

PATENT SPECIFICATION

(11) 1 473 868



(21) Application No. 44448/74 (22) Filed 14 Oct. 1974

(31) Convention Application No. 70117

(32) Filed 23 Oct. 1973

(31) Convention Application No. 68469

(32) Filed 10 May 1974 in

(33) Italy (IT)

(44) Complete Specification published 18 May 1977

(51) INT CL² B41J 3/20

(52) Index at acceptance

B6F 5A21 5AY 6B9A 6B9Y 6G2B5 6G2Y 7L1 7LY 8A12A
8A12Y L8

(72) Inventors RENATO CONTA
LUCIO MONTANARI
RICCARDO BRESCIA
FLAVIO BISSON and
ARMANDO APRATO

(54) IMPROVEMENTS RELATING TO ELECTROTHERMAL PRINTERS

(71) We, ING. C. OLIVETTI & C.,
Societa per Azioni, a body corporate
organised and existing under the laws of
Italy, of Via G. Jervis 77, 10015 Ivrea
(Turin), Italy, do hereby declare the
invention, for which we pray that a patent
may be granted to us, and the method by
which it is to be performed, to be
particularly described in and by the
following statement:—

The present invention relates to an
electrothermal printer having an improved
printing head for impactless printing. Such
a head is designed to produce, in response
to ingoing electrical impulses, visible
imprints on a recording medium which is
electrically insulating and heat sensitive.

For effective utilization of the speed of
modern systems of electronic information
handling, it is essential to have available
peripheral high-speed printing units, and it
is also desirable that such printing units
should be fairly noiseless, since they are
normally located near the user, in offices or
other working sites. While the use of
printing devices depending on the ballistic
impact of a character-bearing member
against an inked ribbon in contact with the
recording medium often involves speed
limitations intrinsic to the system of
mechanical actuation of the character-
bearing member, with noise levels often
reaching the limits of tolerability,
introduction of impactless printing devices
removes the above-mentioned drawbacks
of noisiness and slowness.

Impactless printing devices are known
which utilize the method of electrothermal
printing. For example, British Patent No.
1,151,848 relates to an electrothermal

printing unit having a printing head with a
matrix of points or printing elements for
generating characters to be printed. The
matrix is composed normally of 35
elements, i.e. of five columns evenly spaced
over the width of the character, each
containing seven elements, the seven
elements of each column being also evenly
spaced over the height of the character to
be printed. The elements are heated by
resistances incorporated in them when they
are subjected to an electrical potential
difference.

Printing takes place character by
character, a selection and control circuit
providing for electrical excitation and
heating only those points of the matrix
required to form the character that is to be
printed.

According to the patent above-
mentioned, the operation of printing is
performed with a head fixed relative to the
recording medium, and consists of pressing
the head, with the printing points warm, on
to the heat-sensitive recording medium.
This operation is therefore similar to a hot-
stamping operation, and the imprint of each
point on the recording medium is
substantially the same size as the printing
points. The movement of the head along a
printing line is therefore intermittent, with
a number of halts equal to the number of
the characters constituting a line of print.
These halts, however brief and alternating
with very rapid movements from one
printing position to the next, contribute
intrinsically to slowing down the printing
speed.

Another method of printing by points of
the electrothermal type, to which reference

1 473 868

5

10

15

20

25

30

35

40

45

50

55

60

65

70

75

80

is made in our British Patent No. 1,402,269, consists in using an electrothermal head having a single column of seven elements regularly spaced over the height of the character to be printed; the height of each of these printing elements is that of the printed point which it is desired to obtain on the recording medium, while the width of each element is much less than that of the printed point. This permits the head to move continuously along a line of print, the printed point resulting from the combined action of heating the printing element and from the movement of the latter.

Now if we consider a configuration of characters of the kind of those obtainable with a matrix of 7x5 elements such as those described, this latter head generates each character by five elementary printing acts, a control and selecting circuit taking care of actuating, with the required delays, the elements required for printing the desired character.

Although in comparison with the method described in the aforesaid United States Patent an increased number of elementary printing acts is required to form the characters, this last method permits higher printing speeds, since the head moves rapidly and without any interruption along a line of print. In addition, the arrangements for moving the head are considerably simplified, since a step-wise movement is no longer necessary.

The device of our aforementioned patent has, however, some drawbacks relating to the individual printing elements and fitting them into a single head. The elements are composed of graphite and are built into a rectangular body connected to the control and piloting circuit; on a tapered portion is formed the printing surface. The elements are fitted in a single head, with the printing surfaces in contact with a ribbon of metallic material, supported by the head, which constitutes the common return line for the actuation circuits of all of the printing elements. The head is positioned so that the metallic ribbon is in contact with a heat-sensitive recording medium.

The contact resistances between the printing surfaces of each element and the metallic ribbon, the particular dimensions of the printing elements and finally the material used, all contribute to a considerable increase in the electrical power required for activation of the printing elements.

The object of the present invention is to provide a printer with a printing head of the electrothermal kind with printing elements capable of printing while continuously sliding along a recording medium, in which the printing elements are so formed that they permit higher printing speed, better

definition of the printed points and therefore of the printed characters, and at the same time reduce the electric power required for excitation of the printing elements.

