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Methods of Associating Typewriter Ribbons and Correcting Tapes with a Questioned Text

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ABSTRACT: Various methods of associating fabric and film typewriter ribbons and correction systems with a questioned typewritten text are reviewed. Identifying characteristics produced by inexpensive typewriters using thermal transfer ribbons are also described.

KEYWORDS: questioned documents, typewriters, typewriter ribbons

The anonymous letter writer, extortionist, and check counterfeiter often use a typewriter in conjunction with their criminal activity. The investigator who seized a suspect typewriter and submitted it along with the questioned typewritten document to the document examiner wants to know if the typewriter can be identified as the source of the questioned document. In the past, the typewriter was typically a portable typebar machine, and the document examination focused on a comparison of the class characteristics such as the size and style of type, followed by a comparison of the distinctive characteristics. The identifying characteristics present in a typebar machine develop over a period of time through use and abuse. These defects in combination with one another are the basis for the identification of the typewriter as being the source of preparation of the typewritten text to the exclusion of all other typewriters.

In recent years, the typebar typewriter has been replaced by portable electronic typewriters, which are available at low cost with many of the options previously found mainly on business office machines. These portable electronic machines have interchangeable styles of type font, lift-off correction systems, and character memory. Additionally, portable electronic typewriters are now available that use a thermal transfer ribbon process. They are lightweight, inexpensive, quiet, and can operate on batteries. Consequently, these versatile, modern machines are being used more frequently in conjunction with criminal activity.

These modern electronic typewriters are difficult to associate with a questioned typewritten text because they do not develop the defects through use and abuse that are found on typebar typewriters. Today's typewriter is a two- or three-component system consisting of: the electromechanical system; the ribbon system; and for impact typewriters, the single-element system with interchangeable type font in the form of a typeball, printwheel, or thimble.

Considering the individuality of each component in the modern typewriting system, the electromechanical system is not a fruitful source of individual identifying characteristics be-

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cause a developed defect in this system usually causes the entire machine to quit operating rather than to continue to operate, but in a defective manner. The single-element system, because of its design, does not readily produce individual identifying characteristics from wear and tear. The typeface and alignment defects developed on a typebar machine from the inadvertent stacking of one typebar on top of another are nonexistent on a single-element machine. Additionally, when a noticeable defect develops, the single element is easily and inexpensively replaced. This leaves the typewriter ribbon system, which is the most abundant source of characteristics whereby a typewriter could be associated with a particular questioned typewritten text. Most of the distinctive characteristics found on a typewriter ribbon are an inherent part of the ribbon system's design and function. They do not depend upon developed defects.

Categories Of Typewriter Ribbons

The various typewriter ribbons in common use are grouped into two families of ribbons. The first type is the fabric ribbon where the substrate or ink carrier is a woven fabric. The second major family is the film ribbons, which are manufactured by applying solid ink to polymer film bases. The ink may be transferred to the document by impact or other means. Single-strike, impact film ribbons transfer all the ink to the paper where the character strikes the ribbon. Multi-strike film ribbons permit repeated use of the same on-film portions. As a general rule, polyethylene is used for single-use film ribbons, and polyester is used for multiuse film ribbons [*1*]. Thermal transfer film ribbons are nonimpact, since the ink is heat transferred from the ribbon to the paper.

Fabric Ribbons

A fabric ribbon consists of a base fabric ribbon and ink. The silk- and cotton-base fabrics which were used on earlier typewriters have given way to the much better quality nylon-base fabrics. The ink, which is a viscous liquid at room temperature, is oil based with pigments and dyestuffs. The average yield is 700 000 impressions (IBM data).

Methods of Association—The methods of associating a fabric ribbon with a questioned typewritten text are limited and are applicable under certain circumstances. If the fabric ribbon is new and has not been used enough to be completely transferred from the original supply spool onto the take-up spool to begin overtyping, there is a reasonable chance that the questioned text can be observed on the ribbon and can be photographed. Red and black bicolor ribbons may also show outlines of letters which have been typed in black, then typed on the red portion of the ribbon [*2*].

Some fabric ribbons are composed of half fabric and half cover-up tape. These ribbons, along with any hand-held cover-up tapes such as Ko-Rec-Type® used to cover up a faulty character strike-up, deposit a chalky substance which releases from its substrate upon impact. A characteristic fracture pattern along the separated edge which outlines the character is produced. If both the spent correction tape and the covered strikeup remain sufficiently intact, their corresponding distinctive fracture patterns are an excellent source of association (Fig. 1).

