illustration of air flow rates obtainable in the different zones by an apparatus as illustrated in Fig. 1.

Fig. 3 is a schematic view of a second weft insertion apparatus of an air jet weaving machine.

Fig. 4 is an illustration of air flow rates obtainable in the different zones by an apparatus as illustrated in Fig. 3.

Fig. 5 is a schematic view of a third weft insertion apparatus of an air jet weaving machine.

Fig. 6 is an illustration of air flow rates obtainable in the different zones by an apparatus as illustrated in Fig. 5.

Fig. 7 is a schematic view of a fourth weft insertion apparatus of an air jet weaving machine.

Fig. 8 is an illustration of air flow rates obtainable in the different zones by an apparatus as illustrated in Fig. 7.

Fig. 9 is a schematic view of a fifth weft insertion apparatus of an air jet weaving machine.

Fig. 10 is an illustration of air flow rates obtainable in the different zones by an apparatus as illustrated in Fig. 9.

Fig. 11 is a schematic view of a sixth weft insertion apparatus of an air jet weaving machine.

Fig. 12 and Fig. 13 are illustrations of air flow rates obtainable in the different zones by an apparatus as illustrated in Fig. 11.

Fig. 14 is an illustration of air flow rates obtainable in the different zones by a device according to embodiments of the present invention; the left hand bars in the illustration express air flow rate values in function of the position of the group of relay nozzles along the shed from which air flow rate values are derivable, while the right hand bars in the illustration express air flow rate values to which adjustments are applied.

Fig. 15, Fig. 16 and Fig. 17 each show an alternative of Fig. 14.

Fig. 18 is a schematic view of a seventh embodiment of a weft insertion apparatus of an air jet weaving machine, suitable for applying a method according to an embodiment of the present invention.

Fig. 19 is a schematic view of the seventh embodiment when used for weaving to a width less than the nominal width.

Fig. 20 is an illustration of air flow rates obtainable in the different zones by an apparatus as illustrated in Fig. 18.

Fig. 21 is an illustration of air flow rates obtainable in the different zones by an apparatus as illustrated in Fig. 19.

Fig. 22 is a schematic view of a eighth embodiment of a weft insertion apparatus of an air jet weaving machine, suitable for applying a method according to an embodiment of the present invention.

Fig. 23 is a schematic view of the eighth embodiment when used for weaving to a width less than the nominal width.

Fig. 24 schematically shows a processing system comprising a controller according to an embodiment of the present invention.

[0022] In the different figures, the same reference signs refer to the same or analogous elements.

[0023] It should be pointed out that only embodiment of figure 1 falls within the scope of the claims of the instant application, figures 2-24 being only for illustrative purposes.

Description

[0024] The terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequence, either temporally, spatially, in ranking or in any other manner. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

[0025] It is to be noticed that the term "comprising", used in the claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. It is thus to be interpreted as specifying the presence of the stated features, integers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression "a device comprising means A and B" should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

[0026] Similarly, it is to be noticed that the term "coupled", also used in the claims, should not be interpreted as being restricted to direct connections only. The terms "coupled" and "connected", along with their derivatives, may be used. It should be understood that these terms are not intended as synonyms for each other. Thus, the scope of the expression "a device A coupled to a device B" should not be limited to devices or systems wherein an output of device A is directly connected to an input of device B. It means that there exists a path between an output of A and an input of B which may be a path including other devices or means. "Coupled" may mean that two or more elements are either in direct physical or electrical contact, or that two or more elements are not in direct contact with each other but yet still co-operate or interact with each other.

[0027] All numbers expressing pressure values, lengths, distances and so forth used in the specification and claims are to be understood as being modified in all instances, whether explicitly mentioned in the description or not, by the term "about". Accordingly, unless indicated to the contrary, the numerical parameters set forth in the specification and attached claims are approximations that may vary depending upon the desired properties sought to be obtained by the present invention.

[0028] Figure 1 shows an overall schematic view of a weft insertion system of an air jet weaving machine. Three main jet nozzles 2A, 2B, 2C and three additional main jet nozzles 2D, 2E, 2F are shown. Each main jet nozzle 2A, 2B, 2C, 2D, 2E, 2F is supplied with air, from a reservoir or an air tank 5A, being a buffer vessel comprising compressed air, at given pressure. Each main jet nozzle 2A, 2B, 2C, 2D, 2E, 2F is supplied with air via an adjustable throttle valve 11A, 11B, 11C, 11D, 11E, 11F and a shut-off valve 10A, 10B, 10C, 10D, 10E, 10F, each pair of throttle valves and shut-off valves forming a valve system. The throttle valves 11A, 11B, 11C, 11D, 11E, 11F, may be throttle valves as described in WO2006/066616A1 hereby incorporated by reference in its entirely.

[0029] A weft preparation device 7A, 7B, 7C draws off a weft thread 8A, 8B, 8C from a corresponding thread supply spool or thread package 9A, 9B, 9C. Each supply spool 9A, 9B, 9C may be provided with a different kind of weft thread, e.g. weft threads having different properties, such as e.g. colour, thickness, spun yarn or (multi-)filament yarn and alike. The weft preparation device 7A, 7B, 7C stores the weft thread 8A, 8B, 8C on a winding drum and releases the required length of the weft thread 8A, 8B, 8C at the proper moment in the weaving cycle to be inserted into the shed 1 by means of one of the associated and cooperating pairs of main jet nozzles 2A, 2B and 2C and additional main jet nozzles 2D, 2E and 2F respectively. The weft threads 8A, 8B, 8C are inserted in the shed 1 at an insertion side 110. The shed 1 is formed in a known manner between two planes of warp yarns. After the insertion of a weft thread is completed, the weft thread is beaten to the cloth fell by a weaving reed (not shown) and bonded into the fabric. The weft threads 8A, 8B, 8C may be inserted in the warp shed 1 according to a predefined sequence which is programmed in a controller 20.

[0030] Several groups of relay nozzles 4[1], 4[2], ..., 4[14] are positioned across the shed 1, and serve to carry a weft thread 8A, 8B, 8C across the shed 1. An air flow rate from the groups of relay nozzles is controlled by providing compressed air to each of the groups of relay nozzles. The air flow rate of a relay nozzle depends on the parameters of the relay nozzles, such as the dimension and the arrangement of the nozzle opening or nozzle openings, as well as on the pressure of the air supplied to the relay nozzle. The pressure of the air supplied to the relay nozzles may be controlled by controlling associated throttle valves and/or associated pressure regulators (not illustrated in Fig. 1). This controlling may be performed by means of a controller 20. Typical values for air flow rates out of the respective relay nozzles 4[1], 4[2], ..., 4[14] at a given pressure of the respective reservoir are 30%-100% of the air flow rate when the associated throttle valves do not throttle the air between a respective reservoir and a respective relay nozzle 4[1], 4[2], ..., 4[14]. Typical values for the air pressure in a pressure reservoir are 4-6 bar.

[0031] It is to be pointed out that some of the groups of relay nozzles 4[1], 4[2], ..., 4[14] may be actively used, i.e. provided with at least a minimum of compressed air during a weaving cycle. Between two groups of relay nozzles, optionally relay nozzles may be present which are not provided with compressed air, i.e. which are kept inactive during a weaving cycle. In the embodiments of methods according to embodiments of the present invention described hereafter, the groups of relay nozzles indicated with reference numbers 4[i] in the drawings are the actively used groups of relay nozzles, i.e. provided with compressed air at a predetermined air flow rate during a weaving cycle. Hence, "active relay nozzle" or "an active group of relay nozzles" is to be understood as a relay nozzle or a group of relay nozzles, which is provided with compressed air at least at one moment during a weaving cycle. The provision of the compressed air is to assist the flight or insertion of the weft thread through the shed. An "inactive relay nozzle" or "an inactive group of relay nozzles" is to be understood as a relay nozzle or a group of relay nozzles, which is not provided with compressed air during a weaving cycle.

[0032] In the example illustrated in Fig. 1, the groups of active relay nozzles are 4[1], 4[2], 4[3], 4[4], 4[5], ..., 4[11], 4[12], 4[13], 4[14]. In the first embodiment illustrated, each group of relay nozzles comprises, as an example only, two relay nozzles, which are supplied with air from a respective reservoir or air tank 5B, 5C, 5D via a further shut-off valve 12[1], 12[2], 12[3], 12[4], 12[5], ..., 12[11], 12[12], 12[13], 12[14]. In the embodiment illustrated, three reservoirs are provided, a first reservoir 5B, a second reservoir 5C and a third reservoir 5D. The shed 1 is functionally divided into three zones in transport direction of the weft thread 8A, 8B, 8C through the shed: a first functional zone, zone 1, also called acceleration zone, where the weft thread is accelerated; a second functional zone, zone 2, also called transportation zone, where the weft thread is further transported, for example at substantially constant velocity; and a third functional zone, zone 3, also called stretch zone, where the weft thread can be decelerated and kept straight until it is beaten up to the cloth fell by the reed (not illustrated). The first functional zone is preferably not larger than about the first 0.5 m of the shed near the insertion side. The third functional zone is preferably not larger than about the last 0.5 m of the shed, more preferred not larger than about the last 0.3 m of the shed near the opposite side. The zones are defined over the part of the shed 1 which is actively used during weaving; i.e. if weaving is performed over a smaller width than the nominal width of the weaving machine, then the functional zones are distributed over that smaller width. In that case, "the last 0.5 m of the shed" means "the last 0.5 m of the shed which is actively used during weaving".

[0033] In the embodiment illustrated in Fig. 1, the groups of relay nozzles 4[1], 4[2], 4[3] and their corresponding shut-off valves 12[1], 12[2], 12[3] that are associated with the first functional zone, zone 1, are associated with the first reservoir 5B. The groups of relay nozzles 4[4], 4[5], ..., 4[11] and their corresponding shut-off valves 12[4], 12[5], ..., 12[11] that are associated with the second functional zone, zone 2, are associated with the second reservoir 5C. The groups of relay nozzles 4[12], 4[13], 4[14] and their corresponding shut-off valves 12[12], 12[13], 12[14] that are associated with the third functional zone, zone 3, are associated with the third reservoir 5D. In the embodiment illustrated in Fig. 1, the pressure in the first reservoir 5B may be higher than the pressure in the second reservoir 5C. The pressure in the third reservoir 5D may be higher than the pressure in the second reservoir 5C. The pressure in the first reservoir 5B may be higher than the pressure in the third reservoir 5D. As an example only, and not intended to be limiting to the present invention, the pressure in the first reservoir 5B may be about 5.5 bar, the pressure in the second reservoir 5C may be about 3.5 bar and the pressure in the third reservoir 5D may be about 5.0 bar. The pressure in the reservoir 5A can be about 6.0 bar. As another example only, the pressure in the first reservoir 5B can be substantially equal to the pressure in the third reservoir 5D.

[0034] At the far end of the shed 1, opposite to the insertion side 110, a so-called stretching device can be provided, for example a stretching nozzle 3 which serves to stretch and/or hold an inserted weft thread 8A, 8B, 8C. This nozzle 3 is supplied with air from a further reservoir or air tank 5E via a shut-off valve 17. The pressure in the reservoir 5E can for example be about 5.5 bar.

[0035] The reservoirs 5A, 5B, 5C, 5D, 5E may optionally be coupled, via respective pressure regulators 14A, 14B, 14C, 14D, 14E to a master reservoir 15 at high pressure. The master reservoir may for example be at a pressure of about 6.0 bar.

[0036] In order to decelerate the weft threads 8A, 8B, 8C at the end of the insertion of the weft threads 8A, 8B, 8C, threads brakes 60A, 60B, 60C can be provided that are arranged near the insertion side 110 of the shed 1.

[0037] Controller 20 operates the throttle valves 11A, 11B, 11C, 11D, 11E, 11F and shut-off valves 10A, 10B, 10C, 10D, 10E, 10F, 12[1], 12[2], ..., 12[14], 17 to provide a required air flow rate at each moment in the weaving cycle during the weaving operation. The controller 20 can also operate to control the pressure regulators 14A, 14B, 14C, 14D, 14E. For a desired weaving pattern, the controller 20 has a set of instructions which determine, amongst others, the required weft threads 8A, 8B, 8C, air flow rates for the nozzles, and also valve settings and timings for the throttle valves 11A, 11B, 11C, 11D, 11E, 11F and the shut-off valves 10A, 10B, 10C, 10D, 10E, 10F, 12[1], 12[2], ..., 12[14], 17. Further a weft thread detector 6 may be provided at the far end of the shed 1 in order to determine the arrival of the weft thread 8A, 8B, 8C. The settings of the controller 20 or the set of instructions may be adapted based on an input from the weft thread detector 6.

[0038] In the embodiment illustrated in Fig. 1, the shed 1 may be about 190 cm wide. It is connected to fourteen valves 12[i] that are normally each connected to two relay nozzles. Optionally a third relay nozzle can be connected to each valve. Two relay nozzles may be provided for each relay nozzle valve. The relay nozzles may be arranged at a uniform distance of about 74 mm to each other. This means that (for this embodiment), the first functional zone, zone 1, will be covered by the first three valves 12[1], 12[2], 12[3], and consequently the first six relay nozzles corresponding to the first three groups 4[1], 4[2], 4[3] of relay nozzles.

[0039] In other apparatus (as for example illustrated in Fig. 5), the relay nozzles associated with the third functional zone, may be spaced closer to each other than the other nozzles. For example, the relay nozzles associated with the third functional zone may be spaced at half the distance to each other, e.g. spaced apart about 37 mm. This is useful in order to keep the weft thread straight in the third functional zone.

[0040] Fig. 2 illustrates the air flow rate of the different relay nozzles, for the embodiment of Fig 1, this means the air flow rate generated by the different relay nozzles. It is to be noted that in all embodiments of the present invention the actual air flow rate in the first, second and third functional zones may be different from the air flow rate of the relay nozzles as in the illustrations. The actual air flow rate may be higher than the air flow rate of the relay nozzles in the first zone, for example due to an air flow rate which may be generated by the main nozzles 2A, 2B, 2C in the first zone. Furthermore air flow escapes along the weaving width. In the third zone there may be only an air flow rate generated by relay nozzles, as the air flow of the main nozzles is normally already escaped in the second zone.

[0041] In the abscissa, the number (1 to N, more particularly 1 to 14 for the embodiment illustrated in Fig. 1) of the group of relay nozzles in the sequence of groups of relay nozzles along the shed 1 is expressed. In the ordinate, values for air flow rate are indicated. Several values A to K are indicated. It can be seen that the air flow rate of the relay nozzles in the first functional zone is higher than the air flow rate of the relay nozzles in the second functional zone, and that the air flow rate of the relay nozzles in the third functional zone is higher than the air flow rate of the relay nozzles in the second functional zone. In Fig. 2 the air flow rate of the relay nozzles in the first functional zone is higher than the air flow rate of the relay nozzles in the third functional zone.

[0042] Fig. 3 illustrates a second weft insertion apparatus of an air jet weaving machine. Only the shed 1 with its first, second and third functional zones, the corresponding valves 12[i] and relay nozzles 4[i], the stretching nozzle 3 and corresponding valve 17, and the reservoirs 5B, 5C, 5D, 5E are illustrated for the sake of simplicity. Remainders of the weft insertion apparatus, like the main jet nozzles 2A, 2B, 2C, the additional main jet nozzles 2D, 2E, 2F, the reservoir 5A for supplying air to the main jet nozzles and the additional main jet nozzles, the throttle valves 11A, 11B, 11C, 11D, 11E, 11F and the shut-off valves 10A, 10B, 10C, 10D, 10E, 10F, the weft preparation device 7A, 7B, 7C, the weft threads 8A, 8B, 8C, the thread supply spool or thread package 9A, 9B, 9C, the controller 20 may be as illustrated in Fig. 1, or may form any suitable alternative configuration as known by a person skilled in the art. Together these components provide suitable lengths of weft thread, at the right moment in time, to the shed 1.

[0043] In the apparatus illustrated in Fig. 3, several groups of relay nozzles 4[1], 4[2], ..., 4[14] are positioned across the shed 1, and serve to carry a weft thread 8A, 8B, 8C across the shed 1. As in the first embodiment, each group of relay nozzles 4[1], 4[2], ..., 4[14] comprises, as an example only, two relay nozzles, which are supplied with air from reservoirs 5B and 5C via shut-off valves 12[1], 12[2], 12[3], 12[4], 12[5], ..., 12[11], 12[12], 12[13], 12[14]. In accordance with embodiments of the present invention, the shed 1 is functionally divided into three zones in transport direction of the weft thread 8A, 8B, 8C through the shed: a first functional zone, zone 1, also called acceleration zone, where the weft thread is accelerated; a second functional zone, zone 2, also called transportation zone, where the weft thread is transported, optionally at substantially constant velocity; and a third functional zone, zone 3, also called stretch zone, where the weft thread can be decelerated and kept straight until it is beaten up to the cloth fell by the reed (not illustrated). The first functional zone is preferably not larger than about the first 0.5 m of the shed. The third functional zone is preferably not larger than about the last 0.5 m of the shed, more preferred not larger than about the last 0.3 m of the shed.

[0044] The groups of relay nozzles 4[1], 4[2], 4[3] and their corresponding shut-off valves 12[1], 12[2], 12[3] that are associated with the first functional zone, zone 1, are associated with the first reservoir 5B at higher pressure. The groups of relay nozzles 4[4], 4[5], ..., 4[11] and their corresponding shut-off valves 12[4], 12[5], ..., 12[11] that are associated with the second functional zone, zone 2, are associated with the second reservoir 5C. In the embodiment illustrated, the groups of relay nozzles 4[12], 4[13], 4[14] and their corresponding shut-off valves 12[12], 12[13], 12[14] that can be associated with the third functional zone, zone 3, are associated via a switch 16[12], 16[13], 16[14] with either one of the second reservoir 5C at lower pressure, or the third reservoir 5D at higher pressure. The selection of which reservoir the groups of relay nozzles 4[12], 4[13], 4[14] are connected to, is performed for example based on the type of weft thread 8A, 8B, 8C used.

[0045] If the switch 16[12] associates the relay nozzles 4[12] with the reservoir 5D, then the relay nozzles 4[12] are at higher pressure and are associated to the third functional zone as shown in Fig. 3. If, however, the switch 16[12] associates the relay nozzles 4[12] with the reservoir 5C, then the relay nozzles 4[12] are associated to the second zone (not as illustrated in Fig. 3).

[0046] In the apparatus illustrated in Fig. 3, the pressure in the first reservoir 5B may be higher than the pressure in the second reservoir 5C, and the pressure in the third reservoir 5D may be higher than the pressure in the second reservoir 5C. The pressure in the third reservoir 5D may be substantially equal to, or lower than the pressure in the first reservoir 5B. As an example only, and not intended to be limiting to the present invention, the pressure in the first reservoir 5B may be about 6.0 bar, the pressure in the second reservoir 5C may be about 3.5 bar, and the pressure in the third reservoir 5D may be about 6.0 bar. The reservoirs 5B, 5C, 5D may optionally be coupled, via pressure regulators 14B, 14C, 14D to a master reservoir 15 at higher pressure. The master reservoir 15 may for example be at a pressure of about 6.0 bar or slightly higher. According to an alternative of Fig. 3, the reservoirs 5B and 5D are both connected via the same pressure regulator to the master reservoir 15, hence the reservoirs 5B and 5D are both at the same pressure.

[0047] At the far end of the shed 1, opposite to the insertion side 110 of the weft thread 8A, 8B, 8C, a so-called stretching device can be provided, for example a stretching nozzle 3 which serves to stretch and/or hold an inserted weft thread 8A, 8B, 8C. This nozzle 3 may be supplied with air from a further reservoir 5E via a shut-off valve 17. In the example illustrated in Fig. 3, the pressure in the reservoir 5E is substantially equal to the pressure in the master reservoir 15. Further a weft thread detector 6 may be provided at the far end of the shed 1, opposite to the insertion side 110, in order to determine the arrival of the weft thread 8A, 8B, 8C.

[0048] A controller 20 is provided for operating the shut-off valves 12[1], 12[2], ..., 12[14], 17 and switches 16[12], 16[13], 16[14] to provide a required air flow rate at each moment in the weaving cycle during the weaving operation. For a desired weaving pattern, the controller 20 has a set of instructions which determine, amongst others, the required weft threads 8A, 8B, 8C, air flow rates for the nozzles 4[1], ..., 4[14], and also valve settings and timings for the shut-off valves 12[1], 12[2], ..., 12[14], 17. The settings of the controller 20 or the set of instructions may be adapted based on an input from the weft thread detector 6.

[0049] As can be seen in Fig. 4, the set-up of Fig. 3 may in a particular embodiment be operated so that the air flow rate of the relay nozzles in the first functional zone is higher than the air flow rate of the relay nozzles in the second functional zone, and that the air flow rate of the relay nozzles in the third functional zone is higher than the air flow rate of the relay nozzles in the second functional zone. The set-up of Fig. 3 corresponding to the illustration of Fig. 4 is such that the groups of relay nozzles 4[1], 4[2], 4[3] associated with functional zone 1 supply air delivered from reservoir 5B at higher pressure. The groups of relay nozzles 4[4], 4[5], ..., 4[11], 4[12], i.e. the groups of relay nozzles associated with functional zone 2, supply air delivered from reservoir 5C at lower pressure. In order to obtain this, the groups of relay nozzles 4[4], 4[5], ..., 4[12] associated with functional zone 2 are associated via a shut-off valve 12[4], 12[5], ..., 12[12], and the group of relay nozzles 4[12] furthermore via switch 16[12], with reservoir 5C at lower pressure. The other groups of relay nozzles 4[13], 4[14] associated with functional zone 3 are connected via respective switches 16[13], 16[14] to reservoir 5D at higher pressure. This way, a higher air flow rate is obtained in functional zones 1 and 3, while a lower air flow rate is obtained in functional zone 2.

