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 [33] **Denmark**
 [31] **493/68**

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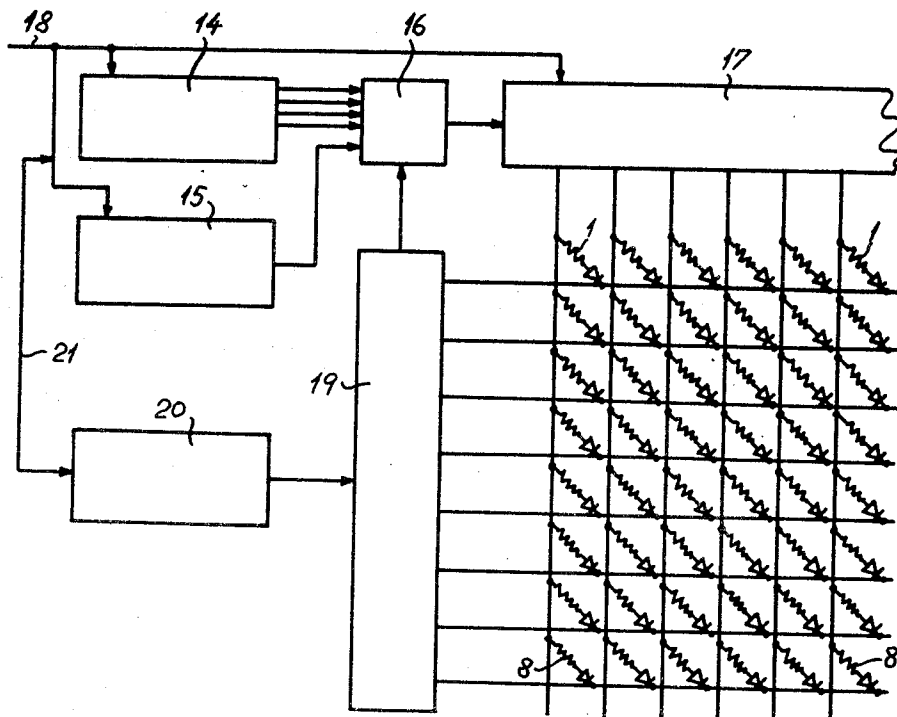
[54] **THERMOPRINTING DEVICES**
5 Claims, 12 Drawing Figs.

[52] U.S. Cl. **219/216,**
346/76
 [51] Int. Cl. **H05b 1/00**
 [50] Field of Search. **219/216,**
201; 340/324, 339, 336; 313/109.5; 346/76

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ABSTRACT: In a thermoprinting device the electric resistors forming the printing elements serving to print marks on a thermosensitive sheet by thermocopying consist of film deposits in a plurality of superposed microlayers on a surface on an electrically insulated base member, said layers being separated by electrically insulating films. Important forms of superposed printing elements are complementary bar groups of a bar mosaic, and a full selection of full character printing elements placed on top of one another. Electronic means are provided for either activating the printing elements of a row successively or simultaneously, or simultaneously activating selected printing elements in a plurality of rows, thereby increasing printing speed, where signals representative of lines of characters to be printed are available in rapid succession, such as from data processing equipment.



