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Title:

## Printer with a Print Head Distance-setting Device

This invention relates to a printer with a distance-setting device for a print head.

Such a distance-setting device is known (DE 42 21 265 C2). This design presupposes a print head freely movable in the direction of advance and thickness-sensing rollers. The thickness-sensing rollers transmit an indirectly generated electronic signal (analogue signal) which is supplied to a control means for the distance setting. In order to obtain this signal, a first magnetic flux is located on the thickness-sensing roller. Located on the print head carriage or slide is a second magnetic element generating an opposed second magnetic flux. A Hall-effect device is arranged in the region of the second magnetic flux on the print head slide and, when a recording medium is present and the print head slide is in a specific lateral position, the drive motor of the distance-setting device is activated, until the voltage corresponding to a basic air gap is present at the Hall element. This device acts with relatively high accuracy, but accuracy could usefully be increased further.

Moreover, it is located, in part, in a relatively accessible place on the print head slide and is not protected completely from external effects, such as, for example, contamination.

Another distance setting device (DE 196 11 772 A1) is based on the transport rollers which can be set to the paper thickness and which are arranged in pairs on a driven rigidly mounted shaft and on a pivot axis. Arranged on the pivot axis is a measurement-signal transmitter which co-operates with a measurement-signal receiver located on the print head slide.

Moreover, a position indicator for the print head slide is provided. Measurement signals occurring at the measurement-signal receiver are compared with clock pulses from the position indicator, specifically in the absence of paper and with paper in-

serted. The print head distance drive is controlled on the basis of the difference signal. This design, admittedly, is cost-effective, since only the measurement-signal transmitter and a conventional measurement-signal receiver are required. However, it is necessary for the light barrier formed to have highly accurate and stable switching points which cannot be maintained when the ambient and / or operating temperatures for the printer change.

In the case of dot-matrix and ink-jet printers, it is important for the distance from the print head end face to the recording medium ( for example, paper) to be printed to form a value located within narrow limits. Should the paper thickness change, for example, as a result of single-ply paper of different thickness or as a result of the use of multi-ply paper, the position of the print head relative to the printing abutment has to be reset in order to ensure optimum printing quality and a long print head life ( in the case of matrix printers).

The object on which this invention is based is to eliminate the effects of vibrations occurring as a result of the overall movement of the slide and print head and as a result of (stepping) motors and tolerances present between the measuring point and the print head end face.

According to this invention there is provided a printer with a distance-setting device for a print head which is moveable during printing back and forth on a carriage or slide, the print head being adjustable perpendicularly to the direction of movement towards and away from a printing abutment against which a print recording medium lies, the distance between the print head end face, on which the printing elements are located and recording medium lying against the printing abutment, being capable of being determined by means of a sensor carried by the slide, the slide being moveable relative to the printing abutment in a controlled manner by means of a drive, wherein relative movement between a probe on the slide and slide itself following contact between the probe and the recording medium is determined by means of a reflex sensor arranged in a space between the slide and a part coupled with the

probe, an output signal from the sensor serving to control the drive for setting the distance of the print head from the recording medium or from the printing abutment.

According to this invention there is further provided a printer with a distance-setting device for a print head which is moveable during printing back and forth on a slide, the print head being adjustable perpendicularly to the direction of movement towards and away from a printing abutment against which a print recording medium lies, the distance between the print head end face, on which the printing elements are located and recording medium lying against the printing abutment being capable of being determined by means of a sensor and the slide being moveable relative to the printing abutment in a controlled manner by means of a drive, wherein the print head forms the probe and is displaceable relative to the slide following contact with the recording medium, the displacement movement and / or displacement angle being measured using a reflex sensor which is arranged in a space between the slide and a surface of the print head, the measurement result from the sensor forming an output signal derived from an evaluation circuit serving to control a drive means for the setting of the distance of the print head from the recording medium or from the printing abutment.