In accordance with the invention, there is provided an electrothermal printer for effecting impactless printing on heat-sensitive recording means, comprising an electrothermal printing head and means for effecting relative movement along a printing direction between the printing head and means for supporting a heat-sensitive recording medium, the printing head comprising an electrically insulating support having a surface facing the said supporting means, a pattern of conductors lying on the said surface and a plurality of individually energisable resistive printing elements on the said surface, each making contact with two of the conductors, by way of which conductors the elements can be selectively energised, each element comprising a region of resistive material which has a part-cylindrical outer surface concave towards the said surface, the generatrices of the part-cylindrical outer surface of all regions being parallel to a common direction which is transverse to the printing direction.

In thermal printers, the thermal printing head is normally fixedly secured to the carriage which moves the head along a printing line of the recording medium. Therefore, the replacing of the head owing to breakage or wear thereof is generally an operation that cannot be carried out by the user but requires the attention of skilled personnel as, normally, they have to unscrew securing screws, to disconnect electric connections and to restore them when the replacing operation is carried out and, finally, to adjust the head position with respect to the printing medium by means of suitable adjusting devices.

Furthermore, the use of a head fixedly mounted on the carriage does not confer thereon any flexibility of the printing character format or type face for the user, namely, it does not allow the user to select, for instance, italic characters by the immediate positioning of a suitable head on the carriage of the printer.

Embodiments of the invention provide a device for positioning and removably fixing the head on the part of the printer which carries the head.

The invention will be described in more detail, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is an exploded perspective view of a printing device using an electrothermal head embodying the invention;

Figure 2 is a front view of a first embodiment of an electrothermal head;

Figure 3 is a plan view of the head of Figure 2;

Figure 4 is an enlarged detail of Figure 2;

Figure 5 is a section along line V—V of Figure 4;

Figure 6 is an enlarged detail of a front view of a second embodiment of an electrothermal head;

Figure 7 is a section along line VII—VII of Figure 6;

Figure 8 is a front view of a third embodiment of a head;

Figure 9 is a plan view of the head of Figure 8;

Figure 10 is a plan view of a fourth embodiment of a head;

Figure 11 is a front view of a fifth embodiment of an electrothermal head;

Figure 12 is an enlarged detail of Figure 11;

Figure 13 is a section along line XIII—XIII of Figure 12;

Figure 14 is a perspective view of a first embodiment of a positioning and locking device for removably fixing the head on the carriage;

Figure 15 is a perspective view of a second embodiment of the positioning and locking device;

Figure 16 is a side view of the device of Figure 15;

Figure 17 is a cross-section IV—IV of the device of Figure 16;

Figure 18 is a cross-section V—V of the device of Figure 17; and

Figure 19 is a perspective view of a third embodiment of the locking device.

Figures 2, 3, 4 and 5 relate to a first embodiment of a thermographic head according to the invention. The head comprises a support 10 (Figure 2) in the form of a rectangular plate, on a planar face 11 of which, near a side 12, are deposited seven resistance elements 13 aligned parallel to the side 12, each having the base in contact with the face 11. Each base is substantially rectangular (Figure 4) with a short side 14 parallel to the side 12. The surfaces of the resistance elements 13, opposite to the base in contact with the face 11, have a part-cylindrical form with the generatrices parallel to the side 14, and the concavity turned towards the base in contact with the face 11 (Figure 5).

Seven feed conductors 15 (Figure 2) deposited on the face 11, one for every resistance element 13, extend substantially parallel to each other and suitably spaced, from the side 16 adjacent to the side 12 until they contact the resistance elements 13 (Figure 4) along the dimension 14 of these latter, extending part-way under the base.

Seven return conductors 17, deposited on the face 11 extend perpendicular to the side 12 and are in contact, at one end, with the

resistance elements 13 along a line of contact parallel to the side 14, and at the other end with a common conductor 18, also deposited on the face 11, which extends parallel to the side 12 (Figure 2) as far as the side 16. Again, the conductors 17 partly underlie the bases of the elements.

The technique for obtaining such a deposit of resistance elements and conductors on the face 11 can be one of the many known in the art; as a preferred example the thick film technique may be cited to which particular reference is made in connection with Figures 2, 4 and 5 of the present description. Using this technique, the conducting layers 15, 17 and 18 are first deposited by means of thick film conducting pastes, such as for instance, gold, silver-palladium, or gold-palladium, according to the configuration shown in Figure 4, i.e. leaving a gap of a few tenths of a micron between each feed conductor 15 and the corresponding return conductor 17. In this way, there are formed on the face 11 seven rectangular zones 20, not covered with conducting material and interposed between a feed conductor 15 and the corresponding return conductor 17, which are aligned with side 12 of the face 11 and have dimensions equal to the width of the feed and return conductors of the said zones (of the order of hundreds of microns), and to the width of the gap a .

In each zone 20 there are then deposited, using thick film techniques, further layers of thick film resistance paste, as for example, oxides of bismuth and ruthenium, or noble metals, in order to obtain the resistance element 13 of the required thickness and cross-section.

By suitable control of the operations of depositing the resistive layers, it is possible to obtain the outer surface of the resistance elements 13 with the curvature described above. Deposition of the resistive layers leads to spreading of the resistance paste beyond the above-mentioned zone 20 above the conducting layers 15, 17 and 18, forming portions of the resistance elements 13 which, at least from the electrical aspect, are completely short-circuited by the underlying conducting layers 15, 17 and 18. The only portion of the element 13 electrically activable is that deposited in the above-mentioned zone 20 and delimited by the hatched lines in Figure 5.