8:1234567890



Fig. 1

Fig. 2

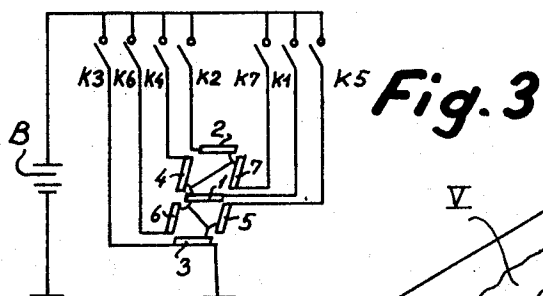


Fig. 3

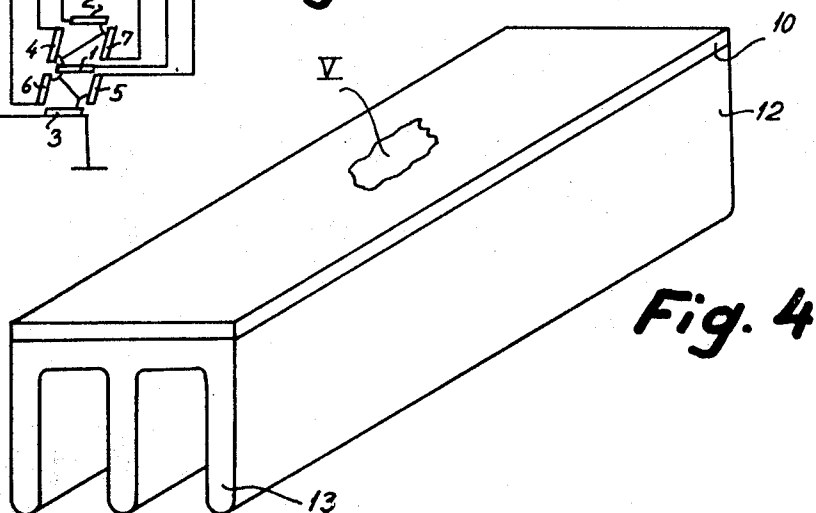


Fig. 4

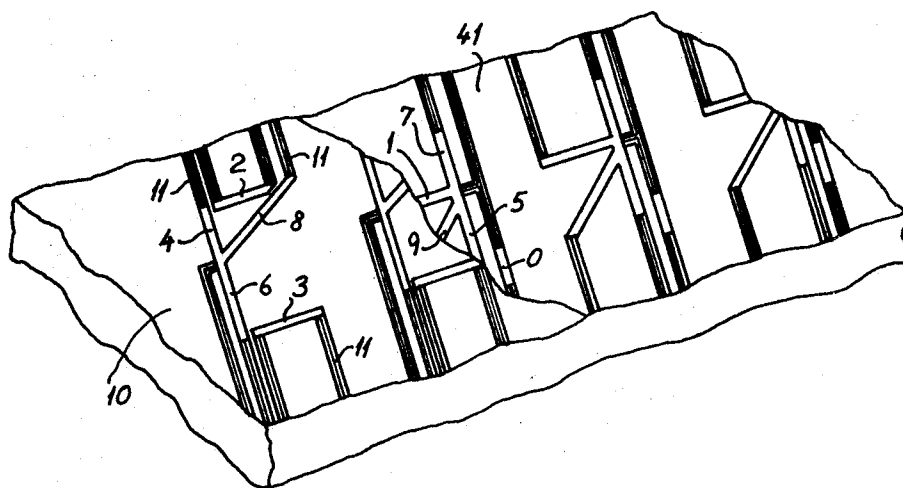


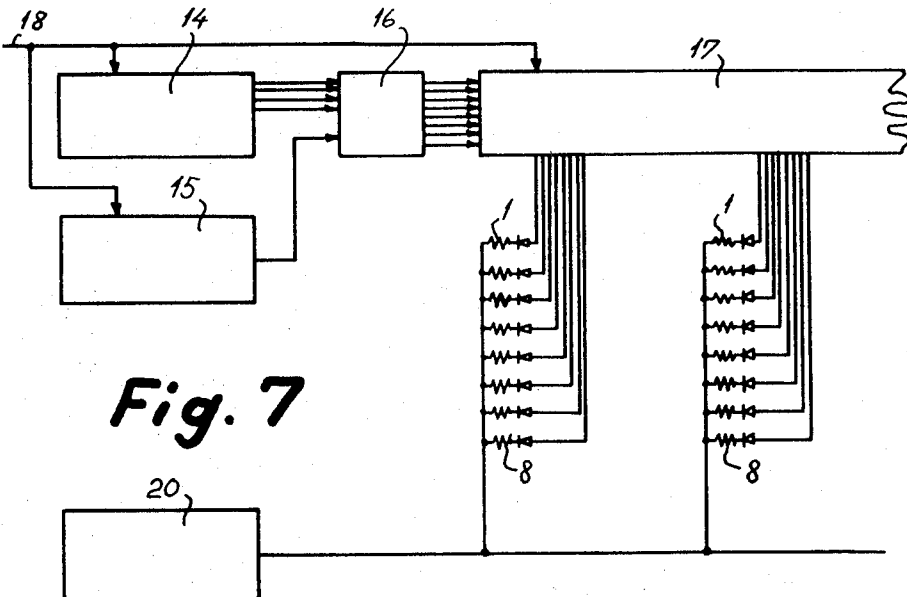
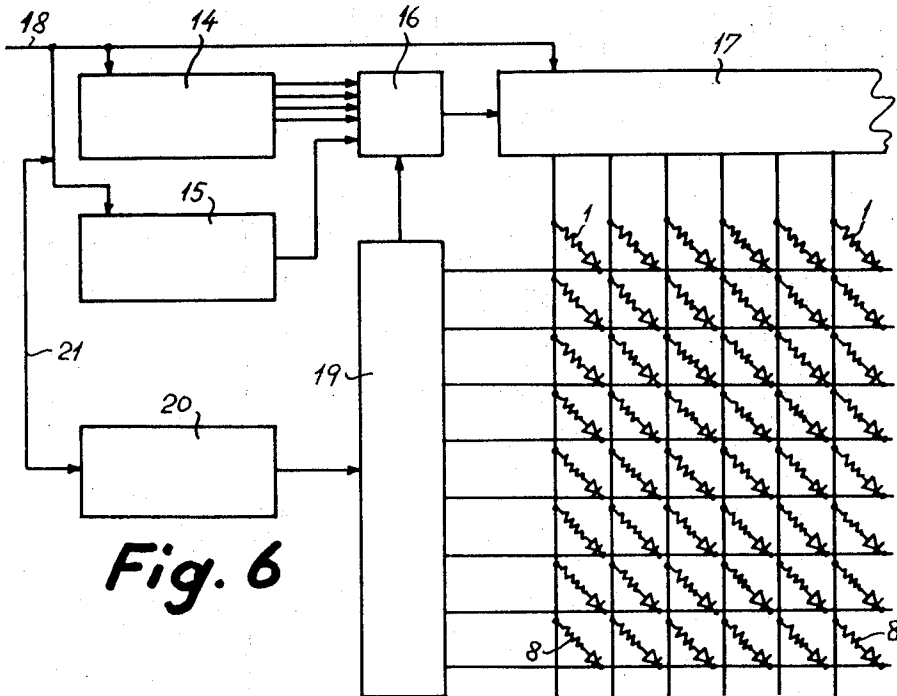
Fig. 5