Other methods of associating a fabric ribbon and questioned typewritten text are possible when cover-up correction material such as Ko-Rec-Type is used. After a mistyped character is covered with correction material, the new character is struck on top of the covered character. This causes the ribbon to come into direct contact with the cover-up material. As the back side of the fabric ribbon separates from the cover-up material on the document, a layer of the cover-up material adheres to the ribbon. The pattern produced on the ribbon is determined by the design of the character covered up and the new character struck. Figure 2 shows the back side of a fabric ribbon where cover-up material has transferred to the ribbon.

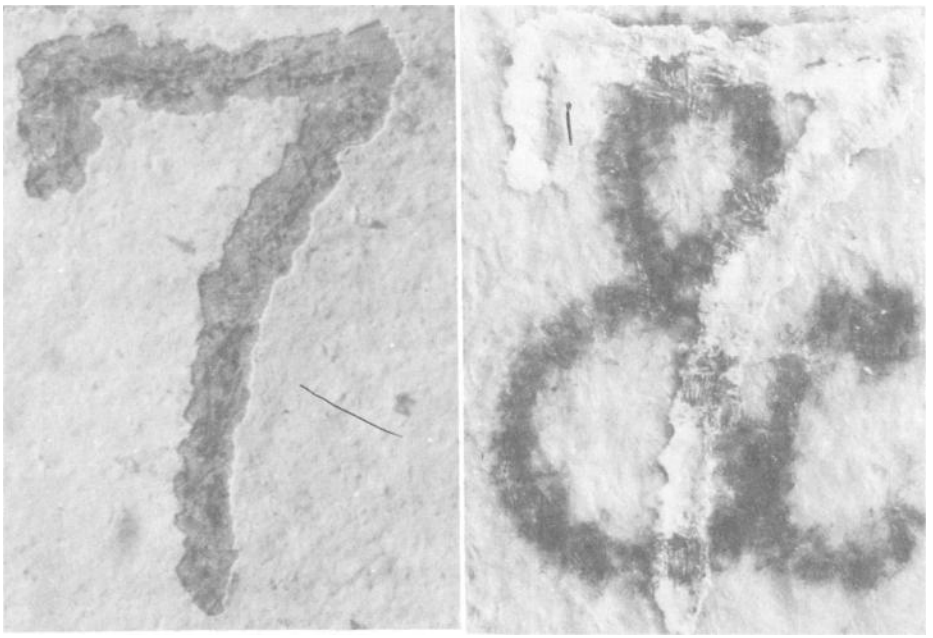

FIG. 1—*Ko-Rec-Type cover-up tape image* (left) *which has been reversed for ease of comparison displays a common fracture pattern along its perimeter with the cover-up material deposited on the document* (right).

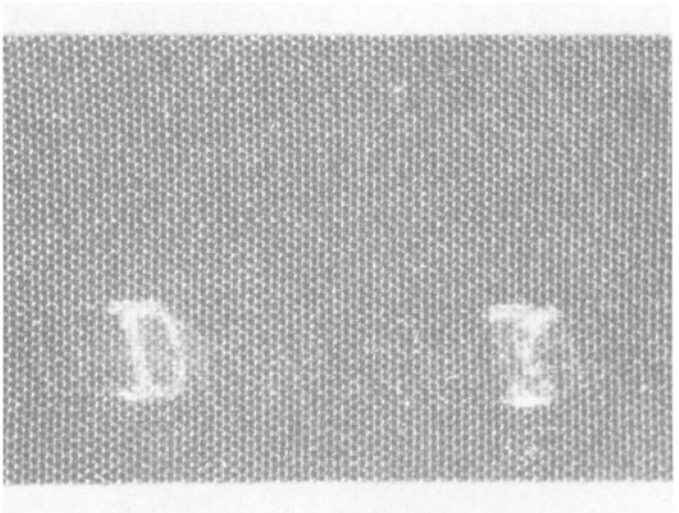

FIG. 2—*A layer of cover-up material adhered to back side of fabric ribbon when it came in contact with the character on the document which had been covered up. The unusual shapes are a function of the overlapping areas of covered and newly struck characters.*

Figure 3 shows another example of transferred cover-up material onto the back side of a fabric ribbon. This pattern was produced when the "&" symbol was struck over the number "7," which was previously covered with correction material (Fig. 1). The shapes of these peculiar patterns can be anticipated by examining the questioned document and noting the common areas where the newly struck character overlaps the covered character. These patterns may be located on the fabric ribbon utilized if the area in question has not been disturbed by subsequent strikeover or deteriorated by the excessive absorption of ribbon ink.

