Dec. 13, 1966 J. F. MILNE ET AL 3,291,276

PRINT HEAD HAVING CUP SHAPED PROTECTIVE MEMBER

Filed April 30, 1965 2 Sheets-Sheet 1

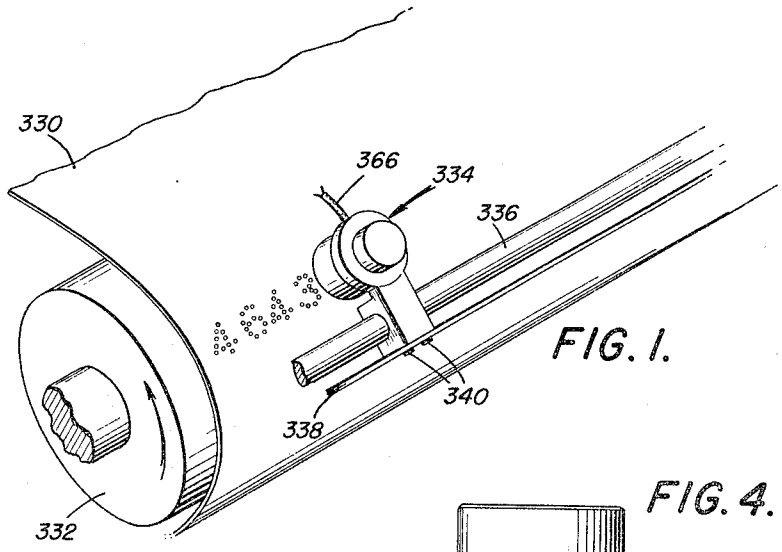


FIG. 1.

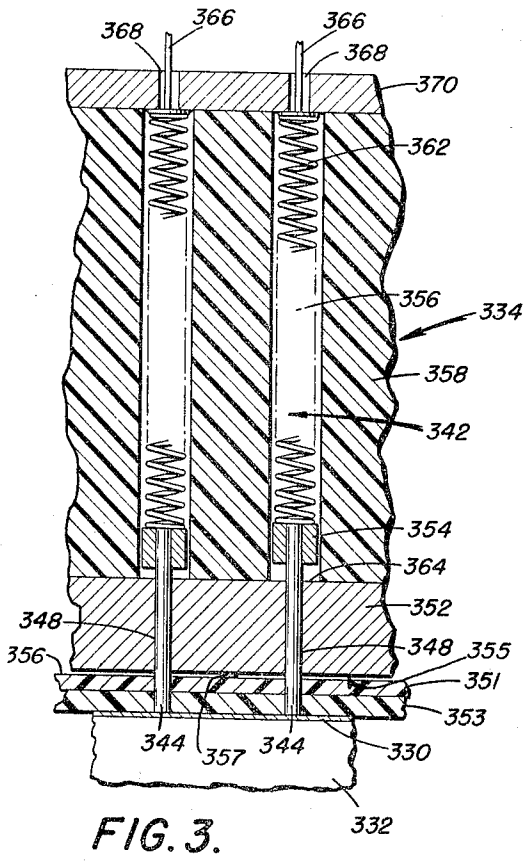
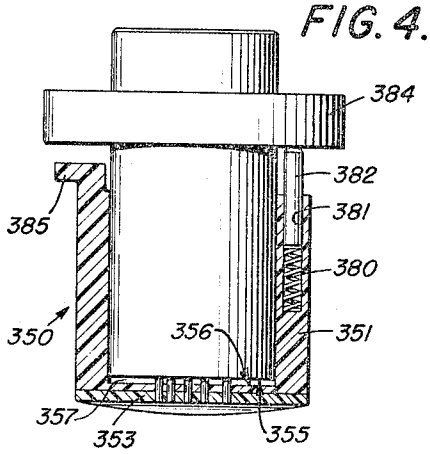


FIG. 3.

FIG. 4.



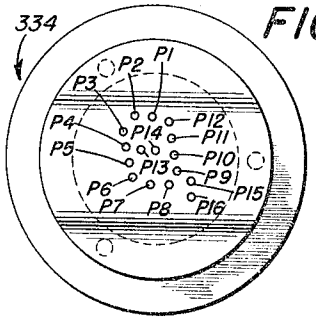


FIG. 2.