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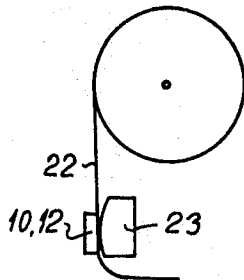


Fig. 8

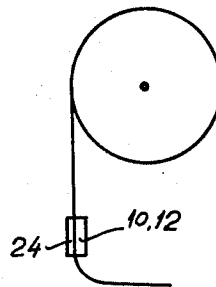


Fig. 9

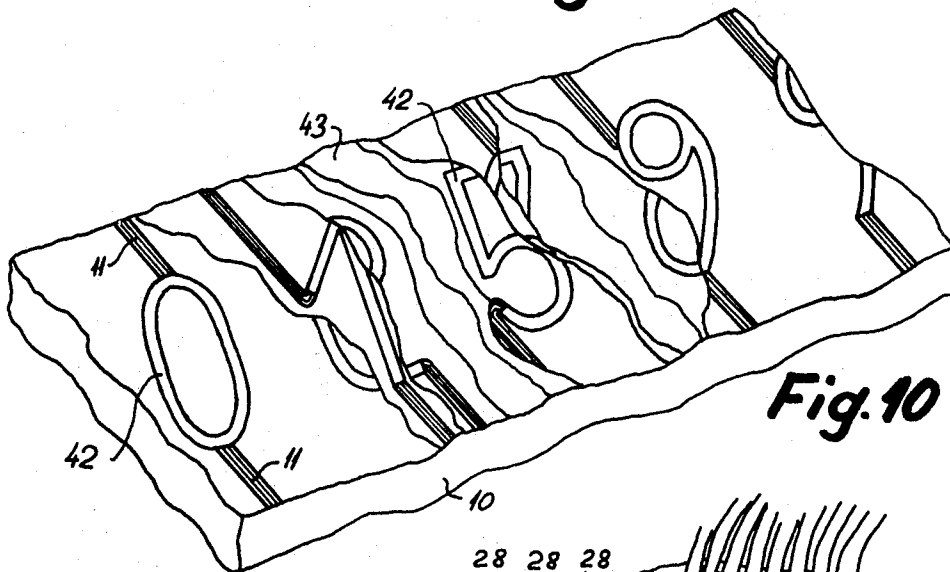