Once the cover-up material is located on the ribbon, additional comparisons can be made regarding the weave pattern. When a fabric ribbon is examined under magnification, the weave pattern is readily apparent. The individual bundles of filaments making up each thread form varied patterns, with some filament positions being more distinctive than others. This filament pattern appears on the typewritten document as inked impressions in the cover-up material. The extent of observable fabric detail on a document can be seen in Fig. 4.

Film Ribbons

Single-Strike Impact Ribbons—These ribbons, which were first introduced by IBM in 1960, consist of a polymer film coated with pigments, dyes, waxes, and oils. The inks soak into the paper, and corrections are made by covering up the faulty character. On 1 April 1973, IBM introduced the correctable film ribbon [*3*]. The new ribbon contained resins and lacked the dye found in the noncorrecting ribbons. This ink formulation remains on the surface of the paper rather than penetrating the paper fibers so it can be lifted off upon contact with a pressure-sensitive adhesive tape [*4*]. The ink will begin to "set up" in 24 h, making removal of the ink increasingly more difficult with time [*3*]. The lift-off ribbons, which have a thinner substrate, produce a higher yield of 150 000 impressions versus 120 000 impressions for cover-up film (IBM data).

Methods of association—Single-strike film ribbons are designed to be used only once, then discarded. A clear outline of each character struck is left on the ribbon, and with a properly operating machine, none of the characters overlap. The reading of the text left on the ribbon varies slightly depending on the mechanical design of the ribbon advance system. Some ribbons display a single line of characters which can be read from either the left or right, depending on the direction of movement of the ribbon. Other ribbons display a double row of characters alternately placed in the two rows. Ribbons displaying three rows of slightly staggered characters are read from the left or right depending on the position of the

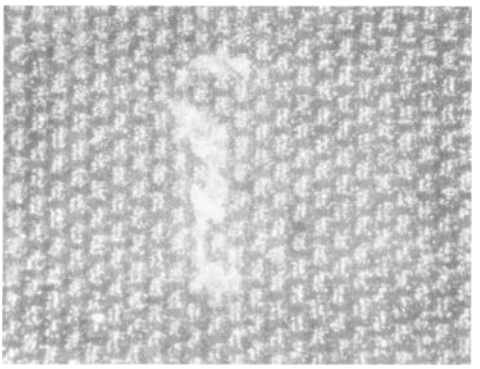

FIG. 3—*This pattern of cover-up material appearing on back side of fabric ribbon resulted from the correction made in Fig. 1.*

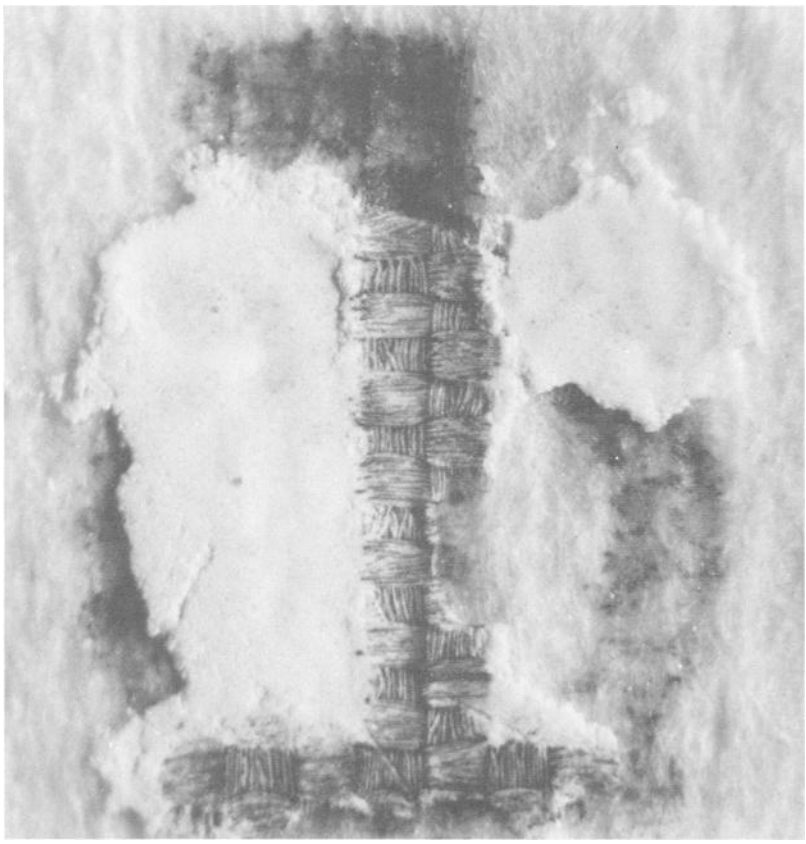

FIG. 4—*Mistyped "o" was partially covered using cover-up tape by striking lower case "r." Weave pattern of typewriter ribbon can be seen where ribbon contacted cover-up material.*

supply spool, and from the top down or bottom up, again depending on the ribbon advance mechanism.