PRINT HEAD HAVING CUP SHAPED PROTECTIVE MEMBER

Filed April 30, 1965 2 Sheets-Sheet 2

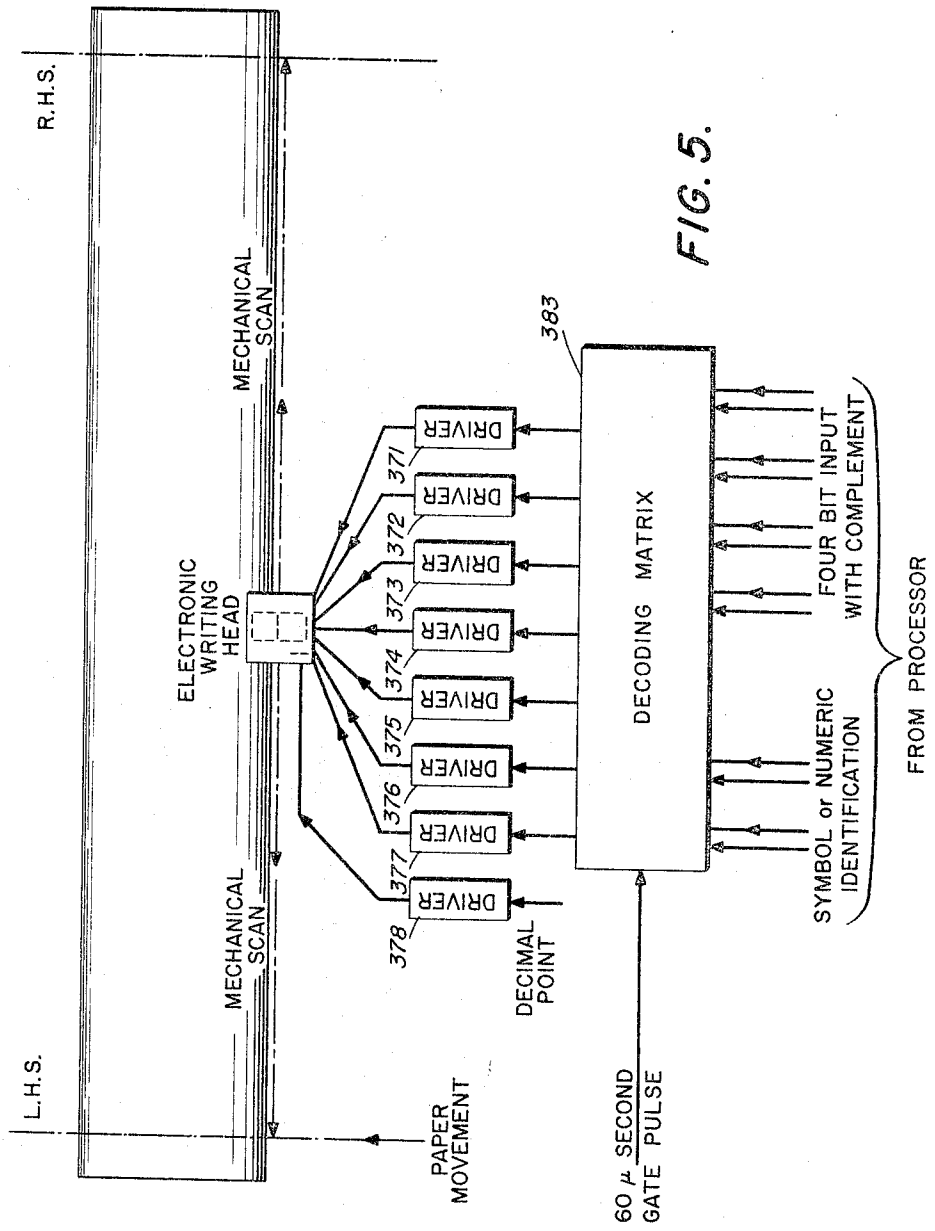


FIG. 5.

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PRINT HEAD HAVING CUP SHAPED PROTECTIVE MEMBER

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11 Claims. (Cl. 197—1)

The invention relates in general to printing apparatus and more particularly to an improvement in apparatus for printing data electrically on electrosensitive record material.

Certain known printing arrangements provide a plurality of styli in a patterned arrangement capble of producing characters through selective time energization of the styli as the printer is swept across the face of the record material. The styli are physically separated and electrically isolated from each other in a pattern most conducive to the generation of the desired characters.