Fig. 10

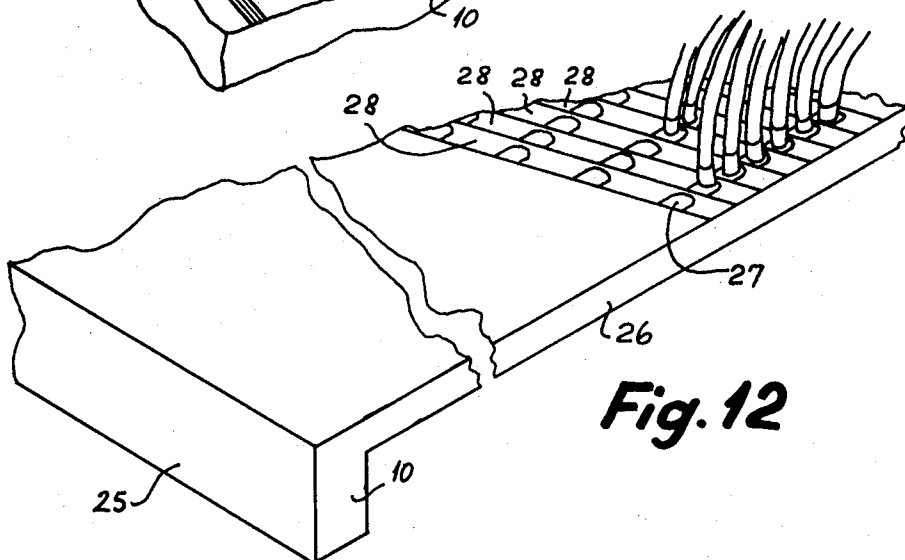


Fig. 12

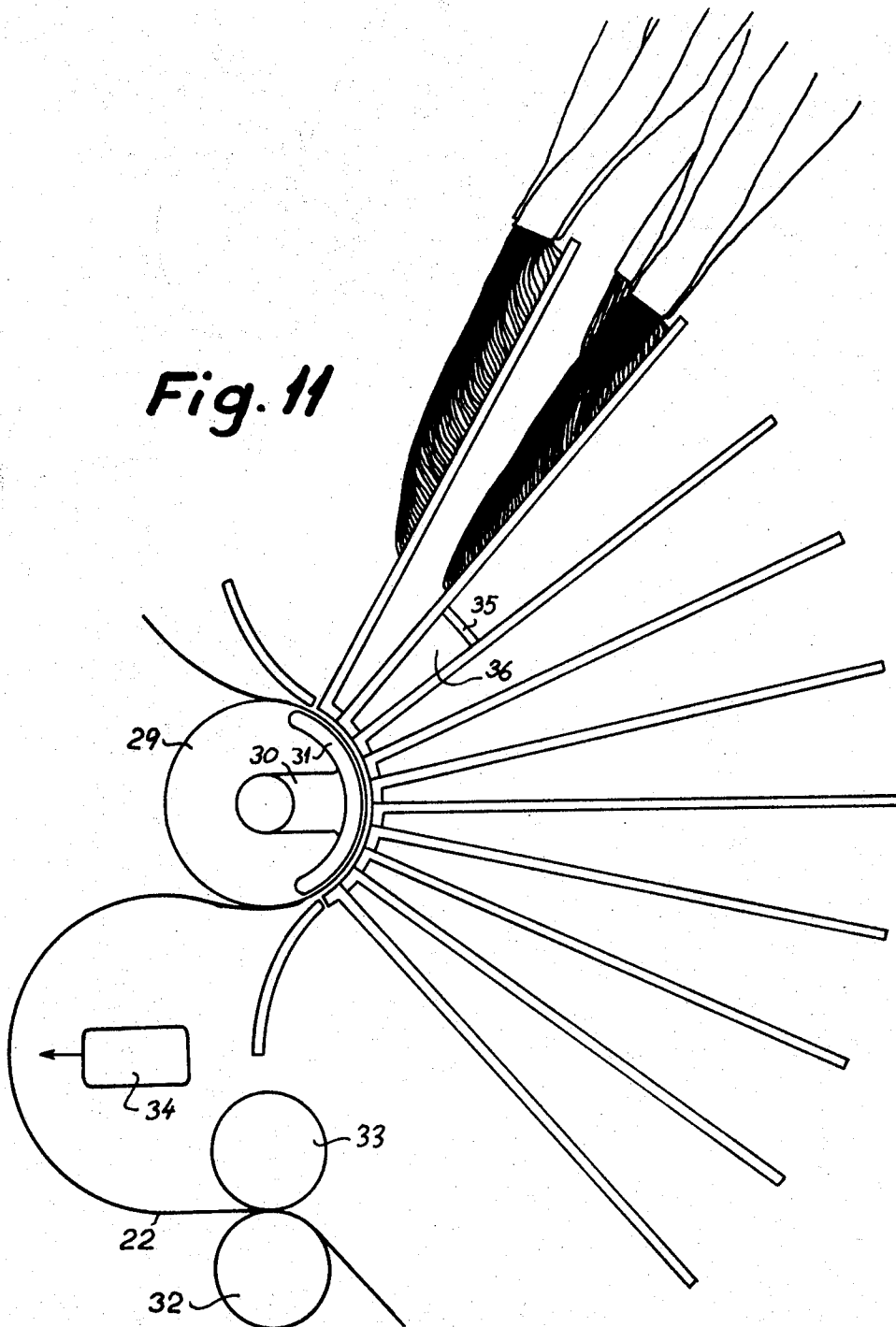
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Fig. 11