[0050] A further weft insertion apparatus of an air jet weaving machine is illustrated in Fig. 5. Again, only the shed 1 with its first, second and third functional zones, the corresponding valves 12[i] and relay nozzles 4[i], the stretching nozzle 3 and corresponding valve 17, and the reservoirs 5B, 5C, 5E are illustrated for the sake of simplicity. Remainders of the weft insertion apparatus, like the main jet nozzles 2A, 2B, 2C, the additional main jet nozzles 2D, 2E, 2F, the reservoir 5A for supplying air to the main jet nozzles and the additional main jet nozzles, the throttle valves 11A, 11B, 11C, 11D, 11E, 11F and the shut-off valves 10A, 10B, 10C, 10D, 10E, 10F, the weft preparation device 7A, 7B, 7C, the weft threads 8A, 8B, 8C, the thread supply spool or thread package 9A, 9B, 9C, the controller 20 may be as illustrated in Fig. 1, or may form any suitable alternative configuration. Together these components provide suitable lengths of weft thread, at the right moment in time, to the shed 1.

[0051] The shed 1 is divided into three functional zones in transport direction of the weft thread 8A, 8B, 8C through the shed: a first functional zone, zone 1, also called acceleration zone, where the weft thread is accelerated; a second functional zone, zone 2, also called transportation zone, where the weft thread is transported, optionally at substantially constant velocity; and a third functional zone, zone 3, also called stretch zone, where the weft thread can be decelerated and kept straight until it is beaten up to the cloth fell by the reed (not illustrated). In the apparatusillustrated in Fig. 5, several groups of relay nozzles 4[1], 4[2], ..., 4[13] are positioned across the shed 1, and serve to carry a weft thread 8A, 8B, 8C across the shed 1.

[0052] The groups of relay nozzles 4[1], 4[2], 4[3] and their corresponding shut-off valves 12[1], 12[2], 12[3] that are associated with the first functional zone, zone 1, are associated with the first reservoir 5B at higher pressure. The groups of relay nozzles 4[4], 4[5], ..., 4[10] and their corresponding shut-off valves 12[4], 12[5], ..., 12[10] that are associated with the second functional zone, zone 2, are associated with the second reservoir 5C at lower pressure. The groups of relay nozzles 4[11], 4[12], 4[13] and their corresponding shut-off valves 12[11], 12[12], 12[13] that are associated with the third functional zone, zone 3, are also associated with the second reservoir 5C at lower pressure. However, in order to obtain a higher air flow rate of the relay nozzles in functional zone 3 than in functional zone 2, the relay nozzles of the groups of relay nozzles 4[11], 4[12], 4[13] may be placed at closer interdistance than the relay nozzles of the groups of relay nozzles 4[4], ..., 4[10] associated with the second functional zone, for example the distance between the relay nozzles associated with functional zone 3 may be reduced by 50% compared to the distance between the relay nozzles associated with functional zone 2. An alternative embodiment, not illustrated in the drawings, would be to disconnect a predetermined percentage of the relay nozzles in the transportation zone, zone 2. An alternative embodiment, not illustrated in the drawings, would be to provide relay nozzles with other physical properties, e.g. with another number of nozzle openings, with a nozzle opening having other dimensions, with nozzle openings having other dimensions, or with more or less and larger or smaller nozzle openings, so as to be able to obtain a different air flow rate of the relay nozzles in the first, second and/or third functional zone.

[0053] As an example only, and not intended to be limiting to the present invention, the pressure in the first reservoir 5B may be about 6.0 bar, and the pressure in the second reservoir 5C may be about 4.0 bar. The reservoirs 5B and 5C may optionally be coupled, via pressure regulators 14B, 14C to a master reservoir 15 at higher pressure. The master reservoir 15 may for example be at a pressure of about 6.0 bar or slightly higher.

[0054] The set-up at the far end of the shed 1, opposite to the insertion side 110 of the weft thread 8A, 8B, 8C, may be as already explained with respect to Fig. 1 and Fig. 3, with a so-called stretching device e.g. a stretching nozzle 3, a further reservoir 5E, a shut-off valve 17, and optionally also a weft thread detector 6.

[0055] A controller 20 is provided for operating the shut-off valves 12[1], 12[2], ..., 12[13], 17 to provide a required air flow rate at each moment in the weaving cycle during the weaving operation. For a desired weaving pattern, the controller 20 has a set of instructions which determine, amongst others, the required weft threads 8A, 8B, 8C, air flow rates for the nozzles, and also valve settings and timings for the shut-off valves 12[1], 12[2], ..., 12[13], 17. The settings of the controller 20 or the set of instructions may be adapted based on an input from the weft thread detector 6. The controller 20 may also control pressure regulators 14B, 14C.

[0056] As can be seen in Fig. 6, the set-up of Fig. 5 may in a particular example be operated so that the air flow rate of the relay nozzles in the first functional zone is higher than the air flow rate of the relay nozzles in the second functional zone, and that the air flow rate of the relay nozzles in the third functional zone is higher than the air flow rate of the relay nozzles in the second functional zone.

[0057] Yet another weft insertion apparatus of an air jet weaving machine is illustrated in Fig. 7. Again, only the shed 1 with its first, second and third functional zones, the corresponding valves 12[i] and relay nozzles 4[i], the stretching nozzle 3 and corresponding valve 17, and reservoirs 5, 5E containing pressurised air under pressure, are illustrated for the sake of simplicity. Remainders of the weft insertion apparatus, like the main jet nozzles 2A, 2B, 2C, the additional main jet nozzles 2D, 2E, 2F, the reservoir 5A for supplying air to the main jet nozzles and the additional main jet nozzles, the throttle valves 11 A, 11B, 11 C, 11D, 11E, 11 F and the shut-off valves 10A, 10B, 10C, 10D, 10E, 10F, the weft preparation device 7A, 7B, 7C, the weft threads 8A, 8B, 8C, the thread supply spool or thread package 9A, 9B, 9C, the controller 20 may be as illustrated in Fig. 1, or may form any suitable alternative configuration. Together these components provide suitable lengths of weft thread, at the right moment in time, to the shed 1.

[0058] The shed 1 is divided into three functional zones in transport direction of the weft thread 8A, 8B, 8C through the shed: a first functional zone, zone 1, also called acceleration zone, where the weft thread is accelerated; a second functional zone, zone 2, also called transportation zone, where the weft thread is transported, optionally at substantially constant velocity; and a third functional zone, zone 3, also called stretch zone, where the weft thread can be decelerated and kept straight until it is beaten up to the cloth fell by the reed (not illustrated).

[0059] In the apparatus illustrated in Fig. 7, several groups of relay nozzles 4[1], 4[2], ..., 4[14] are positioned across the shed 1, and serve to carry a weft thread 8A, 8B, 8C across the shed 1. In this embodiment, all relay nozzles 4[1], 4[2], ..., 4[14] distributed across the shed 1 are associated with one and the same reservoir 5 comprising pressurised air, e.g. air under pressure. The reservoir 5 may optionally be coupled, via pressure regulator 14 to a master reservoir 15 at higher pressure. The master reservoir 15 may for example be at a pressure of about 6.0 bar or slightly higher. The air flow rates of the relay nozzles 4[i] in the different functional zones are controlled in this embodiment, not by providing air under different pressures in the different functional zones, but by providing different air flow rates by providing relay nozzles at different distances in the different functional zones, e.g. by providing more or less relay nozzles in different functional zones.

[0060] In the apparatus illustrated in Fig. 7, as an example only, the shut-off valves 12[1], 12[2], ..., 12[11] associated with the first and second functional zones are placed at a first distance from each other, while the shut-off valves 12[12], 12[13], 12[14] associated with the third functional zone are placed at a second distance from each other, the second distance being smaller than the first distance. The second distance may for example, the invention not being limited thereto, be half of the first distance. In the embodiment illustrated, four relay nozzles are provided in each group of nozzles 4[1], 4[2], 4[3] associated with the first functional zone, zone 1, and two relay nozzles are provided in each group of nozzles 4[4], 4[5], ..., 4[11] associated with the second functional zone. As the associated shut-off valves 12[1], 12[2], 12[3], and 12[4], ..., 12[11], respectively, are all at the same distance with respect to each other, the relay nozzles in the first functional zone are twice as close to each other compared to the relay nozzles in the second functional zone. Therefore, the air flow rate of the relay nozzles in the first functional zone is higher than the air flow rate of the relay nozzles in the second functional zone. Two relay nozzles are provided in each group of relay nozzles 12[12], 12[13], 12[14] associated with the third functional zone. The distance between the nozzles 4[12], 4[13], 4[14] associated with the third functional zone is smaller than the distance between the nozzles associated with the second functional zone, and each group of relay nozzles associated with these shut-off valves has the same number of relay nozzles. The relay nozzles in the third functional zone are spaced more closely with respect to each other than the relay nozzles in the second functional zone. Therefore, the air flow rate of the relay nozzles in the third functional zone is higher than the air flow rate of the relay nozzles in the second functional zone, as also illustrated in Fig. 8. In this apparatus the air flow rate of the relay nozzles in the third functional zone is substantially equal to the air flow rate of the relay nozzles in the first functional zone.

[0061] The set-up at the far end of the shed 1, opposite to the insertion side 110 of the weft thread 8A, 8B, 8C, may be provided as already explained with respect to Fig. 1, with a so-called stretching device e.g. a stretching nozzle 3, a further reservoir 5E, a shut-off valve 17, and optionally also a weft thread detector 6.

[0062] A controller 20 is provided for operating the shut-off valves 12[1], 12[2], ..., 12[14], 17 to provide a required air flow rate at each moment in the weaving cycle during the weaving operation. For a desired weaving pattern, the controller 20 has a set of instructions which determine, amongst others, the required weft threads 8A, 8B, 8C, air flow rates for the nozzles, and also valve settings and timings for the shut-off valves 12[1], 12[2], ..., 12[14], 17. The settings of the controller 20 or the set of instructions may be adapted based on an input from the weft thread detector 6. The controller 20 may also control pressure regulator 14.

[0063] An example of a resulting air flow rate of the relay nozzles is represented in Fig. 8.

[0064] In the set-up of a further apparatus illustrated in Fig. 9, a single reservoir 5 is used as in Fig. 7 for providing air to the relay nozzles. In this apparatus, a wider shed 1 in relation to the shed of Fig. 7 is illustrated, with three groups of relay nozzles 4[1], 4[2], 4[3] and their associated shut-off valves 12[1], 12[2], 12[3] associated with the first functional zone, zone 1, sixteen groups of relay nozzles 4[4], ..., 4[19] and their associated shut-off valves 12[4], ..., 12[19] associated with the second functional zone, zone 2, and three groups of relay nozzles 4[20], 4[21], 4[22] and their associated shut-off valves 12[20], 12[21], 12[22] associated with the third functional zone, zone 3. This set-up differs from the set-up of Fig. 7 in that not necessarily the different spacing of the relay nozzles provides a different air flow rate of the relay nozzles in the different functional zones, but rather a throttle valve 16B, 16C, 16D provided between the pressure reservoir 5 and the shut-off valves 12[i] associated with one of the functional zones. The throttle valves 16B, 16C, 16D are controlled by a controller 20 such that the air flow rate of the relay nozzles in the first functional zone, zone 1, is higher than the air flow rate of the relay nozzles in the second functional zone, zone 2. The throttle valves 16B, 16C, 16D may furthermore be controlled by controller 20 such that the air flow rate of the relay nozzles in the third functional zone, zone 3, is higher than the air flow rate of the relay nozzles in the second functional zone, zone 2. Alternatively, or on top thereof, as illustrated in the embodiment of Fig. 9, the relay nozzles associated with the third functional zone, zone 3, may be placed physically closer to each other than the relay nozzles associated with the second functional zone, zone 2, thus also increasing the air flow rate of the relay nozzles in the third functional zone. The controller 20 (not shown) operates the shut-off valves 12[1], 12[2], ..., 12[22], 17 to provide a required air flow rate at each moment in the weaving cycle during the weaving operation. For a desired weaving pattern, the controller 20 has a set of instructions which determine, amongst others, the required weft threads 8A, 8B, 8C, air flow rates for the nozzles, and also valve settings and timings for the shut-off valves 12[1], 12[2], ..., 12[22], 17. The settings of the controller 20 or the set of instructions may be adapted based on an input from the weft thread detector 6. The controller 20 may also control pressure regulator 14. An example of a resulting air flow rate of the relay nozzles is illustrated in Fig. 10.

[0065] Yet another apparatus is illustrated in Fig. 11. This is close to the apparatus illustrated in Fig. 9, but now each group of relay nozzles 4[1], ..., 4[13] has, apart from its own shut-off valve 12[1], ..., 12[13], also its own throttle valve 13[1], ..., 13[13]. A throttle valve 18 is provided between the reservoir 5E and the shut-off valve 17. The pressure regulator 14 and the valves 12[i], 13[i], 17, 18 can be controlled by the controller 20. In this set-up, the control of the air consumption in each functional zone, zone 1, zone 2, zone 3 can be controlled for each group of relay nozzles individually. This allows a more gradual transition from one functional zone to another, as illustrated in the illustrations of Fig. 12 and Fig. 13.

[0066] Fig. 12 shows an apparatus where the air flow rate delivered by the groups of relay nozzles 4[1], 4[2], 4[3] associated with the first functional zone, zone 1, is constant and high. This equally holds for the air flow rate delivered by the groups of relay nozzles 4[11], 4[12], 4[13] associated with the third functional zone, zone 3. The air flow rate delivered by the groups of relay nozzles 4[4], ..., 4[10] associated with the second functional zone, zone 2, gradually decreases up to a minimum air flow rate, and then gradually increases again.

[0067] Fig. 13 shows an apparatus where the air flow rate delivered by the groups of relay nozzles 4[1], 4[2], 4[3] associated with the first functional zone, zone 1, gradually decreases. This gradual decrease continues for the air flow rate delivered by the first groups of relay nozzles 4[4], ..., 4[6] associated with the second functional zone, zone 2, up to a minimum air flow rate, and then gradually increases again for the last groups of relay nozzles 4[8], ..., 4[10] associated with the second functional zone, zone 2. This gradual increase continues for the air flow rate delivered by the groups of relay nozzles 4[11], ..., 4[13] associated with the third functional zone, zone 3.

[0068] An apparatus (not shown) is analogous to the apparatus illustrated in Fig. 11, but in this embodiment each relay nozzle has its own buffer tank and pressure regulator. This, similarly as the set-up apparatus illustrated in Fig. 11, allows the air flow delivery of a relay nozzle in each functional zone to be controlled for each relay nozzle individually. This allows a more gradual transition from one functional zone to another. This also allows to set any distribution of the air flow rate of the relay nozzles.

[0069] Fig. 14 to Fig. 17 illustrate different air flow distribution rates which may be obtained by suitable control of one or more of the set-up embodiments of the present invention, as disclosed and set out above. It can be seen that in all the embodiments, the air flow rate in the first functional zone, zone 1, is higher than the air flow rate in the second functional zone, zone 2. The left hand bars in the illustrations express air flow rate values in function of the position of the group of relay nozzles along the shed from which air flow rate values are derivable, while the right hand bars in the illustration express air flow rate values to which adjustments are applied, as described below.

[0070] According to a further apparatus, for each of the valves of the air jet weaving machine as shown in any of the set-up embodiments, a control signal for each of the valves is determined for providing an air flow to the respective group of relay nozzles. The control signal is such that it controls the valves so as to control the air flow rates of the relay nozzles in the first, second and third functional zones in order to assist the transport of the weft so as to accelerate the weft through the first functional zone of the shed, so as to transport the weft, optionally at substantially constant velocity, through the second functional zone of the shed, and so as to allow to decelerate and stretch the weft when transporting it through the third functional zone of the shed. The assistance to the transport of the weft may be obtained by controlling the air flow rate through the relay nozzles associated with each of the functional zones.

[0071] The control signal for each of the valves, in some apparatus as many valves as there are groups of relay nozzles, may be provided by an operator by means of an appropriate interface (e.g. a keyboard or a touch screen). Alternatively, the control signals for the valves may be read from a memory being part of the controller of the air jet weaving machine.

[0072] The determining of the control signal for each of the valves may comprise the selection of a set of predetermined control signals for the valves from a plurality of sets of predetermined control signals for the valves. This plurality of sets of predetermined control signals for the valves may be stored in look-up tables stored in a memory unit of the processing unit. This selection may be done automatically, for example based upon information similar as the selection of appropriate sets of air flow rate values as set out above, or by an operator via an interface.

[0073] A control signal for a valve is related to a known air flow rate value for the group of relay nozzles coupled to the valve. Hence by selecting a control signal for each of the valves, a predetermined value for the air flow rate provided to the group or groups of relay nozzles coupled to the valve is obtained.

[0074] Once the control signals for the valves are determined, optionally calculated by a processing unit of a controller 20, the control signals are provided to each of the valves for controlling the air flow rate from the groups of relay nozzles by providing compressed air to each of the groups of relay nozzles.

[0075] It is understood that by determining appropriate control signals for each of the valves, air flow rates may be provided to the groups of relay nozzles so as to obtain desired air flow rate distribution, of which some examples are shown in Fig. 2, 4, 6, 8, 10, 12 and 13.

[0076] Turning back to the weft insertion system of a weaving machine as for example shown in the different set-up embodiments, a method according to embodiments of the present invention may further comprise a step of calculating a control signal for each of the valves. The controller 20 may determine such control signal. As an example, the controller 20 may use an air flow rate value to be provided, for comparing this value with air flow rate values in a look-up table linking air flow rate values to valve settings. From the look-up table, the controller 20 may derive the control signal generating the valve setting required by the corresponding valve to obtain the corresponding air flow rate value. The look-up table may link air flow rate values to valve settings for each valve individually. Of course, other suitable algorithms within the reach of a person skilled in the art may be used as well.

[0077] Additionally, the controller 20 may determine, for each of the throttle valves 13[i] and for the shut-off valves 12[i], an activation and optionally an interruption moment for switching the control signal to that valve to a value corresponding to an active, respectively inactive or intermediate state in function of the progress of the weaving cycle, e.g. in function of a value for the angular position of the main shaft of the weaving machine.

[0078] During application of the method according to an embodiment of the present invention, the controller 20 may, at the activation moment for a particular group of relay nozzles, switch the control signal for the corresponding throttle valves 13[i] associated with that group, and shut-off valves 12[i] associated with that group, to a value corresponding to the active state of the respective valves, causing the provision of the determined air flow rate value to the respective valve, and later, at the interruption moment, switch the control signal for the corresponding valves 13[i], 12[i] to a value corresponding to the inactive state of the respective valves, thus interrupting the provision of the determined air flow rate value to the corresponding group of relay nozzles.

[0079] The controller 20 may be adapted for determining, e.g. calculating the activation and interruption moments for each of the shut-off valves 12[i], may be adapted for calculating the setting of the throttle valves 13[i] and may be adapted for calculating a control signal based on each of the desired air flow rate values for the relay nozzles. Such controller 20 may also be adapted for determining the angular position of the main shaft, e.g. for determining the progress of the weaving cycle.

[0080] The controller 20 may be adapted for obtaining information about the air flow rate values to be used or to obtain information on the type of yarns and yarn properties to be inserted as weft threads. This information may optionally be obtained by means of one or more weft preparation devices 7A, 7B, 7C.

[0081] The weft preparation devices are not limited to weft preparation devices 7A, 7B, 7C as shown in the drawings, but other weft preparation devices can be used in a weft inserting apparatus according to this invention. For example, weft preparation devices as known from EP 268313 A1, EP 315235 A1 or similar devices can be used to this end.

[0082] The controller 20 may comprise an interface, such as e.g. a keyboard or a pointing device such as a mouse or trackball, for allowing an operator to indicate which air flow rates are to be used.

[0083] Alternatively, the controller 20 may comprise an interface, such as e.g. a keyboard or a pointing device such as a mouse or trackball, for allowing an operator to indicate which type of yarn is to be used as weft thread. The controller 20 may be adapted for defining the air flow rates which is to be used based on the yarn information thus provided.

[0084] The controller 20 may comprise a keyboard and screen, or a touch screen, to exchange information with the operator.

[0085] The controller 20 may be adapted for obtaining adjustment data, e.g. for adjusting the air flow rate values and the activation and interruption moments for switching the control signals for the throttle valves 13[i] and shut-off valves 12[i], in particular, but not limited thereto, in function of flight behaviour of the yarn to be inserted in the shed.

[0086] As an example, the controller 20 may be adapted for determining, e.g. calculating, the angular position of the main shaft of the weaving machine, hence the moment when the weft thread passes the yarn detector 6, indicating that the weft insertion is completed at that moment relative to the weaving cycle. By comparing the measured arrival with an expected arrival, the controller 20 may notice that the arrival is sooner or is later than expected. The controller 20 may be adapted for calculating the average time difference between measured and expected arrival. If the average arrival is later than the expected, the yarn tends to arrive late during a weaving cycle. If the average arrival tends to be sooner than expected, the yarn tends to arrive early relative to the weaving cycle.