Within the limits above described, the dimensions of the zone 20 and of the conducting layers 15, 17 and 18 may vary at discretion. In practice, good results of low electricity consumption, better definition of the printed characters and higher printing speed, have been obtained with conducting layers of thickness 7—10 μ and widths of

(12)

200 μ in the proximity of zone 20, and with a gap width of about 50 μ .
The distance between one resistance element and another depends on the height of the character to be printed and the necessity for maintaining good electrical insulation between each resistance element 13 and the next. For printing characters with a height of 2.54 mm a distance of about 200 μ provides satisfactory results. The function of the resistance elements 13 is to produce heat in zone 20 as a consequence of the passage of an electrical current through them, thus generating a "hot point" having the dimensions of the zone 20. Therefore the resistance of these resistance elements must be at least an order of magnitude greater than that of the corresponding conductors. In practice it is found that a resistance of about 60 to 100 ohms is sufficient for heating to a temperature of 150–200°C with a current of 150 to 200 mA.
Figures 6 and 7 show a second embodiment for the resistor elements of the electrothermal head according to the invention. Figure 6 is an enlargement of the zone of the face 11 of the plate 10, adjacent to the side 12, while the configuration of the conductors 15 in the remaining part of the face 10 is identical with that seen in the first embodiment. In this zone on the other hand, differing from what is described in the first embodiment, the conductors 15 show a first portion of reduced width 30 so that their relative distance is increased compared with the first embodiment, and an adjoining end portion 31 in which the width of every conductor is increased compared with that of the portion 30 and also compared with that of the corresponding portion in the first embodiment: in fact it is about 300 μ , while the corresponding distance between the conductors 15 becomes, in these terminal portions, about 100 μ . The terminal portions 31 of the conductors 15 face the conductor 18 deposited on the face 11, separated from it by a gap b equal to 50 μ and extending parallel to the side 12 as far as the side 16 of the face 11.
A strip 35 consisting of several layers of thick film resistor paste is deposited above the terminal portions 31 and the conductor 18 parallel to the side 12 and over the whole zone concerning the conductors 15. The strip 35 has the surface which is not in contact with the face 11 part-cylindrical with the concavity turned towards the face 11 (Figure 7) and the generatrices parallel to the side 12.
When a potential difference of a suitable value is applied between one of the conductors 15 and the conductor 18 there circulates in the circuit composed of these conductors 15 and 18 and the resistor zone

included between them, an electric current which heats up the zone included between the terminal portion 31 of the excited conductor 15 and the common return conductor 18, thus defining, as in the first embodiment, a "hot point" substantially rectangular in form with dimensions approximately equal to the width of the terminal portion 31 and to the width of the gap b .
The arrangement of the conductors 15 is such as to prevent undesired heating of the parts of the resistor strip adjacent to the thermally excited part. Compared with the first embodiment this avoids physical separation of the resistor elements 13 while ensuring the required thermal insulation between portions of the strip 35 included between different conductors 15.
As stated above, the head is designed for printing characters with matrices of points, in elementary printing acts during each of which a column of the character is printed on a recording medium in continuous relative movement with respect to the head during the printing operation. A head-sensitive recording medium 25 (Figure 3) may, for example, be composed of treated paper consisting of a normal sheet of paper acting as support, covered with a layer of heat-sensitive material having the property of changing colour when it is raised to a temperature above a certain threshold characteristic of the material in question. The initial and final colours depend both on the paper support and on the heat-sensitive material coating it. In general it is preferred to have a very light initial colour and a very dark final colour in order to get a good contrast in the print-out. Another recording medium can be represented by a heat-transferable inked ribbon of known type, interposed between the head and a sheet of ordinary paper on to which ink transfer occurs by selective heating of the ribbon. For printing, the head is positioned for example on a sheet 25 of heat-sensitive paper of the above described type, in such a way that the column of resistor elements 13 or the resistor strip 35 is in contact with the paper and perpendicular to a line to be printed (Figure 3). The overall length of the column of the seven resistor elements 13 or of the strip 35 thus determines the height of the character to be printed. By using the support 10 in the form of a rectangular plate as shown in Figures 2 and 3 the electrothermal head can also be positioned so that the plane of the face 11 of the plate 10 makes with the plane of the paper an angle α of a few degrees, from 0.5° to 2.5°. This inclined position is desirable to prevent the head from catching on the sheet, as could happen if the head were kept with the face 11 parallel to the plane of

the paper, since the thickness of the resistive paste which separates the face 11 from the sheet 25 is any how very little, normally less than $60\ \mu$. The inclination of the head relative to the heat-sensitive paper is not however essential, since it is a consequence of the type of support used for the conducting and resisting deposits.

In Figures 8, 9 and 10 are shown two examples of embodiments of the thermographic head in which the support is such as to prevent the possibility of catching on the recording medium, and which in addition permit sliding and two-directional printing on the medium without inclining the support relative to the recording medium.

