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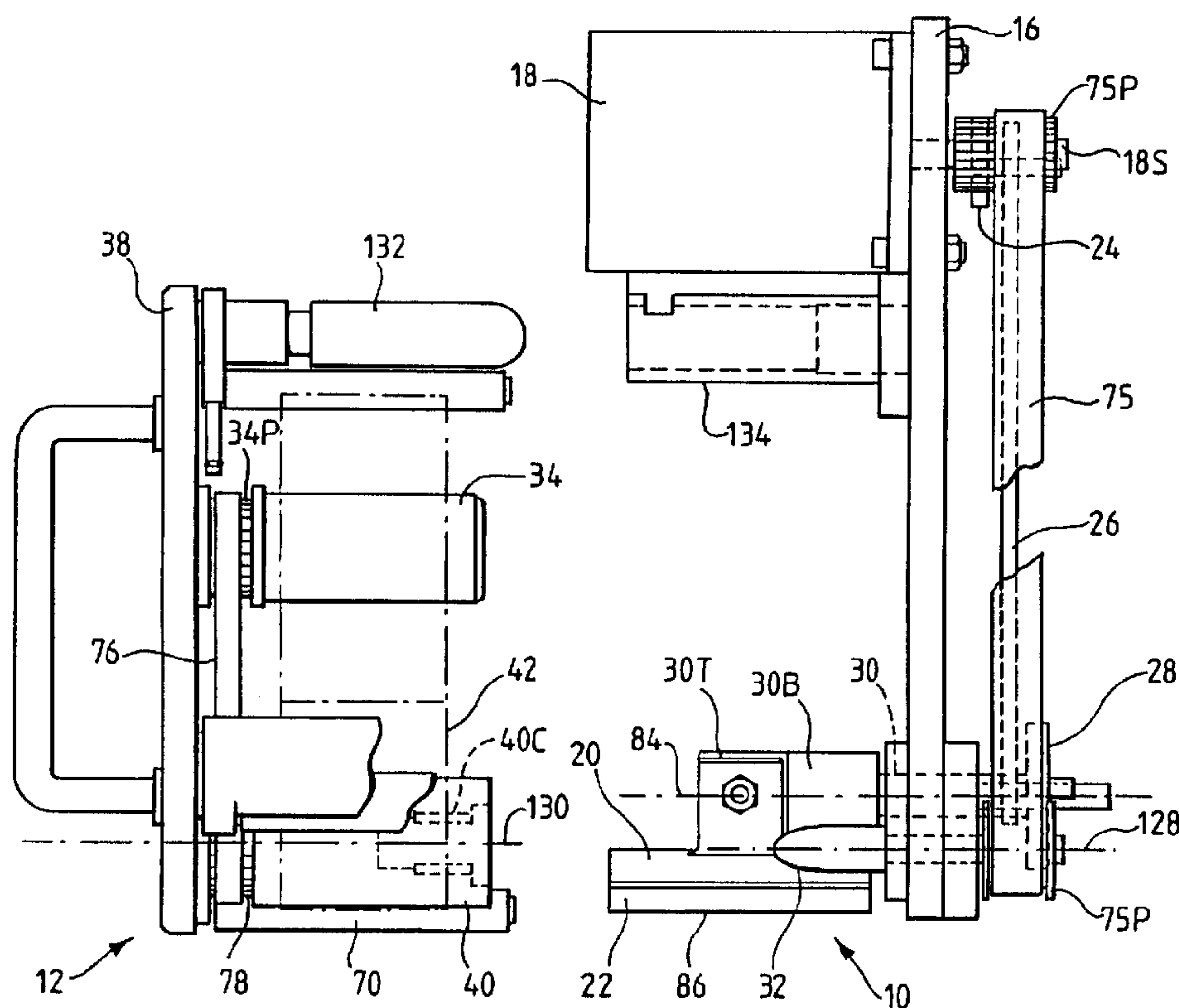
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(54) Title: A PRINTER FOR PRINTING ON A CONTINUOUS PRINT MEDIUM



(57) Abrégé/Abstract:

A thermal printer for printing on a continuous print medium by ink transfer from a thermal print ribbon has a print head which is pivotally mounted and which is driven in an oscillatory nodding motion by means of a stepper motor so as repeatedly to bring a linear array of energisable printing elements to bear against a platen roller. Both the element array and the platen extend transversely to respective paths of travel of the print medium and the ribbon. The print medium is fed through the printer from an inlet region, between the platen and print head, and thence to an outlet region. The instantaneous rate of travel of the print



(57) Abrégé(suite)/Abstract(continued):

medium past the print head is substantially the same as the rate of feed of print medium to the printer. Typically this rate is of the order of 250 to 400 mm per second. The ribbon also travels between the print head and the platen, overlying the print medium and is driven in such a manner that it travels at the same rate as the print medium during each printing operation up to a speed equivalent to the maximum printing speed of the print head. This is achieved by driving the ribbon with a motor the speed of which is controlled according to the sensed speed of travel of the print medium, e.g. by coupling the motor to processing circuitry which takes an input signal from a shaft encoder associated with the platen roller. These methods of driving the ribbon have the advantage that the ribbon speed can be varied to take account of different print medium speeds, e.g. due to the requirements of differing packaging processes, and also in response to transient variations in print medium speed during each printing operation. To restore the aspect ratio of characters when the print medium is travelling faster than the speed equivalent to the maximum speed of the print head, lines of dots are skipped.

A PRINTER FOR PRINTING ON A CONTINUOUS PRINT MEDIUMABSTRACT

A thermal printer for printing on a continuous print medium by ink transfer from a thermal print ribbon has a print head which is pivotally mounted and which is driven in an oscillatory nodding motion by means of a stepper motor so as repeatedly to bring a linear array of energisable printing elements to bear against a platen roller. Both the element array and the platen extend transversely to respective paths of travel of the print medium and the ribbon. The print medium is fed through the printer from an inlet region, between the platen and print head, and thence to an outlet region. The instantaneous rate of travel of the print medium past the print head is substantially the same as the rate of feed of print medium to the printer. Typically this rate is of the order of 250 to 400 mm per second. The ribbon also travels between the print head and the platen, overlying the print medium and is driven in such a manner that it travels at the same rate as the print medium during each printing operation up to a speed equivalent to the maximum printing speed of the print head. This is achieved by driving the ribbon with a motor the speed of which is controlled according to the sensed speed of travel of the print medium, e.g. by coupling the motor to processing circuitry which takes an input signal from a shaft encoder associated with the platen roller. These methods of driving the ribbon have the advantage that the ribbon speed can be varied to take account of different print medium speeds, e.g. due to the requirements of differing packaging processes, and also in response to transient variations in print medium speed during each printing operation. To restore the aspect ratio of characters when the print medium is travelling faster than the speed equivalent to the maximum speed of the print head, lines of dots are skipped.

A PRINTER FOR PRINTING ON A CONTINUOUS PRINT MEDIUM

This invention relates to a thermal printer for printing on a continuous print medium by thermal ink transfer from a print ribbon.

5 It is known to print continuous packaging material and other continuous print media such as label bearing substrates with alphanumeric information and other symbols using a thermal transfer printer. A print head having a row of electronically driven heating elements is brought to bear against an ink-carrying thermal transfer ribbon lying over the print medium while the print medium is driven perpendicularly to the row of print elements. In one known printer, the ribbon is supplied from a take-off spool and then passes along a ribbon path 10 which extends between the print head and the path of the print medium and thereafter is fed onto a take-up spool, the ribbon travelling across the print head at least approximately the same speed as the print medium whilst printing is taking place. The path followed by the print medium extends around movable rollers which deflect the print medium by variable amounts both upstream and downstream of the print head. These rollers impose significant 15 stresses on the print medium and complicate threading when the print medium is loaded into the printer. Such a printer operates typically at print medium speeds up to 200 mm per second.

Accordingly this invention seeks to provide an improved printer for continuous printing.

