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Identification of IBM Keypunch Machines by Their Printed Products

A little over a year ago, the Document Division of the United States Army Criminal Investigation Laboratory received a referral requesting the examination of 44 keypunch cards to determine the machine responsible for their preparation. Supplies were being diverted, and the shortages were covered by the preparation of fraudulent keypunch cards. The contributor of the case also submitted known standards from the 15 keypunch machines most likely to have been responsible for the preparation of the fraudulent cards. The questioned cards were approximately 7 $^{3}/_{8}$ in. wide by 3 $^{1}/_{4}$ in. high (187 by 83 mm), contained a series of punched holes, and bore printed characters consisting of a series of dots along the top of the cards (see sample, Fig. 1). Our first impression was

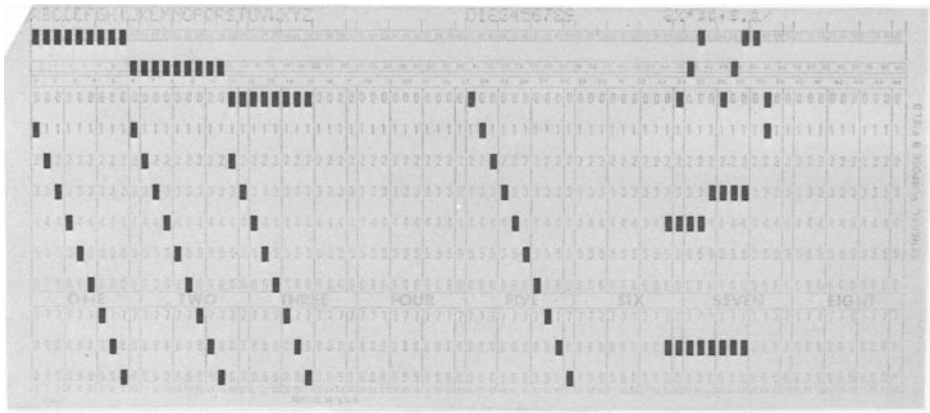

FIG. 1—*A sample card from an IBM keypunch machine.*

that this would be another tedious, complex, time-consuming examination; however, as work progressed on the examination, the case became extremely interesting and very rewarding from a document examiner's viewpoint.

This laboratory had received questioned keypunch cards on previous occasions; however, the questioned material had been handwritten or handprinted entries placed on the cards and not the punched or the printed text. This laboratory did not have any informa-

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tion on keypunch machines. Several questions arose immediately: Are typeface standards necessary? How is the printing accomplished? Are the characters printed at once like on a typewriter or are they printed one dot at a time? A review of the literature and a query of several other document examiners did not reveal any articles or other information on keypunch machines. The initial examination of the printed text on the questioned cards disclosed numerous faults such as missing dots, extra dots, and misaligned dots in various characters. In order to determine the significance of the variations, we made arrangements to see several keypunch machines. The operators could not furnish any detailed information on the mechanical operation of the machines; however, this information was obtained from IBM, White Plains, N.Y., and the local IBM office in Augusta, Ga.

Once the mechanical operation of the IBM keypunch machines was known, it was determined that the printed product of each machine was highly individual. Further examination of the 44 fraudulent cards resulted in their being placed into six groups, with each group having been prepared on a different machine. A conclusion was rendered that none of the 15 machines that prepared the known standards were responsible for any of the questioned cards. Several months later the 44 fraudulent cards were resubmitted to the laboratory with standards from an additional 104 machines. Subsequent examination resulted in the conclusion that five of the machines in this group prepared five groups of the questioned cards. The one remaining group could not be identified with a specific machine, perhaps because a machine was repaired or one machine was overlooked in the collection of standards. Of note during this examination was that each of the 104 machines could be differentiated from each other by examination of the printed product.

This paper will describe the mechanical operation of IBM keypunch machines, specifically printing, wire printing units, the identification factors, observations from some additional research, and conclusions. A detailed examination of punch holes is not discussed as the printed product of these machines is highly individual. The information contained in this paper is not an evaluation of the quality of the IBM keypunch machine. Defects in the printed product are listed to enable document examiners to reach sound conclusions in examinations of this type.