In Figures 8 and 9 the support 10 has a trapezoidal section with the obtuse angles β between the minor base and the oblique sides (Figure 9) a little less than 180° . The resistor elements 13, or the resistor strip 35, and the end portions of the conductors, 15 and 18, are deposited according to the geometry of Figures 5 and 6 on the face 37 corresponding to the minor base and having a width little greater than the width of the resistor elements 13, while the conductors 15 and 18 extend on the faces 39 and 40 corresponding to the oblique sides of the section of the support 10. The head is positioned relative to the plane of the registration medium 25 as indicated in Figure 9, i.e. with the surface 37 parallel to the registration medium.

In Figure 10 the support 10 has a part-cylindrical surface 28 with its generatrix perpendicular to the plane of Figure 10; in such a case the resistor deposits 13 are produced on the top of the surface along the generatrix. The conductors 15 and 18 extend suitably spaced on the surface 28. The head is positioned relative to the recording medium as indicated in Figure 10, with the plane of the recording medium 25 in contact with the resistor elements 13 and with the curved surface 28 substantially tangent to the recording plane.

Whichever type of support is used, contact between the resistor elements 13 or the strip 35 and the heat-sensitive sheet of paper 25 occurs, because of their curved surfaces, along a tangent line (theoretically only a line) perpendicular to a print line and hence to the direction of movement of the head along the paper. In practice this tangent line has a finite width of less than $50\ \mu$, i.e. smaller than the width of the zone 20 (gap a) of the resistor elements 13 or the gap b of the strip 35. The feed conductors 15 and the common return conductor 18 are connected to a selector and control circuit designed to energize electrically, and hence thermally, during the movement of the head relative to the paper, those

elements in the column of resistor elements 13 required for formation of the character to be printed. This circuit can be similar to that described in our patent aforementioned and will therefore not be described in what follows.

The use of a "hot point" of the type described above permits a considerable increase in the velocity of sliding of the head across the paper, without however having recourse to very short excitation times which could lead to results difficult to control. Having decided on the width of the printing "hot point" and that of the printed point that is to be obtained (normally the printed point is square and hence its width corresponds to the height of the printing "hot point") it is in fact evident that increasing the velocity of sliding of the head across the paper implies a corresponding diminution of the time of thermal excitation of the "hot point" during such movement in order to obtain a printed point with the required dimensions, but it is however not possible to limit the excitation time below a certain value corresponding to the thermal inertia of each resistor element 13, i.e. the time required for altering its temperature from a value above the threshold to a value below it and vice versa. The thermal inertia is in general a function of the dimensions of the body to be heated, and hence the fact of having constructed a resistor element 13 with the above-mentioned characteristics, i.e. heated parts of minimal dimensions and making tangential contact with the recording medium, results in the double advantage of reduced thermal inertia and the possibility, even at high sliding velocities, of using relatively long excitation times resulting in greater definition and coloration of the printed point. Given also the values of resistance and current involved, the result is that the electric power required for energizing the resistor elements is reduced to very low values, of the order of 2 to 4 watt, i.e. low enough to permit power supply from batteries.

In Figures 11, 12 and 13 there is shown a further embodiment of the thermal head according to the invention, in which the same precision of deposition of the conductor and resistor layers is maintained, which, thanks to a different geometry of the electrodes and feed conductors allows about twice as good definition as that obtainable with the previous embodiments, more precisely, to obtain on the same height of the character, a column of thirteen "hot points" or printing points which can be individually selected. An arrangement of this kind, however, evidently requires a selection and control circuit designed for selective feeding of

thirteen instead of seven hot points. With reference to Figure 12, on a support 10 trapezoidal in section, of the type illustrated in Figure 9, there are deposited on the thick film technique a first and a second group of seven conductors respectively 61 to 67 and 68 to 74, spaced regularly on each of the two oblique faces 39 and 40 and having enlarged terminal portions 61a to 67a and 68a to 74a respectively on the face 37, which are opposite but staggered with respect to each other according to the geometry shown in Figure 12. The distance *c* between each conductor of the first group and the opposite ones of the second group is about 50 μ . The width *d* of the terminal portions is identical for both groups and is about 350 μ . The distance *e* between two contiguous terminal portions of the same group is 30 to 50 μ . The width *f* of the conductors near the terminal zones is about 100 μ . Above the opposed terminal portions 61a to 67a and 68a to 74a there is deposited, by the thick film technique, a strip 75 of several layers of resistive paste in thick film, extending perpendicular to the direction of the conductors over the whole zone in question of the terminal portions. The strip has its cylindrical curved surface which is not in contact with the face 37 with its concavity turned towards the face 37 (Figure 13).

As an illustration, the conductors of each family are shown electrically connected (Figure 11) through the switches 61b to 67b and 68b to 74b to opposite poles of a generator 76 of an electric potential of suitable value. Simultaneous closure for example of the switches 61b and 69b produces current flow in the circuit consisting of the conductors 61, 69 (Figure 12) and of the zone 81 of the resistor strip 75 included between the facing parts of the terminal portions 61a and 69a. This current causes heating of the resistor paste located in the zone 81, thus defining a "hot point" of dimensions about 50 $\mu \times$ 150 μ .