20 According to a first aspect there is provided a thermal printer for printing on a continuous print medium by means of ink transfer from a thermal print ribbon, comprising means defining a print medium path along which a print medium is conducted, a thermal print head having energizable print elements and located adjacent to the print medium path and means defining a print ribbon path which extends substantially in the same direction as the print medium path and along which a print ribbon is conducted such that the print ribbon is 25 interposed between the print head and the print medium. Ribbon drive means is operable to drive the print ribbon at varying speeds along the print ribbon path and speed sensing means is operable to sense the speed of travel of the print medium along the print medium path. Processing means, including memory means, is provided for controlling the ribbon drive

means in order to vary the speed at which the print ribbon is driven, up to a maximum speed substantially corresponding to the maximum printing speed of the print head, for energizing selected ones of the print elements according to predetermined patterns of dots stored within the memory means so as to cause the transfer of ink from the print ribbon to the print medium in accordance with a predetermined one of the patterns of ink dots as the print medium moves past the print head along the print medium path. The processing means also monitoring the speed of the print medium using the speed sensing means such that when the speed of the print medium is greater than the maximum ribbon and print head speeds, the print elements are energized such that selected ink dots are omitted from the predetermined pattern of ink dots formed upon the print medium.

In the prior art machine, where the print medium passes the print head at a speed greater than the maximum printing speed of the print head, ribbon is wasted. This is because the print medium and the ribbon travel past the head at the same speed. By limiting the ribbon speed to a speed which corresponds to the maximum printing speed of the head, i.e. a ribbon speed at which the used portions of the ribbon are adjacent one another when the print head is operating at maximum speed, ribbon is saved. It will be appreciated that in the prior art machine, the used portions of the ribbon are spaced apart. Correspondingly, the printed pattern on the print medium is spaced apart thus stretching the intended aspect ratio of the pattern in the direction of the print medium travel. The present invention solves this additional problem by omitting selected ink dots from the predetermined pattern. This has the effect of condensing the pattern in the direction of the print medium travel thereby tending to restore the aspect ratio of the pattern.

Typically the print elements are arranged in a line in the print head transversely of the direction of print medium travel. Preferably the processing means is arranged to cause dots to be omitted by periodically skipping a set of dots (typically a single one of the lines) and instead to activate the elements according to the subsequent set of dots stored in the memory means. Thus it will be appreciated that the line is truly omitted and replaced with the subsequent line rather than merely being delayed to the next printing operation of the printing head which would not have the desired condensing effect.

Preferably the processing means is arranged to skip X sets on average where $X = 1 - (\text{MAX}/\text{speed of print medium})$ and where MAX is a print medium speed substantially corresponding to the maximum printing speed of the print head. By arranging for sets to be skipped according to this formula, the aspect ratio is accurately restored. For example, where the ratio of the speed of the print medium to the print medium speed which substantially corresponds to the maximum printing speed of the print head is 1.25, by omitting on average 0.2 of the lines (i.e. one line in five) the effective width of the pattern printed on the print medium is restored to the width that it would have if the print medium were running at a speed only equivalent to MAX. Since MAX is the print medium speed that equates to the maximum printing speed of the print head i.e. the print medium speed at which the print head is able to print sufficiently quickly to maintain the correct aspect ratio of the pattern, the aspect ratio of the pattern is restored albeit with some loss of detail due to the omitted set or sets of dots.

Preferably, the speed with which the ribbon is driven during each printing operation is variable in response to the print medium speed of travel so as to match the speed with which the print medium is fed past the print head up to the said maximum speed. This may be achieved, for example, by forming the platen as a roller around which the print medium is wrapped so that the speed of rotation of the roller is a measure of the speed of passage of the print medium. A shaft encoder, typically an optical encoder, may be used to provide an input to processing means forming part of the printing actuator to control movement of the print head and energisation of the printing elements. In addition, the ribbon may be driven by a stepper motor coupled to a ribbon drive roller, the speed of operation of the stepper motor being governed by the sensed speed of rotation of the platen roller.

In the preferred embodiment, the speed of the ribbon is limited by reducing for every two sets of dots which are skipped, the amount of ribbon fed past the printhead by an amount equal to the length of ribbon used by a single set of dots. For example, assuming that each set of dots uses 0.25mm of ribbon length, in the preferred embodiment, if two sets of dots are omitted, then without this feature, 0.5mm of ribbon length would be fed past

the head and wasted since it would not be used. In the preferred embodiment, only 0.25 mm of ribbon is fed past the head, i.e. 0.25 mm less than would normally have been fed.

According to a method aspect, the invention includes a method of saving ribbon in a thermal printer which prints upon a continuous print medium by ink transfer from a thermal print ribbon and wherein the thermal printer includes a thermal print head having energizable print elements. The method comprises the steps of driving a print medium past the thermal print head at a speed which can be greater than a maximum printing speed characteristic of the thermal print head, driving a thermal print ribbon past the thermal print head in the same direction as the print medium at a speed substantially equal to the maximum printing speed of the thermal print head, providing a memory having stored therein predetermined patterns of dots, selectively energizing predetermined ones of the print elements of the thermal print head according to predetermined patterns of dots stored within the memory so as to transfer ink from the thermal print ribbon to the print medium in accordance with a predetermined one of the predetermined patterns of ink dots as the print medium is driven past the print head and periodically omitting selected ink dots from the predetermined one of the predetermined patterns of ink dots formed upon the print medium when the speed of the print medium is greater than the maximum ribbon and print head speeds.

Preferably, the method includes removing one unit of ribbon length (typically 0.25 mm) for each 2 sets of dots omitted as described above in connection with the apparatus aspect of the invention. This saves ribbon since less ribbon is used as sets of dots are removed. The same ribbon length will therefore last longer than in the prior art machine.

The invention is applicable primarily to printing variable information on continuous plastics film packaging material, with each print operation being triggered by, for example, sensing the position of products to which the packaging material is to be applied as they travel along an adjacent conveyor. Typically, the information includes sell-by dates, serial numbers, pricing information and bar codes.

The invention will be described below by way of example with reference to the drawings in which:

Figure 1 is a diagrammatic exploded side view of a printer in accordance with the invention;

Figure 2 is a front view of a base unit printer of Figure 1;

Figure 3 is a rear view of a ribbon cassette of the printer of Figure 1;

5 Figure 4 is a block diagram of electrical parts of the printer;

Figure 5 is a plan view of a ribbon drive roller for the printer of Figure 1;

Figure 6 is a flow-chart of part of the software of the printer of Figure 1; and

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Figure 7 is a flow-chart of another part of the software of the printer of Figure 1.

Referring to Figures 1, 2 and 3 together, a printer for the continuous printing of a continuous print medium by transfer from a thermal transfer print ribbon has a base unit
15 10 and a removable ribbon cassette unit 12. The base unit, which is mounted to a frame of the printer (not shown), contains a print head stepper motor 14 mounted on a front plate 16 of the unit 10, and a ribbon drive stepper motor 18 similarly mounted on the front plate 16. Coupled to the motor shaft 14S of the print head stepper motor 14 is a pivotable print head carrier 20 which supports a print head 22.

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Coupling of the print head carrier 20 to the motor shaft 14S is by way of a parallelogram linkage lying behind the front plate 16 and comprising a first crank 24 fixed to the motor shaft 14S, a connecting link or rod 26, and a second crank 28 generally in the form of a semi-circular plate which is mounted on a shaft 30 supporting the print head carrier 20.
25 Shaft 30 takes the form of a boss 30B on the front side of plate 16, with an axially extending tongue 30T to which the print head carrier 20 is bolted.

The motor shaft 18S of the ribbon drive stepper motor 18 is attached to a drive spindle 32 which, like the print head carrier 20, projects perpendicularly from the front plate 16 of
30 the base unit 10.

For clarity, the cassette unit 12 is shown in Figure 1 spaced from the base unit 10. In practice, when fitted to the base unit 10, the cassette unit 12 is closer to the base unit 16, such that ribbon spools 34, 36, which are rotatably mounted on a front plate 38 of the cassette unit 12, are coextensive with the print head 22 in terms of their location in a direction perpendicular to the front plate 38 of the base unit 40. Also attached to the cassette unit front plate 30 is a ribbon drive roller 32 visible in Figure 1 below ribbon spool 34, and also in Figure 3.