[0087] In case the yarn tends to arrive early, the controller 20 that is adapted for changing the speed of the weaving machine may increase the speed of the weaving machine, i.e. reduce the time for the weaving machine to make one pick. Alternatively or additionally, the controller 20 that is adapted for changing the air flow rate may reduce the air flow rate value provided to the main jet nozzles, and optionally also reduce the air flow rate value provided to some or all of the groups of relay nozzles.

[0088] Similarly, in case the yarn tends to arrive late, the controller 20 may decrease the speed of the weaving machine, i.e. increase the time for the weaving machine to make one pick. Alternatively or additionally, the controller may increase the air flow rate value provided to the main jet nozzles, and optionally also increase the air flow rate value provided to some or all of the groups of relay nozzles.

[0089] The controller 20 may be adapted for measuring yarn insertion properties, e.g. the instantaneous thread speed during insertion. The controller may obtain signals from e.g. a thread winding sensor 70A, 70B, 70C present at the thread preparation devices 7A, 7B, 7C, respectively, as illustrated in Fig. 1. The controller 20 may be adapted to calculate or determine the take off speed of the weft thread from the signal of the thread winding sensor 70A, 70B, 70C.

[0090] Instead of a winding sensor, alternatively a thread speed sensor or a sensor arranged along the weaving shed can be used to calculate or determine insertion properties of the weft yarn during the insertion of the weft yarn.

[0091] In case the thread tends to fly too quickly, the controller 20 may bring forward, i.e. earlier, the interruption moment and optionally the activation moment of the groups of relay nozzles which are still of significance to guide the weft thread inserted. Alternatively or additionally, the controller may reduce the air flow rate value provided to the main jet nozzles, and optionally also reduce the air flow rate value provided to some or all of the groups of relay nozzles.

[0092] Similarly, in case the thread tends to fly too slowly, the controller may postpone the interruption moment and optionally the activation moment of the groups of relay nozzles, which are still of significance to guide the weft thread inserted. Alternatively or additionally, the controller may increase the air flow rate value provided to the main jet nozzles, and optionally also increase the air flow rate value provided to some or all of the groups of relay nozzles.

[0093] As shown in Fig. 14 to 17 (right hand bars of the illustrations), such adjustment may cause an adjustment of at least part of the predetermined air flow rate values of the relay nozzles to a reduced value, wherein the reduction is less than or equal to the predetermined air flow rate value for at least one of the groups of relay nozzles. In other words, the air flow rate values of some or all of the groups of relay nozzles may be reduced with a determined value. A typical reduction factor is between 15% and 30%.

[0094] In the apparatus of Fig. 14 the left indicated values are the values before adjustment, while the right indicated values are the values after an adjustment. Such an adjustment may be carried out when the successive weft threads tend to be inserted with a higher speed. In the example, in the functional zone 1 an air flow rate reduction for the relay nozzles of 10% and in functional zone 2 an air flow rate reduction for the relay nozzles of 20% is provided, while in functional zone 3 no air flow rate reduction for the relay nozzles is provided. Preferably, the air flow rate reduction for the relay nozzles is chosen higher in zone 2 than in the zone 1, because in zone 2 the weft only needs to be transported further on, while in zone 1 the weft still has to be accelerated. In the example, the air flow rate for the relay nozzles is not adjusted in zone 3 in order to allow stretching of the weft thread.

[0095] In the apparatus of Fig. 15 the air flow rate out of the relay nozzles in the functional zone 2 is reduced, while the air flow rate out of the relay nozzles in the functional zone 3 is increased. Such an adjustment may be carried out when the actual inserted weft thread reaches already a relative high speed during the initial part of the insertion, for example has a higher speed than the average weft thread when the first or second winding has been drawn off from the prewinders. This means for example, the winding time for leaving the first or second winding is relatively low. Due to this already high speed, the air flow rate of the relay nozzles in functional zone 2 can be reduced. As this weft has a high speed, it can be favourable to increase the air flow rate of the relay nozzles in the functional zone 3 in order to keep this fast weft thread stretched. In other words, if an inserted weft thread reaches an already sufficient speed during the acceleration of this weft thread, then the right indicated values of Fig. 15 will be used for the further insertion of this weft thread, while if an inserted weft thread does not reach a sufficient speed during the acceleration of this weft thread, then the left indicated values of Fig. 15 will be used for the further insertion of this weft thread.

[0096] According to an alternative not shown, if a fast weft thread is measured, for example, only the air flow rate of relay nozzles 9, 10 and 11 may be reduced to the right indicated values of Fig. 15, while the air flow rate of the other relay nozzles will not be changed. According to a further alternative not shown, similarly to the apparatus of Fig. 15 the air flow rate of the relay nozzles 4 to 11 can be changed in case of a fast weft thread, while the air flow rate of the relay nozzles 12 to 14 will not be changed at all.

[0097] In the apparatus of Fig. 16 the air flow rate out of the relay nozzles in the functional zone 3 is decreased. Such an adjustment may be carried out when the actual inserted weft yarn only reaches a relative low speed during the initial part of the insertion, for example has a lower speed than the average weft thread when the first or second winding has been drawn off from the prewinders. This means for example, the winding time for leaving the first or second winding is relatively high. Due to this low speed, the air flow rate of the relay nozzles in functional zone 3 can be reduced while this slow weft thread can still be kept stretched.

[0098] In the apparatus of Fig. 17 the air flow rate of all relay nozzles is reduced, whereby the reduction amount of the air flow rate is depending on the functional zone. The air flow rate of the relay nozzles can be reduced as long as the weft threads arrive soon enough at the opposite side of the shed and/or as long as no weaving faults occur. For rough spun yarns it seems most appropriate to reduce the air flow rate in all the functional zones, while for smooth filament yarns it could be more appropriate to reduce the air flow rate of the relay nozzles only in functional zone 2. In air jet weaving machines it is known to provide higher air flow rates for smooth filament yarns than for rather rough spun yarns.

[0099] Alternatively, such adjustment may cause an adjustment of at least part of the predetermined air flow rate values to the predetermined value scaled with a scaling factor, the scaling factor preferably being less than one. It is understood that various routines may be implemented to allow the controller itself to change the air flow rate values dependent on measured and obtained adjustment data. For example when a bobbin change detector detects that a new bobbin is used a stepwise adjustment can be executed.

[0100] As an example, the controller 20 may be adapted for counting the process interruptions for given settings of air flow rate values, activation and interruption moments of the relay nozzles and yarn properties. The controller, noticing that the number of process interruptions is higher than a pre-determined acceptable number, may automatically reduce or increase the air flow rate values or may shift the activation and/or interruption moments gradually or stepwise. The number of process interruptions may change due to this adjustment.

[0101] The controller 20 may, for given adjusted settings of air flow rate values, activation and interruption moments and yarn properties find that further adjustments cause the number of process interruptions to increase too much. As such, the controller 20 may itself automatically define the optimum given settings of air flow rate values, activation and interruption moments and yarn properties in function of an acceptable number of process interruptions.

[0102] It is understood that such statistics may also be applied by an operator, who may provide and initiate adjustments of settings of air flow rate values, activation and interruption moments and yarn properties in function of the process interruptions the operator notices.

[0103] The controller 20 may be adapted for executing a number of instructions and routines which may be made available as a computer program product for executing any of the above-described methods when executed on a computing device associated with an air jet weaving machine. The computer program product may be transmitted over a local or wide area telecommunication network.

[0104] Alternatively the instructions and routines may be provided in the form of hardware.

[0105] The present invention can be applied to weave on a weaving machine over a width which is smaller than a nominal width of the machine. This is illustrated in Fig. 18 and Fig. 19.

[0106] In the apparatus illustrated in Fig. 18 and Fig. 19, again, only the shed 1 with its first, second and third functional zones, the corresponding valves 12[i] and relay nozzles 4[i], the stretching nozzle 3 and corresponding valve 17, and the reservoirs 5B, 5C, 5E are illustrated for the sake of simplicity. Remainders of the weft insertion apparatus, like the main jet nozzles 2A, 2B, 2C, the additional main jet nozzles 2D, 2E, 2F, the reservoir 5A for supplying air to the main jet nozzles and the additional main jet nozzles, the throttle valves 11 A, 11B, 11C, 11D, 11E, 11 F and the shut-off valves 10A, 10B, 10C, 10D, 10E, 10F, the weft preparation device 7A, 7B, 7C, the weft threads 8A, 8B, 8C, the thread supply spool or thread package 9A, 9B, 9C, the controller 20 may be as illustrated in Fig. 1, or may form any suitable alternative configuration. Together these components provide suitable lengths of weft thread, at the right moment in time, to the shed 1.

[0107] In the apparatus illustrated in Fig. 18 and Fig. 19, several groups of relay nozzles 4[1], 4[2], ..., 4[13] are positioned across the shed 1, and serve to carry a weft thread 8A, 8B, 8C across the shed 1.

[0108] The groups of relay nozzles 4[1], 4[2], 4[3] and their corresponding shut-off valves 12[1], 12[2], 12[3] are associated with the first reservoir 5B at higher pressure. The groups of relay nozzles 4[4], 4[5], ..., 4[10] and their corresponding shut-off valves 12[4], 12[5], ..., 12[10] are associated with the second reservoir 5C at lower pressure. Each group of relay nozzles 4[4], ..., 4[10] has, apart from its own shut-off valve 12[4], ..., 12[10], also its own throttle valve 13[4], ..., 13[10]. The groups of relay nozzles 4[11], 4[12], 4[13] and their corresponding shut-off valves 12[11], 12[12], 12[13] are also associated with the second reservoir 5C at lower pressure. However, in order to obtain a higher air flow rate of the relay nozzles in functional zone 3 than in functional zone 2, the relay nozzles of the groups of relay nozzles 4[11], 4[12], 4[13] may be placed at closer interdistance than the relay nozzles of the groups of relay nozzles 4[4], ..., 4[10], for example the distance between the relay nozzles associated with functional zone 3 may be reduced by 50% compared to the distance between the relay nozzles 4[4], ... 4[10]. An alternative embodiment, not illustrated in the drawings, would be to disconnect a predetermined percentage of the relay nozzles in the transportation zone, functional zone 2. An alternative embodiment, not illustrated in the drawings, would be to provide relay nozzles with other physical properties, e.g. with another number of nozzle openings, with a nozzle opening having other dimensions, with nozzle openings having other dimensions, or with more or less and larger or smaller nozzle openings, so as to obtain a higher air flow in the third functional zone than in the second functional zone.

[0109] As an example only, and not intended to be limiting to the present invention, the pressure in the first reservoir 5B may be about 6.0 bar, and the pressure in the second reservoir 5C may be about 5.0 bar. The reservoirs 5B and 5C may optionally be coupled, via pressure regulators 14B, 14C to a master reservoir 15 at higher pressure. The master reservoir 15 may for example be at a pressure of about 6.0 bar or slightly higher.

[0110] A controller 20 is provided for operating the shut-off valves 12[1], 12[2], ..., 12[13], 17 and the throttle valves 13[4], ..., 13[10] to provide a required air flow rate of the respective relay nozzles at each moment in the weaving cycle during the weaving operation. For a desired weaving pattern, the controller 20 has a set of instructions which determine, amongst others, the required weft threads 8A, 8B, 8C, air flow rates for the nozzles, and also valve settings and timings for the shut-off valves 12[1], 12[2], ..., 12[13], 17 and the throttle valves 13[4], ..., 13[10]. The settings of the controller 20 or the set of instructions may be adapted based on an input from the weft thread detector 6. The controller 20 may also control pressure regulators 14B, 14C.

[0111] When weaving, the shed 1 is divided into three functional zones in transport direction of the weft thread 8A, 8B, 8C through the shed: a first functional zone, zone 1, also called acceleration zone, where the weft thread is accelerated; a second functional zone, zone 2, also called transportation zone, where the weft thread is transported, optionally at substantially constant velocity; and a third functional zone, zone 3, also called stretch zone, where the weft thread can be decelerated and kept straight until it is beaten up to the cloth fell by the reed (not illustrated).

[0112] Depending on the width of the material to be woven on the weaving machine, the functional zones are located differently, as illustrated respectively in Fig. 18 and Fig. 19.

[0113] When weaving the nominal width of the weaving machine, as illustrated in Fig. 18, the first relay nozzles 4[1], 4[2], 4[3] connected to the first reservoir 5B at higher pressure are associated with the first functional zone, zone 1, also called acceleration zone, where the weft thread is accelerated. The relay nozzles 4[4], ..., 4[10] connected via throttle valves 13[4], ..., 13[10] to the second reservoir 5C are associated with the second functional zone, zone 2, also called transportation zone, where the weft thread is transported, optionally at substantially constant velocity. The relay nozzles 4[11], ..., 4[13] also connected to the second reservoir 5C are associated with the third functional zone, zone 3, also called stretch zone, where the weft thread can be decelerated and kept straight until it is beaten up to the cloth fell by the reed (not illustrated).

[0114] When weaving smaller than the nominal width of the weaving machine, the last relay nozzles, e.g. 4[12] and 4[13] are not actuated, as they are located past the width of the woven material. However, a few of the relay nozzles provided with a throttle valve may be actuated substantially without throttling, e.g. relay nozzles 4[9] and 4[10], so that relay nozzles 4[9], 4[10], 4[11] are associated with the third functional zone where the weft thread can be decelerated and kept straight. The relay nozzles 4[1], 4[2], 4[3] are associated with the first functional zone, and the relay nozzles 4[4], ..., 4[8] are associated with the second functional zone.

[0115] Depending on the width of the fabric to be woven, different relay nozzles are associated with different functional zones. Corresponding air flow rates of relay nozzles for apparatus illustrated in Fig. 18 and Fig. 19 are shown in Fig. 20 and Fig. 21, respectively. It can be seen that, in Fig. 20, corresponding with the apparatus of Fig. 18 where the weaving is performed on nominal width, the relay nozzles 4[11], 4[12], 4[13] are actuated so as to provide a higher air flow rate than relay nozzles 4[4], ..., 4[10]. In Fig. 21, corresponding with the apparatus of Fig. 19 where the weaving is performed on smaller than nominal width, the relay nozzles 4[12] and 4[13] are not actuated, while the relay nozzles 4[9], 4[10], 4[11] are actuated so as to provide a higher air flow rate than relay nozzles 4[4], ..., 4[8].

[0116] In the apparatus of Fig. 22 and Fig. 23, a single reservoir 5 is provided. Some of the relay nozzles 4[i] are connected with their shut-off valves 12[i] directly onto the reservoir 5, while other relay nozzles are connected with their shut-off valves 12[i] via a throttle valve 13[i] onto the reservoir 5. The components of the apparatus illustrated in Fig. 22 and Fig. 23 may be as in any of the previous apparatus, analogous components having same reference numbers.

[0117] When weaving on nominal width, as illustrated in Fig. 22, the first relay nozzles 4[1], 4[2], 4[3] connected to the reservoir 5 are associated with the first functional zone, zone 1, also called acceleration zone, where the weft thread is accelerated. The relay nozzles 4[4], ..., 4[10] connected via throttle valves 13[4], ..., 13[10] to the reservoir 5 are associated with the second functional zone, zone 2, also called transportation zone, where the weft thread is transported, optionally at substantially constant velocity. By providing the throttle valves 13[i], the air flow rate of the relay nozzles 4[i] associated with the second zone can be made lower than the air flow rate of the relay nozzles 4[i] associated with the first zone. The relay nozzles 4[11], ..., 4[13] also connected to the reservoir 5 are associated with the third functional zone, zone 3, also called stretch zone, where the weft thread can be decelerated and kept straight until it is beaten up to the cloth fell by the reed (not illustrated).

[0118] When weaving smaller than the nominal width of the weaving machine, the last relay nozzles, e.g. 4[12] and 4[13] are not actuated, as they are located past the width of the woven material. However, a few of the relay nozzles provided with a throttle valve may be actuated substantially without throttling, e.g. 4[9] and 4[10], so that relay nozzles 4[9], 4[10], 4[11] are associated with the third functional zone where the weft thread can be decelerated and kept straight. The relay nozzles 4[1], 4[2], 4[3] are associated with the first functional zone, and the relay nozzles 4[4], ..., 4[8] are associated with the second functional zone.

[0119] The above-described method embodiments of the present invention may be implemented in a processing system 1200 such as shown in Fig. 24. The controller 20 may be provided by means of elements of the processing system 1200 as shown in Fig. 24. The controller 20 may comprise one or more of:

- an input port adapted for obtaining a predetermined air flow rate value for each of the groups of relay nozzles, the air flow rate values for relay nozzles of a first functional zone of the shed being so as to accelerate the weft thread through the first functional zone, the air flow rate values for relay nozzles of a second functional zone of the shed being so as to transport the weft thread, optionally at substantially constant velocity, through the second functional zone of the shed, and the air flow rate values for relay nozzles of a third functional zone of the shed being so as to allow to decelerate or stretch the weft thread when transporting it through the third functional zone of the shed;
- a processing unit 1203 adapted for calculating a control signal for each of the valves, based on the predetermined air flow rate value for the respective groups of relay nozzles, the control signal having values corresponding to activated and inactivated states of the valves; and
- a signal providing means 1215 adapted for switching the control signals applied to each of the valves between values corresponding to activated and inactivated states for controlling the air flow from the groups of relay nozzles.

[0120] In a similar way, the processing unit 1203 may be adapted for determining a control signal for each of the valves for providing an air flow rate value for each of the groups of relay nozzles, the air flow rate values for relay nozzles of a first functional zone of the shed being so as to accelerate the weft thread through the first functional zone, the air flow rate values for relay nozzles of a second functional zone of the shed being so as to transport the weft thread, optionally at substantially constant velocity through the second functional zone of the shed, and the air flow rate values for relay nozzles of a third functional zone of the shed being so as to allow to decelerate or stretch the weft thread when transporting it through or present in the third functional zone of the shed. Such determining of the control signals may be done by calculating the signals based upon a set of air flow rate values, or may be obtained by reading out a set of control signals from a memory unit, e.g. the memory unit 1205, or by obtaining a set of control signals by means of an interface, e.g. user interface subsystem 1209.

[0121] Fig. 24 shows one configuration of processing system 1200 that includes at least one programmable processor or the processing unit 1203 coupled to a memory subsystem 1205 that includes at least one form of memory, e.g., RAM, ROM, and so forth. It is to be noted that the processor 1203 or processors may be a general purpose, or a special purpose processor, and may be for inclusion in a device, e.g., a chip that has other components that perform other functions. Thus, one or more aspects of the present invention can be implemented in digital electronic circuitry, or in computer hardware, firmware, software, or in combinations of them. The processing system may include a storage subsystem 1207 that has at least one disk drive and/or CD-ROM drive and/or DVD drive. In some implementations, a display system, a keyboard, and a pointing device may be included as part of a user interface subsystem 1209 to provide for a user to manually input information. Ports for inputting and outputting data also may be included. More elements such as network connections, interfaces to various devices, and so forth, may be included, but are not illustrated in Fig. 24. The various elements of the processing system 1200 may be coupled in various ways, including via a bus subsystem 1213 shown in Fig. 24 for simplicity as a single bus, but will be understood to those in the art to include a system of at least one bus. The memory of the memory subsystem or memory unit 1205 may at some time hold part or all (in either case shown as 1211) of a set of instructions that when executed on the processing system 1200 implement the steps of the methods described herein. Thus, while a processing system 1200 such as shown in Fig. 24 is prior art, a system that includes the instructions to implement aspects of the methods for controlling an air flow rate from a number of consecutive groups of relay nozzles is not prior art, and therefore Fig. 24 is not labelled as prior art.

[0122] The memory unit 1205 may hold a plurality of predetermined air flow rate values for the groups, the processing unit being adapted for obtaining one of said predetermined air flow rate values for the groups from the memory unit 1205. The memory unit 1205 may hold a plurality of predetermined sets of control signals for the valves. The memory unit 1205 may also hold rules to be used for calculating control signals from the air flow rate values. The processing unit 1203 may be adapted for executing these rules.

[0123] The processing system 1200 may further comprise a measuring device 1217 for measuring a parameter relative to the speed of the weft thread during insertion, such as e.g. a weft thread detector 6 may be provided at the far end of the shed 1 in order to determine the arrival of the weft thread 8A, 8B, 8C. The processing system 1200 may comprise an interface 1216 for converting the measured parameter to information suitable to be processed by the processing unit 1203. The processing unit 1203 may be adapted for determining adjustment data based on said measured parameter relative to the weft thread speed and/or relative to the weft thread arrival. The memory unit 1205 may also hold the rules to be used for adjusting the air flow rate values in function of the measured parameter. The processing unit 1203 may be adapted for executing these rules.

[0124] The processing system 1200 may comprise a signal providing device 1215 adapted for switching the control signals applied to each of the valves between a value corresponding to an activated state and a value corresponding to an inactivated state for controlling the air flow from the groups of relay nozzles.

[0125] The processing system 1200 may further comprise one or more input ports for obtaining data on e.g. angular rotation of the main shaft of the weaving machine.

[0126] The method and the weft-inserting apparatus according to the invention are particularly suitable to be carried out in combination with the method and apparatus according to WO2007/057217, where the time of activation and/or interruption of activation of the valves for the relay nozzles is controlled. This means that both the air flow rate of the relay nozzles and the blowing times of the relay nozzles can be controlled. These blowing times are substantially determined by the activation and interruption of activation of the shut-off valves for the relay nozzles. The different valves for the relay nozzles can be activated and/or interrupted of activation at moments in the weaving cycle similar to the ones explained in WO2007/057217.