Once the text of the questioned document has been located on the ribbon, there is an excellent chance that the ribbon can either be positively identified or eliminated as the source of preparation of the questioned text. The technique used is described by Hahn [5] and is based on the unique pattern of paper fiber impressions left on the typewriter ribbon after being struck against the surface of the paper (Fig. 5). In addition, the fracture patterns along the separated edges which outline the characters appearing on the ribbon and paper, if undisturbed, are other sources of association. Since positive identification can often be made with as little as one character, Hahn's method is especially useful when the questioned document is a counterfeit check where the typewriting consists only of a numerical dollar amount.

Faulty ribbon advance systems occasionally produce distinctive characters if the ribbon does not completely cover the character or overlaps a previously struck character. Some ribbons also produce less than fully formed characters because of flaking and uneven transfer during impact. These characteristics are especially useful when only a photocopy and not the original typewritten document is available for comparison with the ribbon (Fig. 6).

The lift-off correction ribbon may be useful when the text of the questioned document is not found on the installed ribbon. When the sequence of characters on the correction ribbon

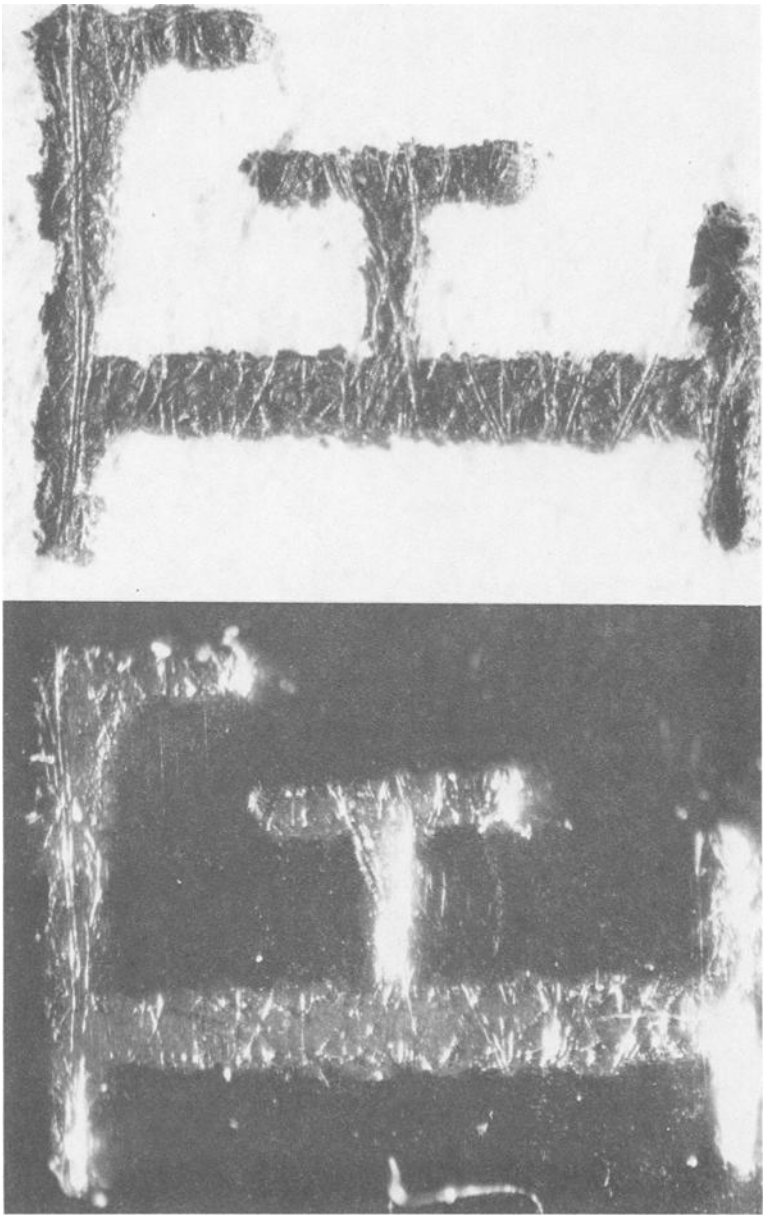

FIG. 5—*An example of Huhn's method, showing indentations in film ribbon* (left) *caused by surface paper fibers on document* (right).