The relative positioning of the ribbon spools 34, 36, the print head 22, and the ribbon drive roller 40 may be ascertained by comparison of Figure 1 with Figure 3. The ribbon 42 itself is shown in full lines in Figure 3, but in phantom lines in Figure 1 for clarity. Certain items shown in Figure 1 are not shown in Figure 2, and vice versa. In particular, a platen roller 44 and a deflection roller 46 are shown in Figure 2 but not in Figures 1 and 3. These components are mounted on the printer frame or other apparatus which the printer is associated.

Referring to Figure 2, continuous film material to be printed (shown by reference numeral 50) enters the printer in an inlet region 52, passes over and wraps around platen roller 44 from where it follows a downwardly inclined path to pass underneath and wrap around a deflection roller 46 before passing to an outlet region 54 of the printer. The positioning of platen and deflection rollers 44 and 46 is such that the film substrate 50 is nowhere deflected through an angle greater than 60° by any one guiding element, and preferably not greater than 45° . The function of the deflection roller 46 may be performed instead by any deflecting support for the film substrate 50 positioned to cause the substrate to be wrapped partly around the platen roller. Both platen roller 44 and deflection roller 46 have axes of rotation which extend at right angles to the direction of travel of the substrate film 50, and both axes are fixed in position so that the path of the substrate film 50 remains substantially constant during and between successive printing operations. As a result, the instantaneous rate at which the film 50 passes over the platen 44 always matches the rate at which it is supplied to and extracted from the printer through the inlet and outlet regions 52 and 54.

The thermal transfer ribbon 42 follows a ribbon path as follows. Firstly, a supply of the ribbon is provided on a feed spool 36 which is mounted by means of a bearing (not shown) fixed to the cassette unit front plate 38. A degree of friction is built into this bearing to maintain tension in ribbon 42. From spool 36, the ribbon 42 passes over a break detector roller 58 attached to the end of a break detector arm 60 which is rotatable about the rotation axis of the feed spool 36 and biased in a clockwise direction as seen in Figure 3 by a spring 62. From roller 58, the ribbon 42 passes over guide rollers 64 and 66 attached to the cassette unit front plate 30 and thence through a region which, when the cassette unit 12 is loaded into the base unit 10, lies between the print head 22 and the platen 44. The ribbon then passes over a further guide roller 68. The head and the platen are seen in Figure 2, as are also guide rollers 66 to 68, so that the location of the ribbon path relative to the head and platen can be seen. Where the ribbon 42 passes over platen 44 it is in frictional contact with the substrate film 50. The ribbon 42 is held in contact with substrate film 50 only between the start and finish of each printing operation, during which the lower surface of the print head 22 bears against the platen 44 through the ribbon 42 and film 50, as shown in Figure 2. At other times, the print head 22 is raised by operation of its stepper motor 14.

From the print head 22, the ribbon 42 travels over guide roller 70 and is then wrapped around the drive roller 40. A pinch roller 72, mounted on a pivotable support arm 74, maintains the ribbon 42 in gripping contact with drive roller 40. Drive roller 40 has a rubber sleeve and is driven by motor 18 via a toothed belt 75 and toothed pulleys 75P behind base unit front plate 16 on the motor shaft 18S and the spindle 32, (shown in Figures 1 and 2) so that the ribbon 42 is pulled through the space between the print head 22 and the platen 44. From the drive roller 40, the ribbon 42 passes to a take-up spool 38 which is belt-driven by a belt 76 from a pulley 78 (see Figure 1) mounted on the shaft of drive roller 40. The mounting bearing (not shown) of the take-up spool 34 is mounted on a shaft fixed to the cassette unit front plate 30 and, like the mounting bearing of the feed spool 36, has a degree of friction built in. The diameter of the pulley 34P associated with take-up spool 34 together with the diameter of the pulley associated with drive roller 40 are such that the shaft bearing the take-up spool 34 is always driven faster than the speed

of rotation necessary to take up the ribbon 42 from the drive roller 40, regardless of the diameter of the ribbon reel. The friction slip built into the connection between spool 34 and the belt-driven shaft allows the respective speeds of rotation of the drive roller 40 and the take-up spool 34 to be different from each other.

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The print head 22 has side-facing printing elements 82 (Figure 1) extending along a line parallel to the axis of rotation 84 of the print head carrier 20. These printing elements 82 project from a lower surface 86 of the print head 22 which, in the printing position of the print head 22 is tangential to the platen roller 44, as shown by the chain lines in Figure 2.

10 The arcuate locus followed by the line of printing elements 82 when the print head 22 is pivoted about axis 84 passes through the intersection of a tangent parallel to the print head lower surface 86 and the platen roller surface. Consequently, the ribbon 42 and the substrate film 50 are pinched between the print head 22 and the platen roller 44 precisely at the line of printing elements 82. When these elements are heated under electronic
15 control, and the film 50 and ribbon 42 are passed together over the element, ink is transferred from the ribbon 42 to the film 50 to print characters and symbols according to pre-programmed information incorporated in the signals fed to the print head 22.

During printing, the ribbon 42 is in contact with film 50 and normally travels at the same
20 speed. This is achieved by mounting an optical shaft encoder on a shaft bearing the platen roller 44. The output of the encoder is representative of the speed of the film 50, and by processing this output signal, the stepper motor 18 driving ribbon drive roller 40 is adjusted such that the ribbon is driven at the correct speed. This synchronisation between ribbon 42 and film 50 can be maintained over a wide range of speeds.

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The print head 22 has a characteristic maximum printing rate or speed. Thus if the ribbon and film 50 are always driven at the same speed, there will come a point where the printing head reaches its maximum speed and where gaps are left in the usage of the ribbon because portions of the ribbon move past the head when the head is inoperative.
30 As the ribbon and film speed increases beyond the speed equivalent to the maximum printing speed of the print head, the gaps in the ribbon usage become larger. The

processor 94 (see Figure 4) is therefore arranged to drive the motor 18 such that the ribbon moves at the same speed as the film 50 until the print head is operating at maximum rate and the used portions of the ribbon are spaced as compactly as possible. At this point no further speed increase in the ribbon is permitted. Thus any further increase in the speed of the film 50 results in "slippage" between the ribbon and the film. In this way, maximum use is made of the ribbon yet the speed of the film 50 is not limited by the speed of the print head.

The preferred embodiment is capable of operating at a film speed of 400 mm per second.

The shaft encoder associated with the platen roller 44 is shown in Figure 4 by reference numeral 90. Encoder 90 provides an input signal representative of film speed to an input 92 of a processor unit 94. The processor unit has at its heart a microprocessor, and has three outputs. These are a first output 96 coupled to a first motor driver circuit 98 for moving the print head between its inactive retracted position and its active extended position (respectively shown in Figure 2) by means of stepper motor 14 and its associated linkage.

A second output of the processor unit 94 is a multi-wire input 100 coupled to the energisable elements 82 of the print head 22.

The third output 102 is coupled to a second motor driver 104 to control stepper motor 18, thereby stopping and starting the ribbon, and controlling the ribbon speed during each printing operation.

Other inputs to the processor include trigger input 106 which receives a trigger signal initiating each printing operation. Typically, the trigger signal is generated by sensing the position of products to which the substrate film is to be applied as packaging, as the products travel along an adjacent conveyer. Another input 108 receives the information to be printed from a memory 110. Thus, on receipt of a trigger signal at input 106, the processor is programmed firstly to move the print head 22 to its extended position, to start

the ribbon drive motor, and to initiate printing by energising the elements of the print head 22 in accordance with the information stored in the memory 110 thereby to print the information as a pattern or a series of characters.