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THERMOPRINTING DEVICES

BACKGROUND OF THE INVENTION

This invention relates to a thermoprinting device, i.e. a device by means of which information can be printed on a thermosensitive record carrier, such as a sensitized sheet of paper, by means of selectively heated printing elements in heat transfer relationship with the carrier, a change of color being produced in the areas of the carrier to which heat is transferred from the printing elements. The printing elements consist of electric resistors to which current is supplied in accordance with signals received from a source of information, said signals being representative of information to be printed, usually in the form of letters, numerals, mathematical symbols etc. The source of information may on principle be of any type, even mechanical, but the most logical use of thermoprinting devices is in combination with electronic equipment such as electronic computers or data processing equipment, thereby extending the principle of electronic operation to the printing unit and avoiding mechanical motion therein, except for the feeding of the record carrier, and also avoiding the use of printing ribbons or printing ink.

Thermoprinting devices are known, in which the printing elements are in the form of dots placed on a stationary support either in a single line for progressive printing or in a two-dimensional pattern. In either case, it is impossible to print characters or symbols having a continuous contour, and if an attempt is made at improving the distinctness of the printed characters or symbols by increasing the fineness of the dot division, difficulties of both a mechanical and electrical nature are encountered.

It is the object of the invention to provide a thermoprinting device of the general type referred to which permits the printing of characters or symbols with a continuous or practically continuous contour.

SUMMARY OF THE INVENTION

According to the invention, the printing elements consist of film deposits in a plurality of superposed layers on a surface of an electrically insulating base member, said layers being separated by electrically insulating films.

By placing the printing elements in a plurality of superposed layers as described, it becomes possible to use printing elements which have overlapping or intersecting contours so that the possibilities of truly representing characters or symbols having a continuous or practically continuous contour and/or characters or symbols of any desired configuration are greatly enhanced.

The invention is based on the recognition that film deposits adequate for forming printing elements and supply conductors for same may be made extremely thin so that heat can easily be transferred from a printing element through a plurality of layers superposed thereon to a thermosensitive carrier, as will be explained below.

According to one embodiment of the invention, the printing elements in each layer comprise a row of bar groups forming subdivisions of a bar mosaic suitable for selectively printing any one of a number of characters forming a system of recording information, superposed bar groups in the various layers combining to form a complete bar mosaic. A bar mosaic is a FIG. consisting of a number of bars which in their different combinations may represent any one of the characters of a system of recording information. It will be realized that if printing elements in the form of a bar mosaic are placed in a single layer, there must of necessity be gaps between the various bars. By placing bar groups of a bar mosaic in superposed layers as described, the bars of the various groups may overlap or at least come very close to one another so that it becomes possible to avoid or practically avoid some of the gaps or all of them. A very considerable improvement is obtained already by placing bar groups in two layers.

According to another embodiment of the invention, the printing elements in each layer comprise a row of character

printing elements of full character configuration, the character printing elements of the various layers being superposed and combining to form, in each position of the row, a full selection of characters forming a system of recording information. In this case the configuration of the printed characters can be selected as desired, because the printing takes place in each position of the row from a selected one of the full character printing elements superposed on each other in the position considered.

In both embodiments the thermoprinting device may be multiplied so as to comprise a plurality of rows of superposed printing elements for the simultaneous printing of a corresponding number of lines whereby extremely high printing speeds can be obtained as will likewise be explained below.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1 and 2 show examples of bar mosaics;

FIG. 3 is a diagram illustrating the basic principle of operation of a thermoprinting device in which the printing elements are arranged in the form of bar mosaics;

FIG. 4 is an enlarged perspective view of a thermoprinting block according to one embodiment of the invention;

FIG. 5 shows a fraction of the surface of the printing block of FIG. 4 on a still larger scale, the fraction being indicated by the reference V;

FIGS. 6 and 7 are block diagrams showing examples of the electronic equipment of a thermoprinting device according to the invention;

FIGS. 8 and 9 are diagrammatic illustrations of examples of the paper feed of a thermoprinting device according to the invention;

FIG. 10 is a fractional view, corresponding to FIG. 5, of a modified construction of the surface of the printing block;

FIG. 11 is a diagrammatic side view of a thermoprinting device according to the invention for the simultaneous printing of a plurality of lines; and

FIG. 12 is a perspective view on an enlarged scale of a structural element of the thermoprinting device of FIG. 11.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows an example of a bar mosaic comprising seven bars and the manner in which the numerals of the decimal system can be formed from different combinations of the bars of the mosaic. FIG. 2 shows a bar mosaic comprising 16 bars from which, in addition to the numerals, also the letters of the Latin alphabet can be formed.