[0127] The terms "air" and "air jet weaving machines" used through the description are not meant to indicate air or compressed air as such, but are meant to indicate a suitable gas allowing blowing a yarn through the shed of a weaving machine.

[0128] The functional zones are defined functionally, i.e. according to the function they accomplish in a predetermined set-up. There may be a transition between the zones: a nozzle providing an air flow to provide a function in one functional zone, may at the same time provide an air flow to provide another function in another functional zone. There may be a so-called phase shift; e.g. the last nozzle of the first functional zone also blows in the second functional zone, and the last nozzle of the second functional zone also blows in the third functional zone. End and begin of the functional zones are not necessarily strictly defined.

[0129] A computer program product can be provided, which provides the functionality of any of the method embodiments according to the present invention when executed on a computing device. Such computer program product can be tangibly embodied in a carrier medium carrying machine-readable code for execution by a programmable processor. A carrier medium carrying said computer program product could also be provided, that, when executed on computing means, provides instructions for executing any of the methods as described above. The term "carrier medium" refers to any medium that participates in providing instructions to a processor for execution. Such a medium may take many forms, including but not limited to, non-volatile media, and transmission media. Non volatile media includes, for example, optical or magnetic disks, such as a storage device which is part of mass storage. Common forms of computer readable media include, a CD-ROM, a DVD, a flexible disk or floppy disk, a tape, a memory chip or cartridge or any other medium from which a computer can read. Various forms of computer readable media may be involved in carrying one or more sequences of one or more instructions to a processor for execution. The computer program product can also be transmitted via a carrier wave in a network, such as a LAN, a WAN or the Internet. Transmission media can take the form of acoustic or light waves, such as those generated during radio wave and infrared data communications. Transmission media include coaxial cables, copper wire and fibre optics, including the wires that comprise a bus within a computer.

Claims

1. A weft-inserting apparatus for an air jet weaving machine comprising a controller (20) for controlling transportation of a weft (8A, 8B, 8C) through a shed (1) of an air jet weaving machine, wherein the shed (1) comprises, in transport direction of the weft (8A,

8B, 8C), subsequently a first zone (zone 1), and a second zone (zone 2), the controller (20) being adapted for controlling the air flow rates of the relay nozzles (4[i]) in the zones (zone 1, zone 2) so as to accelerate the weft (8A, 8B, 8C) through the first zone (zone 1) of the shed (1), and so as to transport the weft (8A, 8B, 8C) through the second zone (zone 2) of the shed (1); wherein the shed (1) further comprises, in transport direction of the weft, subsequent to the first zone (zone 1) and the second zone (zone 2), a third zone (zone 3); controlling the air flow rates of the relay nozzles (4[i]) associated with the first, second and third zones (zone 1, zone 2, zone 3) being performed by providing a first air flow rate by relay nozzles (4[i]) associated with the first zone, by providing a second air flow rate by relay nozzles associated with the second zone and by providing a third air flow rate by relay nozzles associated with the third zone; and wherein the controller (20) is adapted for controlling the air flow rates of the relay nozzles (4[i]) in the zones (zone 1, zone 2, zone 3) so as to allow the weft (8A, 8B, 8C) to stretch in the third zone (zone 3) of the shed (1), **characterized in that** the controller (20) is adapted for changing an air flow rate value provided to some or all of the relay nozzles, wherein the apparatus further comprises at least a first pressure tank (5B) associated with at least the relay nozzles (4[i]) associated with the first zone (zone 1),a second pressure tank (5C) associated with at least the relay nozzles (4[i]) associated with the second zone (zone 2) and a third pressure tank (5D) associated with the relay nozzles (4[i]) associated with the third zone (zone 3), and wherein an air pressure in the third pressure tank (5D) is substantially equal to an air pressure in the first pressure tank (5B).

2. An air jet weaving machine comprising a weft-inserting apparatus according to claim 1.

3. A method for controlling transportation of a weft (8A, 8B, 8C) through a shed (1) of an air jet weaving machine with a weft-inserting apparatus according to claim 1, wherein the shed (1) comprises, in transport direction of the weft, subsequently at least a first zone (zone 1), and a second zone (zone 2), the method comprising controlling the air flow rates of relay nozzles (4[i]) in the zones so as to accelerate the weft (8A, 8B, 8C) through the first zone (zone 1) of the shed (1), and so as to transport the weft (8A, 8B, 8C) through the second zone (zone 2) of the shed;
wherein the shed (1) further comprises, in the transport direction of the weft, subsequent to the first zone (zone 1) and the second zone (zone 2), a third zone (zone 3); wherein controlling the air flow rates of the relay nozzles (4[i]) associated with the first, second and third zones (zone 1, zone 2, zone 3) is performed by providing a first air flow rate by relay nozzles (4[i]) associated with the first zone, by providing a second air flow rate by relay nozzles associated with the second zone and by providing a third air flow rate by relay nozzles associated with the third zone; and wherein the method further comprises controlling the air flow rates of the relay nozzles (4[i]) so as to allow to stretch the weft (8A, 8B, 8C) in the third zone (zone 3) of the shed, the air flow rate provided by relay nozzles (4[i]) associated with the first zone (zone 1) being higher than the air flow rate provided by relay nozzles (4[i]) associated with the second zone (zone 2), the air flow rate provided by the relay nozzles (4[i]) associated with the second zone (zone 2) being lower than the air flow rate provided by the relay nozzles (4[i]) associated with the third zone (zone 3) and the air flow rate provided by the relay nozzles (4[i]) associated with the first zone (zone 1) being substantially equal to the air flow rate provided by the relay nozzles (4[i]) associated with the third zone (zone 3).

Patentansprüche

1. Eine Schusseintragsvorrichtung für eine Luftstrahlwebmaschine enthaltend eine Steuerung (20) zum Steuern des Transports eines Schusses (8A, 8B, 8C) durch ein Webfach (1) einer Luftstrahlwebmaschine, wobei das Webfach (1) in Transportrichtung des Schusses (8A, 8B, 8C), nachfolgend eine erste Zone (Zone 1) und eine zweite Zone (Zone 2) enthält, die Steuerung (20) ist angepasst zum Steuern der Luftströmungsraten der Hilfsdüsen (4[i]) in den Zonen (Zone 1, Zone 2), um den Schuss (8A, 8B, 8C) durch die erste Zone (Zone 1) des Webfachs (1) zu beschleunigen, und um den Schuss (8A, 8B, 8C) durch die zweite Zone (Zone 2) des Webfachs (1) zu transportieren; wobei das Webfach (1) weiter in Transportrichtung des Schusses, anschliessend an der ersten Zone (Zone 1) und der zweiten Zone (Zone 2), eine dritte Zone (Zone 3) enthält; das Steuern der Luftströmungsraten der Hilfsdüsen (4[i]) zugeordnet zu den ersten, zweiten und dritten Zonen (Zone 1, Zone 2, Zone 3), wird ausgebildet durch das Vorsehen einer ersten Luftströmungsrate durch Hilfsdüsen (4[i]) zugeordnet zu der ersten Zone, durch das Vorsehen einer zweiten Luftströmungsrate durch Hilfsdüsen zugeordnet zu der zweiten Zone und durch das Vorsehen einer dritten Luftströmungsrate durch Hilfsdüsen zugeordnet zu der dritten Zone; und wobei die Steuerung (20) angepasst ist zum Steuern der Luftströmungsraten der Hilfsdüsen (4[i]) in den Zonen (Zone 1, Zone 2, Zone 3) um zu ermöglichen den Schuss (8A, 8B, 8C) in der dritten Zone (Zone 3) des Webfachs (1) zu strecken, **dadurch gekennzeichnet, dass** die Steuerung (20) angepasst ist zum Ändern eines Luftströmungsratenwerts, der für einige oder alle Hilfsdüsen vorgesehen ist, wobei die Vorrichtung weiter mindestens einen ersten Druckbehälter (5B) zugeordnet zu mindestens den Hilfsdüsen (4[i]) zugeordnet zu der ersten Zone (Zone 1), einen zweiten Druckbehälter (5C) zugeordnet zu mindestens den Hilfsdüsen (4[i]) zugeordnet zu der zweiten Zone (Zone 2) und einen dritten Druckbehälter (5D) zugeordnet zu mindestens den Hilfsdüsen (4[i]) zugeordnet zu der dritten Zone (Zone 3) enthält, und wobei einen Luftdruck in dem dritten Druckbehälter (5D) im Wesentlichen gleich ist an einen Luftdruck in dem ersten Druckbehälter (5B).

2. Eine Luftstrahlwebmaschine enthaltend eine Schusseintragsvorrichtung nach Anspruch 1.

3. Ein Verfahren zum Steuern des Transports eines Schusses (8A, 8B, 8C) durch ein Webfach (1) einer Luftstrahlwebmaschine mit einer Schusseintragsvorrichtung nach Anspruch 1, wobei das Webfach (1) in Transportrichtung des Schusses nachfolgend mindestens eine erste Zone (Zone 1) und eine zweite Zone (Zone 2) enthält, das Verfahren das Steuern der Luftströmungsraten der Hilfsdüsen (4[i]) in den Zonen enthält, um den Schuss (8A, 8B, 8C) durch die erste Zone (Zone 1) des Webfachs (1) zu beschleunigen, und den Schuss (8A, 8B, 8C) durch die zweite Zone (Zone 2) des Webfachs zu transportieren;
wobei das Webfach (1) weiter in der Transportrichtung des Schusses anschliessend an der ersten Zone (Zone 1) und der zweiten Zone (Zone 2), eine dritte Zone (Zone 3) enthält; wobei das Steuern der Luftströmungsraten der Hilfsdüsen (4[i]) zugeordnet zu den ersten, zweiten und dritten Zonen (Zone 1, Zone 2, Zone 3) ausgeführt wird durch das Vorsehen einer ersten Luftströmungsrate durch Hilfsdüsen (4[i]) zugeordnet zu der ersten Zone, durch das Vorsehen einer zweiten Luftströmungsrate durch Hilfsdüsen zugeordnet zu der zweiten Zone und durch das Vorsehen einer dritten Luftströmungsrate durch Hilfsdüsen zugeordnet zu der dritten Zone; und wobei das Verfahren weiter das Steuern der Luftströmungsraten der Hilfsdüsen (4[i]) enthält, um zu ermöglichen den Schuss (8A, 8B, 8C) in der dritten Zone (Zone 3) des Webfachs zu strecken, die Luftströmungsrate vorgesehen durch Hilfsdüsen (4[i]) zugeordnet zu der ersten Zone (Zone 1) höher ist als die Luftströmungsrate vorgesehen durch Hilfsdüsen (4[i]) zugeordnet zu der zweiten Zone (Zone 2), die Luftströmungsrate vorgesehen durch die Hilfsdüsen (4 [i]) zugeordnet zu der zweiten Zone (Zone 2) niedriger ist als die Luftströmungsrate vorgesehen durch die Hilfsdüsen (4[i]) zugeordnet zu der dritten Zone (Zone 3) und die Luftströmungsrate vorgesehen durch die Hilfsdüsen (4[i]) zugeordnet zu der ersten Zone (Zone 1) im Wesentlichen gleich ist an die Luftströmungsrate vorgesehen durch die Hilfsdüsen (4[i]) zugeordnet zu der dritten Zone (Zone 3).

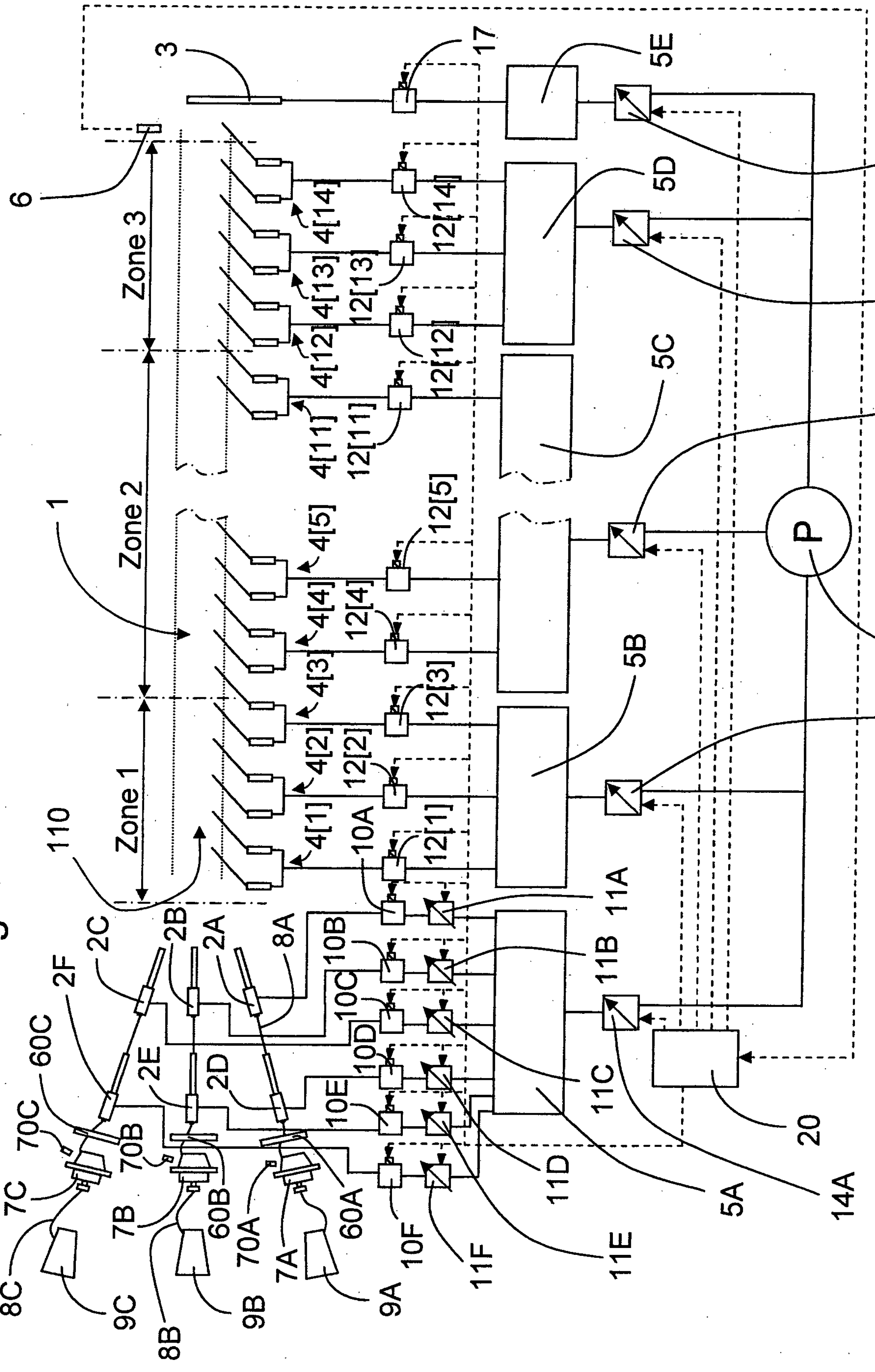
Revendications

1. Un dispositif d'insertion de trame pour une machine à tisser à jet d'air comprenant un dispositif de commande (20) pour commander le transport d'une trame (8A, 8B, 8C) à travers d'une foule (1) d'une machine à tisser à jet d'air, dans lequel la foule (1) comprend dans la direction de transport de la trame (8A, 8B, 8C) subséquemment une première zone (zone 1) et une deuxième zone (zone 2), le dispositif de commande (20) est adapté pour commander les taux de courant d'air des buses-relais (4[i]) dans les zones (zone 1, zone 2) afin d'accélérer la trame (8A, 8B, 8C) à travers la première zone (zone 1) de la foule (1) et afin de transporter la trame (8A, 8B, 8C) à travers la deuxième zone (zone 2) de la foule (1); dans lequel la foule (1) comprend en outre, dans la direction de transport de la trame, subséquent à la première zone (zone 1) et la deuxième zone (zone 2), une troisième zone (zone 3); commander les taux de courant d'air des buses-relais (4[i]) associés aux premières, deuxièmes et troisièmes zones (zone 1, zone 2, zone 3) est réalisée en prévoyant un premier taux de courant d'air par des buses-relais (4[i]) associés à la première zone, en prévoyant un deuxième taux de courant d'air par des buses-relais associés à la deuxième zone et en prévoyant un troisième taux de courant d'air par des buses-relais associés à la troisième zone; et dans lequel le dispositif de commande (20) est adapté pour commander les taux de courant d'air des buses-relais (4[i]) dans les zones (zone 1, zone 2, zone 3), afin de permettre la trame (8A, 8B, 8C) de retenir dans la troisième zone (zone 3) de la foule (1), **caractérisé en ce que** le dispositif de commande (20) est adapté pour modifier une valeur de taux de courant d'air prévue à quelques ou tous les buses-relais, dans lequel le dispositif comprend en outre au moins un premier réservoir de pression (5B) associé à au moins les buses-relais (4 [i]) associés à la première zone (zone 1), un deuxième réservoir de pression (5C) associé à au moins les buses-relais (4[i]) associés à la deuxième zone (zone 2) et un troisième réservoir de pression (5D) associé aux buses-relais (4[i]) associés à la troisième zone (zone 3), et dans lequel une pression d'air dans le troisième réservoir de pression (5D) est sensiblement égale à une pression d'air dans le premier réservoir de pression (5B).

2. Une machine à tisser à jet d'air comprenant un dispositif d'insertion de trame selon la revendication 1.

3. Un procédé pour commander le transport d'une trame (8A, 8B, 8C) à travers la foule (1) d'une machine à tisser à jet d'air avec un dispositif d'insertion de trame selon la revendication 1, dans lequel la foule (1) comprend, dans la direction de transport de la trame, subséquemment au moins une première zone (zone 1) et une deuxième zone (zone 2), le procédé comprenant la commande des taux de courant d'air des buses-relais (4[i]) dans les zones, afin d'accélérer la trame (8A, 8B, 8C) à travers la première zone (zone 1) de la foule (1), et afin de transporter la trame (8A, 8B, 8C) à travers la deuxième zone (zone 2) de la foule; dans lequel la foule (1) comprend en outre dans la direction de transport de la trame subséquent à la première zone (zone 1) et la deuxième zone (zone 2), une troisième zone (zone 3); dans lequel la commande des taux de courant d'air des buses-relais (4[i]) associés aux premières, secondes et troisièmes zones (zone 1, zone 2, zone 3) est exécutée en prévoyant un premier taux de courant d'air par des buses-relais (4[i]) associés à de la première zone, en prévoyant un deuxième taux de courant d'air par des buses-relais associés à la deuxième zone et en prévoyant un troisième taux de courant d'air par des buses-relais associés à de la troisième zone; et dans lequel le procédé comprend en outre la commande des taux de courant d'air des buses-relais (4[i]) afin de permettre de retenir la trame (8A, 8B, 8C) dans la troisième zone (zone 3) de la foule, le taux de courant d'air prévu par des buses-relais (4[i]) associés à la première zone (zone 1) est plus élevé que le taux de courant d'air prévu par des buses-relais (4[i]) associés à la deuxième zone (zone 2), le taux de courant d'air prévu par des buses de relais (4[i]) associés à la deuxième zone (zone 2) est inférieur au taux de courant d'air prévu par les buses relais (4[i]) associés à la troisième zone (zone 3) et le taux de courant d'air prévu par les buses-relais (4[i]) associés à la première zone (zone 1) est sensiblement égale au taux de courant d'air prévu par les buses-relais (4[i]) associés à la troisième zone (zone 3).