5 Whilst the printing operation is progressing, the speed at which the ribbon is driven via driver 104 and motor 18 is determined according to the film speed signal input received by the processor at input 92, so as to drive the ribbon at the same speed as the film up to the maximum speed as described above. The rate at which the print head elements are driven (i.e. the rate at which the pattern or characters are printed) is also varied by
10 processor unit 94 according to the film speed signal input.

It will be appreciated that when the speed of the film 50 passes the print head at a speed greater than that equivalent to the maximum printing speed of the print head, although the ribbon speed is limited to save ribbon, the dots formed on the film 50 will still be spaced
15 apart in the direction of travel of the film. Thus the characters or patterns formed on the film 50 will appear to be stretched in the direction of film travel. To overcome this, in the preferred embodiment, the characters or patterns are compressed by periodically selectively omitting or skipping a line of dots.

20 With reference to Figure 6 and 7, two of the software processes executing in the processor 94 are shown. Steps 202, 204, 206 operate in a loop to derive a measurement of the speed of the film by reading the "T-period" which is the time period between encoder pulses from the shaft encoder 90. In the preferred embodiment, the T-period is measured between the rising edges of the series of encoder pulses.

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In steps 208, 210, 212, 214 the measured T-period is compared with MAX which is a stored value which represents the maximum film speed at which characters are printed at the correct aspect ratio on the film 50 whilst the print head 22 is operating at maximum rate. Each of these steps also increment a "ribsave" variable which is used by the ribbon
30 control loop as described below in connection with Figure 7.

Taking step 208 for example, if T-period is between MAX and MAX x 1.25 then after every four lines are printed, the next line is skipped. Thus a fifth of the lines are skipped on average which has the effect of compressing the character or pattern being printed by $\frac{4}{5}$. Since the film is measured as passing the head at 1.25 (i.e. $\frac{5}{4}$ of the maximum printing speed, the effect of compressing by $\frac{4}{5}$ is to restore the aspect ratio by bringing the character width back to 1 (i.e. normal width). Similarly, steps 210, 212, 214 restore the aspect ratio for film speeds even greater than MAX up to the point in step 214 where the film speed is twice the speed equivalent to the maximum printing head speed which therefore requires every other line to be skipped to compress the characters or patterns by half in the direction of travel of the film 50.

Steps 216 and 218 limit "T-Period" to be between MIN and MAX, namely the preferred minimum ribbon speed and the maximum speed respectively, the maximum speed being the speed which is equivalent to the maximum rate of the printhead as described above.

15 T-Period is used in the ribbon control loop described below

Figure 7 shows the process which controls ribbon speed by loading the T-period into the ribbon control segment of the software which ultimately controls the motor 18. This process matches the ribbon speed to the film speed as discussed above until the film speed reaches the speed equivalent to the maximum printing speed of the print head at which point the ribbon speed is kept constant until the film speed decreases below the speed equivalent to the maximum speed of the print head. The variable "ribsave" is used to adjust a variable "riblength" which maintains a record of the amount of ribbon remaining.

25 When the processor senses that all of the information relating to the required design has been supplied from memory 110 and has been fed to the print head 22, it issues a stop signal to the ribbon driver 104 to stop ribbon travel and the driver 98 for the print head motor 14 receives a signal causing the motor to withdraw the print head to its retracted, inactive position. A processor 94 then waits for the next trigger signal on 106 before repeating the above process. Further inputs 112 and 114 of the processor 94 are called respectively to a ribbon status sensor 116 and a ribbon break sensor 118 which are

respectively associated with a spring loaded pivotable arm 120, seen in Figure 3. This arm 120 has a roller 122 at its distal end contacting the periphery of the ribbon supply on ribbon feed spool 36, so that when the ribbon supply runs low, an alarm can be activated and/or operation of the packaging apparatus of which the printer is part can be halted.

5 Similarly, the break sensor 118 is responsive to excessive clockwise movement of arm 60 (see Figure 3) to sense breakage of the ribbon 42 which, during normal operation, keeps roller 58 approximately in the position shown in Figure 3.

Further details of the preferred printer in accordance with the invention will now be
10 described. Limits on the movement of print carrier 20 and print head 22 are determined firstly by the striking of the print head elements 82 against the platen 44 (see Figure 2) through the ribbon 42 and film 50, and, in the retractive position, by an adjustable stop (not shown) associated with the semi-circular plate 28 behind the front plate 16 of the base unit.

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Drive to the ribbon drive roller 40, which, it will be seen, is mounted on the cassette front plate 30, is transferred from the base unit 10 to the roller by means of drive spindle 32 shown in Figure 1. Referring to Figure 5, roller 40 contains a clutch bearing 40C which is so mounted within the roller 40 that it is allowed to float in the sense that the centre of
20 bearing 40C need not coincide exactly with the centre of the roller 40. When the cassette unit 12 is mounted on base unit 10, the drive shaft or spindle 32 attached to ribbon drive motor 18 (see Figure 1) enters clutch bearing 40C (Figure 3). Needle rollers of the clutch bearing, which are self-locking when driven in one rotary direction, engage the outer surface of shaft or spindle 32 and drive is transferred from spindle 32 to the bearing 40C
25 and thence via pins 40P to the roller 40. The floating nature of the clutch bearing 40C within the roller 40 allows for a degree of mismatch between the axis 128 of drive spindle 32 and that 130 of roller 40 when the cassette unit 12 is mounted on the base unit 10.

The cassette unit 12 is located on base unit 10 by means of a retention pin 132 and a
30 tubular socket 134, as shown in Figure 1.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A thermal printer for printing on a continuous print medium by means of ink transfer from a thermal print ribbon, comprising:

means defining a print medium path along which a print medium is conducted;

a thermal print head having energizable print elements and located adjacent to said print medium path;

means defining a print ribbon path which extends substantially in the same direction as said print medium path and along which a print ribbon is conducted such that said print ribbon is interposed between said print head and said print medium;

ribbon drive means operable to drive said print ribbon at varying speeds along said print ribbon path;

speed sensing means operable to sense the speed of travel of said print medium along said print medium path; and

processing means, including memory means, for controlling said ribbon drive means in order to vary the speed at which said print ribbon is driven, up to a maximum speed substantially corresponding to the maximum printing speed of said print head, for energizing selected ones of said print elements according to predetermined patterns of dots stored within said memory means so as to cause the transfer of ink from said print ribbon to said print medium in accordance with a predetermined one of said patterns of ink dots as said print medium moves past said print head along said print medium path and for monitoring the speed of said print medium using said speed sensing means such that when the speed of said print medium is greater than said maximum ribbon and print head speeds, said print elements are energized such that selected ink dots are omitted from said predetermined pattern of ink dots formed upon said print medium.

2. A printer according to claim 1, wherein:

said processing means comprises means for causing said dots to be omitted by periodically skipping a set of dots and instead energizing said print elements according to the subsequent set of dots stored within said memory means.

3. A printer according to claim 2, wherein:

said processing means comprises means for skipping X sets of said dots, wherein $X = 1 - (\text{MAX}) / \text{speed of print medium}$, in which MAX is the print medium speed substantially corresponding to said maximum printing speed of said print head.

4. A printer according to claim 3, wherein:

said processing means comprises means for reducing, for each two sets of dots skipped, the amount of ribbon fed past said print head by an amount substantially equal to the length of ribbon used for printing one set of dots.

5. A printer as set forth in claim 1, wherein:

said processing means comprises control means operatively connected to said speed sensing means for receiving a speed sensor output signal therefrom and operatively coupled to said ribbon drive means for driving said ribbon drive means at a rate of speed dependent upon said speed sensor output signal.

6. A printer as set forth in claim 5, wherein:

said ribbon drive means comprises a ribbon drive roller operatively connected to a ribbon drive motor; and

said control means is operatively connected to said ribbon drive motor so as to cause said ribbon drive motor to be driven at a rate of speed which is dependent upon said sensor output signal.

7. A printer as set forth in claim 6, further comprising:

drive spindle means for operative coupling to said ribbon drive roller;

first pulley means operatively connected to said ribbon drive motor;

second pulley means operatively connected to said drive spindle means; and

first pulley belt means operatively interconnecting said first pulley means to said second pulley means so as to transmit drive from said ribbon drive motor to said drive spindle means and said ribbon drive roller.