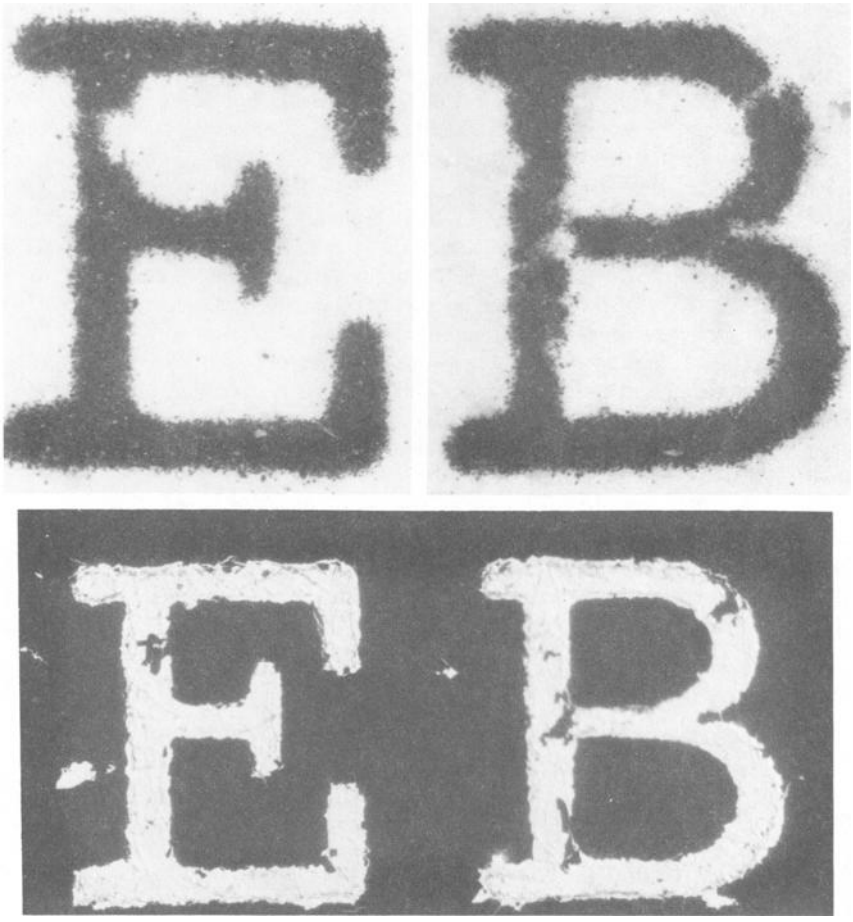

FIG. 6—*The questioned document which was a photocopy displayed numerous incompletely formed characters. Void areas on the document above are consistent with the ink segments left on the ribbon below.*

and document correspond, closer examination of lifted-off characters may reveal paper fiber impressions on the surface of the waxy ink coating. These impressions correspond to the paper fibers defined by the indented area on the paper. Incident light on the back side of the lift-off ribbon aids in viewing these impressions. Other associations are possible when the character is incompletely lifted off the page [*3*].

Multistrike Impact Ribbons—The multistrike ribbons, also known as Tech III and Security ribbons, consist of a thin film substrate of polyester. The substrate is coated with a spongelike resin layer impregnated with ink [*4*]. When the ribbon is struck and compressed during typing, the ink is squeezed out onto the paper. The ink then flows back into the squeezed areas. This ink flow permits considerable overlap of the characters as the ribbon advances resulting in a yield of over 500 000 characters in a cartridge (IBM data). The ink, like fabric ink, soaks into the paper and is permanent. IBM has produced a different multistrike ribbon which consists of a porous spongelike polymer substrate ribbon impregnated with ink.

Methods of association—The considerable overlapping of characters on a multistrike rib-

bon prevents the text from being read. The middle portions of all characters overlap adjacent characters. Those characters having tall letters or descending structure may or may not be visible, depending on the design of the character in the immediate vicinity. The recognizable characters may be of value if the examination of the ribbon can be limited to a small area, for example, if the questioned text was believed to have been the last item prepared on the ribbon. Those multistrike ribbons other than IBM brand have a resinous ink coating with a waxy surface, which effectively holds the impressed pattern of paper fibers it comes in contact with. Identification is possible with a single character if the corresponding character on the paper and ribbon can be located. Figures *7a* and *7b* show a Nukote Tech III brand ribbon with a staggered, three-row ribbon advance system. Some of the characters are recognizable. The two "i"'s appearing in the top row, left side, are separated on the document by two characters which were placed on the other two rows of the ribbon.