In such systems the styli rest directly upon the record material and current is caused to pass from the selected styli through the record material to a ground plate located at the opposite side of the record material, or from one styli through the paper to another styli. The current in passing through the record material causes distinct marks or dots which can be combined through proper timed energization of the styli to form the data to be printed. Such a printing arrangement is disclosed in applicant's co-pending application Serial No. 356,527 filed April 1, 1964.

One serious problem encountered with printing arrangements of the type mentioned above is a fouling of the printing head with dust particles and other foreign matter due in part to the direct contact by the styli with the recording materials and the effect of the electrostatic field generated by these styli. As a result of this continued depositing of dust particles and other foreign matter on the styli and other elements of the print head, a deterioration of the printing quality and eventual failure to print results from continued use of such devices. While mechanical means for physically cleaning the print head during each cycle of scan have been suggested, such solutions are cumbersome, expensive and have proven to be inefficient and impractical.

It is therefore an object of the present invention to provide an improved arrangement for forming characters from a styli printer wherein means are provided to prevent the accumulation of foreign matter on the individual styli during the print operation.

It is a further object of the instant invention to provide such a printer wherein the means for preventing the accumulation of foreign matter on the print head is simple, inexpensive and highly reliable.

It is still another object of the present invention to provide such a printer wherein the means for preventing the accumulation of foreign matter on the printing head additionally increases the stability of the styli to improve print clarity and reduce the scratching of the recording medium.

According to a preferred embodiment of the invention, sixteen individual styli, each in the form of a pin, are mounted in a printing head, adapted to reciprocate across the recording material with the styli in contact therewith. The pin-type styli are each electrically insulated from one another and spaced apart into a matrix configurated generally like the digit "8." Each stylus is

yieldably mounted in the print head, protrudes therefrom and is biased by a spring into contact with the record material.

A cap made from a phenolic or simlar material and a gasket are mounted over the end of the print head from which the syli project. The gasket is made from a thermoplastic resin, preferably a plastic of the polytetrafluoro-ethylene type of fluorocarbon. The latter substance is commonly known and sold under the trademark Teflon. The properties of Teflon, which include resistance to high and low temperatures, excellent dielectric properties, high impact strength and low coefficient of friction, are well known. This combination of cap and gasket is spring loaded to the print head so that the Teflon gasket during the print operation rides across the face of the recording material. The styli project through the cap and through the Teflon gasket to contact the face of the recording material; however, due to the spring bias on the cap and gasket combination only the cross-sectional ends of the styli are exposed and these are pressed directly onto the record material.

As a result of the Teflon gasket, a seal is provided around the print pins or styli without, however, preventing independent print pin movement. Each stylus therefore remains individually yieldable so as to permit automatic individual adjustment thereof in response to unevenness of record material and uneven wear of the individual styli; however, for all practical purposes, each stylus is completely sealed except for its extreme tip end.

The Teflon has very low coefficient of friction, and a high dielectric strength and the phenolic cap provides a rigid backing to keep the Teflon gasket from distorting. As a result of this effective isolation and support of the individual styli, fouling of the print head is eliminated, insuring good printing qualities of the device over a prolonged period of operation.

In addition, the provision of the additional gasket and cap about the printing head provides increased support of the styli along substantially their entire length to the very end thereof in contact with the record paper. This added support of the styli materially increases the stability thereof, improving the print clarity and reducing scratching marks on the paper, noted in connection with prior art arrangements.

The many objects and advantages of the instant invention can be seen from the above discussion, and will be further clarified by the following description when taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is a simplified schematic view in perspective of portions of a printer in accordance with the invention;

FIGURE 2 is a simplified schematic view greatly enlarged of the printing head of FIGURE 1, showing the configuration of the styli matrix;

FIGURE 3 is a schematic, cross-sectional view in side elevation and greatly enlarged of a pair of pin styli taken through the printing head of FIGURE 1 and including the improvement of the instant invention, and

FIGURE 4 is a perspective view of the print head partly in section;

FIGURE 5 is a simplified schematic block diagram of the energizing circuits for the printing head of FIGURE 1.

Referring to FIGURE 1, printing is accomplished on a tape or strip 330 of chemically treated paper of the electrosensitive type. A tape conveyor of any conven-

tional design is represented schematically by merely a conveyor roller 332; it being understood that the tape conveyor is adapted to move tape 330 line by line to place successive lines of the tape into printing position; the direction of tape movement being indicated by the directional arrow shown on roller 332.