8. A printer as set forth in claim 7, further comprising:
one-way clutch means disposed within said ribbon drive roller and operatively connectable to said drive spindle means for transmitting drive from said drive spindle means to said ribbon drive roller.
9. A printer as set forth in claim 7, further comprising:
a ribbon supply spool for supplying said print ribbon in preparation for a printing operation; and
a ribbon take-up spool for receiving print ribbon which has been used in a printing operation.
10. A printer as set forth in claim 9, wherein:
said printer comprises a base unit and a ribbon cassette;
said ribbon drive motor, said first and second pulleys and said spindle drive means are mounted upon said base unit; and
said ribbon drive roller, said ribbon supply spool and said ribbon take-up spool are mounted upon said ribbon cassette.
11. A printer as set forth in claim 9, further comprising:
third pulley means mounted upon said ribbon drive roller;
fourth pulley means mounted upon said ribbon take-up spool;
second pulley belt means operatively interconnecting said third and fourth pulley means for transmitting drive from said ribbon drive roller to said ribbon take-up spool.
12. A printer as set forth in claim 1, wherein:
said processing means comprises control means operatively connected to said speed sensing means for receiving a speed sensor output signal therefrom and operatively connected to said print head for energizing said print elements in accordance with said speed sensor output signal.

13. A printer as set forth in claim 1, wherein:
said speed sensing means comprises an optical shaft encoder.
14. A printer as set forth in claim 1, wherein:
said processing means comprises control means operatively connected to said speed sensing means for receiving a speed sensor output signal therefrom and operatively connected to said thermal print head for moving said thermal print head toward and away from said print ribbon path in response to said speed sensor output signal.
15. A printer as set forth in claim 14, wherein:
said thermal print head is mounted upon a pivotable thermal print head carrier which is operatively connected to a print head drive motor; and
said control means is operatively connected to said print head drive motor so as to drive said print head drive motor which thereby oscillates said pivotable thermal print head carrier.
16. A method of saving ribbon in a thermal printer which prints upon a continuous print medium by ink transfer from a thermal print ribbon and wherein the thermal printer includes a thermal print head having energizable print elements, the method comprises the steps of:
driving a print medium past said thermal print head at a speed which can be greater than a maximum printing speed characteristic of said thermal print head;
driving a thermal print ribbon past said thermal print head in the same direction as said print medium at a speed substantially equal to said maximum printing speed of said thermal print head;
providing a memory having stored therein predetermined patterns of dots;
selectively energizing predetermined ones of said print elements of said thermal print head according to predetermined patterns of dots stored within said memory so as to transfer ink from said thermal print ribbon to said print medium in accordance with a predetermined one of said predetermined patterns of ink dots as said print medium is driven past said print head; and

periodically omitting selected ink dots from said predetermined one of said predetermined patterns of ink dots formed upon said print medium when the speed of said print medium is greater than said maximum ribbon and print head speeds.

17. The method as set forth in claim 16, further comprising the step of:

omitting said selected ink dots from said predetermined pattern of ink dots by periodically skipping a set of ink dots and replacing said skipped set of ink dots with a subsequent set of ink dots.

18. A method according to claim 17, further comprising the step of:
skipping X sets of said ink dots, wherein $X = 1 - (\text{MAX}) / \text{speed of print medium}$,
in which MAX is the print medium speed substantially corresponding to said maximum printing speed of said print head.

19. The method as set forth in claim 18, further comprising the step of:
reducing, for each two sets of dots skipped, the amount of ribbon fed past said thermal print head by an amount substantially equal to the length of ribbon used for printing one set of dots.

20. The method as set forth in claim 16, further comprising the steps of:
sensing the rate of speed of said print medium; and
driving said print ribbon at a rate of speed which is variable in response to said sensed rate of speed of said print medium.

21. A thermal printer for printing on a continuous print medium by means of ink transfer from a thermal print ribbon, comprising:
means defining a print medium path along which a print medium is conducted;
a thermal print head having energizable print elements and located adjacent to said print medium path;

means defining a print ribbon path which extends substantially in the same direction as said print medium path and along which a print ribbon is conducted such that said print ribbon is interposed between said print head and said print medium;

ribbon drive means operable to drive said print ribbon at varying speeds along said print ribbon path;

speed sensing means operable to sense the speed of travel of said print medium along said print medium path; and

processing means, including memory means, for controlling said ribbon drive means in order to vary the speed, at which said print ribbon is driven, up to a maximum speed substantially corresponding to the maximum printing speed of said print head, for energizing selected ones of said print elements according to predetermined line patterns of dots stored within said memory means so as to cause the transfer of ink from said print ribbon to said print medium in accordance with a predetermined one of said line patterns of ink dots as said print medium moves past said print head along said print medium path and for monitoring the speed of said print medium using said speed sensing means such that when the speed of said print medium is greater than said maximum ribbon and print head speeds, said print elements are energized such that a selected line of ink dots is omitted from said predetermined line pattern of ink dots formed upon said print medium.

22. A printer as set forth in claim 21, wherein said processing means comprises:
means for omitting X lines of said dots wherein

$$X = 1 - \frac{\text{maximum speed of ribbon/print head}}{\text{speed of print medium}}$$

23. A method of saving ribbon in a thermal printer which prints upon a continuous print medium by ink transfer from a thermal print ribbon and wherein the thermal printer includes a thermal print head having energizable print elements, the method comprising the steps of:

driving a print medium past said thermal print head at a speed which can be greater than a maximum printing speed characteristic of said thermal print head;

driving a thermal print ribbon past said thermal print head in the same direction as said print medium at a speed substantially equal to said maximum printing speed of said thermal print head;

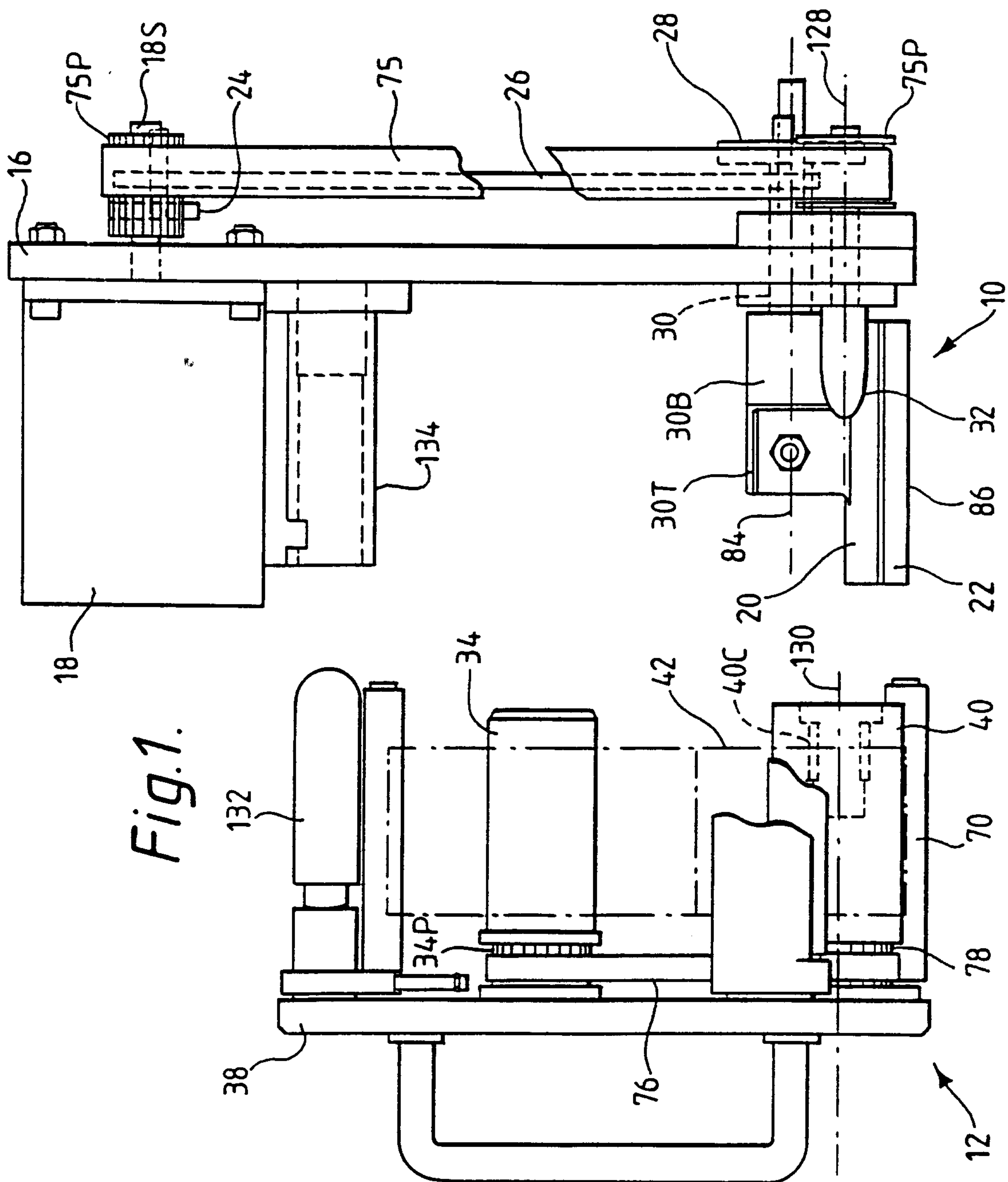
providing a memory having stored therein predetermined line patterns of ink dots; selectively energizing predetermined ones of said print elements of said thermal print head according to predetermined line patterns of dots stored within said memory so as to transfer ink from said thermal print ribbon to said print medium in accordance with a predetermined one of said predetermined line patterns of ink dots as said print medium is driven past said print head; and