During brief contact, slight deformation of the probe or the print head on the slide occurs, this deformation amounting to only a few  $\mu\text{m}$ , but is recorded as a signal change by the reflex sensor, without any other disturbing influence. The measurement operation can be triggered in an automated manner and is independent of the slide position.

A reliable initial position of the print head on the slide is obtained in a preferred embodiment if the print head is secured by a front part on the slide using a spring clip with an interposed elastic intermediate layer allowing limited movement.

The principle of the reflex of reflective sensor may be applied in many different embodiments. Correspondingly, there is provision, according to further preferred features, for the reflex sensor to be formed from a unit arranged on the slide and con-

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sisting of a light-emitting diode and a phototransistor located next to each other and with a reflecting surface arranged opposite the unit on the print head housing.

According to another preferred embodiment, there may be provision, with the same effect, for the reflex sensor to be formed from a Hall effect sensor arranged on the slide and with an opposed magnet secured to the print head housing.

Furthermore, the desired action may be achieved by forming the reflex sensor from a resistor arranged on the slide and sensitive to a magnetic field using an opposed magnet attached to the print head.

For the reflection of optical beams, it is advantageous if the reflex surface of the reflex sensor comprises a mirror. Simple polished metal plates are suitable as a mirror, and whether refraction is diffuse or specular is unimportant.

The possibility of external influences is detrimental to all electronic or optical elements operating with waves, beams or magnetic fields. For this reason, there is provision for arranging the units consisting of paired light-emitting diode and phototransistor with reflex surface or of a Hall effect sensor and magnet or of resistor sensitive to magnetic field and a magnet, in a protected space between a larger part of the print head housing and a surface of the slide, the said surface facing away from the printing abutment.

When the print head is moved up against the recording medium and / or up against the printing abutment, only a small electrical signal, which could be processed only with great difficulty, if at all, is generated. It is therefore expedient for a change in the signal to be sensed by the phototransistor.

According to further features, the signal is modified, in that the signal change, in the form of a difference signal, is supplied to an evaluation circuit, amplified and filtered.

A modified control signal is then obtained at the output of the evaluation circuit, in that the filtered signal change is freed of residual interference in an amplifier module by means of a voltage threshold and is defined as an output signal from the evaluation circuit.

In a further preferred arrangement the sensor element comprises a resiliently fastened angular arm, the first limb of which is located with a projection opposite the recording medium (the printing abutment) and the second limb of which forms part of the sensor. As a result, a simple manufacturing technique may be employed and the measuring pulse is transmitted to the reflex sensor reliably and over a short distance.

In another embodiment, the element, designed to be displaceably on the slide, comprises a resiliently mounted sensor, the front end of which forms the projection in relation to the recording medium and the rear of which forms part of the reflex sensor. Since the slide must be capable of being advanced in the direction of the recording medium / printing abutment, the sensor may remain out of contact with the paper except for measurement which amounts to only microseconds, and therefore does not disturb the printing operation or paper transport in any way.

According to other features, protected accommodation in a protected space, as before, is achieved in that the reflex sensor is arranged in the slide within a defined gap, and in that the light-emitting diode / phototransistor unit is located on one side of the gap and the reflex surface on the opposite side of the gap.

It is advantageous furthermore, if the sensor comprises a spring loaded pin and carries the reflex surface at the rear end. In this case, the reflex surface moves together with the sensor, whereas the light-emitting diode / phototransistor unit is connected rigidly to the slide.

An embodiment according to this invention and a modification is shown by way of example in the drawings and is described in more detail below.

In the drawings:

- Figure 1 shows a side view of a first embodiment with a print head on a slide movable perpendicularly to the printing plane,
- Figure 2 shows a front view of the slide with the print head attached,
- Figure 3 shows a profile of the I - d characteristic of the reflex sensor,
- Figure 4 shows a block diagram of the evaluation circuit,
- Figure 5 shows a side view of a second embodiment with slide guide and printing abutment, in an initial position,
- Figure 6 shows a view as in Figure 5, but in the contact position of the element on the recording medium,
- Figure 7 shows a side view of a third embodiment in the initial position, and
- Figure 8 shows a view as in Figure 7 but in the contact position of the element on the recording medium or on the printing abutment.