The arrangement of the conductors and the choice of their dimensions is such as to prevent heating up of the portions of the resistor strip adjacent to that selected. Since there are thirteen zones in which terminal portions of conductors of the first family are opposite terminal portions of the second family, it is eventually possible to single out in the strip of resistor paste 13 hot portions or hot points 80 to 92 which are selectively and individually thermally activable, which, if desired, may be physically separated by transverse recesses 96 produced in the strip 75. With the dimensions shown, it is clear that the technique of deposition does not call for greater precision than that required for the first two embodiments. The considerations

cited in regard to the positioning of the head relative to the registration medium, and its method of printing, are also valid. The two groups of conductors must be connected to a control and selecting circuit of generally known type, designed to activate, with the required delay, at each elementary printing act the portions 80 to 93 of the resistor strip required for printing the desired characters.

Figure 1 shows in a partially exploded perspective view, a printing machine whose carriage is indicated generally by 42, which uses the first embodiment of the electrothermal head for in-line printing of characters along a line of print.

The head is fixed, for example by an adhesive, on the face 43 of a support block 44 designed to engage with a positioning and locking device 46 fixed on a carriage 47 for the purpose of positioning the support block 44 and hence the head fixed on to the same so that it contacts the sheet of heat-sensitive paper 25 at the desired angle of inclination α , and with the resistor elements 13 perpendicular to a line of print, as will be better described in what follows. Also fixed to the carriage 47 are eight electrically-conducting elastic laminae 48 connected through a cable 49 to the selector and control circuit (not shown in the Figure), which make contact, when the support 44 is positioned on the carriage 47, with the terminal parts of the seven conductors 15 and of the conductor 18 next to the side 16 of the plate 10, thus ensuring electrical connection of the latter with the above-mentioned selector and control circuit.

The carriage 47 is mounted so that it can slide on a guide 50 extending transverse to the sheet of heat-sensitive paper 25 and fixed at opposite ends to the body 42; the carriage is also able to rotate about said guide and for this purpose cooperates with a bar 51 fixed to the body 42 and movable vertically.

Means for pulling the carriage in continuous motion along the guide are known in the art and are not indicated in the Figure. The sheet of heat-sensitive paper is fed from a reel 52 and pulled stepwise by the rollers 53 and 54, during each step the sheet being moved to a new printing line.

The sheet 25 is kept in contact, along the printing line, with a flat platen 55 fixed to the body 42. During movement of the carriage from left to right, with reference to Figure 1, the bar 51 is in the position of the Figure, so that the head contacts the sheet of heat-sensitive paper 25 along the printing line and the operations of printing take place on it with formation of the characters 56.

When the carriage has completed its

course towards the right the bar is moved vertically downwards so that the carriage is turned to the right and the printing head is withdrawn from the heat-sensitive paper, and the carriage can carry out its return run to the left free from any risk of catching the head on the paper. During the movement of the carriage to the left the sheet 25 is pulled by the rollers 53 and 54 and shifted to a new printing line.

The use of seven or thirteen resistor elements 13 or printing points, arranged in line and perpendicular to a line of print along the height of the character, is not to be regarded as a limiting example, either relative to their arrangement with respect to the recording medium or relative to the number of resistor elements used.

For example, the column of resistor elements 13 may be as long as a printing line on the registration means and may contain a number of resistor elements equal to a multiple n (say 5) of the number of characters which can be printed on a printing line. The head is positioned in this case with the column of resistor elements 13 parallel to the printing line but perpendicular to the direction of the continuous pulling movement of the sheet. In this case, the printing is of the "parallel" kind and during each elementary act of printing there is, if we consider characters printed with matrices of m rows for n columns, printing of one of the m rows of all characters in one line of print.

Figure 14 shows a first detailed embodiment of the device for positioning and locking the head on to the carriage 47. Referring to Figure 14, the support plate 10 of the head is secured to the surface 43 of a prismatic support 44 by suitable means, for instance by adhesive. The prismatic support 44 furthermore comprises a surface 100 opposite to the surface 43, and two flanks 101 and 102 extending perpendicularly to the surface 100. If the support 10 cross-section is rectangular, namely as specified in the first embodiment of the print head, then the surface 43 is inclined with respect to the surface 100 by an angle α corresponding to that shown in Figure 3. When conversely, the support 10 has a trapezoidal or a semicylindrical section as according to other embodiments of the print head, then the surface 43 and the surface 100 should be in parallel relation to each other. Hereinafter, reference will be made to the drawings referring to the embodiment provided with a flat rectangular plate as shown in Figure 3.

Provided in the two flanks 101 and 102 are two symmetrically located grooves 105 and 106 respectively, extending along the whole height of the support 44, and two tapered projections 107 and 108 each

having a first flat working portion 109 and a second flat working portion 110. A pair of guides 112 and 113 is unitary with the flat portion 114 of the carriage 47. The guides 112 and 113 are suitable to engage the grooves 105 and 106 and to allow the support 44 to slide therebetween for its positioning with respect to the carriage 47. Two resilient elements 117 and 118, for instance of a flexible plastics material, are also unitary with the flat portion 114 of the carriage 47 in parallel relation to the guides 112 and 113 and suitably spaced therefrom.

The free ends of the resilient elements 117 and 118 have a tapered shape provided with flat working portions 120 and 121 and are suitable to engage the lateral projections 107 and 108 for locking the support 44 on to the carriage 47. Secured to the flat portion 114 of the carriage 47 are furthermore eight resilient electrically conductive laminae 48 which are connected as already specified to the selection and control circuit of the printing thermoelement by means of the cable 49.