FIG. 3 shows how printing elements in the form of electric resistors 1-7 arranged in accordance with the pattern of FIG. 1 are connected through contacts K1-K7 to a battery B. If e.g. the contacts K2, K5 and K7 are closed, the printing elements 2, 5 and 7 are heated. These are the elements corresponding to the numeral 7 as represented in FIG. 1. If now a piece of thermosensitive paper is pressed against the bar mosaics, the numeral 7 is printed on the paper by contact copying. The contacts K1-K7 represent electronic contacts which are controlled from the store of an electronic computer, such as will be described in more detail below.

In FIGS. 4 and 5, 10 is an electrically insulating flat member forming a substrate, on which a number of bar mosaics are placed side-by-side in a row. In this embodiment the bar mosaics are supplemented by two additional bars 8 and 9 and a bar 0 representing a decimal point or comma. The added bars are only intended to illustrate an alternative form of a bar mosaic, and in the description of the function this deviation from the pattern of FIG. 1 will be disregarded, except for the decimal point bar 0.

In accordance with one aspect of the present invention, as illustrated in FIG. 5 each bar mosaic is subdivided into two bar groups comprising the bars 2, 3, 4, 6, 8 and 1, 5, 7, 9, 0 respectively, which are placed in two superposed layers on the surface of the electrically insulating member 10, said layers being separated by an electrically insulating film 41. Alternatively

the bar mosaics could be subdivided into a greater number of groups. Owing to the subdivision of the bar mosaics these may be arranged to overlap or practically overlap at some of or all of their junctions, thereby to eliminate or reduce the gaps occurring in characters printed from the bar mosaic.

The bars constitute printing elements of the thermoprinting device and are selectively activated for printing by the supply of current through supply conductors 11. Printing from the bars 2, 3, 4, 6, 8 in the lower layer is effected through the electrically insulating film, which should be thin enough to permit ready heat transfer. Both the bars and the supply conductors consist of film deposits on the surface of the insulating member 10 and on the insulating film 41 respectively. The insulating member 10 is mounted on a body 12 consisting of material of high heat conductivity, the body 12 serving both as a support for the insulating body and as a heat sink for absorbing excess heat from the insulating member, and thereby from the printing elements, and dissipating this heat to the surroundings. To increase the heat dissipating surface of the body 12, this is constructed with ribs 13.

The substrate member 10 may e.g. consist of fused quartz (silica) or boron silicate glass. It should be thin enough to permit rapid transfer of excess heat from the printing elements to the heat sink, but on the other hand thick enough so as not to permit excessive travel of heat from the printing elements during printing. A thickness of 0.5 mm. has been found suitable for the conditions of operation of a printing device for a desk calculator.

The film deposits constituting the printing elements 1—8 may be applied to the substrate 10 and to the insulating film 41 by well-known circuit printing methods such as thin film technique, thick film technique or planar technique. Suitable examples are evaporation (condensation from the vapor phase) and sputtering (cathode atomization). Application by dotation or diffusion in combination with epitaxial processing is also possible and material applied in this way is intended to be comprised under the term film deposit.

As an example, the printing elements may consist of Cr in a thickness corresponding to $100 \Omega/\square$ (about 300 Angstrom = 0.0003 mm. applied to sputtering and having a length of 1 mm. and widths of 0.1—0.2 mm., while the supply conductors may consist of Au in a thickness corresponding to $0.5 \Omega/\square$ (about 5000 Angstrom = 0.0005 mm.) and have a width of 0.1—0.2 mm. The insulating film 41 must be of a quality and thickness such that voltage break-down is prevented. This may be obtained by means of a pinhole-free quartz film in a thickness of 5000—10000 Angstrom. Film deposits and films of the thicknesses mentioned may be referred to as microfilms. It is essential for the present invention that such microfilms should be used so that the necessary heat transfer through one or more films to the thermosensitive carrier will be possible. In this connection it is observed that in some of the embodiments mentioned below there may be a multitude of layers, but even with as many as 65 layers the total thickness of all the layers will be only a fraction of one-tenth of a millimeter.

To protect the printing elements and supply conductors against mechanical and chemical influences, the printing surface of the member 10 may be covered with an electrically insulating wear resistant and chemically protecting film. As an example, such a film may consist of quartz which is applied in a thickness of 5000—10000 Angstrom by radiofrequency sputtering.