A stylus or printing head 334 is slidably mounted on a guide rod 336 for movement transversely of tape 330 at the printing position. Printing head 334 may be driven by any suitable means from the left edge of tape 330, the initial printing position, to the right edge of the tape during the printing cycle, and then back to the left tape edge, in preparation for printing the next line. Such driven movement is preferably effected at a substantially constant speed by printing head conveying mechanism (not shown) which transmits driven motion to printing head 334 by means of a timing belt 338 attached by fasteners 340 to a printing head 334. It is to be understood that incident to printing head 334 being returned to its initial printing position at the end of a printing cycle, roller 332 of the tape conveyor (not shown) moves tape 330 in the direction of the directional arrow to place the next printing line of tape 330 into printing position. Actuation of roller 332 is effected by the above-mentioned printing head conveying mechanism.

Printing head 334 is formed of an electrically non-conductive material and is provided in the illustrated embodiment with sixteen individual styli assemblies 342 (FIGURE 3), each having a stylus or electrode in the form of a rod-like pin 344. The pins are designated P1 through P16 (FIGURE 2) to differentiate the pins from one another. Styli pins 344 (FIGURE 3) protrude from the bottom of printing head 334, fourteen of which pins (P1–P14) are arranged into a matrix having the configuration of a digit "8" slightly slanted to the left, as seen in the bottom view of the printing head 334, shown in FIGURE 2. In addition, a pair of pins, P15 and P16, are provided for inserting the decimal point designation in the proper position between numerals along the line of print.

The pin 344 of each styli assembly 342 is formed of conductive material, preferably of tungsten and is slidably disposed in an associated pin hole or channel 348 defined in a bottom portion 352 of printing head 334. Each pin 344 is provided with a sleeve 354 of conductive material, such as stainless steel, which sleeve is "press fit" onto the upper end of the pin. Sleeve 354 is slidably confined in a channel 356 aligned with channel 348 and defined in an intermediate portion 358 of printing head 334 to permit up and down movement of pin 334 and sleeve 354 in channel 356. A biasing spring 362 of the coil type and of conductive material is provided for each pin 44 and is loosely disposed under compression in the channel 356 provided for its associated pin. Spring 362 presses against sleeve 354 of its associated pin 344, biasing the pin downward to maintain the free or lower end of the pin in constant contact with the upper surface of tape 330. Downward movement of pin 344 is limited by its sleeve 354 abutting a shoulder 364 formed by printing head portion 352 where channel 348 joins channel 356.

An electrical connecting lead 366 is provided for each pin 344 and extends through a hole 368 defined in a portion 370 of printing head 334. Each lead 366 enters the channel 356 of its respective pin 344 and is connected electrically to the uppermost portion of the spring 362 in such channel. The leads 366 serve to connect their respective pins 344 (P1–P16) to the pin energizing circuits.

It may be noted that with the described mounting arrangement of each styli assembly 342, each styli pin 344 is individually spring biased to continually bear upon and frictionally engage the top surface of tape 330, as printing head 334 is driven transversely of the tape. Such individual spring biasing automatically compensates for unevenness of the tape surface and for variation in the wear rates of the individual styli pins 344. However, this direct contact of the styli pins with the paper surface has a tendency, should the styli pins be exposed from the print head, to pick up fibers from the paper, dust particles and other foreign matter which shortly will cause a fouling of the print head considerably reducing, if not altogether disrupting, the print capability of the arrangement.

As a result of the difficulties with fouling of the print head experienced by prior art devices, the instant invention proposes the inclusion of a boot 350 (FIGURE 4) over the print head, which boot consists of a phenolic cap 351 and a Teflon gasket 353. The boot 350 is provided with a plurality of holes, each in substantial alignment with one of the styli pins of the printing head so that the individually spring biased styli pins may protrude through the boot and contact the recording surface 330. The boot 350 is spring loaded with respect to the print head by springs 380 recessed in channels or grooves 381 in the cap 351. The springs 380 act upon pins 382 in contact with the collar 384 surrounding the print head. The bias provided by springs 380 forces the Teflon gasket 353 against the surface of the tape 330 so that the styli pins 344 are completely isolated except for the cross-sectional ends which contact the surface of the tape. Since the Teflon gasket is in pressure contact with the tape 330 when the print head assembly is in the print position, the end of the cap and Teflon gasket have a radius comparable to that of the roller 332 so as to insure good contact between the gasket and the paper over the full gasket area. The holes in the cap 350 through which the print pins pass have a dimension only slightly larger than the pins themselves; however, due to the natural lubrication provided by the Teflon material, the pins may very easily slide in and out of the print head in response to pressure by the springs 362 insuring good contact between the pins 344 and the surface of tape 330. While the boot 350 is shown as being formed of two separate elements 351 and 353, it is within the purview of the invention to provide the entire boot of a single material such as a fluorocarbon resin with a filler so as to combine the low friction and high dielectric properties of Teflon with low wear and rigidity. In addition, the gasket 353 may be made from other materials having properties similar to Teflon.