Mechanical Operation

Printing is accomplished on IBM keypunch machines by a matrix (code plate) and 35 flexible, stainless steel wires in a funnel guide that converge to a rectangle which is the overall size of the character (Figs. 2 and 3). One character is printed at a time on the top of the card in the same column as the machine is punching, with printing and punching accomplished in the same cycle. Printing can be turned off by a print suppress switch; however, any character to be printed must be punched (with two exceptions listed below).

The print wires in the newer IBM B print unit are 0.009 in. (0.2 mm) in diameter, while the older IBM A print unit (machines produced before 1 Dec. 1945) have 0.012-in. (0.3-mm) diameter print wires. The 35 print wires are in a stationary assembly and are capable of forming all letters of the alphabet, all numerals, and some special symbols. Machines having an expanded code plate can print 62 characters.

The code plate (approximately $^{7}/_{8}$ in. wide by 1 $^{1}/_{4}$ in. high or 22 by 32 mm) contains projections for transmitting pressure to the print wires (Fig. 4). Print interposers shift the code plate vertically or horizontally, or both, depending on the character to be printed. The code plate then presses simultaneously on selected wires, causing a character to be printed. None of the projections on the code plate are used for printing more than one character. The code plate is located between a pressure plate, which provides the pressure on the code plate to cause the printing, and a return plate, which pulls the wire back after the printing is accomplished.

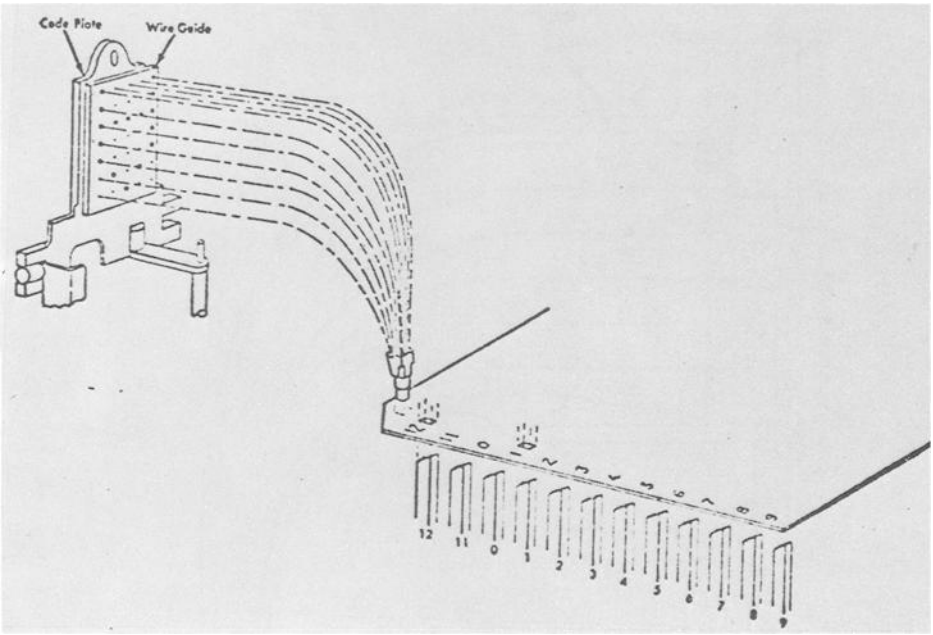

FIG. 2—*A line drawing of the printing and punching operation.*

Wire Printing Units

Information furnished by IBM stated there were no known competitive keypunch machines using wire printing units and that the wire matrix printing method was common to the keypunch types and models shown in Table 1. On all except the Type 026

TABLE 1—*IBM keypunch types and models that use the wire matrix printing method.*

Initial Type Announced	Type	Model Numbers
1949	026	1-2-3-4-5-6-7-8-21
1964	029	A21-A22-B21-B22-C22
1953	047	1-2-3
1954	066	1
1970	129	2-3
1955	536	1-2
1968	545	4
1954	826	1-2-3-4-5-6
1962	836	1-2-3
1963	1058	1-2-3
1963	6426	1-2

Model 21 and 029 Model 22 (Interpreter Models), the printing is done at the time of punching and in the same column as that punched. The 026 Model 21 and 029 Model C22 print the information from prepunched cards in the same columns as punched. IBM stated that as of 15 Dec. 1973 there were 80 standard and 380 "Special" (individually designed) code matrices. The designs are varied to provide for different languages and to meet specific requests of customers.