If cover-up tape is used to correct a misprint, a portion of this chalky substance may adhere to the back side of the multistrike ribbon as previously described with fabric ribbons. Although the shape of the correction material may be altered on the ribbon by overlapping characters, the deposited material could serve to locate the area of the ribbon used to type the questioned text.

IBM brand multistrike ribbons do not display paper fiber impressions because they lack the waxy resinous coating found on other brand ribbons. Numerous tiny holes are present in an IBM ribbon which are easily seen with transmitted light. These holes in the ribbon can produce incompletely inked characters in an older ribbon where the ink is not as fluid.

Thermal Transfer Ribbons—There are two types of thermal transfer ribbons found on

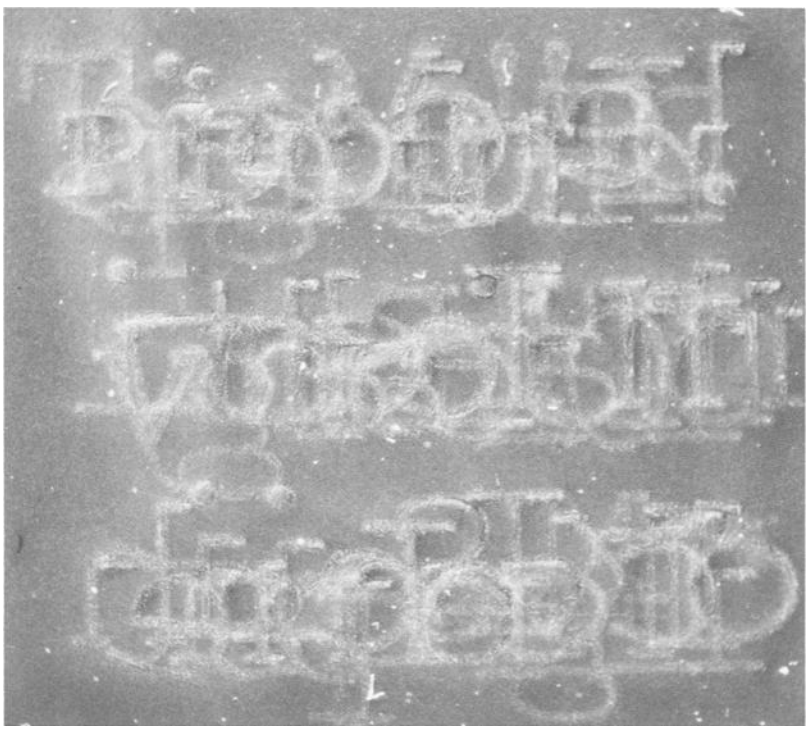

FIG. *7a—Back side of this Nukote Tech III ribbon displays some recognizable characters where overlapping is minimal.*

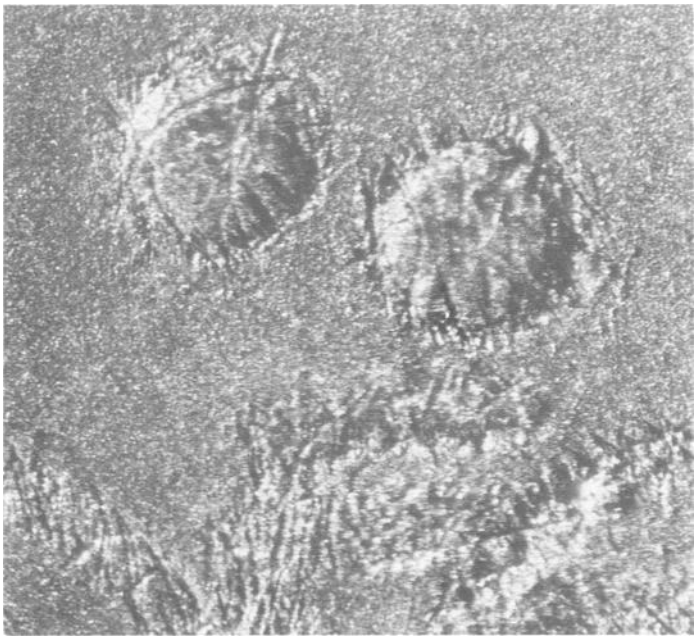

FIG. 7b—*This enlargement is from top left portion of Fig.* 7a. *Note paper fiber impressions appearing in the "i" dots.*