Typical values of the currents and voltages used for the pulses for activating the printing elements are 27 Volt and 30 mA. If found necessary, higher current values may be used for the printing elements in the lower layer or layers. A suitable heating time for printing elements consisting of a Cr film as above described is 20 msec., whereby the average temperature will be raised to about 160°C, which is suitable for printing on thermosensitive paper available in the trade. The heating time may be shorter, e.g. down to 5 msec. or even shorter in the case of other materials and dimensions. The heating

time may also be selected longer where longer printing times are permissible e.g. in the case of desk calculators. The heating time, i.e. the duration of the current pulses, constitutes the elementary printing time. The total printing time depends on the system selected for the activation of the printing elements. Some examples of such systems will be described below.

The heat sink 12 may consist of aluminum and should be so dimensioned that the heat sink will maintain the surface of the substrate on a low average temperature and limit the mutual heating of adjacent printing elements by removing excess heat as rapidly as possible. For a desk calculator a heat sink having a thermal resistance of 10°C/Watt has been found suitable.

Where maximum printing speed is not of the essence, the bars may be activated for printing successively rather than all at a time. Preferably bars in the same position in all characters to be printed in a line, where such bars occur, are then picked for simultaneous printing, and this operation is repeated for bars in other positions until bars in all positions have been picked for printing. If the bars are picked in jumping succession, the danger of mutual thermal influence between adjacent printing elements is reduced. Thus, the bars 1—8 may be picked in the succession indicated by their reference characters.

FIG. 6 illustrates an electronic equipment that may be used for picking and printing the bars successively in the manner described. In FIG. 6, 14 is the numeral store of a computer from which information is to be printed, and 15 is the corresponding decimal point store. The resistors 1—8 represent the bars 1—8 in the various positions of the row. 16 is a decoder by means of which a line of characters in the computer store and any decimal points are transferred to a printing store 17 in bar mosaic language. 18 is a supply line for clock pulses. 19 is a bar selector, by means of which the bars are picked for printing in the desired succession. The bar selector 19 is fed with printing pulses from a printing pulse generator 20. The line 21 symbolizes the timing that must exist between the printing pulses and the clock pulses so that the transmission of printing pulses is initiated when a whole line of characters has been transferred from the computer store to the printing store.

Since all times of electronic operations can be regarded as negligible, the total printing time will be eight times the elementary printing time when using the electronic equipment illustrated in FIG. 6. Thus assuming the elementary printing time to be 20 msec., the total printing time will be 160 msec. This will be satisfactory for a desk calculator where ample printing time is available.

The total printing time will be reduced to one-half if two bars are picked for printing at a time. However, in this case the printing store must have the double size. It is also possible to print all bars in all positions at a time. An electronic equipment for use in this case is illustrated in FIG. 7, where 14 is again a computer numeral store, 15 a decimal point store, 16 a decoder, 17 a printing store and 18 a clock pulse line. 1—8 are again resistors representative of the bars in the various positions. 20 is again a printing pulse generator, which, however, in this case is connected directly to the bars. In this embodiment, the printing store must have eight times the capacity of that of FIG. 6. On the other hand, the total printing time is reduced to one-eighth or in other words 20 msec. = the elementary printing time.

It will thus be realized that in selecting the system of activating the bars, speed of printing has to be weighed against expense. Other systems than those described are also possible. E.g. the characters of a line may be printed one by one.

FIG. 8 shows how a thermosensitive paper sheet 22 is fed forward between the printing block 10, 12 of FIG. 4 and a support 23 so that heat may be transferred from the heated printing elements to the sheet by thermal contact copying.

In the embodiment illustrated in FIG. 9, the paper sheet is fed forward between a glass plate 24, facing the position of an operator, and the printing block 10, 12, which is in this case arranged for inverted printing. The thermosensitive paper used

in this case is of a type having a thermosensitive coating on the rear side, which causes a change of color on the front side of the paper. Thus, in the embodiment of FIG. 9 the printed characters become directly visible immediately upon printing.

In the embodiment illustrated in FIG. 10, the printing elements are in the form of full characters 42, which are arranged in a number of superposed layers with insulating layers 43 therebetween. Thus, in the example shown a row of 0's is arranged in a first layer on the printing element 10, a row of 1's in a second layer, etc. up to a row of 9's in a tenth layer and a row of decimal points in an eleventh layer (not shown), on top of which there may be provided an electrically insulating, wear resistant and chemically protecting film, as in the other embodiments. In each position of the row, all the characters 0—9 will be present on top of each other with the insulating layers 43 in between. The electronic equipment of the printing device is constructed to select in each position of the row the character in the pack to be activated for printing. The electronic equipment may be constructed in the same manner as in FIG. 7, only instead of the eight resistors 1—8 there will be 11 resistors respectively corresponding to the characters 0—9 and the decimal point, and these resistors will represent the full character printing elements in the various layers. With this electronic equipment all characters in row will be printed at a time. Other systems of activation, such as layer to layer, may alternatively be used.