The tongues 48 are located so as to contact the end portions, near the side 16 of the plate 10, of the feed conductors 15 and of the return conductor 18 of the first head of Figure 2 and to exert a pressure against the plate 10 owing to their resilience, so as to guarantee a good electric contact with the said end portions, when the support 44 is slid into the carriage.

To slide the support 44 into the carriage 47, the grooves 105 and 106 should engage the guides 112 and 113, respectively, keeping the surface 43 facing the recording medium (see also Figure 1) and then the support 44 should be displaced along the guides 105 and 106 until the base 124 of the support 44 contacts the flat portion 114 of the carriage 47.

During this displacing operation, when the flat working portions 110 of the projections 107 and 108 co-operate with the flat portions 120 of the free ends of the resilient elements 117 and 118, said elements 117 and 118 flex outwards, increasing the space from each other and allowing the continuation of the displacing movement and the transit of the side projections 107 and 108 therebetween. When the surfaces 110 and 120 cease their mutual engagement, the resilient elements 117 and 118 snap back to their original position and the surfaces 121 of their free ends engage the surfaces 109 of the side projections 107 and 108, so as to push the support 44 to contact the flat portion 114 of the carriage 47 by its base 124 and to lock it fixedly thereon.

In the meantime, the eight resilient tongues 48 are flexed by the support 44 and urged against the face 11 of the support 10,

thus ensuring the electric contact with the terminal portions of the conductors 15 and 18.

5 The head extraction operation is carried out by grasping the head and pulling it upwards; owing to this movement, the engaging of the flat working portions 109 of the projections 107 and 108 with the flat portions 121 of the resilient elements 117 and 118 causes the latter to be flexed outwards thus allowing the support to be displaced along the guides 112 and 113 and to be extracted.

15 Figures 15, 16, 17 and 18 show a second embodiment of the positioning and locking device; differing from the previously described one in that the resilient elements locking the plate carrying support 44 on to the carriage 47 are assembled on the support 44.

20 The support 44, having substantially a parallelepiped shape, comprises a first surface 130 where to the plate 10 of the head is secured by an adhesive, a second surface 131 opposite to the surface 130 and inclined with respect to it by an angle α corresponding to that specified in Figure 3, an upper surface 132, a base surface 133 parallel to the surface 132 and perpendicular to the surface 131, and two flanks 138.

30 Provided in the two flanks 137 and 138, being symmetrically located with reference to a mean axis in perpendicular relation to the surfaces 132 and 133, are two like grooves 140 and 141 extending from the base surface 133 up nearly the full height of the support 44. The grooves 140 and 141 intercommunicate near the upper surface 132 through a substantially square hole 143 going through from flank 137 to flank 138. A circular hole 145 located at the centre of the base surface 133 of the support 44 extends inside the latter in perpendicular relation to the base surface 133, as far as the hole 143.

45 Two like L-shaped levers 147 and 148 are provided with first arms 150 and 151 accommodated in the side grooves 140 and 141, respectively, and with second arms 152 and 153 extending alongside each other through the hole 143. The free ends of the second arms 152 and 153 are constituted by enlarged heads 155 and 156, projecting from the hole 143 along the flanks 137 and 138. The levers 147 and 148 are pivoted at the lower ends of their first arms 150 and 151 on pins 158 and 159 secured inside the grooves 140 and 141, perpendicular to the surface 131 of the support 44.

60 Secured to the flat portion 114 of the carriage 47 is a pin 160 perpendicular with respect to this flat portion and suitable to be inserted into the hole 145 of the support 44 for locking the latter on to the carriage

47. The pin 160 is provided with a circumferential groove 161 located near its free end.

Two projections 163 and 164 integral with the first arms 150 and 151 of the levers 147 and 148 can enter the groove 161 of the pin 160 when the support 44 is placed on the carriage 47, owing to the bias of a spring 166 stretched between two lugs 167 and 168 on the second arms 152 and 153.

A pin 170 standing up from the flat portion 114 of the carriage 47 abuts one internal surface 171 of the groove 141 when the support 44 is in place.

80 The support 44 is placed on the carriage 47 by squeezing in the two heads 155 and 156 against the bias of the spring 166, thus spreading apart the two projections 163 and 164 for allowing the insertion of the pin 160. The support 44 is slid on to the pin 160, with the surface 130 of the support 44 facing the recording medium, until the base 133 comes into contact with the flat portion 114 of the carriage. The heads 155 and 156 are then released so that the projections 163 and 164 engage the groove 161 of the pin 160, preventing the support from being pulled off the pin 160. In addition, the pin 170 co-operating with the internal wall 171 of the groove 140 prevents the support 44 from rotating about the pin 160.

When the insertion operation is carried out, the resilient conductive laminae 48 ensure, as in the first embodiment, the electric connection between the thermoelements borne by the head 10 and the controlling circuit.

The support 44 is extracted by squeezing in the two heads 155 and 156 so as to disengage the projections 163 and 164 from the groove 161 and then the support 44 may be pulled off the pin 160.

Shown in Figure 19 is a third embodiment of the locking device. It differs from the preceding embodiments in that a resilient locking action is created by spring action of the conductive laminae 48.