TABLE 1—*Typewriters using thermal transfer ribbons.*

Brand	Model
Brother	EP series
Canon	SP series
	Typemate 10
	Typestar series
Casio	CW series
Epson	Elite 200
Hermes	Top-Thermic
IBM	Quietwriter series
Panasonic	KX and RK series
Sharp	PA and PC series

FIG. 8a—*Thermal transfer ribbon from a Cannon Typemate 10 typewriter.*

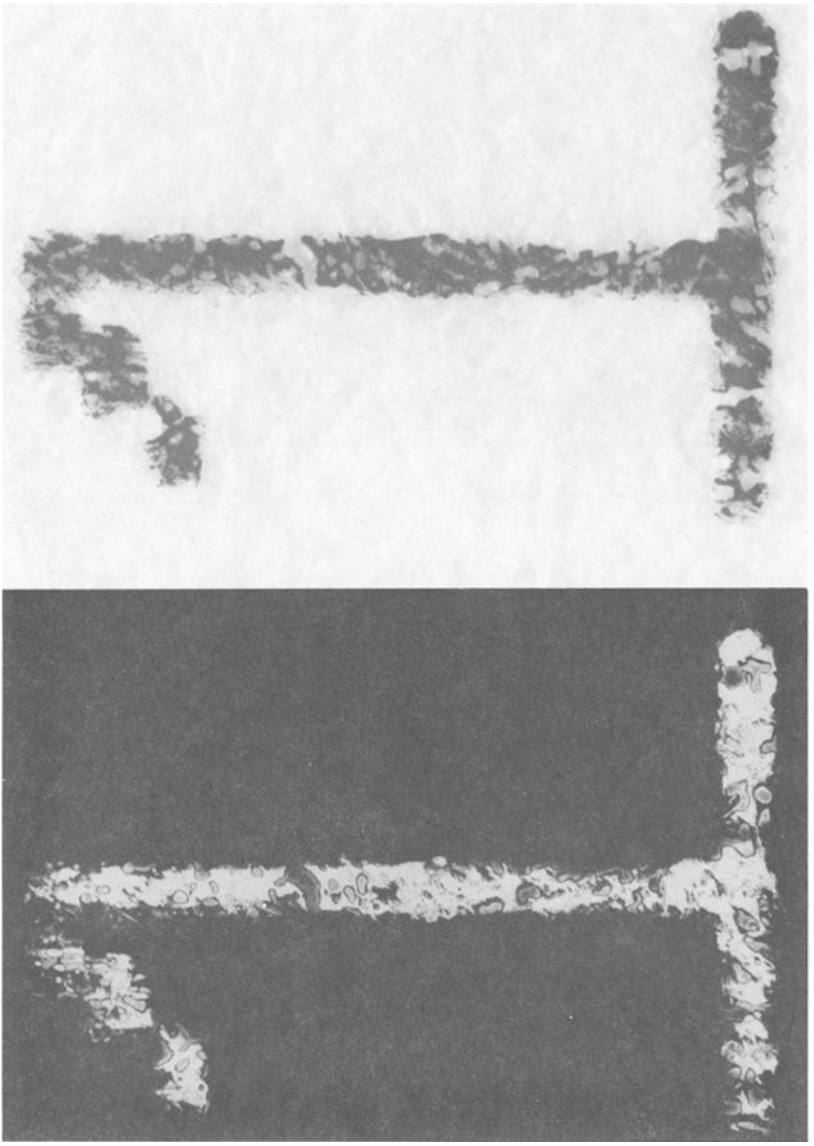

FIG. 8*b*—*Enlargement of number "1" from Fig. 8a* **on ribbon (left), and the character as it appears on the document (right).** *Note close correspondence of distinctive shapes in interior portions of the letter.*

typewriters. Both types involve nonimpact technology where heat is used to melt the ink, transferring it to the paper. Table 1 lists some of the brands of typewriters utilizing thermal transfer ribbons. Thermal transfer techniques were developed in 1975 [*6*]. The ribbon consists of a heat-resistent polyester substrate which is coated with a solid ink composed of a colorant such as carbon black and a waxy resinous material which melts at elevated temperatures. The printhead consists of multiple heat sources arranged in a dot-matrix pattern. The other type of thermal transfer ribbon was introduced by IBM in 1984 [*4*]. The ribbon consists of a hot melt ink layer, an aluminum layer, and a polymer layer containing conductive carbon. A current is passed through the polymer carbon substrate by contact with an electrode. As the current passes through the substrate, it generates heat melting the ink at that point. The aluminum layer conducts the current to ground. With this system, the ribbon itself is used to lift off erroneous characters by heating the ribbon sufficiently to make the surface tacky.