periodically omitting a selected line of ink dots from said predetermined one of said predetermined line patterns of ink dots formed upon said print medium when the speed of said print medium is greater than said maximum ribbon and print head speeds.

24. The method as set forth in claim 23, further comprising the step of:
omitting X lines of said dots wherein

$$X = 1 - \frac{\text{maximum speed of ribbon/print head}}{\text{speed of print medium}}$$

1 / 4



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2/4

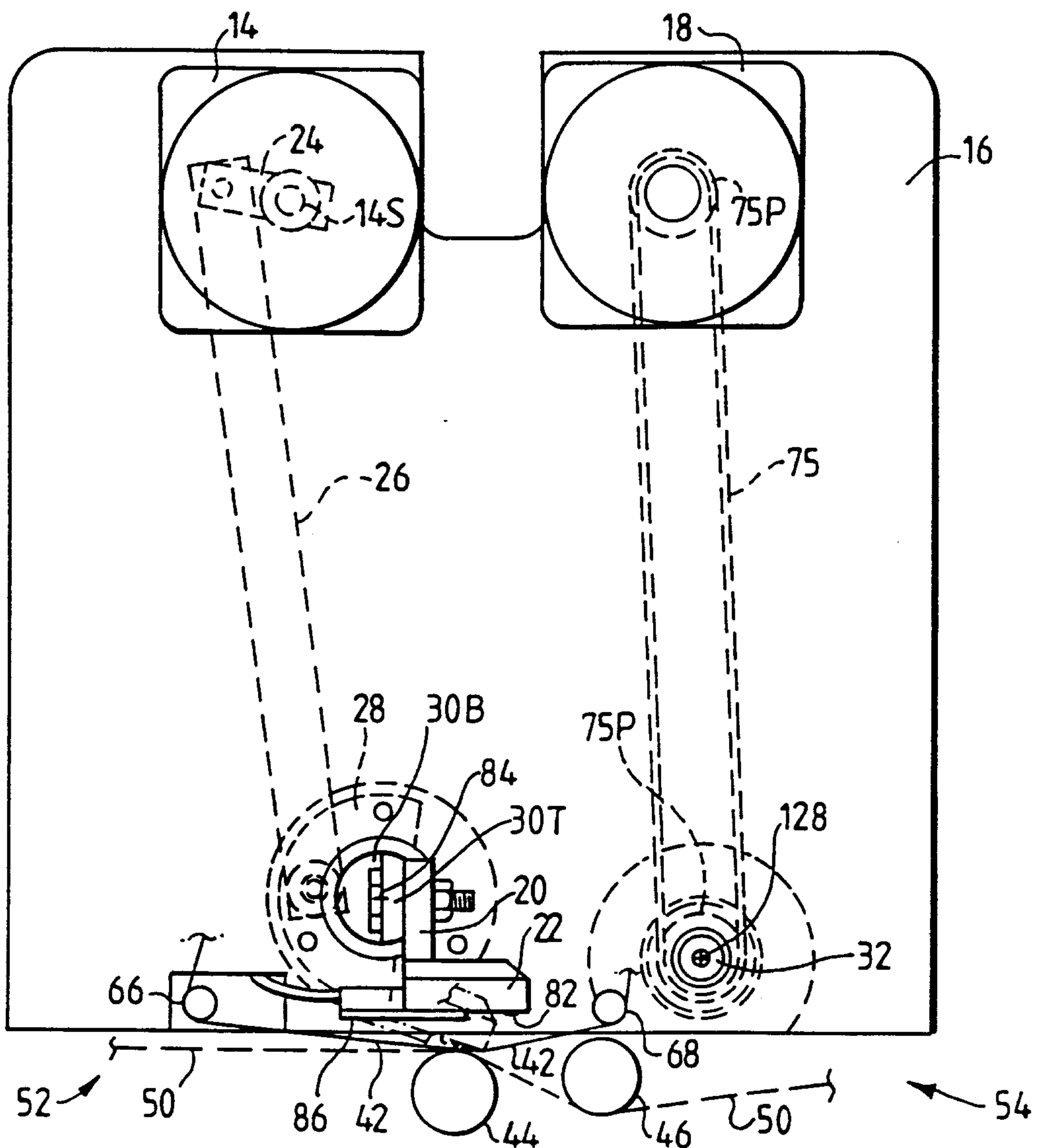


Fig. 2.