The removable support 44 comprises a surface 175 whereon is assembled the plate 10, two lateral sliding portions 176 and 177 extending along the height of the support starting from its base 178, and a guiding groove 179 extending along the entire height of the support 44. In the internal surface 180 of the groove 179 is a transverse groove 182 located in the proximity of the base 178.

The carriage 47 comprises a flat portion 114 and in perpendicular relation thereto a positioning support 183 suitable to receive the head carrying support 44 and comprising two lateral guiding members 185 and 186 wherein the lateral sliding members 176 and 177 of the support 44 can slide, and a central guiding member 189

70

75

80

85

90

95

100

105

110

115

120

125

130

suitable to engage the groove 179 of the support 44.

The central guiding member 189 comprises a surface 190 whereon the internal surface 180 of the groove 179 can slide and a transverse ridge 193 located at a height from the flat portion 114 which is equal to the distance between the groove 182 and the base 178 of the support 44, the projection 193 being adapted to engage in the groove 182 when the insertion is executed.

The lateral sliding members 176 and 177 are provided at the top with knurled portions 198 and 199 facilitating gripping of the support 44 in the insertion and extraction operation of the head.

Secured to the flat portion 114 of the carriage 47 are furthermore eight resilient electrically conductive laminae 48 adapted to come into contact when the insertion is carried out, with the terminal portions of the conductors 15 and 18 on the plate 10, the laminae being connected to the control circuit as already specified.

The support 44 is placed on the carriage by bringing the sliding members 176 and 177 into engagement with the guiding members 185 and 186, with the plate carrying surface 175 of the support 44 facing the recording means. The support is pushed down along the guiding members 185 and 186 until its base 178 bears against the flat portion 114 and consequently the groove 182 engages the ridge 193, being pushed against it by the urge of the resilient electrically conductive laminae 48. There is sufficient play within the guiding members 185 and 186 to allow the bottom part of the surface 180 to ride over the ridge 193 before the latter snaps into the groove 182.

The support 44 is extracted by simply taking its knurled portions 198 and 199 and by pulling it upwardly with sufficient force so as to disengage the ridge 193 from the groove 182.

As already explained, the embodiments here described are only by way of example. Among possible modifications are the following:

The hole 145 of the embodiment of Figures 15 to 18 may be provided in the carriage and the corresponding pin 160 bearing the groove 161 may project from the head. In this event, the locking system made up of the levers 147 and 148 and the spring 166 should be assembled on the carriage.

In the same way, the ridge 193 of the embodiment of Figure 19 may be provided in the head and the corresponding groove 182 may be provided in the carriage.

Finally, in all the embodiments of Figures 14 to 19, the head positioning operation is automatically accompanied by

the locking operation and the engagement of the resilient conductive laminae. The only operation the user has to perform is to displace the head along the guide members. However, the two positioning and locking operations might be carried out by the operator according to two different stages, for instance, by providing the device with a lever mechanism actuating, under the user's control, resilient locking means after the placing operation has been carried out.

In the same way, the extraction operation, instead of being carried out by simply taking the head and by pulling it upwards, as in the embodiments of Figures 14 and 19, might be carried out by providing the device with suitable lever mechanism that renders ineffective the resilient means responsible for the locking action, so that the head can be withdrawn from the guide members without exerting any force for overcoming the urge of the resilient means.

WHAT WE CLAIM IS:—

1. An electrothermal printer for effecting impactless printing on heat-sensitive recording means, comprising an electrothermal printing head and means for effecting relative movement along a printing direction between the printing head and means for supporting a heat-sensitive recording medium, the printing head comprising an electrically insulating support having a surface facing the said supporting means, a pattern of conductors lying on the said surface and a plurality of individually energisable resistive printing elements on the said surface, each making contact with two of the conductors, by way of which conductors the elements can be selectively energised, each element comprising a region of resistive material which has a part-cylindrical outer surface concave towards the said surface, the generatrices of the part-cylindrical outer surfaces of all regions being parallel to a common direction which is transverse to the printing direction.

2. A printer according to claim 1, wherein the printing elements are aligned along a line parallel to the common direction.

3. A printer according to claim 2, wherein the regions of resistive material are segments of a single strip of the resistive material extending along the said line.

4. A printer according to claim 3, wherein the pattern of conductors consists of a common conductor contacted by the strip along one side of the strip and a plurality of individual conductors spaced along and contacted by the other side of the strip so that each said region lies between



17

suitable to engage the groove 179 of the support 44.

The central guiding member 189 comprises a surface 190 whereon the internal surface 180 of the groove 179 can slide and a transverse ridge 193 located at a height from the flat portion 114 which is equal to the distance between the groove 182 and the base 178 of the support 44, the projection 193 being adapted to engage in the groove 182 when the insertion is executed.

The lateral sliding members 176 and 177 are provided at the top with knurled portions 198 and 199 facilitating gripping of the support 44 in the insertion and extraction operation of the head.

Secured to the flat portion 114 of the carriage 47 are furthermore eight resilient electrically conductive laminae 48 adapted to come into contact when the insertion is carried out, with the terminal portions of the conductors 15 and 18 on the plate 10, the laminae being connected to the control circuit as already specified.