As shown in the drawings a printer with a distance-setting device for a print head 1 has a lateral slide guide 4 extending parallel to a printing abutment 2 in the direction of movement 3. The printing head 1, together with a slide 5, is capable of being advanced perpendicularly to the direction of travel 3, that is to say in the direction of advance 6 towards the printing abutment 2, in order to set the most favourable distance between the print head end face 1a, on which printing elements (pins or ink nozzles) are located, and the printing abutment 2. This distance depends on the thickness of the recording medium 7 ( for example, paper) to be printed and whether different paper thicknesses or different numbers of papers plies are present. This distance between the print head end face 1a and the recording medium 7 and printing abutment 2 is measured by means of a sensor, and the slide 5 is controlled and automatically set on the basis of the measurement result by means of a drive (not illustrated).

As shown in Figure 1, the printing head 1 is equipped with a front smaller part 1b and with a rear larger part 1c which accommodates the electromagnetic coils and arma-

ture in the case of dot matrix printers. By means of brief contact between the print head end face 1a and the recording medium 7 and / or the printing abutment 2, the print head housing 1f is displaced relative to the slide 5. The displacement travel and / or a displacement angle is measured by means of a reflex sensor 8. The reflex sensor 8 is located adjacent a lower part 1e in a free zone formed by a gap 9 between the slide 5 and an opposed surface 1d of the print head. The measurement result, in the form of an input signal 10 (Figure 4) to an evaluation circuit 11, serves for controlling a drive, not illustrated in detail, in the direction of advance 6 for the automatic setting of the distance of printing head 1 from the recording medium 7 or from the printing abutment 2. The input signal 10 therefore forms the basis for the movement of the printing elements pins or ink jets and for setting a new reference position in the case of paper of different thickness or a changed number of paper plies.

The printing head 1 is mounted in a stable manner during this operation with the printing head 1 secured by a front part 1b against the slide 5 and located on the larger rear part 1c in the case of dot matrix printing heads 1b. The part 1b is secured by means of a spring clip 13, with an elastic intermediate layer 12 (Figure 2). the printing head 1 has two pegs 1g passing through the intermediate layer 12 and engaging holes 5a in the slide 5.

The reflex sensor 8 comprises a unit 14 comprising a light-emitting diode 15 and a phototransistor 16 located in the same plane and spaced laterally on the slide 5 with a reflecting surface 17 which is arranged opposite the unit 14 on the print head housing 1f and which comprises a mirror 17.

The reflex sensor 8 may also be formed from a unit 14 including a Hall-effect sensor arranged on the slide 5 and from an opposed magnet attached to the print head housing 1f.

Another possibility for an unit 14 uses a resistor arranged on the slide 5 and sensitive to a magnetic field and a permanent magnet located opposite on the printhead housing 1f.

For each of the said units 14, as a result of an appropriate design for the print head housing 1f, a protected zone 18 is provided between the larger part 1c of the print head housing 1f and surface 19 of the slide 5, the said surface facing away from the print abutment 2 (Figure 1).

The measuring method adopted is based on the principle of an (optical) reflex sensor 8 using a signal change 23. As soon as the slide 5 together with the print head 1 moves in the direction of advance 6 against the recording medium 7 resting on the printing abutment 2, displacement of the print head 1 on the slide 5 occurs and the physical distance 20 between the unit 14 and the reflecting surface 17 changes (becoming larger).

An operating point 21 (Figure 3) is then selected on the I-d curve in the descending region of the reflex sensor 8, according to which a small signal decrease 22 of the typical magnitude of a few mV occurs as a result.

Due to the low magnitude of the effect, only the signal change 23 of the phototransistor 16 is recorded at the input module 14 in the evaluation circuit 11 (Figure 4). In a further module 25, filtering the signal change 23, amplified by the input module 24 takes place in order to free the signal of interference and offsets. In a further amplifier module 26, the final amplification of the filtered signal is carried out. Here, the signal change 23 is separated from residual interference by means of a low voltage threshold. By means of the measuring method described, a clear output signal 27 from the evaluation circuit 11 is obtained when the print head 1 impinges on the recording medium 7.