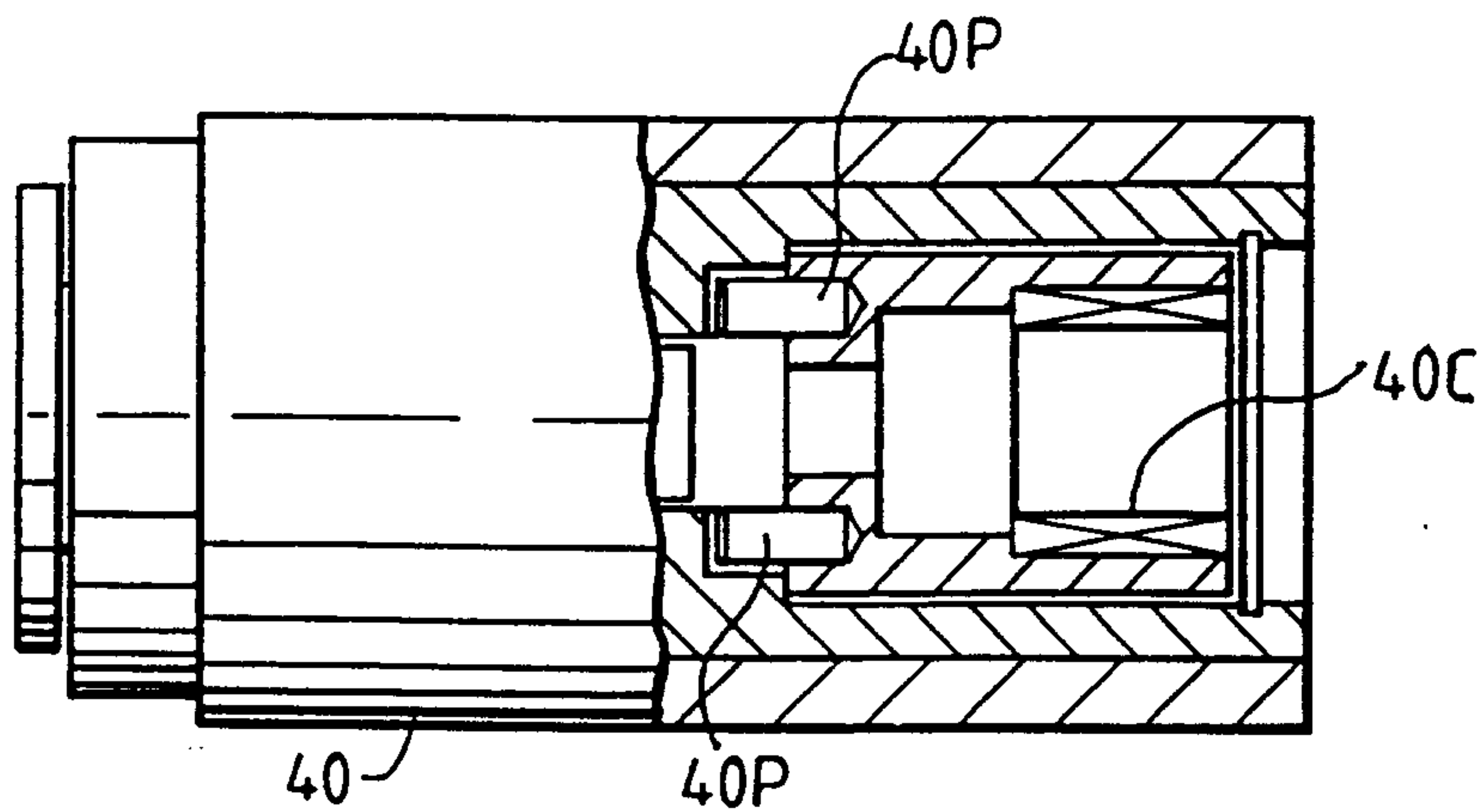
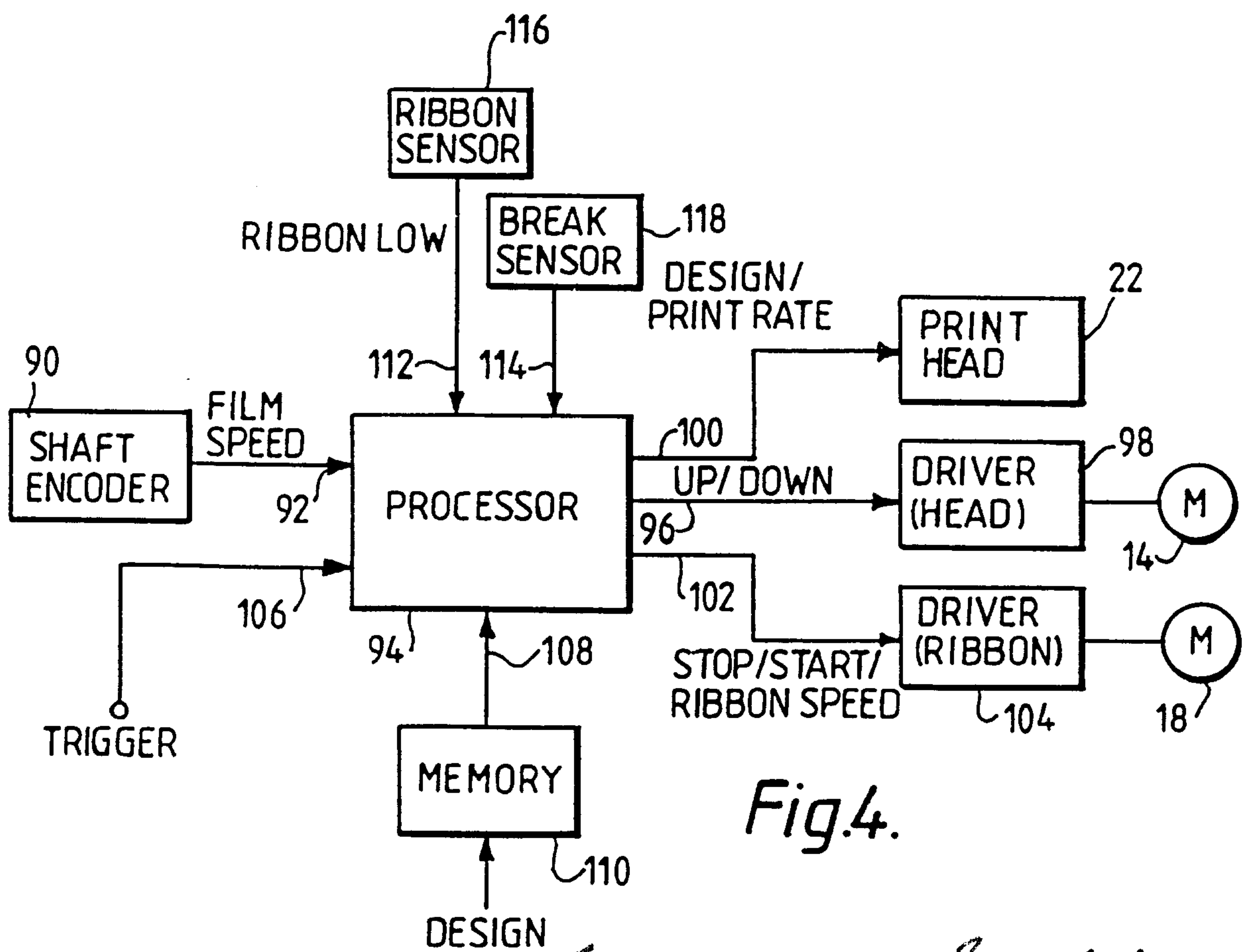
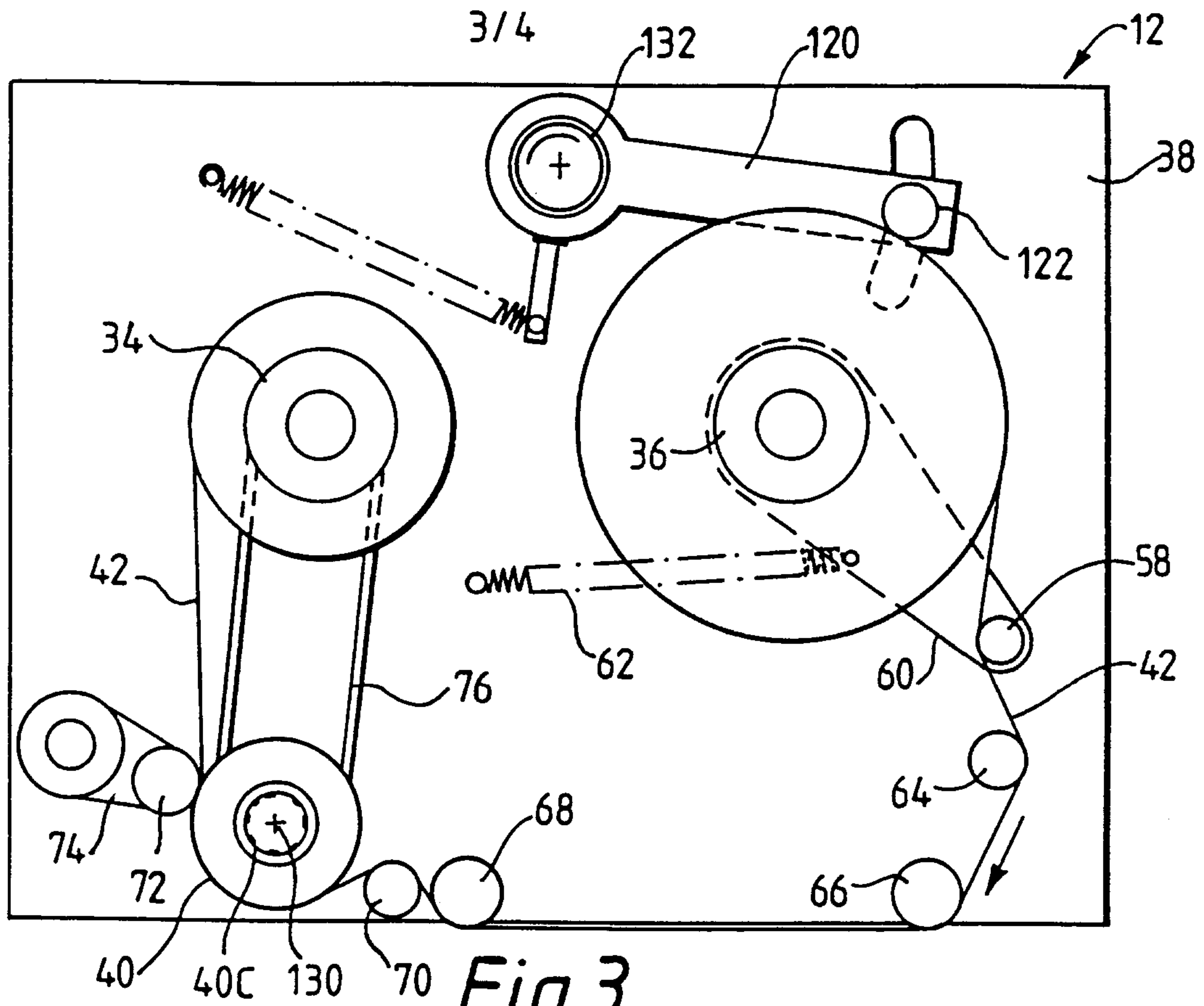