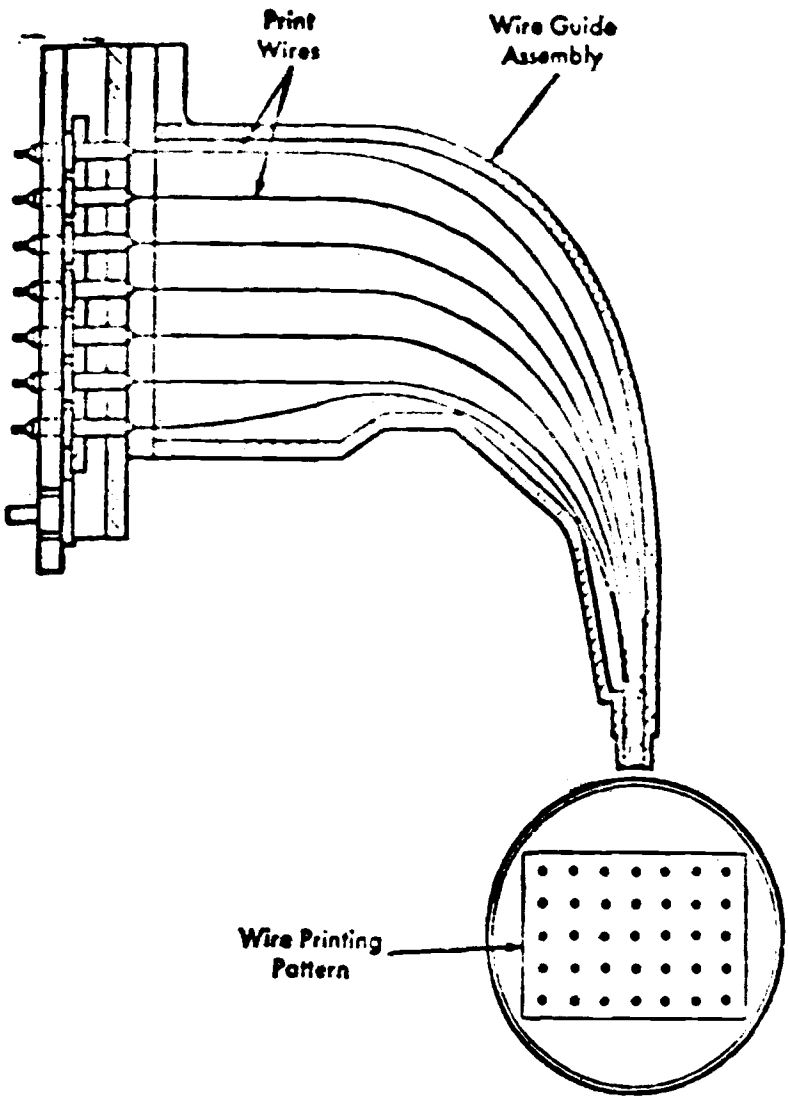

FIG. 3—*Enlarged line drawing of the printing element and the wire printing pattern.*

Identification Factors

The characters printed by these machines are comprised of a series of dots. A close examination of the individual characters will reveal many defects such as missing dots, misaligned dots, and extra dots. It is soon evident to any examiner when comparing the products of two machines that the printed product of each machine is highly individual. In many machines some of the characters are misshaped, as illustrated in the upper rows of letters in Figs. 5 and 6; however, even in those cases where characters are no longer recognizable because of missing dots, the identity of the character can be established by checking the punch holes. Each character has specific punch holes that correspond to the character.

The most common characteristic encountered is misalignment of the individual dots.