Fig. 1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60B
60C
70A
70B
70C
110

Fig. 2

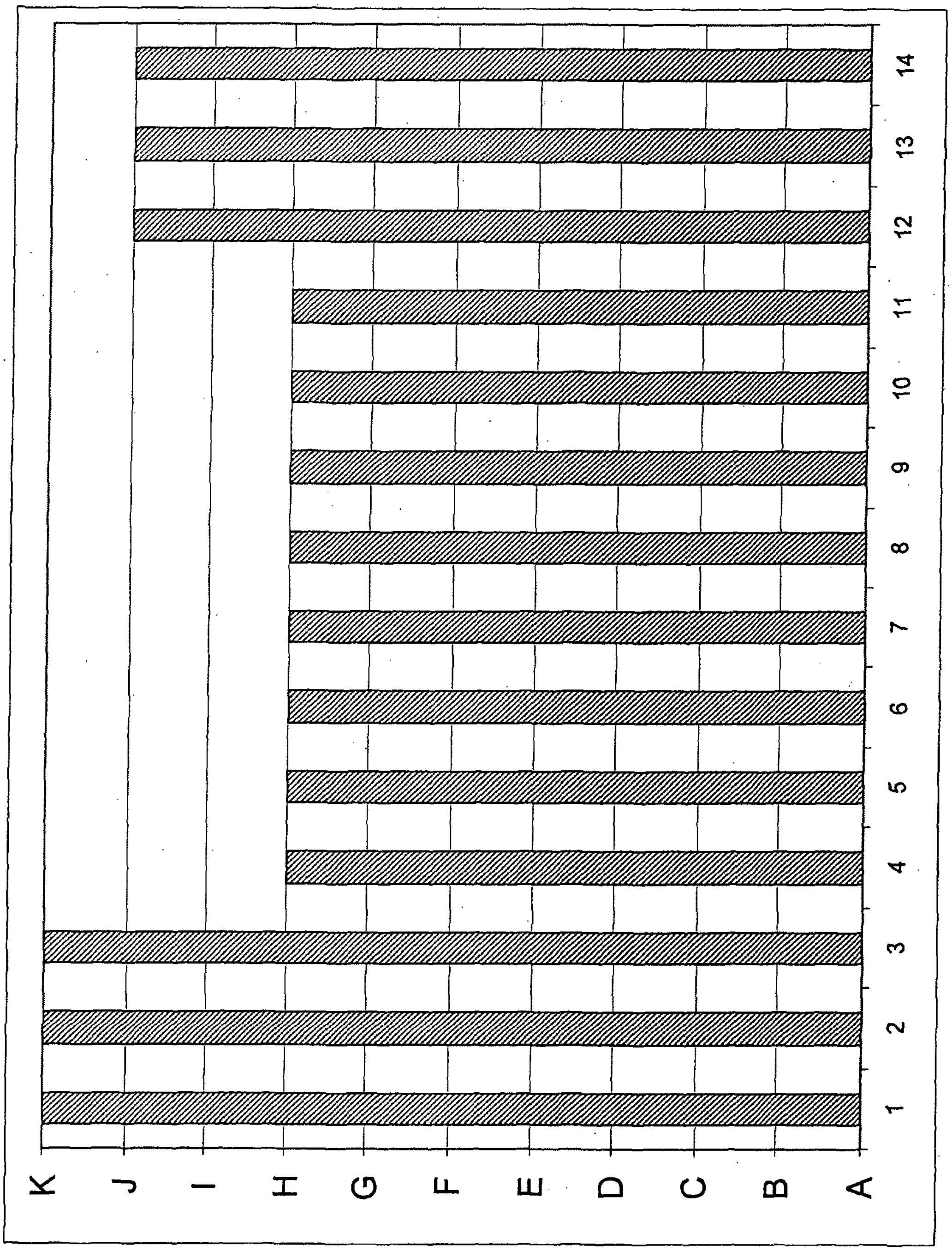
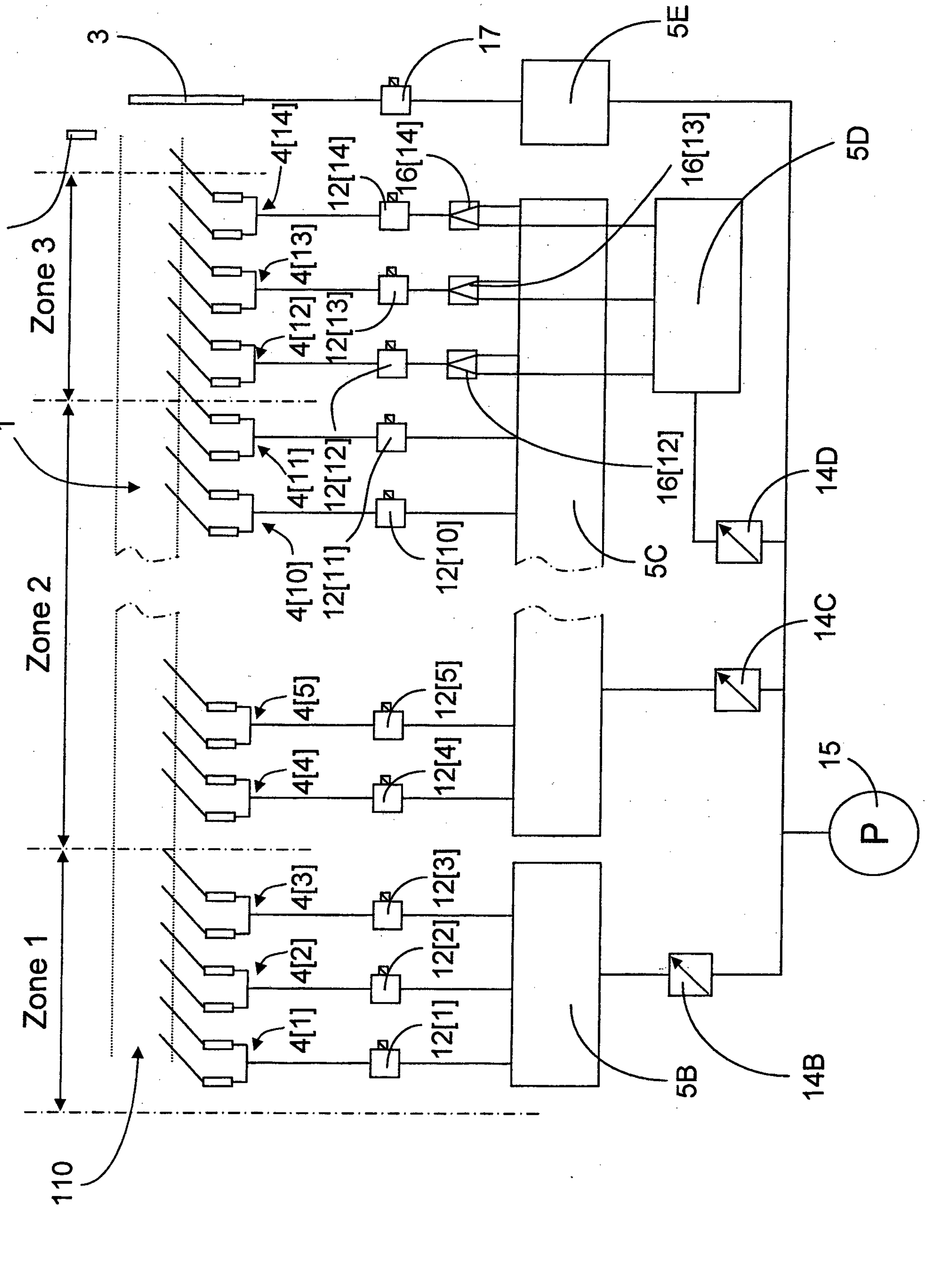


Fig. 3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14D
15
P

Fig. 4

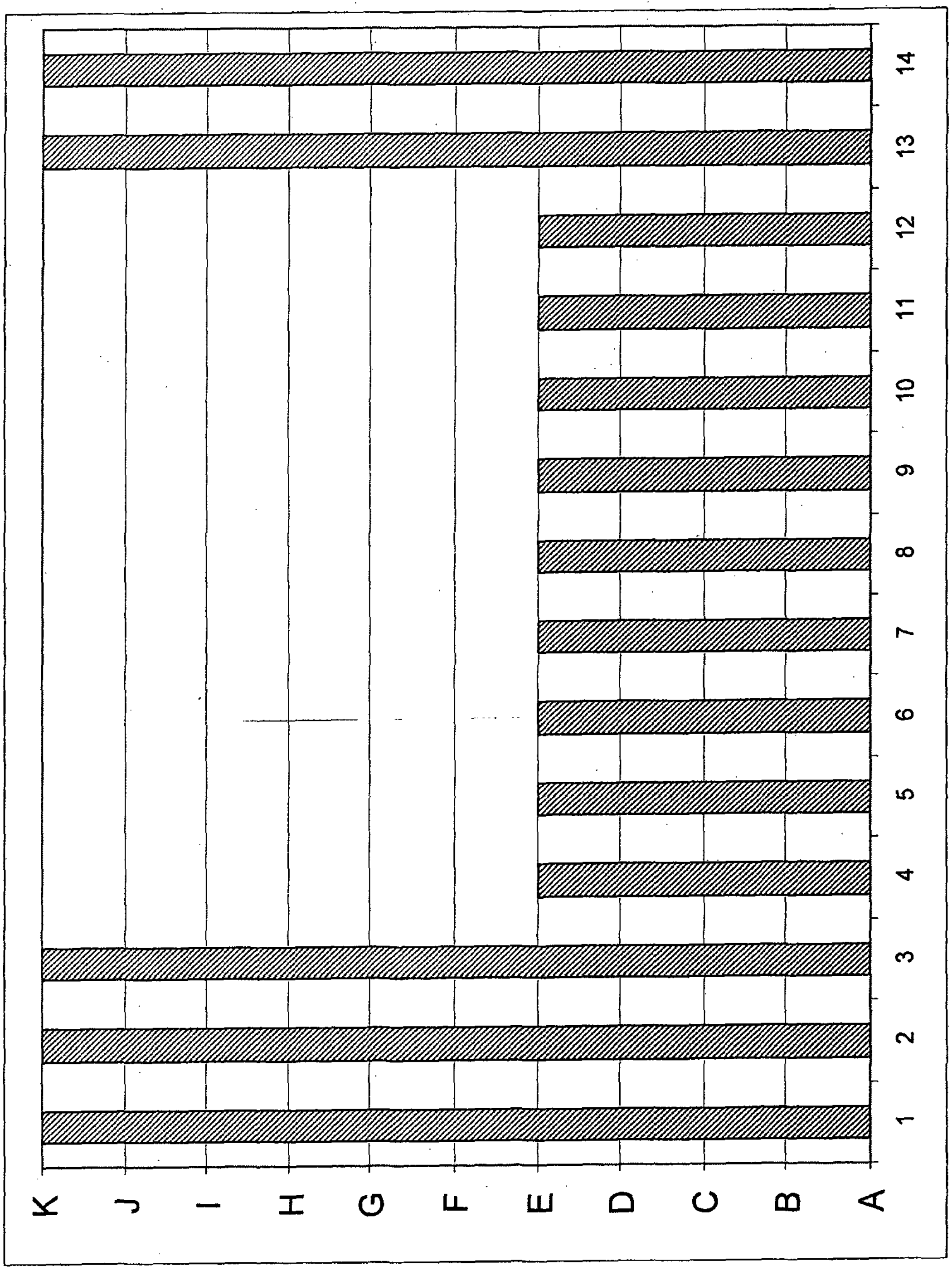
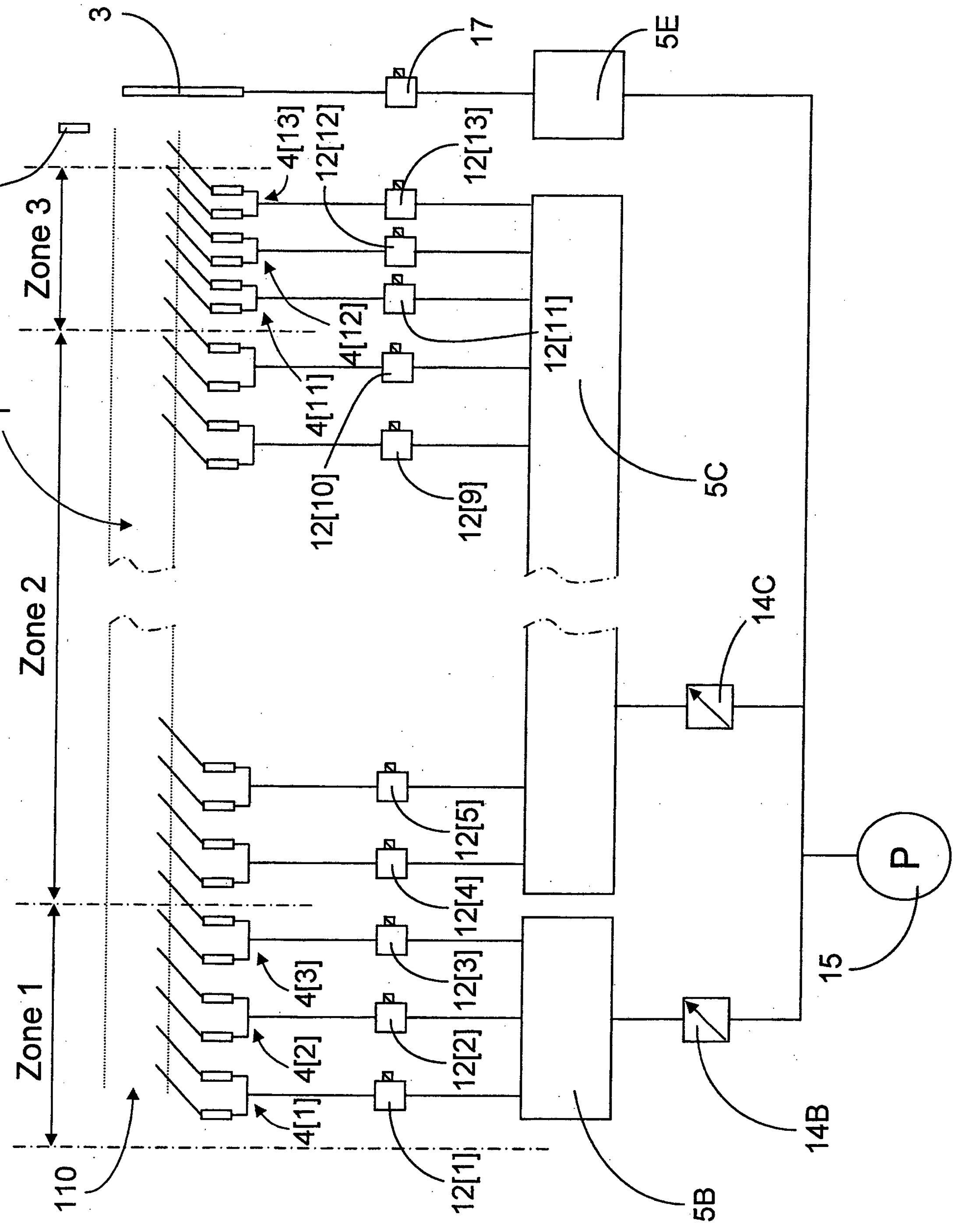


Fig. 5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Zone 2
14C
12[5]
12[4]
P
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4[2]
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12[1]
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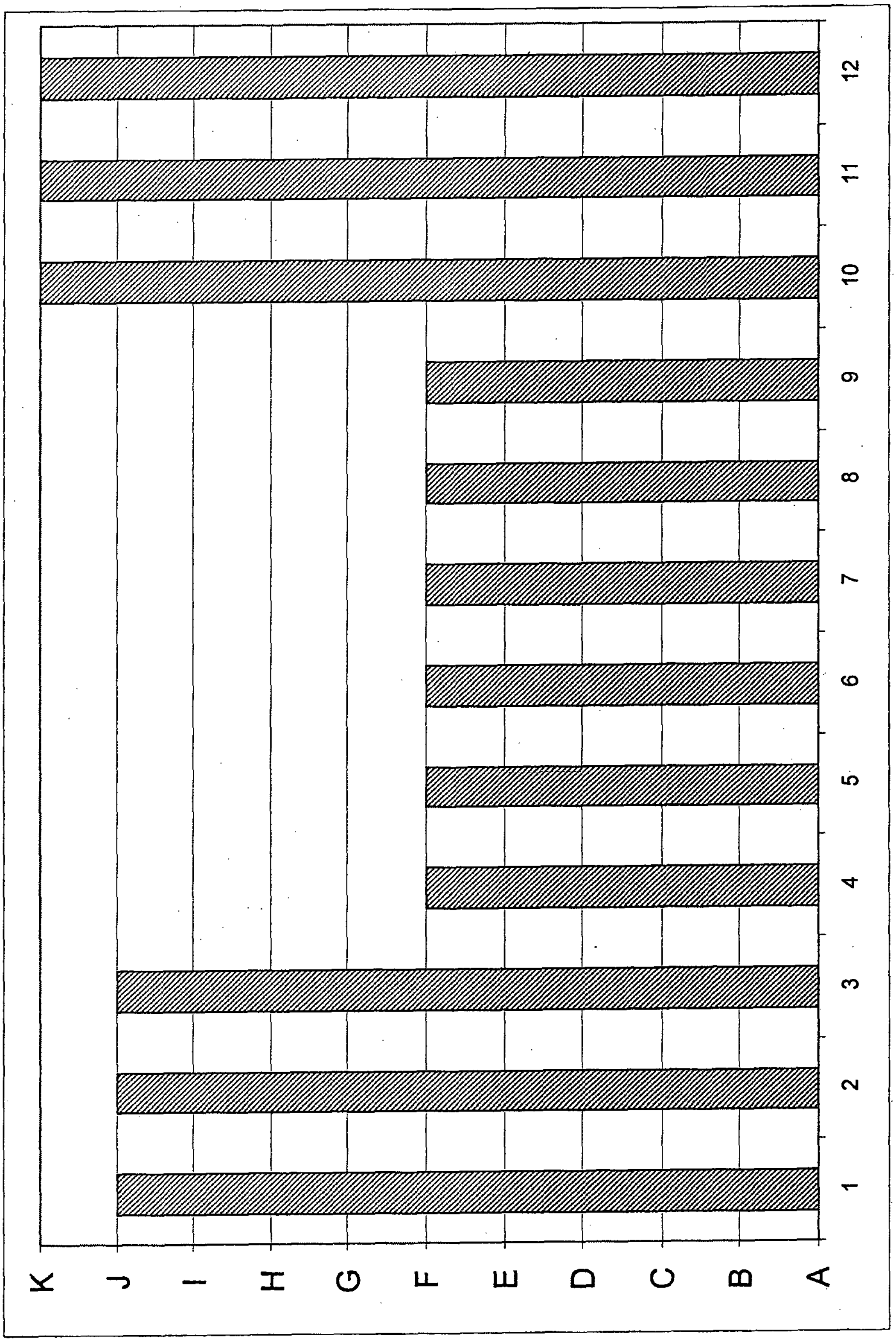
5B