Fig. 5.

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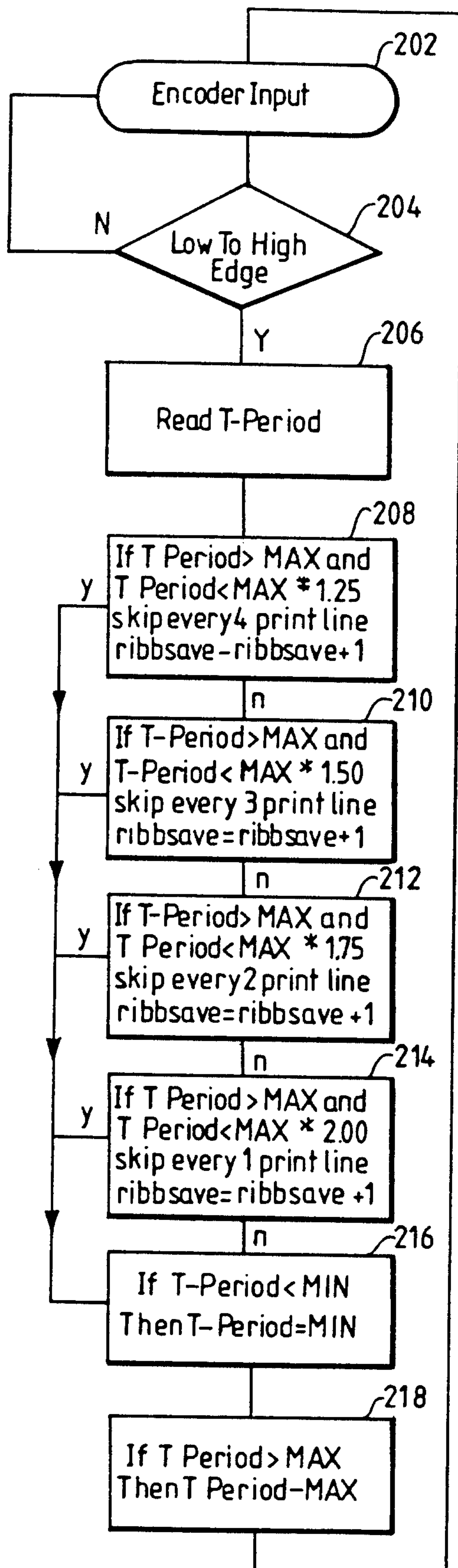


Fig. 6.

T Period Time Between Encode Pulses. Time is read on the high edge of each.

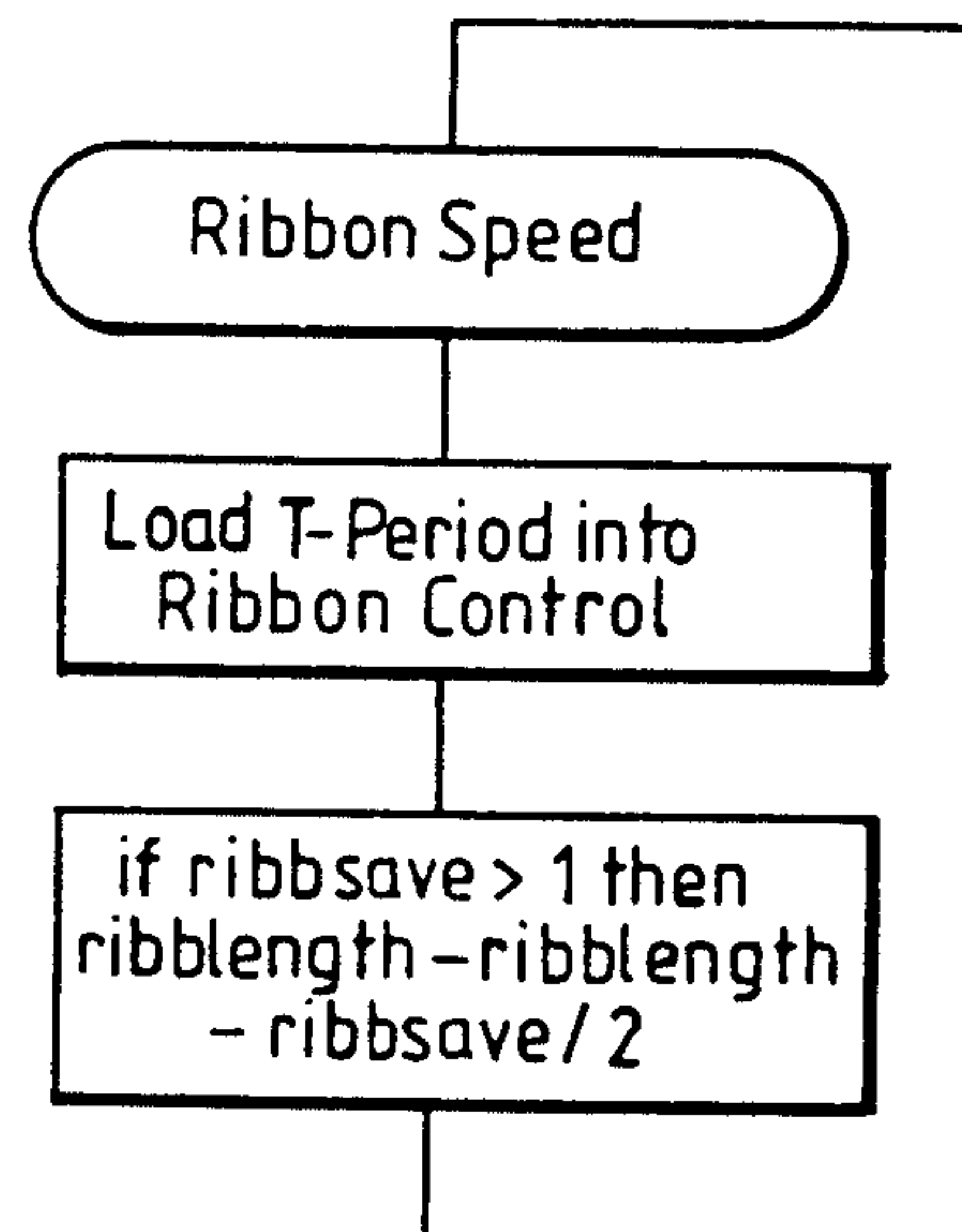


Fig. 7.