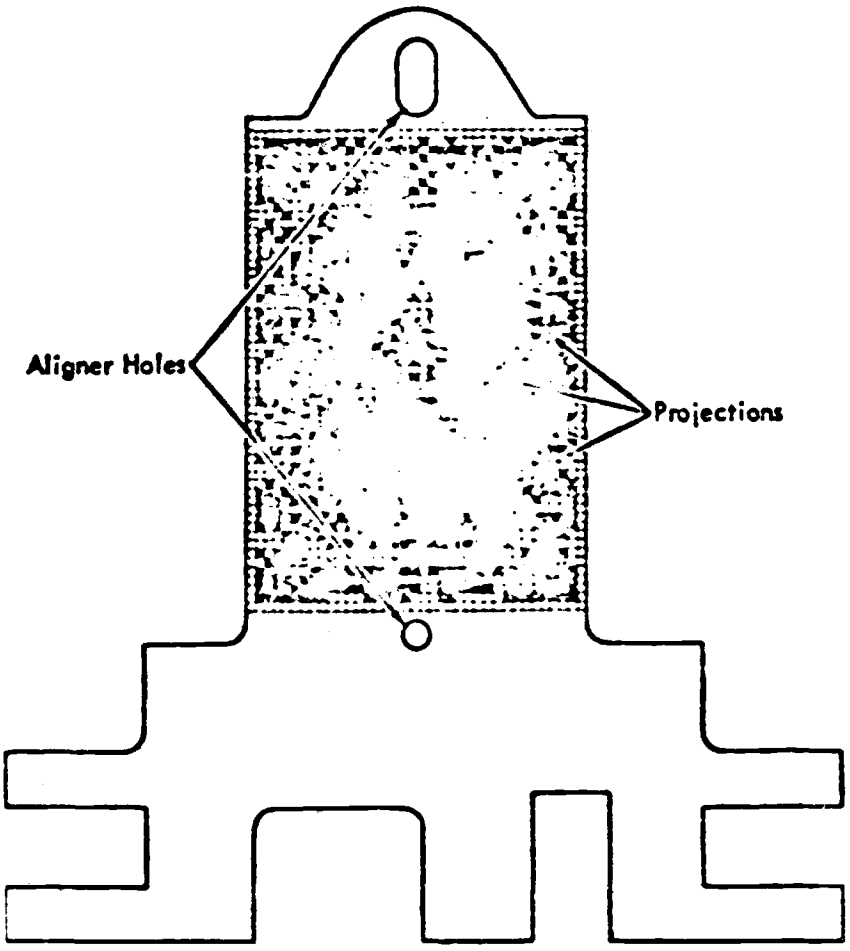

FIG. 4—*Code plate, approximately two times actual size.*

The nature of the printing process in these machines (35 small, individual wires) makes them susceptible to print out of line. In many instances what should be straight lines in characters are not straight, such as the vertical lines in the letters D and E in Fig. 5. Another significant characteristic, in addition to the lines not being straight, is the spacing between dots.

Another common characteristic is missing dots in characters. There are two causes of this problem: bent print wires and broken code plate projections. If the same wire does not print in any character that uses that wire, there is a binding problem caused by a bent print wire. If the wire does not print in one character and does print in others, there is a broken code plate projection. Which wires are used to print specific characters is detailed in Fig. 7. The wires in these machines can print five dots horizontally and seven dots vertically. By referring to Fig. 7, an examiner need only check several characters to determine whether it is a broken code plate projection or a bent print wire. If it is a bent print wire, the missing dot can be forecast in any character that uses that particular wire. In Fig. 5 the right top dot is missing in Letters J, K, M, and N because of a bent print wire. Looking at Letter N in the same figure, an examiner can see there are an additional five dots missing in the right vertical portion of this letter. These