When the print head is released to the print position, the outer surface 355 of bottom portion 352 (FIGURE 3) is stopped before engaging inside surface 356 of the cap 351 by a stop 385 (FIGURE 4) on the cap cooperating with suitable means (not shown) so that a gap 357 is provided therebetween. The individually biased styli pins 344 protrude slidably through the boot 350 to engage the record surface 330. The spring bias on the boot relative to the print head places the front surface of the Teflon gasket 353 firmly but resiliently against the record surface to be printed upon. Thus, the styli pins 344 are completely surrounded by the boot 350 so that only the cross-sectional end surfaces of the pins are exposed and these firmly contact the surface of tape 330. In this position, the record sheet engaging ends of the pins are substantially in the same plane as the outer surface of the Teflon gasket 353.

With such an arrangement, the gasket 353 which follows the record sheet curvature is maintained firmly against the record surface as it and the print head are driven transversely of the record sheet. The Teflon sheet biased against the record surface eliminates the gap which was heretofore present between the print head and the record sheet and in which dust particles accumulated, fouling the pins. In addition to the elimination of such gap, and the relatively tight fit of the pins as they pass through the Teflon gasket, the gasket effectively mashes the exploded dust particles of the record sheet surface back into the sheet surface such that no noticeable loose dust particles are formed to foul the pins. This wiping action of the Teflon gasket as it moves across the record

surface under pressure forcing the dust particles back into the surface impregnates the surface with all loose particles preventing these particles from entering the pin channels in the print head and from generally fouling the styli or other portions of the printing arrangement.

In addition to solving the fouling problem, as indicated above, the provision of the boot **350** over the print head provides an added support for the styli pins over substantially their entire length to the very ends which contact the record surface **330** resulting in increased stability and more accurate registration of the pins so that greater clarity in printing is achieved and scratching of the surface due to vibrations in the pins is completely eliminated.

By selectively electrically pulsing certain combinations of pins **344** of the styli matrix of FIG. 2, the configurations of numerals 0 through 9 and some special symbols may be printed upon tape **330** (FIG. 1), as printing head **334** is moved transversely thereto. Such marking is effected in the preferred embodiment by causing a succession of current pulses to flow from one pin **344** (FIG. 3) along the chemically coated surface of conductive tape **330** to a second pin **344** which is associated with and spaced from the first pin. For example, with the pair of pins (e.g., **P1**, **P2**) shown in FIG. 3, a pulse of current may be caused to flow successively from **P1** along tape **330** to pin **P2**. Such current flow causes chemically treated tape **330** to darken or change color at the two points where pins **P1** and **P2** engage the tape surface to provide legible distinct marks thereat, which due to successive pulsation thereof may take the form of elongated dots or lines. The electrical pulsing of the pins is substantially instantaneous, such that movement of printing head **334** relative to tape **330** is effectively stopped during printing. This prevents blurring, notwithstanding the relative motion between pin **344** and tape **330** during the printing.

The sixteen styli pins **344** (**P1**–**P16**, FIG. 2), comprising the digit "8" styli matrix and a decimal point designation as mentioned above, are electrically connected to the pin energizing circuits in pairs.

The pin styli **344** are therefore divided into pin pairs and an electrical styli energizing circuit is provided for each pair of pins (FIGURE 5). Thus, eight pin energizing circuits, or "driving" circuits **371**–**378** are utilized for energizing the sixteen pins. The digits 0 and 1 through 9, plus certain symbols, such as the letter "C" and the decimal point may be printed by causing the driving circuits to successively energize selective pin pair combinations in accordance with a particular time sequence.