Fig. 6



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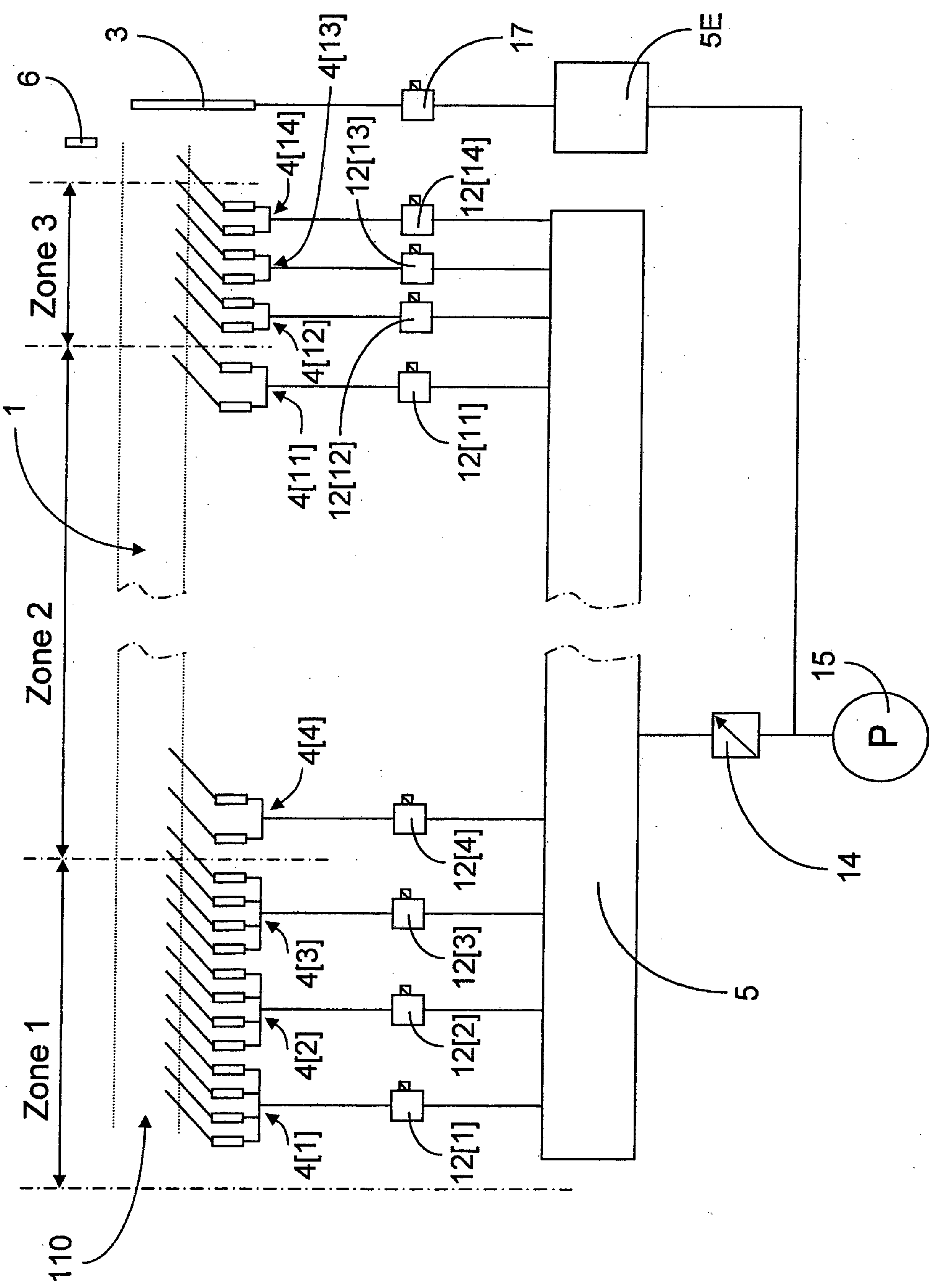
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12[1]
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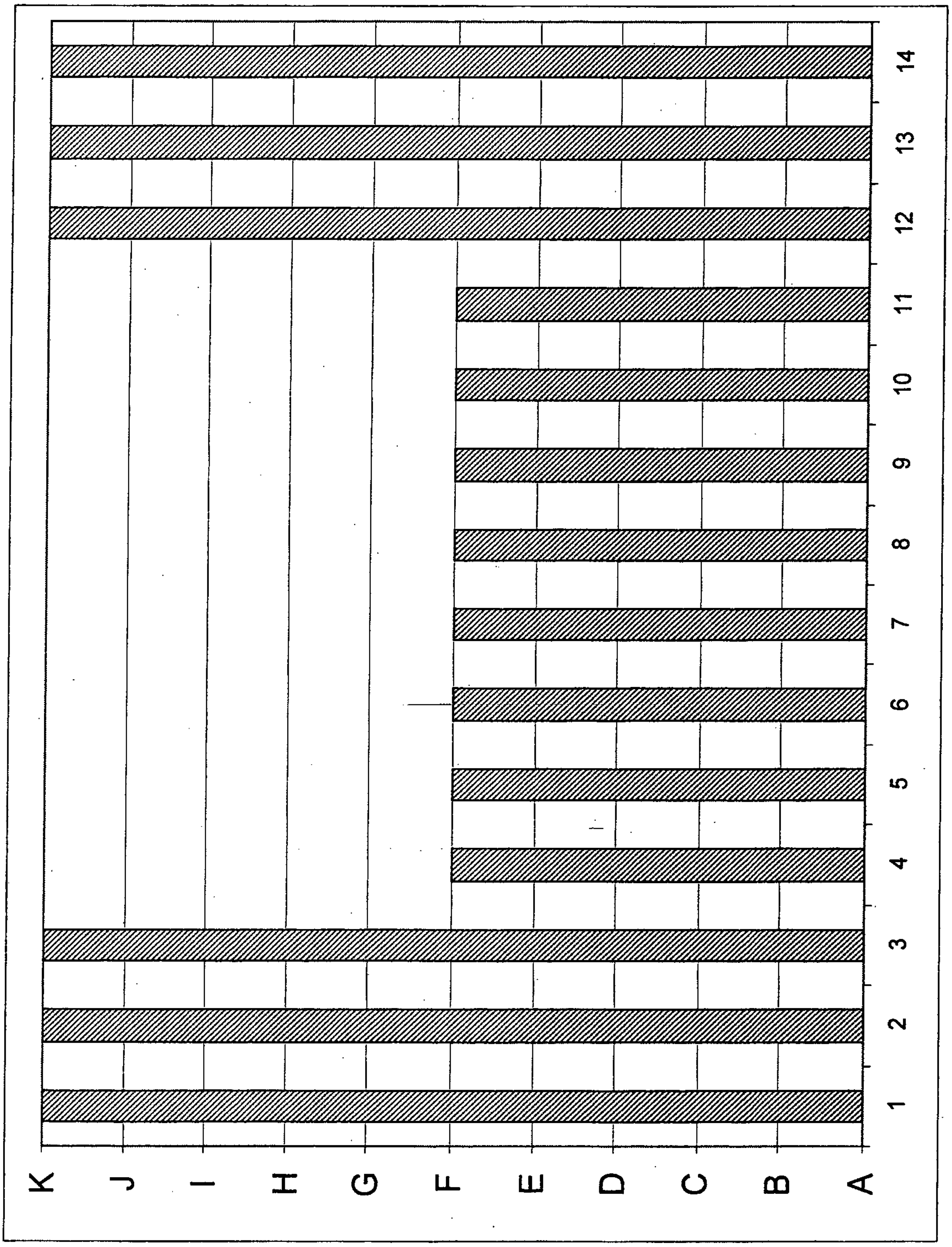
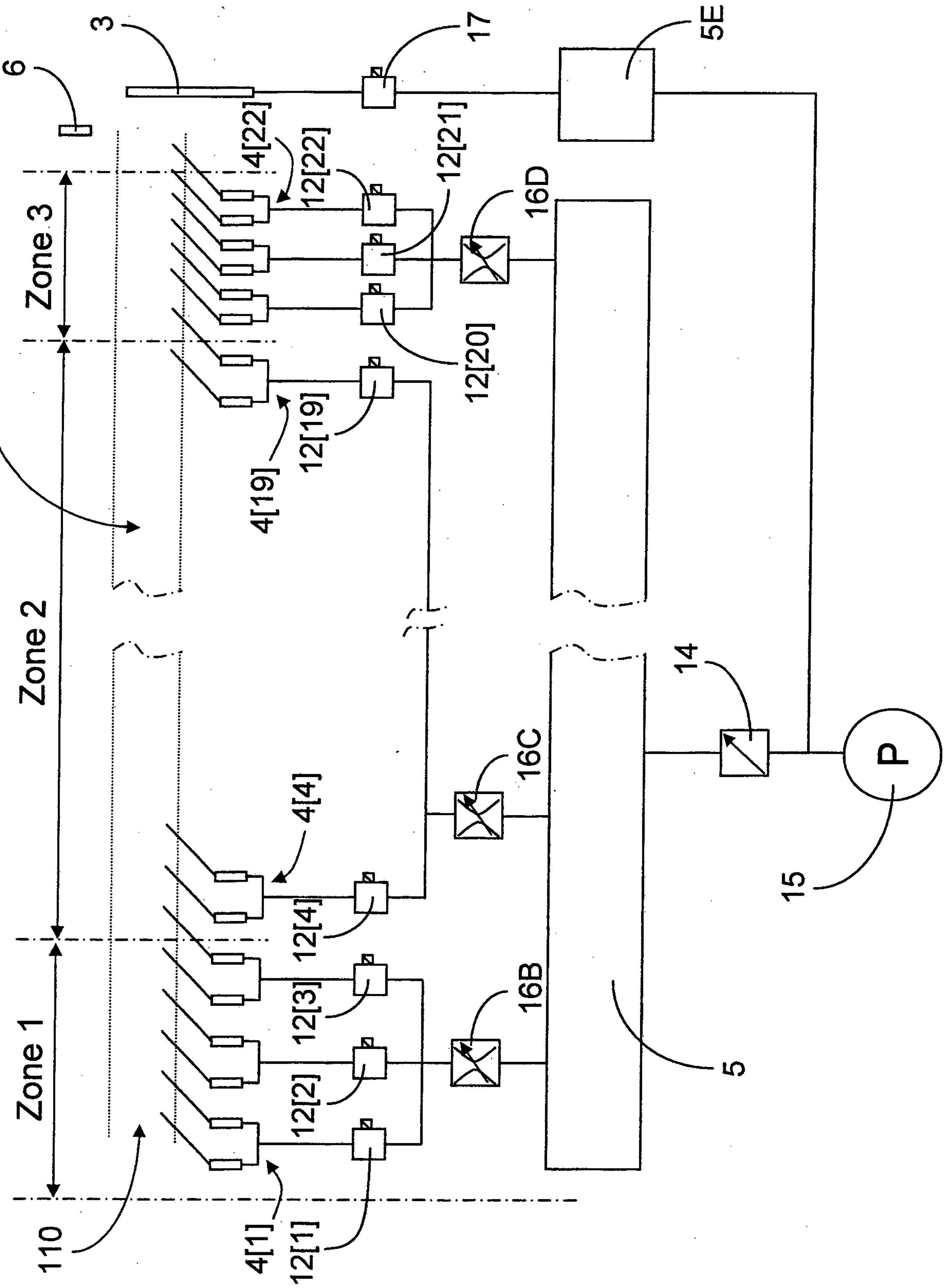
Fig. 8

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16D
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5E
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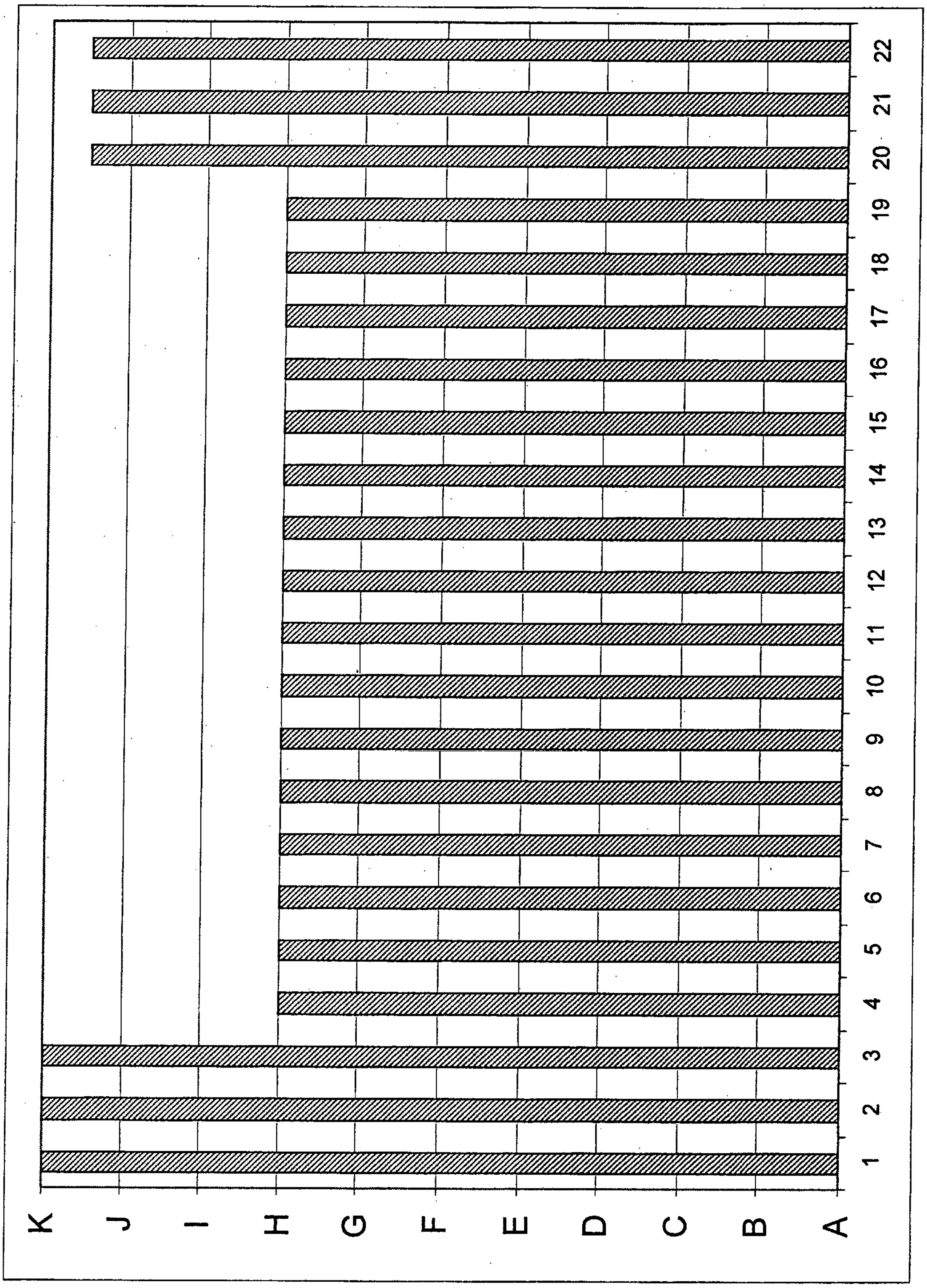
15
P