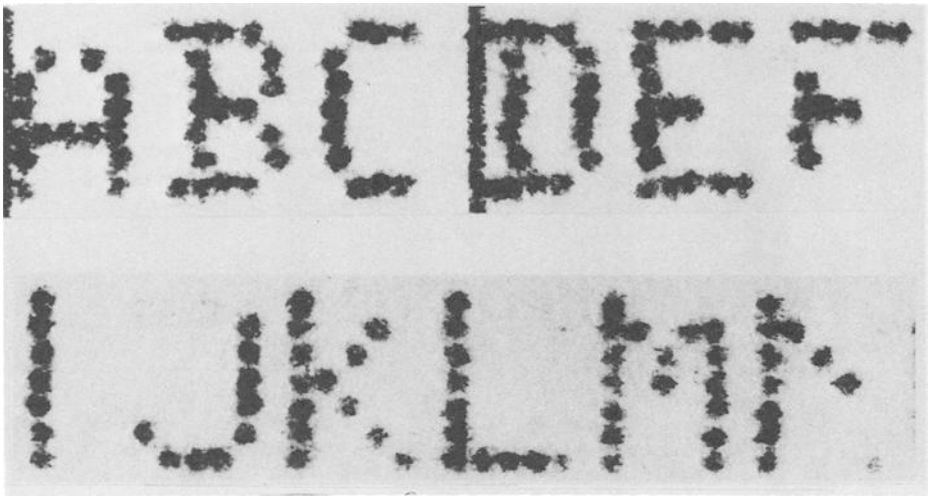

FIG. 5—*An illustration of some defects in printed characters; notice especially the misshapen characters in the upper row and the missing dots in Letters J, K, M, and N.*

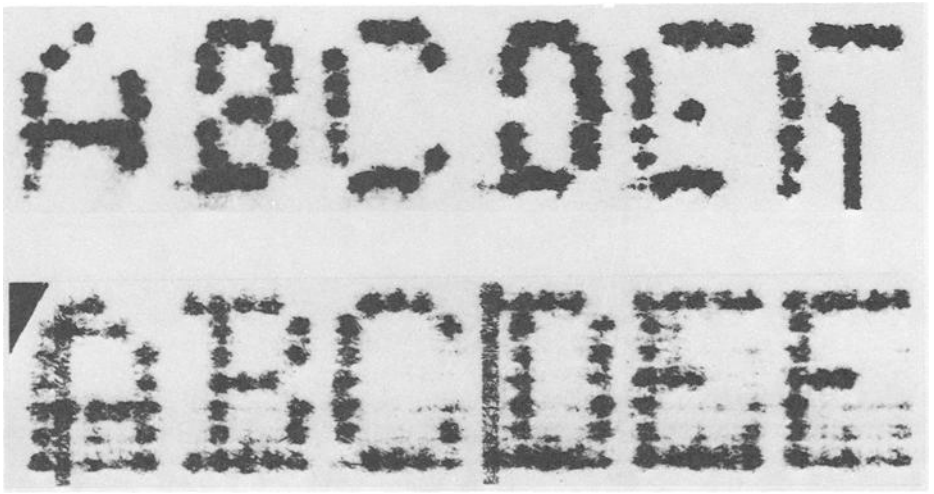

FIG. 6—*Additional defects in printed characters; notice the misshapen letters in the top row, the extra dots in Letters A and F in the lower row, and the effect of too much printing pressure on the bottom row.*

missing dots are due to broken code plate projections because the same wires are printing in Letter M.

Occasionally, extra dots will appear in characters because of improper code plate alignment, such as in Letters A and F in the lower letters in Fig. 6. The lower letters in Fig. 6 also illustrate an example of too much printing pressure.

Research

To determine the effects of usage and machine repairs on the printed products of specific machines, we used five MAI 026 keypunch machines for the research after we