Methods of association—Both the thermal transfer ribbon and IBM resistive thermal ribbon are used only once, and the typewritten text can be read on the ribbon. Once the questioned text is located on the ribbon, the individual characteristics present can be compared.

Thermal transfer typewriter ribbons use plain paper; however, the characters do not print sharply because of the lack of smoothness on the surface of the paper. When the ink is melted, it tends to flow to the high spots on the paper and the concave areas are not easily covered. The nonuniform transfer of ink to the paper produces residual pools of ink of various shapes and sizes. These unique patterns are visible on both the ribbon and paper, and identification is possible by comparison of a single character. The comparison of characters from two different brands of thermal transfer ribbons can be seen in Figs. 8 and 9.

The ink from an IBM resistive thermal ribbon does not tend to separate into pools. Some distinctive characteristics can be seen along the perimeter of some characters; however, careful comparison of all characters may be necessary.

Related Examinations

Lettering machines which produce printed labels such as the Kroy lettering machine use a polymer film ribbon similar to the single-strike impact ribbons. The spent ribbon contains the text of the label prepared; however, no paper fiber impressions are present because of the plastic composition of the label. Identification is made by comparing the fracture patterns along the separated edge which outlines the character appearing on the label and the spent ribbon.

Identification of typewritten original and carbon copies through the examination of fiber impressions on the spent carbon paper is also possible [*7*]. Multiuse carbon paper has a waxy pigment coating similar to that found on multistrike typewriter ribbons. The nonpigment side of the carbon paper has a noncurl wax coating. Paper fiber impressions can be observed on both sides of the carbon paper which correspond to the area of the document it was in contact with during typing.

Conclusions

Suspect typewriter ribbons and correction materials should always be examined when attempting to identify the source of preparation of a typewritten document. They are the most

FIG. 9*a*—*Thermal transfer ribbon from a Sears 300 typewriter manufactured by Brother.*

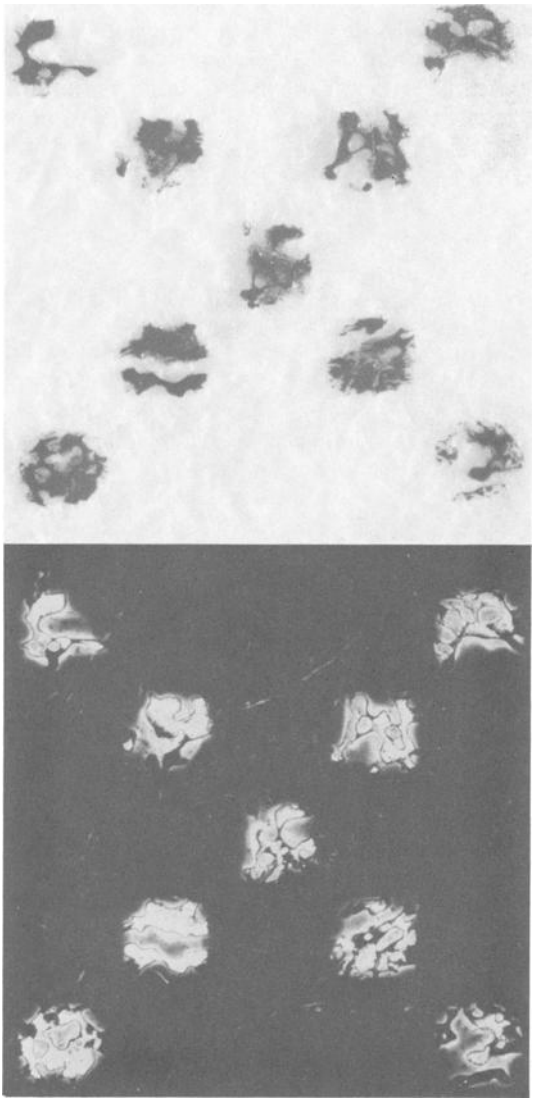

FIG. 9b—*Enlargement of letter "x" from Fig. 9a, showing a unique pattern for each dot appearing on the ribbon* (left) *and document* (right).

productive sources of identifying characteristics for modern typewriting systems and are not dependent upon the long-term development of uniqueness through wear and tear.

Acknowledgment

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