Fig. 9

Fig. 10



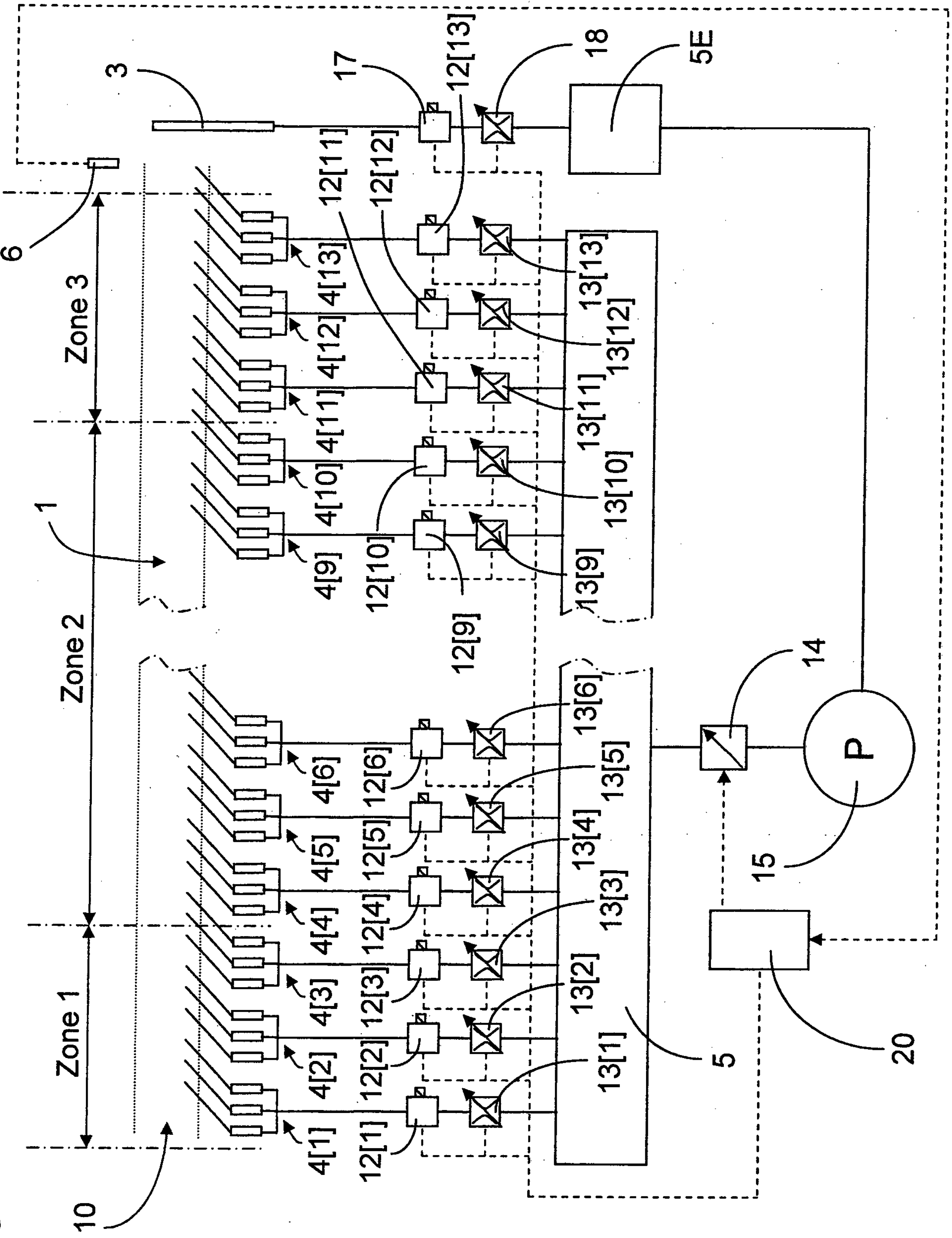


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Fig. 11

Fig. 12

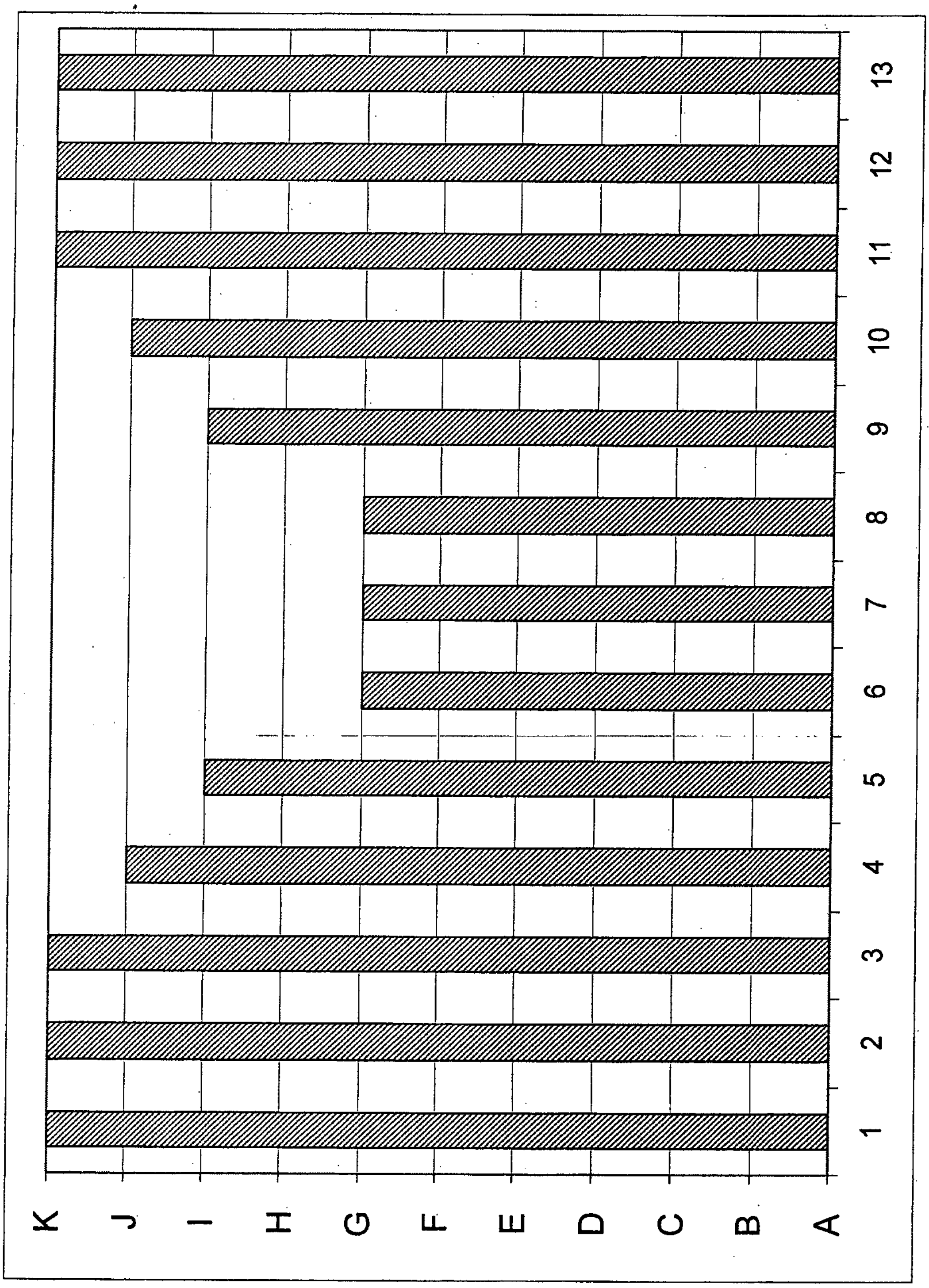


Fig. 13

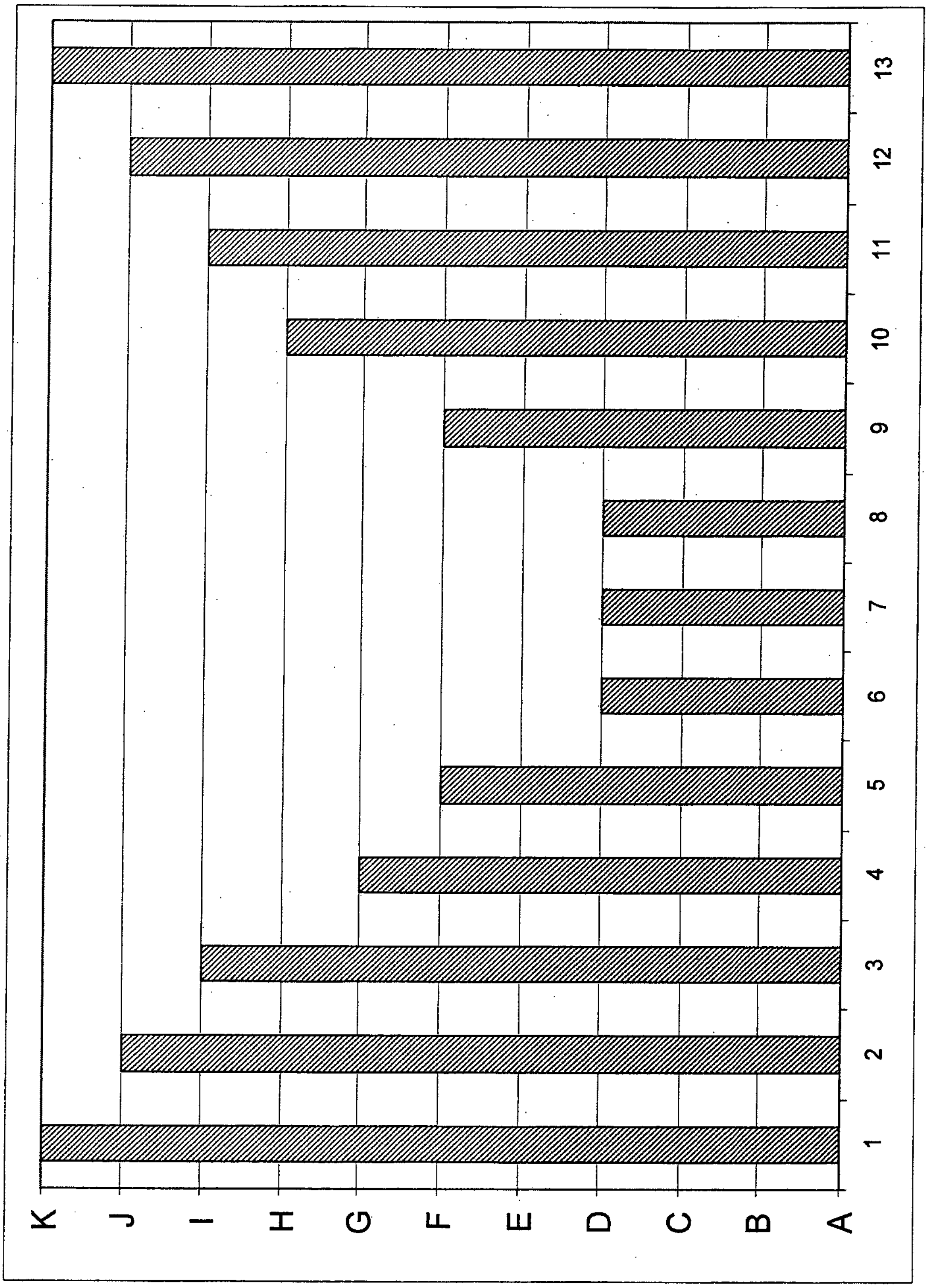


Fig. 14

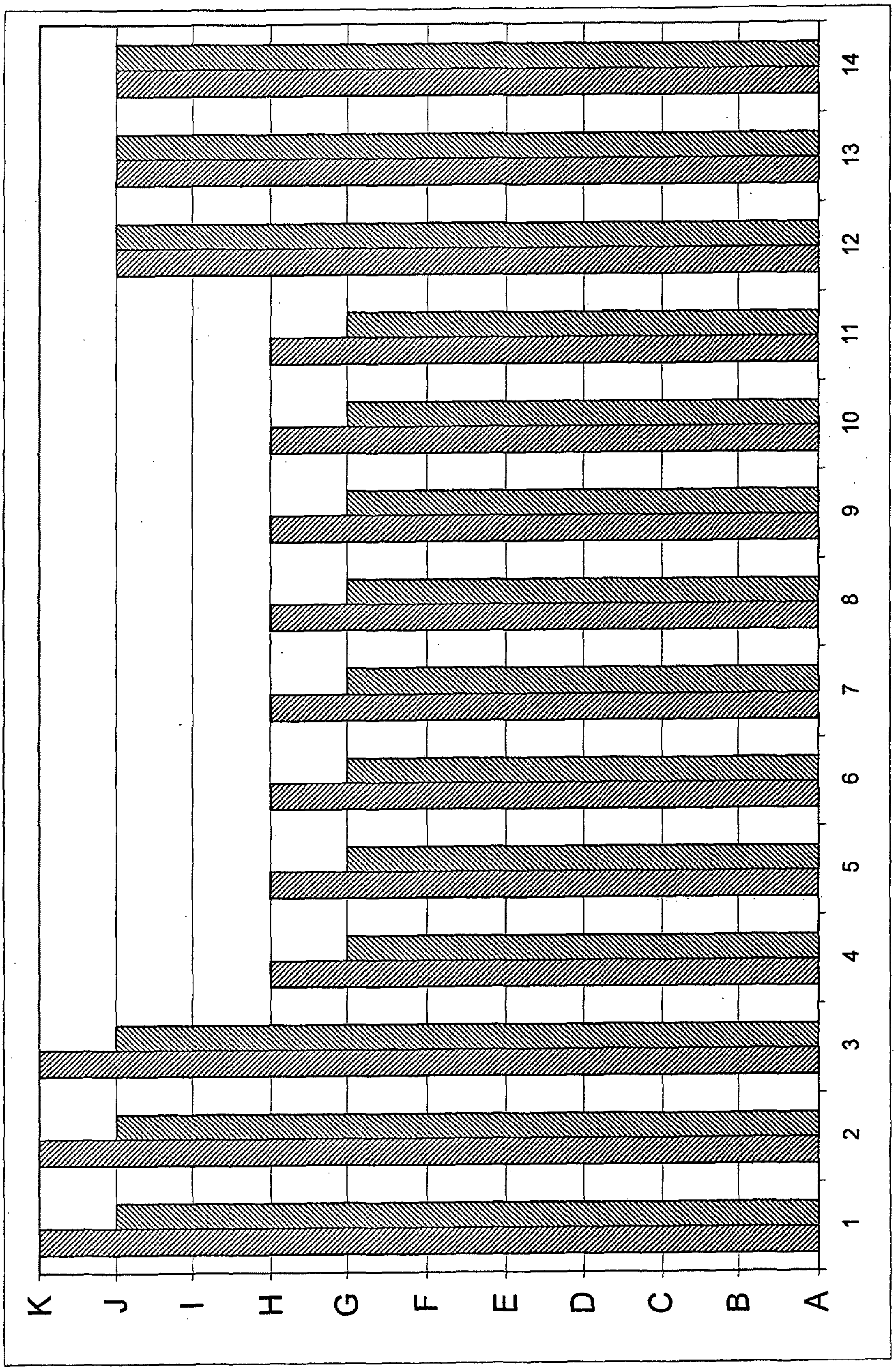


Fig. 15

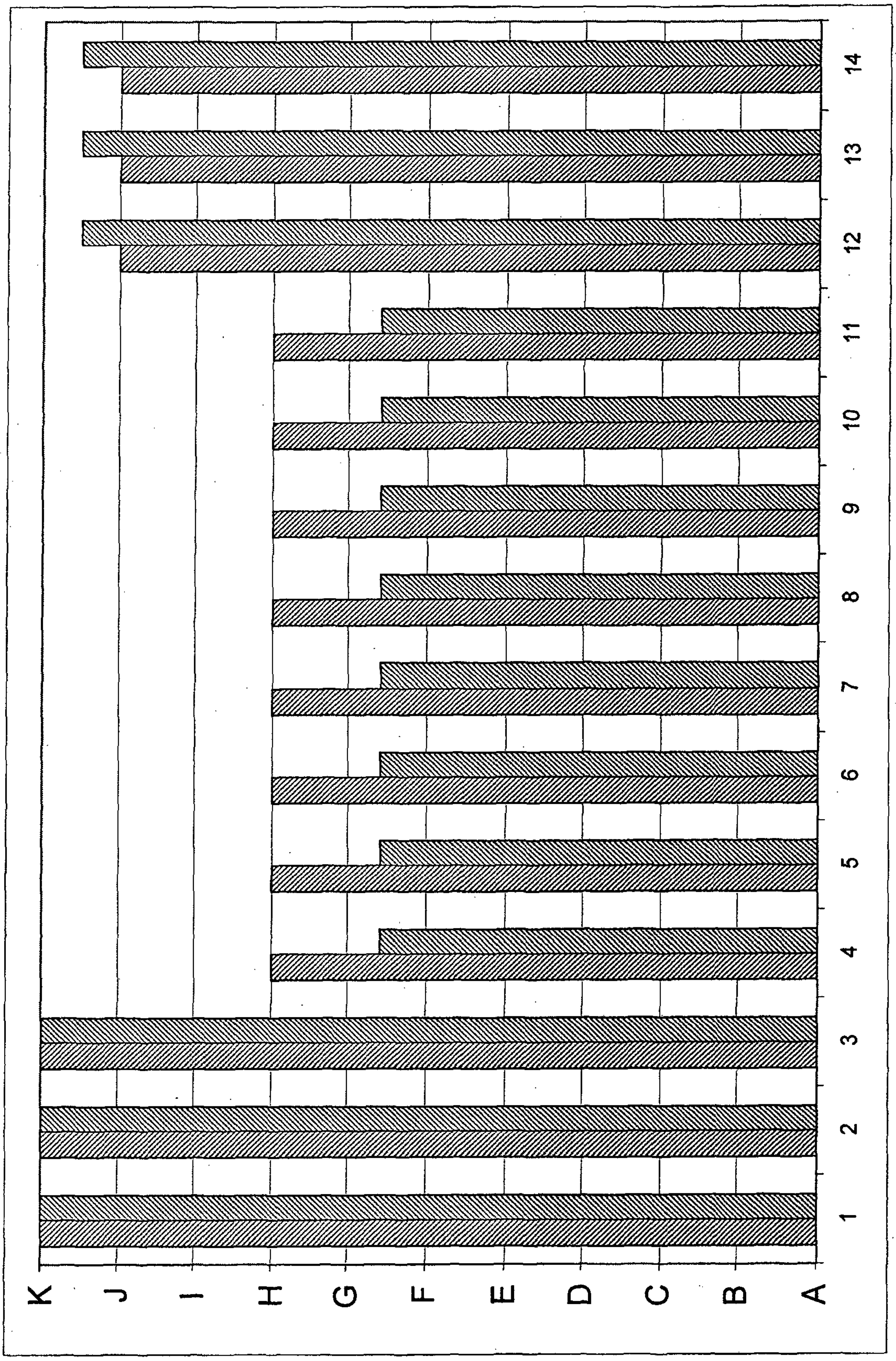


Fig. 16

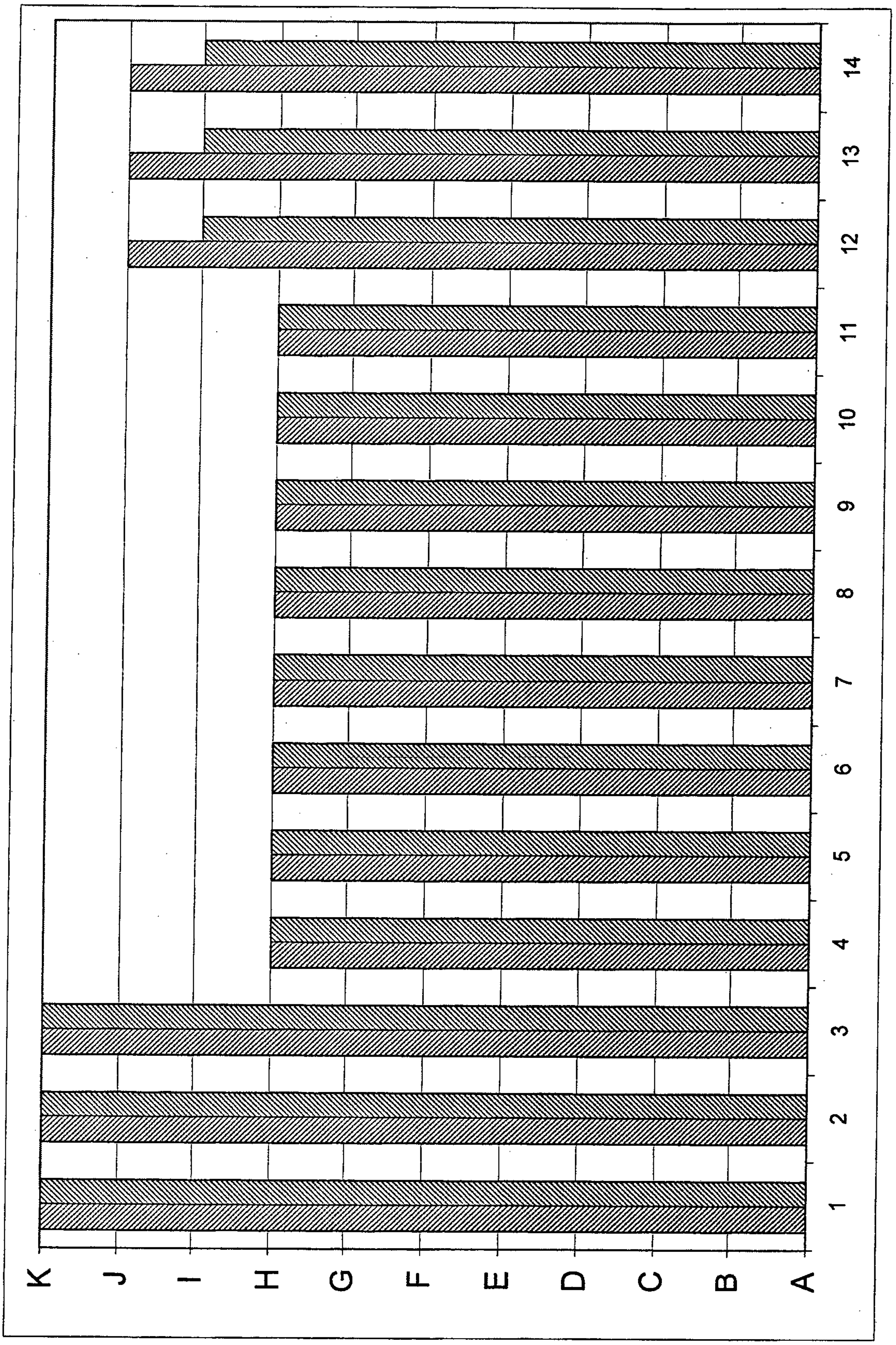


Fig. 17

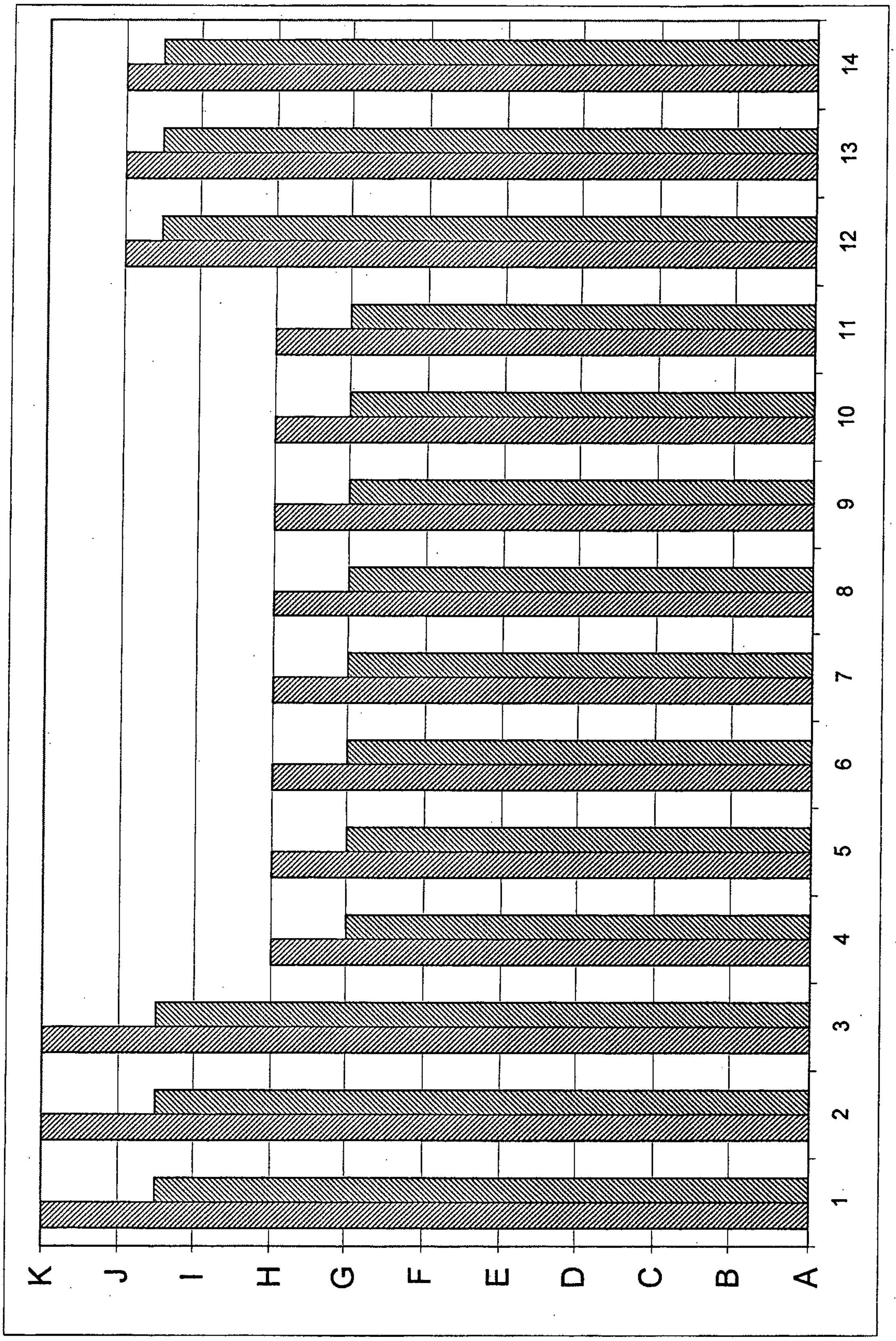
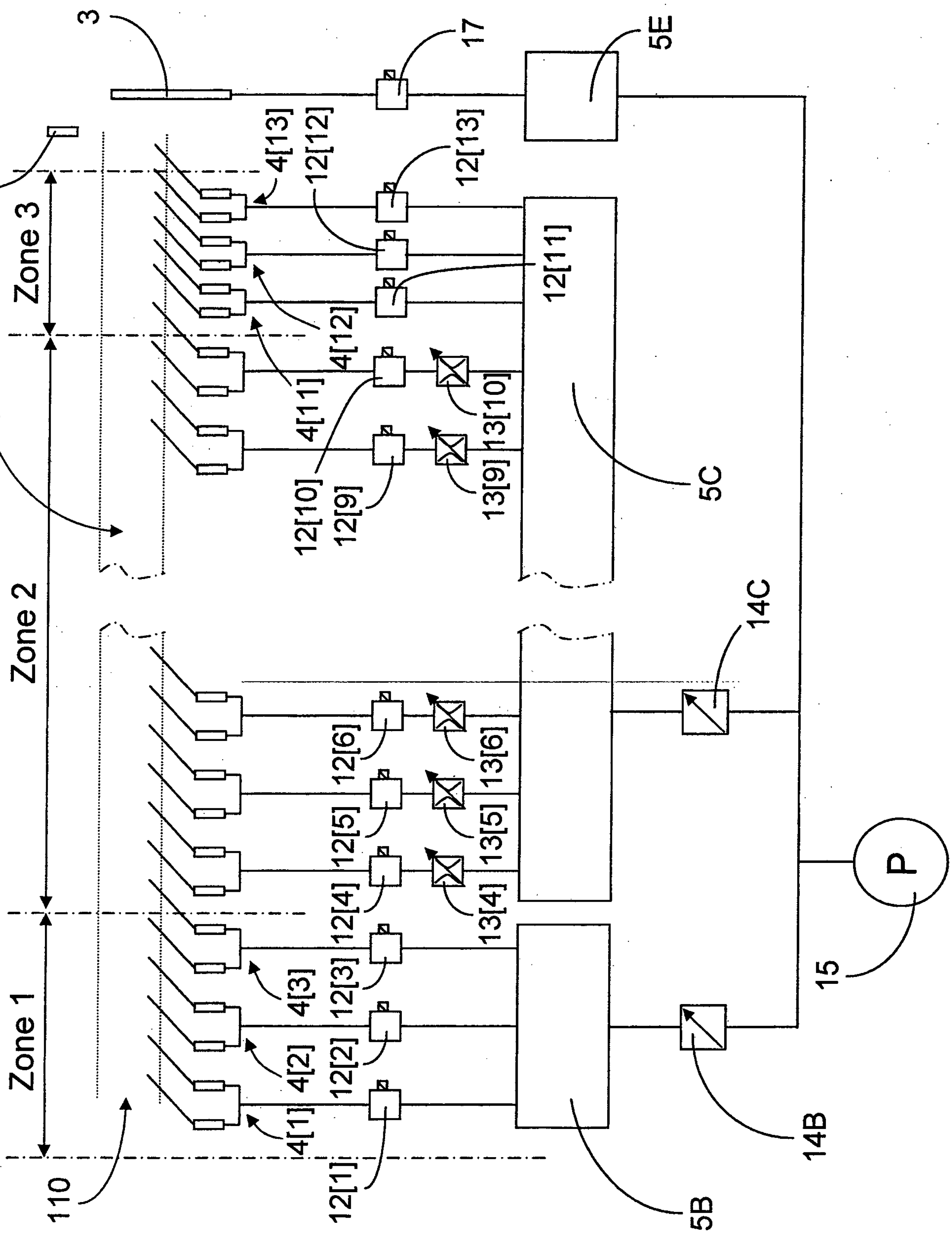