FIGS. 11 and 12 illustrate diagrammatically a thermoprinting device for the simultaneous printing of a plurality of lines. The device comprises a plurality of printing members 10 corresponding to the printing member 10 of FIG. 10, only this has been extended to comprise all 64 characters of the alphanumeric system arranged in 64 layers. The printing elements on the printing surface 25 are not shown. The printing members are arranged along the circumference of a circle and each is provided with a radial extension 26, in which supply conductors 27 for the printing elements are printed with insulating layers 28 of different lengths therebetween so as to provide spreadout connecting points for the wiring. A perforated feeding cylinder 29 is mounted for rotation coaxially with the printing surfaces of the printing members with its surface in close proximity to these. Inside the cylinder 29 there is mounted a stationary pneumatic distributor 30, which has an arcuate chamber 31 extending in close proximity to the perforated wall of the cylinder 29. The outer wall of the chamber 31 is perforated. A sheet 22 of thermosensitive paper is fed forward between two continuously rotating rollers 32 and 33, the speed of which is governed by a loop indicator diagrammatically represented at 34. The pneumatic distributor 30 is connected to a source of alternate air pressure and suction. In the periods where the pressure is above that of the atmosphere, air is blown out through the perforations of the chamber 31 and the perforated wall of the cylinder 29 to press the sheet 22 firmly against the printing surfaces of the printing members 10 where the sheet remains stationary while simultaneous printing of all the lines takes place from electronic equipment corresponding to that of FIG. 7, only with multiplication of the printing store by the number of lines to be printed at a time and with 64 resistors instead of the resistors 1—8. The pneumatic source is then switched over the suction, whereby the sheet 22 is applied firmly to the perforated surface of the cylinder 29 so as to be fed forward by the latter until a fresh area of the sheet 22 has been fed into position for

printing. In the meantime the next batch of lines has been transferred from the signal source to the printing store.

Cooling of the printing members may be effected in any suitable manner. Thus the spaces between the radial extensions of the printing elements may be closed by means of circumferentially extending partitions such as illustrated at 35 to form chambers 36 for the circulation of a cooling medium.

The printing device of FIG. 11 may be constructed for a larger number of printing members, e.g. 100, by increasing the diameter of the cylinder 29 and/or by mounting printing members along a greater part of the circumference of the cylinder. In this form, the device will be particularly suitable for printing information from data processing equipment at extremely high speed.

The printing member of FIG. 5 may be used for a multiline printer in exactly the same manner as illustrated in FIGS. 11 and 12. The only difference will be that the number of wires to be connected to the printing member for each position in the row of characters will be eight instead of 64. By using a suitable bar mosaic the device may be constructed for printing both letters and numerals, e.g. all the characters of the so-called alphanumeric system.

We claim:

1. A thermoprinting device comprising a system of printing elements in the form of electric resistors, means for maintaining a thermosensitive record carrier in cooperative relationship with said resistors, and means for receiving signals representative of information to be printed and for selectively supplying current to said printing elements in accordance with the signals thus received, characterized in that said printing elements consist of film deposits in a plurality of superposed layers on a surface of an electrically insulating base member, said layers being separated by electrically insulating films.

2. A thermoprinting device as in claim 1, in which the printing elements in each layer comprise a row of bar groups forming subdivisions of a bar mosaic suitable for selectively printing any one of a number of characters forming a system of recording information, superposed bar groups in the various layers combining to form a complete bar mosaic.

3. A thermoprinting device as in claim 2, comprising a plurality of rows of superposed bar groups and in which said signal receiving and current supplying means are arranged for simultaneously picking all characters representative of all characters to be printed in a number of lines corresponding to that of rows of superposed bar groups and for simultaneously supplying current to all bars necessary for printing all the characters thus picked.

4. A thermoprinting device as in claim 1, in which the printing elements in each layer comprise a row of character printing elements of full character configuration, the character printing elements of the various layers being superposed and combining to form, in each position of the row, a full selection of characters forming a system of recording information.

5. A thermoprinting device as in claim 4, comprising a plurality of rows of superposed character printing elements and in which said signal receiving and current supplying means are arranged for simultaneously picking all signals representative of all characters to be printed in a number of lines corresponding to that of rows of superposed character elements and for simultaneously supplying current to all the corresponding character printing elements in all the rows of superposed character printing elements.