The origin of the output signal 27 is no longer dependent on the dynamics of the print head movement. As a result, the evaluation circuit 11, particularly the filter module 25, can be freely optimized. Further processing of the output signal 27 by means of software is carried out in order to eliminate the interference signals occurring due to mechanical vibrations in the printer.

Referring now to Figures 5 to 8 of the drawings, a printer, with a distance-setting device for the (ink jet-type or stylus pin-type) print head has a slide guide 4 extending parallel to a printing abutment 2 and parallel to the direction of travel. The print head can be advanced, together with a slide 5, towards the printing abutment 2 and perpendicularly to the direction of travel, that is to say in the direction of advance 6, in order to set the most favourable distance between the print head end face 1a, on which the printing elements are located, and the printing abutment 2. This will depend on the thickness of the recording medium 7 (for example, paper) to be printed, and whether different paper thicknesses or different numbers of paper plies are in use. The distance between the print head end face and the recording medium 7 / printing abutment 2 is measured by means of a reflex sensor 8, and the slide 5 is controlled and set in an automated manner to the optimum value by means of a drive (not illustrated) on the basis of the measurement results.

A brief contact between a flexible element 28 on the recording medium 7 and / or against the printing abutment 2 gives rise to a displacement angle of the reflex sensor 8. The reflex sensor 8 is arranged in a free space which is defined by a clearance 9. The element 28 is integrally formed directly on a slide 5 produced in one piece by plastic injection-moulding and having an angled arm 29 with a first limb 29a with a projection 30, the said first arm having a slightly resilient action due to a plastic hinge joint connection 31 and in an initial position (Figure 5) during printing, is spaced from the recording medium 7 or from the printing abutment 2. During the brief measuring operation (Figure 6) the projection 30 touches the recording medium or if there is no paper, the printing abutment 2 with the relative movement of the first limb 29a inducing a movement of a second limb 29b, so that the position of the components within the reflex sensor 8 is changed.

The reflex sensor 8 forms, on the slide 5, a unit 14 consisting of a light-emitting diode 15 and a phototransistor 16 located in the same plane as and at a lateral distance from the latter and a reflecting surface 17 which is arranged opposite these components and which is formed by a mirror 17a.

The reflex sensor 8 may also form a unit 14 comprising a Hall effect sensor arranged on the slide 5 and a magnet fastened opposite. A protected space 18 with side walls 19 is formed for each of the said units 14 by means of an appropriate design of the angular arm 29.

Another alternative is illustrated in Figures 7 and 8. Here the element 28 is mounted displaceably on the slide 5 and comprises a resilient mounted probe 32, the front end 32a of which forms the projection 30 of the embodiment of Figures 5 and 6 in relation to the recording medium 7 and the rear end 32b of which forms part of a constituent of the reflex sensor 8. The reflex sensor 8 is arranged in the slide 5 within a gap 33 (Figure 8) with the light-emitting diode 15 / phototransistor 16 unit being located on the rear side 34 of side wall 19 defining the gap 33 and the reflective surfaces 17 on the opposite front side 35 of the gap 33.

Then probe 32 which acts like a sensor, comprises a headed pin and carries the reflective surface 17 on the rear end 32b. The initial position of the probe (sensor) 32 is maintained by means of a compression spring 36 around the pin shank and retained by a shoulder abutment.