The driving circuits utilize means in the form of a decoding matrix **383** for detecting the input of certain "pin selection" signals derived from an input processor. The decoding matrix translates the selection signals and conditions the driving circuits to effect subsequent energization of associated pin pairs or to prevent such energization, as the signals dictate. The detecting means also automatically and continually responds to changes in pin selection as denoted by the selection signals..

A "print" signal causes energization of print initiating means (not shown) which generate initiating or gating signals which are applied simultaneously to all driving circuits via the decoding matrix **383**. This causes the driving circuits of the selected pin pair combination to be simultaneously energized to form the desired character on the record medium, while those of the unselected pin pairs are maintained unenergized in accordance with the preconditioned state of the driving circuits. The print initiating signals are in the form of electrical pulses.

During printing, the printing head **334** is moved at a substantially constant speed transversely of the record tape **330**. Selection of the pin pairs to be energized and pulsing of their respective driving circuits are synchronized with transverse movement of the print head such that desired characters are printed sequentially on a print line. In this way, energization of selection pin pairs in response to the common print initiating pulses will be sufficiently instantaneous so as to appear to "stop" relative motion between the print head and record material, producing distinct printed characters on the record material, notwithstanding such relative motion.

Such an arrangement obviates the need to use a "ground" plate, as in prior art system, and minimizes the amount of equipment required for proper operation. The simultaneous energization of selected pin pairs by the common print initiating signals to print a character on the record medium also provides a highly reliable printing arrangement at minimal cost.

It is, of course, understood that the above-described arrangement for print head energization is presented only as an example of one possible arrangement for performing the required function, and any similar known arrangement or system for energization of stylus printing apparatus could be used with the disclosed print head construction.

As changes can be made in the above-described construction and many apparently different embodiments of this invention can be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown on the accompanying drawings be interpreted as illustrated only and not in a limiting sense.

What is claimed is:

1. In stylus printing apparatus for electrically printing on chemically treated record material in the form of a tape which is movable longtiudinally past a printing station, a printing head having a plurality of styli electrodes in continuous contact with one surface of said tape, said styli electrodes being electrically insulated one from the other, means for moving said printing head in transverse excursions with respect to said tape at said printing station, electric circuit means energizable for selectively causing pulses of current to flow simultaneously from a predetermined combination of said styli electrodes through said tape to produce distinct marks on said record surface, and electrode shielding means surrounding said print head and having a plurality of apertures in alignment with said styli electrodes, through which said electrodes protrude, said electrode shielding means having an outer surface portion in contact with said one surface of said tape, and adapted for slidable engagement therewith during said excursions.

2. An apparatus for printing electrically on electrosensitive record material in the form of a tape which is movable longitudinally past a printing station, a printing head having a plurality of styli electrodes protruding from one end thereof, each of which is electrically insulated one from the other and spaced apart into a styli matrix of predetermined configuration, means for moving said printing head transversely of said tape at said printing station and maintaining a free end portion of each of said styli electrodes in contact with one surface of said tape, electrode energizing means energizable for applying electrical energy simultaneously to selected ones of said styli electrodes to cause current to pass through said selected electrodes through said tape, and electrode shielding means positioned over said one end of said printing head for encasing all of each of said styli electrodes except for the cross-sectional surfaces at said free ends thereof.

3. In printing apparatus as set forth in claim **2** wherein said electrode shielding means is formed of electrically non-conducting material and has for each of said electrodes a receiving aperture defined therein, and each of said electrodes is slidably mounted in its associated one of said apertures and is provided with means for biasing said cross-sectional end of its associated electrode into engagement with said tape.

4. In apparatus for printing electrically on electrosensitive record material, the combination of a printing head having at least two styli electrodes with substantially co-

planar end surfaces, said lectrodes being electrically insulated and spaced apart from each other, means for mounting said printing head and adapted to maintain said styli electrodes in a predetermined configuration and in engagement with said record material, and electrodes shielding means slidably positioned over said printing head and substantially enclosing said styli electrodes, said shielding means including an end portion adapted to accommodate said electrodes in engagement with said record material, said end portion having an outer surface substantially coplanar with said coplanar end surfaces and engaging said record material.