The support 44 is placed on the carriage by bringing the sliding members 176 and 177 into engagement with the guiding members 185 and 186, with the plate carrying surface 175 of the support 44 facing the recording means. The support is pushed down along the guiding members 185 and 186 until its base 178 bears against the flat portion 114 and consequently the groove 182 engages the ridge 193, being pushed against it by the urge of the resilient electrically conductive laminae 48. There is sufficient play within the guiding members 185 and 186 to allow the bottom part of the surface 180 to ride over the ridge 193 before the latter snaps into the groove 182.

The support 44 is extracted by simply taking its knurled portions 198 and 199 and by pulling it upwardly with sufficient force so as to disengage the ridge 193 from the groove 182.

As already explained, the embodiments here described are only by way of example. Among possible modifications are the following:

The hole 145 of the embodiment of Figures 15 to 18 may be provided in the carriage and the corresponding pin 160 bearing the groove 161 may project from the head. In this event, the locking system made up of the levers 147 and 148 and the spring 166 should be assembled on the carriage.

In the same way, the ridge 193 of the embodiment of Figure 19 may be provided in the head and the corresponding groove 182 may be provided in the carriage.

Finally, in all the embodiments of Figures 14 to 19, the head positioning operation is automatically accompanied by

the locking operation and the engagement of the resilient conductive laminae. The only operation the user has to perform is to displace the head along the guide members. However, the two positioning and locking operations might be carried out by the operator according to two different stages, for instance, by providing the device with a lever mechanism actuating, under the user's control, resilient locking means after the placing operation has been carried out.

In the same way, the extraction operation, instead of being carried out by simply taking the head and by pulling it upwards, as in the embodiments of Figures 14 and 19, might be carried out by providing the device with suitable lever mechanism that renders ineffective the resilient means responsible for the locking action, so that the head can be withdrawn from the guide members without exerting any force for overcoming the urge of the resilient means.

WHAT WE CLAIM IS:—

1. An electrothermal printer for effecting impactless printing on heat-sensitive recording means, comprising an electrothermal printing head and means for effecting relative movement along a printing direction between the printing head and means for supporting a heat-sensitive recording medium, the printing head comprising an electrically insulating support having a surface facing the said supporting means, a pattern of conductors lying on the said surface and a plurality of individually energisable resistive printing elements on the said surface, each making contact with two of the conductors, by way of which conductors the elements can be selectively energised, each element comprising a region of resistive material which has a part-cylindrical outer surface concave towards the said surface, the generatrices of the part-cylindrical outer surfaces of all regions being parallel to a common direction which is transverse to the printing direction.

2. A printer according to claim 1, wherein the printing elements are aligned along a line parallel to the common direction.

3. A printer according to claim 2, wherein the regions of resistive material are segments of a single strip of the resistive material extending along the said line.

4. A printer according to claim 3, wherein the pattern of conductors consists of a common conductor contacted by the strip along one side of the strip and a plurality of individual conductors spaced along and contacted by the other side of the strip so that each said region lies between

(18)



10

1,473,868

10

one individual conductor and the opposed portion of the common conductor.

5 5. A printer according to claim 3, wherein the pattern of conductors consists of a first group of conductors spaced along and contacted by one side of the strip, and a second group of conductors spaced along and contacted by the other side of the strip in a staggered relationship to the
10 conductors of the first group so that each conductor of the second group is partly opposed to two adjacent conductors of the first group and each said region lies between opposed parts of two conductors,
15 one from each group.

6. A printer according to any of claims 1 to 5, wherein the head is carried by a support which is in turn removably mounted on a base member in a position for
20 presenting the printing elements to the recording medium, a plurality of conductive laminae being arranged to contact the conductors of the said pattern when the support is in position on the base member, and manually releasable latching
25 means arranged to hold the support in position on the base member.

7. A printer according to claim 6, wherein the support is slidably removable from and replaceable on the base member and the laminae make resilient sliding
30 contact with the conductors as the support is slid into position.

8. A printer according to claim 7, wherein the latching means comprise a pair of first latching elements on the support and a pair of second latching elements carried by resiliently flexible arms attached to the base member, in an arrangement
35 such that the arms deform to allow the second elements to ride over the first elements into and out of latching engagement therewith as the support is slid
40

respectively into position and off the base member.

9. A printer according to claim 7, wherein the support and base member have first and second slidably engageable parts of which one has a projection and the other a recess, which projection and recess are urged into engagement, when the support is in position, by the resilient lamina.
45 50

10. A printer according to claim 7, wherein one of the support and base member carries a lever spring-biased to engage in a recess in the other, when the support is in position, the lever being manually operable to disengage the lever from the recess.
55

11. A printer according to any preceding claim, wherein each conductor is a film of conductive material coated on to the said surface.
60

12. A printer according to any preceding claim, wherein the resistive material is a thick film of resistive material coated on to one or more discrete areas of the said surface so as to overlap the conductors.
65

13. An electrothermal printer having a printing head substantially as hereinbefore described with reference to, and as illustrated in, Figures 2 to 5, Figures 6 and 7, Figures 8 and 9 or 10, or Figures 11 to 13 of the accompanying drawings.
70

14. An electrothermal printer according to claim 11 and further substantially as hereinbefore described with reference to, and as illustrated in, Figure 1 and Figure 14 or Figures 15 to 18 or Figure 19 of the accompanying drawings.
75 80

REDDIE & GROSE,
Agents for the Applicants,
6 Bream's Buildings,
London, EC4A 1HN.