## CLAIMS

1. Printer with a distance-setting device for a print head which is moveable during printing back and forth on a carriage or slide, the print head being adjustable perpendicularly to the direction of slide movement towards and away from a printing abutment against which a print recording medium lies, the distance between the print head end face, on which the printing elements are located and recording medium lying against the printing abutment, being capable of being determined by means of a sensor carried by the slide, the slide being moveable relative to the printing abutment in a controlled manner by means of a drive, wherein relative movement between a probe on the slide and the slide itself following contact between the probe and the recording medium is determined by means of a sensor positioned between the slide and a part coupled with and moveable by the probe, an output signal from the sensor serving to control the drive for setting the distance of the print head from the recording medium or from the printing abutment.
2. Printer with a distance-setting device for a print head which is moveable during printing back and forth on a slide, the print head being adjustable perpendicularly to the direction of movement towards and away from a printing abutment against which a print recording medium lies, the distance between the print head end face, on which the printing elements are located and recording medium lying against the printing abutment being capable of being determined by means of a sensor and the slide being moveable relative to the printing abutment in a controlled manner by means of a drive, wherein the print head or integral part thereof forms a probe and is displaceable relative to the slide following contact with the recording medium, the displacement movement and / or displacement angle being measured using a reflex sensor which is arranged in a space between the slide and a surface of the print head, the measurement result from the sensor forming an output signal processed by an evaluation circuit the signal serving to control a drive means for the setting of the distance of the print head from the recording medium or from the printing abutment.

3. Printer according to Claim 2 wherein the print head is secured by a front part on the slide using a spring clip with an interposed elastic intermediate layer providing for relative movement between the slide and print head.
4. Printer according to Claim 1, 2 or 3, wherein the reflex sensor is formed from a unit arranged on the slide and comprising a light-emitting diode and an adjacent phototransistor, with a reflecting surface arranged in opposed relationship on the probe or the print head housing.
5. Printer according to Claim 1, 2 or 3, wherein the reflex sensor is formed from a Hall effect sensor arranged on the slide and an opposed magnet secured to the probe or the print head housing.
6. Printer according to Claim 1, 2 or 3, wherein the reflex sensor is formed from a resistor arranged on the slide and sensitive to a magnetic field and an opposed magnet on the probe or the print head housing.
7. Printer according to any one of Claims 1 to 4, wherein a reflecting surface of the reflex sensor comprises a mirror.
8. Printer according to any one of claims 1 to 7, wherein the reflex sensor unit comprises a light-emitting diode and a phototransistor with a reflecting surface or a Hall effect sensor and magnet or a resistor sensitive to a magnetic field and magnet, and arranged in a partially enclosed zone between a part of the probe or the print head housing and a surface of the slide, the said surface facing away from the printing abutment.
9. Printer according to any one of Claims 1 to 8, wherein the signal change on displacement of the probe is detected by the phototransistor.

10. Printer according to any of Claims 1 to 9, wherein a signal output change from the sensor provides a modified difference signal which is amplified and filtered by an evaluation circuit.
11. Printer according to any one of Claims 1 to 10 wherein the filtered change in sensor signal is cleared of residual interference in an amplifier module using a voltage threshold and forms the output signal of an evaluation circuit.
12. A printer with a print head to print recording medium distance setting device as described herein and exemplified with reference to Figures 1 to 4 of the drawings.
13. A printer in accordance with Claim 1, wherein the slide carries the print head and has a displaceably mounted probe element comprising an arm operatively with a reflex sensor, the sensor being triggered following contact between said arm and print recording medium.
14. Printer according to Claim 13, wherein the arm is resiliently connected with the slide and has a first limb with a projection forming a probe to contact the recording medium and a second limb which forms part of the reflex sensor assembly.
15. Printer according to Claim 1, wherein the probe comprises a displaceable pin, the front end of which forms a projection to contact the recording medium and the rear end of which forms part of the reflex sensor.
16. Printer according to any preceding Claim, wherein the reflex sensor is arranged on the slide within a defined gap with a light-emitting diode and photo-transistor unit located on one side of the gap and a reflective surface on the opposite side of the gap.

17. Printer according to Claim 1 or 13 to 16, wherein the probe is a displaceable pin having a head which carries a reflecting surface.
18. A printer with a print head to print recording medium distance setting device as described herein and exemplified with reference to Figures 5 to 8 of the drawings.