5. In a stylus printing apparatus for electrically printing on chemically treated record material in the form of a tape which is movable longitudinally past a printing station, a printing head having at least two styli electrodes protruding from one end thereof into continuous contact with a surface of said tape at said printing station, said stylus head being movable transversely of said tape for printing along a transverse line on such tape, electric circuit means energizable for causing pulse of current to flow from a first one of said styli electrodes to the other of said electrodes through said tape producing distinct marks on said tape surface where said electrodes contact said tape surface, insulating cup means positioned over said one end of said printing head with said electrodes protruding through the bottom thereof, the outer surface of the bottom of said cup means being provided with a thermoplastic resin layer, said layer being provided with apertures in alignment with said electrodes, and biasing means for said cup means normally urging said outer surface of the bottom thereof into contact with said tape, such that the tape contacting portion of said electrodes and said outer surface are coextensive.

6. A printing head for stylus printing apparatus capable of printing on chemically treated record material comprising an insulating block, a plurality of parallel spaced electrodes protruding from one end of said block, means for effecting individual electrical connections to said electrodes through said block, and electrode shielding means positioned over said one end of said block and substantially enclosing said electrodes, said shielding means being movable with respect to said block and said electrodes and including biasing means for normally biasing said shelding means outwardly from said block in the direction of extension of said electrodes.

7. A printing head as set forth in claim 6 wherein

said shielding means is cup-shaped and provided with a plurality of apertures in substantial alignment with said electrodes for accommodating the passage therethrough of said electrodes,

said shielding means has a curved surface including said apertures for conforming to the surface of said record material, and

said electrodes are spring biased within said insulating block for axial movement relative to said block and said shielding means.

8. A printing head for stylus printing apparatus capable of printing on chemically treated record material comprising an insulating block, a plurality of parallel spaced electrodes protruding from one end of said block, means for effecting individual electrical connections to said electrodes through said block, and electrode shielding means positioned over said one end of said block and substantially enclosing said electrodes, said shielding means being movable with respect to said block and said electrodes and including biasing means for normally biasing said shelding means outwardly from said block in the direction of extension of said electrodes,

said shielding means being cup-shaped and being provided with a plurality of apertures in substantial alignment with said electrodes and accommodating the passage therethrough of said electrodes,

said shielding means having a curved surface including said apertures for conforming to the surface of of said record material,

said curved surface of said shielding means being formed of a material having low friction and high dielectric properties as compared to said electrodes.

9. A printing head for stylus printing apparatus capable of printing on chemically treated record material comprising an insulating block, a plurality of parallel spaced electrodes protruding from one end of said block, means for effecting individual electrical connections to said electrodes through said block, and electrode shielding means positioned over said one end of said block and substantially enclosing said electrodes, said shielding means being movable with respect to said block and said electrodes and including biasing means for normally biasing said shielding means outwardly from said block in the direction of extension of said electrodes,

said shielding means being cup-shaped and being provided with a plurality of apertures in substantial alignment with said electrodes and accommodating the passage therethrough of said electrodes,

said shielding means having a curved surface including said apertures for conforming to the surface of said record material,

said shielding means being formed of a rigid insulating cup and a curved outer layer of thermoplastic resin.

10. A printing head for stylus printing apparatus capable of printing on chemically treated record material comprosing an insulating block, a plurality of parallel spaced electrodes protruding from one end of said block, means for effecting individual electrical connection to said electrodes through said block, and electrode shielding means positioned over said one end of said block and substantially enclosing said electrodes, said shielding means being movable with respect to said block and said electrodes and including biasing means for normally biasing said shielding means outwardly from said block in the direction of extension of said electrodes,

said shielding means being cup-shaped with a continuous sidewall portion extending from an end portion, and being provided with a plurality of apertures in substantial alignment with said electrodes and accommodating the passage therethrough of said electrodes,

said apertures in said shielding means extending through said end portion and having a diameter substantially equal to the diameter of said electrodes.

11. A printing head for stylus printing apparatus capable of printing on chemically treated record material comprising an insulating block, a plurality of parallel spaced electrodes protruding from one end of said block, means for effecting individual electrical connections to said electrodes through said block, and electrode shielding means positioned over said one end of said block and substantially enclosing said electrodes, said shielding means being movable with respect to said block and said electrodes and including biasing means for normally biasing said shielding means outwardly from said block in the direction of extension of said electrodes,

said shielding means being cup-shaped with a continuous sidewall portion extending from an end portion, and being provided with a plurality of apertures in substantial alignment with said electrodes and accommodating the passage therethrough of said electrodes,

said electrodes being spring biased within said insulating block for axial movement relative to said block and said shielding means,

said apertures in said shielding means extending through said end portion and having a diameter substantially equal to the diameter of said electrodes.

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