Fig. 18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14B

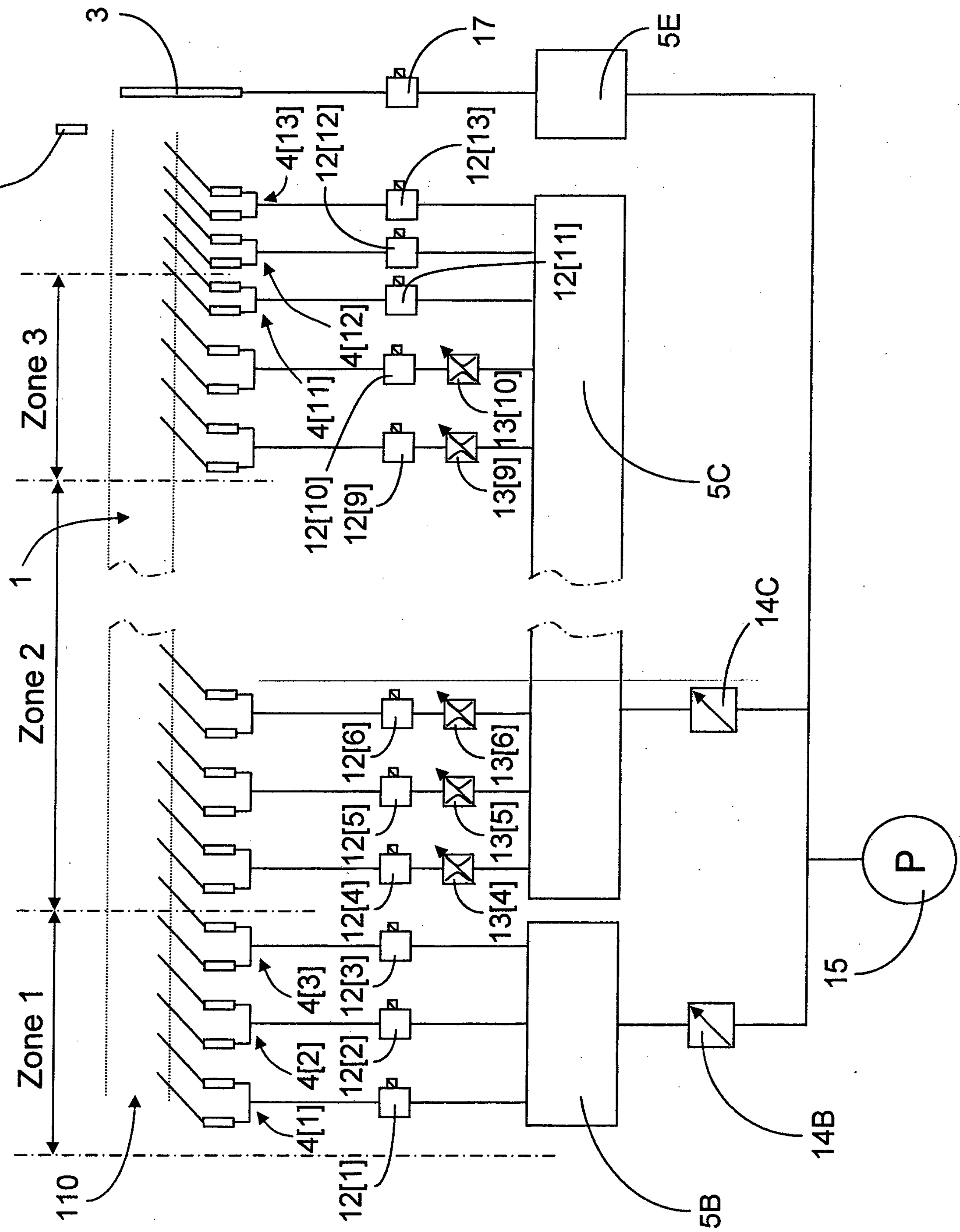
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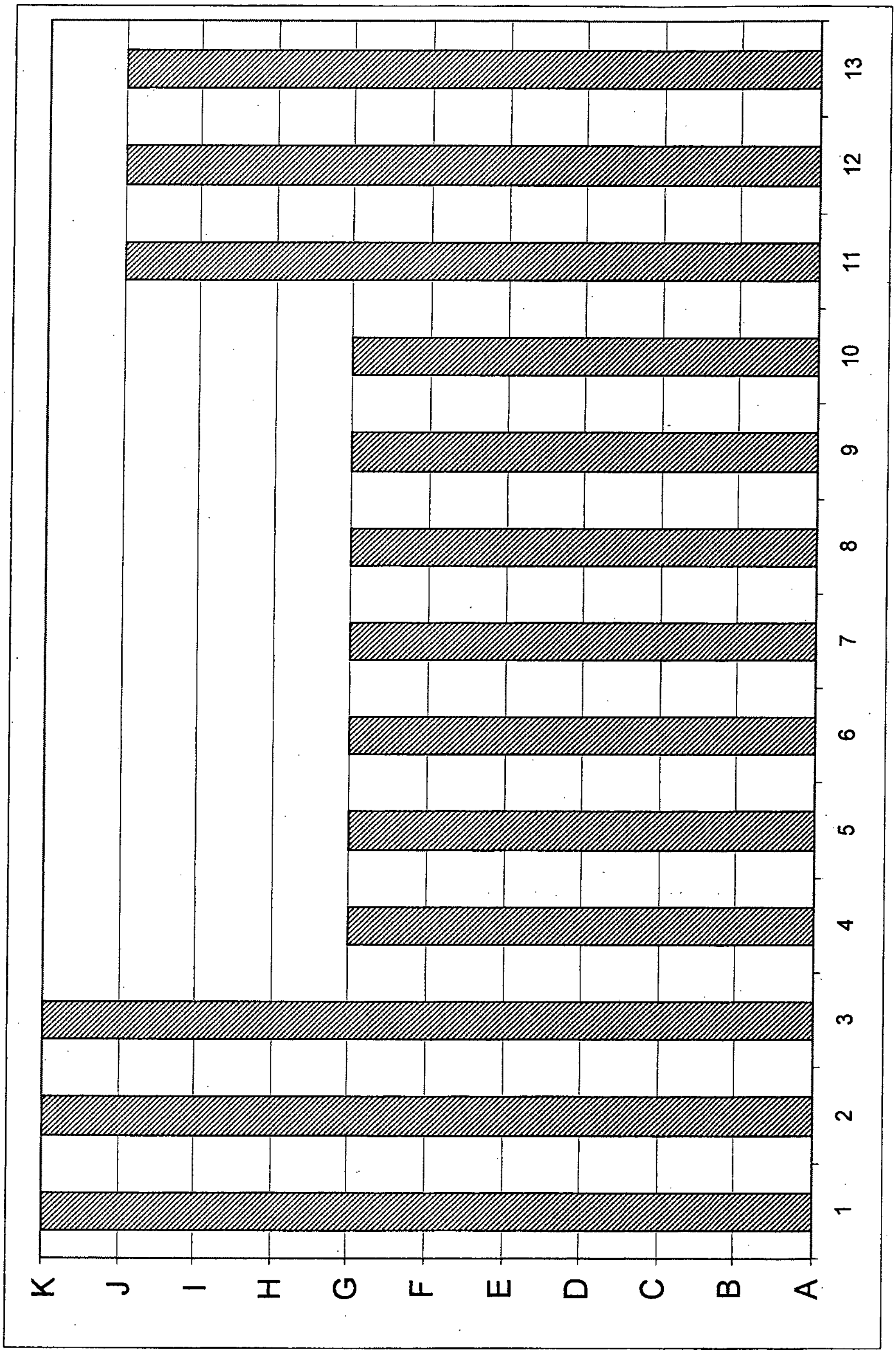
Fig. 19

Fig. 20



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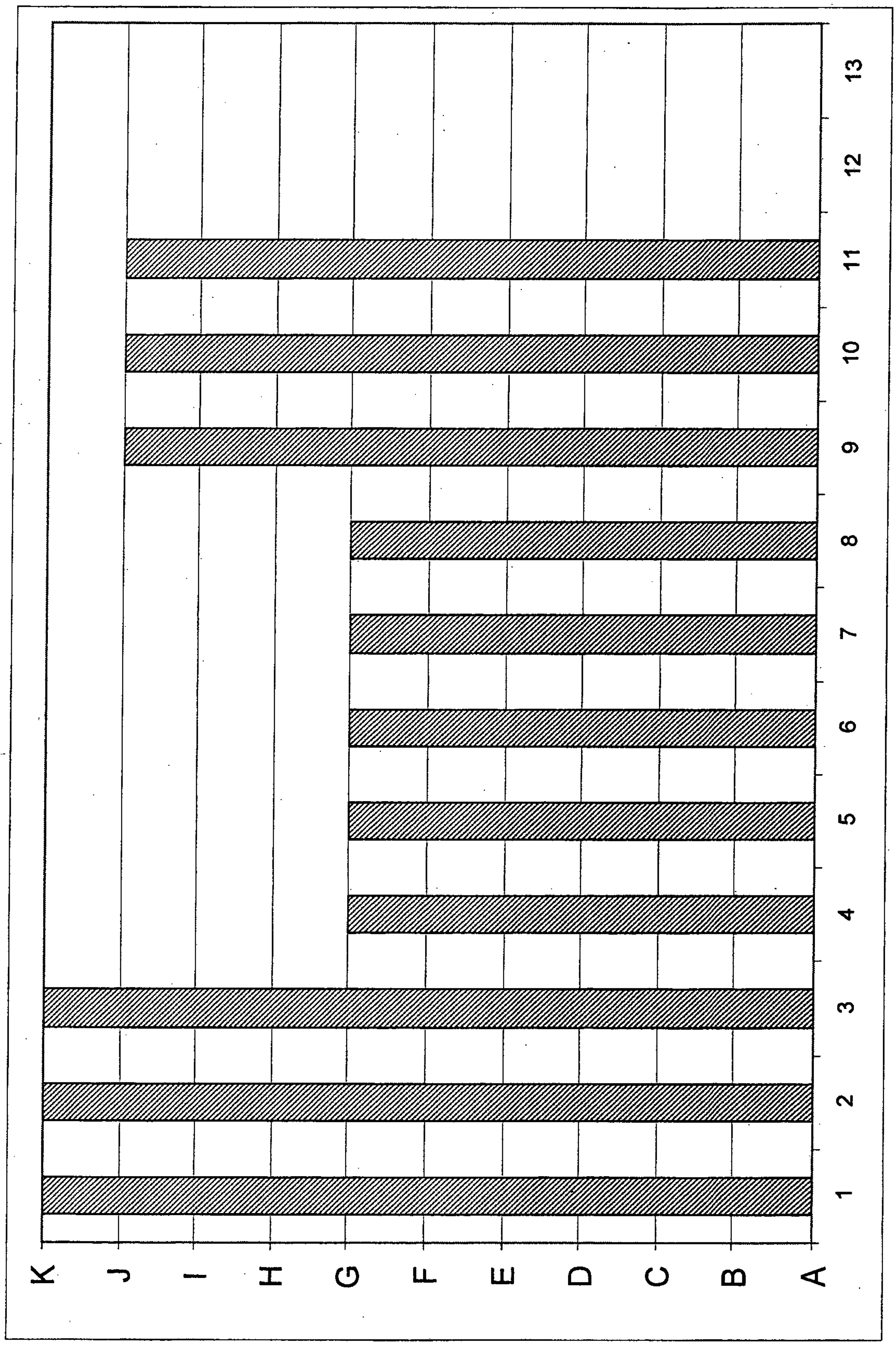

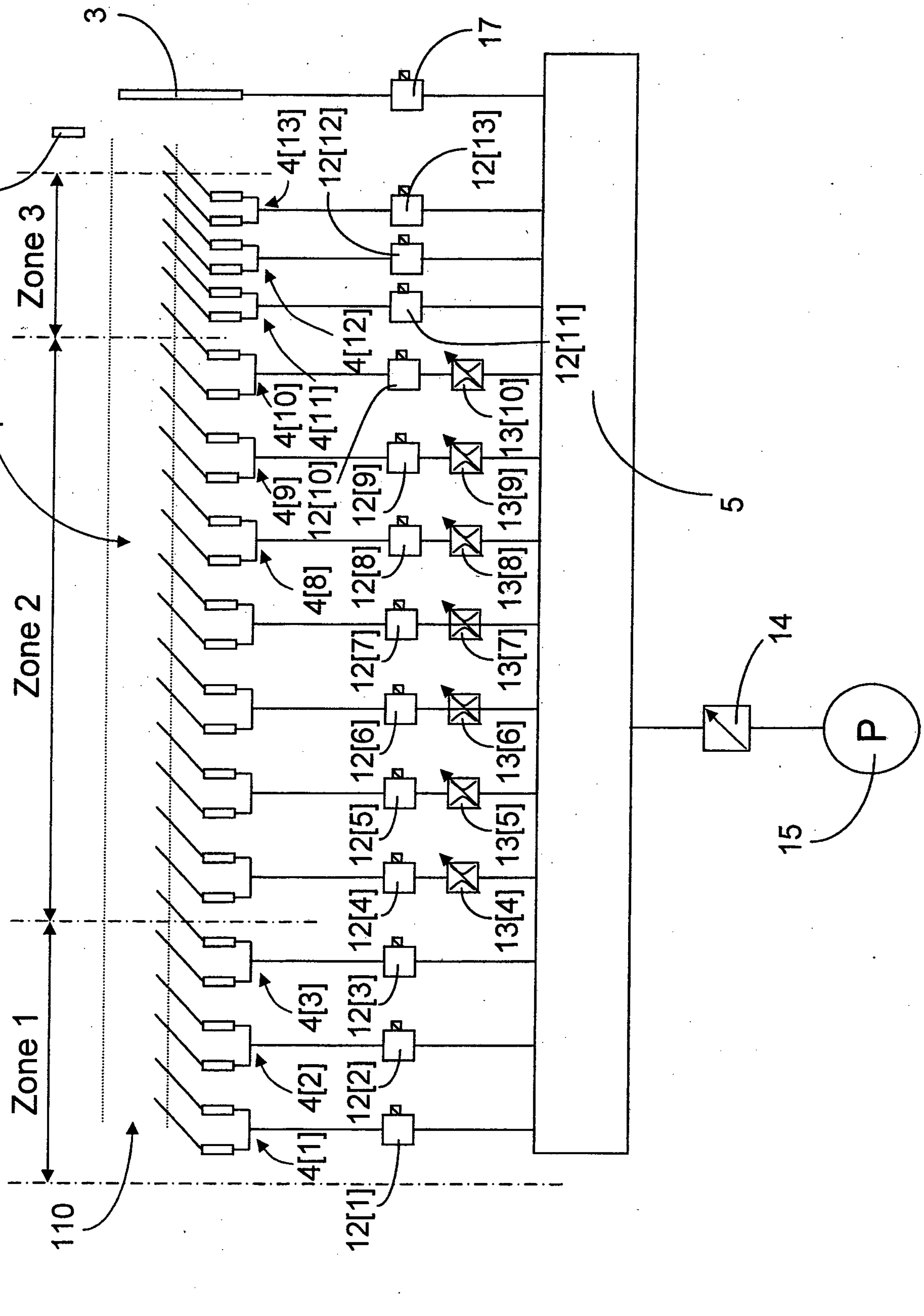
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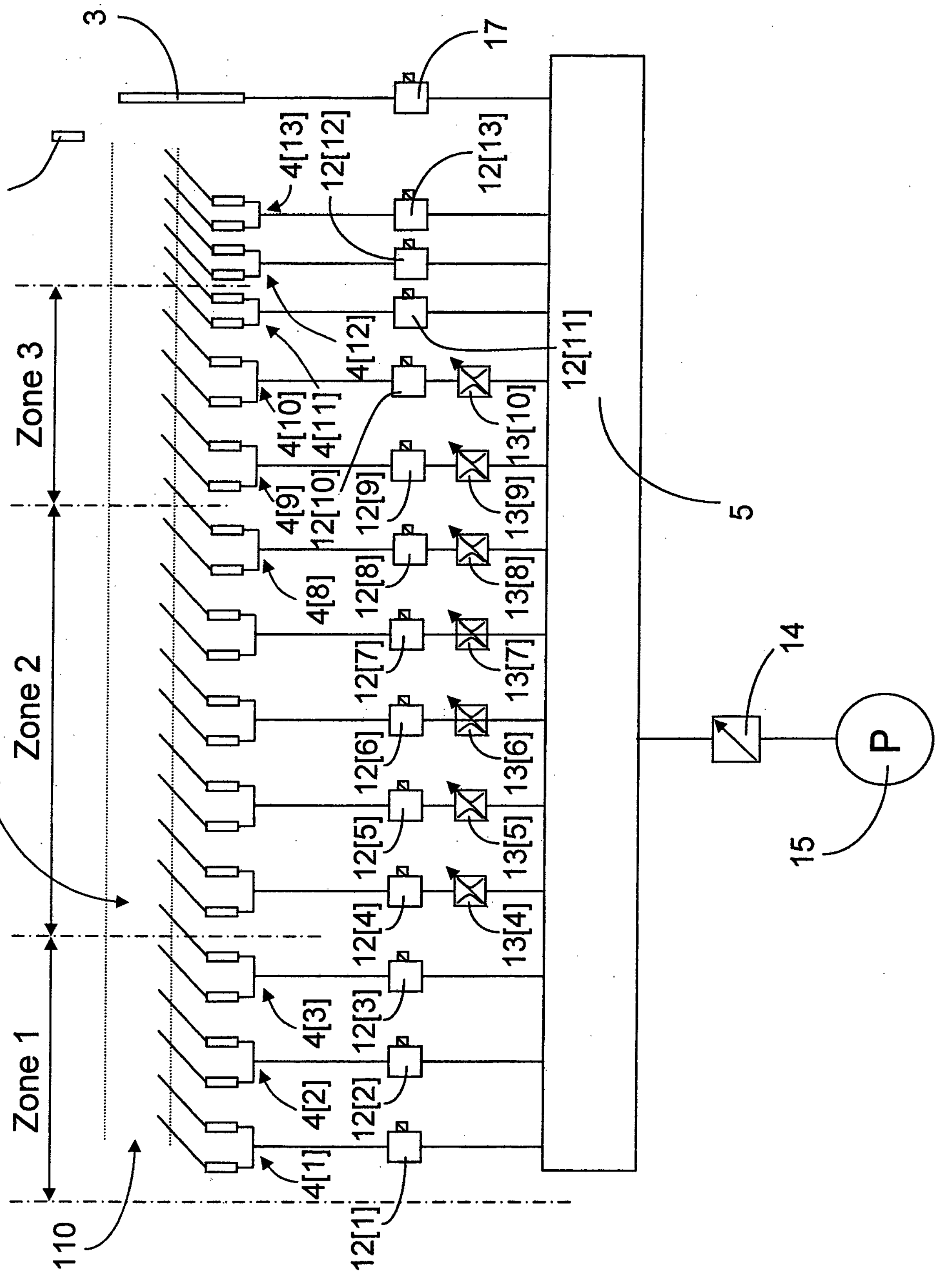
Fig. 22



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110

Fig. 23

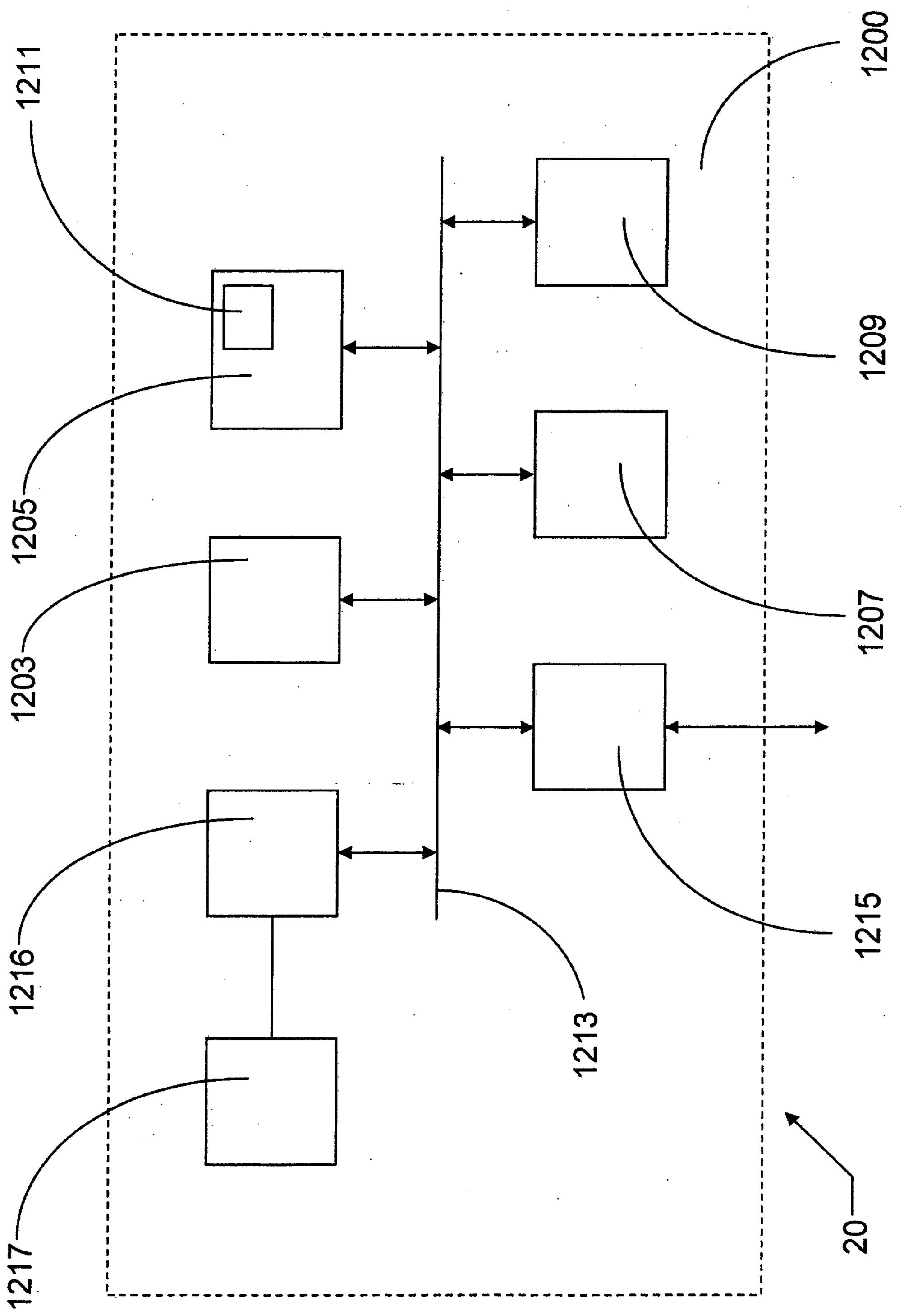

Fig. 24

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