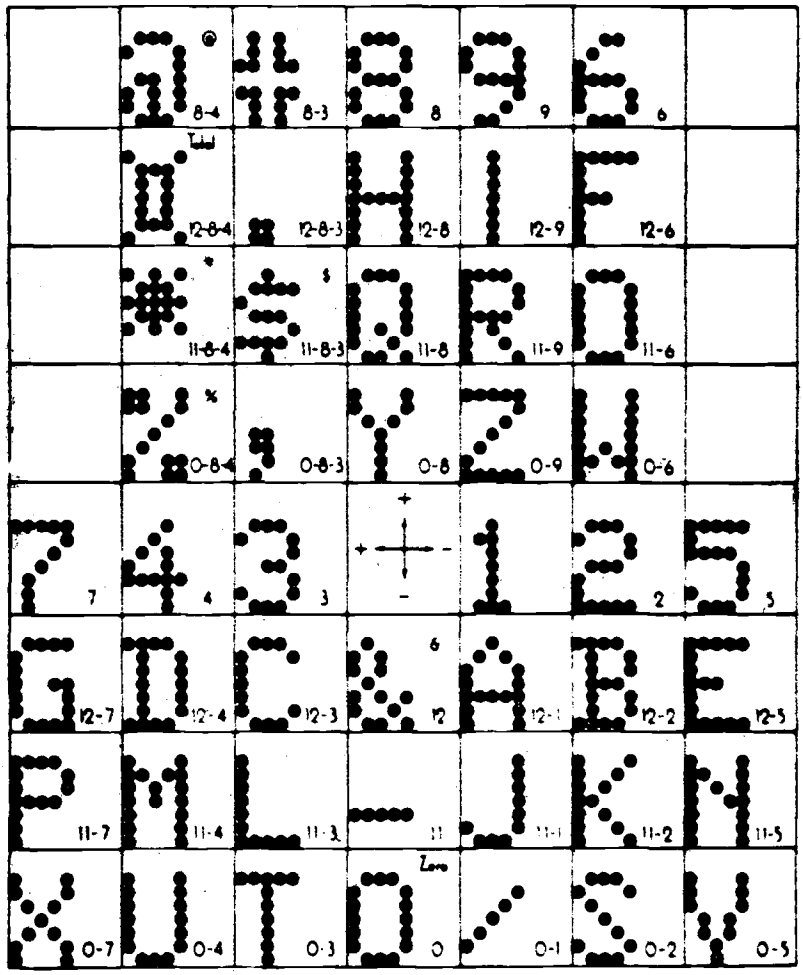

FIG. 7—*A detailed illustration of which wires are used to print specific characters.*

determined that MAI machines are manufactured by IBM. One machine had an indicated installation date of 1963, and presumably all five machines were of that vintage. All machines were used at least 40 h per week.

For comparison purposes, standards were taken on the five machines over a 13-month period. The first set was taken on 23 Aug. 1974; another on 20 Sept. 1974; another on 24 Jan. 1975; and another set on 12 Sept. 1975. Each time standards were taken, the individual machine maintenance logs were checked for repairs since the prior standards were obtained.

Four of the machines did not have any significant repairs to the printing mechanisms other than minor adjustments. A comparison of their products over the 13-month period resulted in the finding that any given standard could be identified with the machine that produced it. In Fig. 8 all of the Letter Zs were produced on one machine over the 13-month period; similarly, the Letter Bs were produced on another machine.

It also became evident that minute changes do occur and, as the machines use 35 individual wires, the changes were excellent for dating purposes while the product still retained its identifiable characteristics. For example, Letter Z in Fig. 8*D* has a dot missing in the standard taken on 12 Sept. 1975; this dot was present in the standards taken up

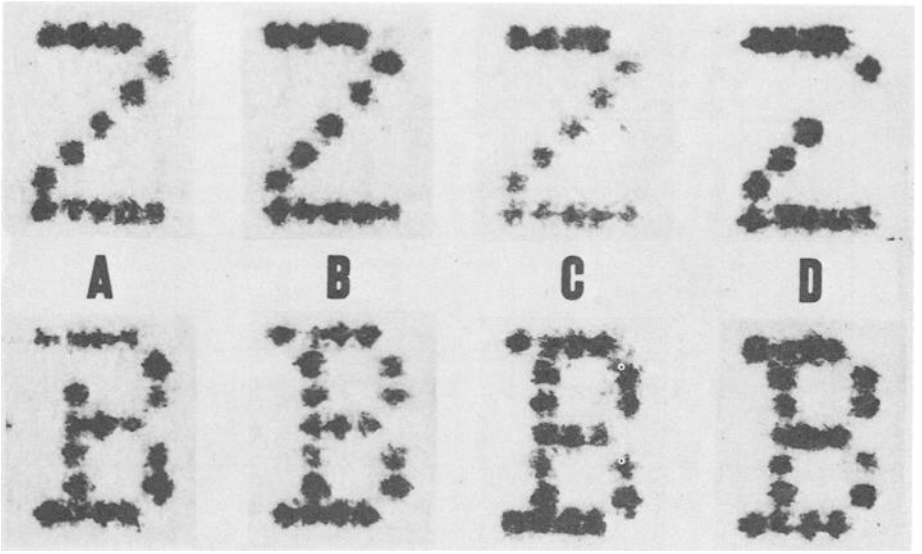

FIG. 8—*A comparison of characters produced over a 13-month period; the top row was produced by one machine and the bottom row by another.*

to 24 Jan. 1975. Also, Letter B in Fig. 8*A* has a dot missing in the standard taken on 23 Aug. 1974; the dot was present in the subsequent standards.

The fifth machine had major printing components replaced during the period the standards were taken. On 1 Aug. 1975, the print unit was replaced and on 12 Aug. 1975, the code plate was replaced. The effect of these replacements was to completely change the printed product of the machine so that identification was no longer possible with the former printed product. In Fig. 6 the upper letters were printed by this machine on 20 Sept. 1974, whereas the lower letters were prepared on this same machine on 12 Sept. 1975. Unfortunately, notification was not received in time to enable standards to be obtained from the machine after the print unit was replaced and before the code plate was replaced; therefore, a determination could not be made of the effect of replacing only the print unit.

While the research was conducted it was obvious that the printing wire elements and the code plate are internal components of these machines and are not easily accessible for changing. Individual wires can be replaced, but each must be replaced in the same position because they are of different lengths. A machine operator of seven years stated she would not be able to change code plates or printing elements from one machine to another. An IBM repairman stated replacement of the printing element would take a highly skilled serviceman approximately 15 to 20 min using special tools. The replacement would be beyond the average person.

Conclusions

The printed product of an IBM keypunch machine is identifiable with the machine that prepared the product. Standards from more than 100 machines could be differentiated from each other. Figure 9 shows the Letter B produced on the same date by five different machines.

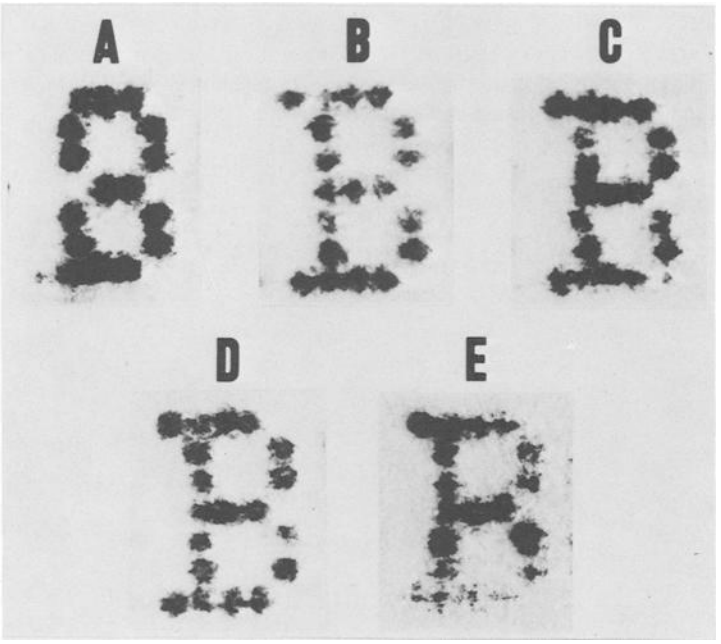

FIG. 9—*An illustration of the same character produced by five different machines on the same day.*

If the code plate and printing element are replaced, identification cannot be made with the former printed product as the entire character of the product changes. If known standards are available of the machine prior to the replacement of the code plate and the printing element, then it is possible to identify other former products printed on the machine.

Due to the nature of the printing process, a code plate with projections and the 35 print wires, there are many individual characteristics present in the printed products of these machines. Therefore, it is believed that replacement of a code plate would not significantly alter the printed product of the machine so as to make the identification of former products produced on a machine impossible. The examination would be a little more complex, as the machine would print dots that were previously missing; however, misalignment and bent print wire defects would still be present. Conversely, if the print element is changed and not the code plate, it is believed identification of the former printed product with the machine would be highly unlikely as the only remaining characteristics would be limited to code plate defects. The effects of replacing one of these parts and not the other on the printed products are suppositions. Additional research must be conducted in these areas to determine the validity of the conclusions.

One other observation was made during the conduct of the research and the examination of the referral: many machines contain significant defects in the printed product. An assumption is made that the quality of the printed product is not important to machine users as long as the characters are recognizable and the machine functions. This observation is important to document examiners from the standpoint of identification.

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