PRODUCTION OF MAGAZINE LABELS
BY THE VIDEOGRAPH PROCESS

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Abstract

System considerations point out the feasibility of using high density master file tapes in the preparation of subscriber labels for magazines, thus eliminating the necessity of using the central computer complex for the preparation of edited tapes. The operation is completely automatic, and operators are required primarily to feed raw materials and file tapes into the machine and to remove the finished products. Production of labels at the rate of 131,000 per hour is accomplished by means of an electrostatic process in which the image is formed directly on a special paper. Several safety features insure reliable operation of the equipment.

Introduction

TIME Inc. maintains an active file of approximately 10,000,000 subscribers to four of its domestic magazines - TIME, LIFE, FORTUNE and SPORTS ILLUSTRATED. A file of this nature is a dynamic one for there is constant activity in the form of changes of address, new subscriptions, renewals, inquiries, etc. Since 1946, the subscriptions have been processed with a semi-mechanical punched card system. Beginning in the fall of 1960, the punched card system will be "phased out" and a magnetic tape system will be installed, bringing a new degree of machine processing to subscription service.

The installation of the new equipment is the result of nine years of intensive study of magnetic storage and processing techniques. As late as 1955, it would have cost considerably more to process subscriptions by magnetic means than by punched card means, but as equipment was improved, the cost kept decreasing until it became obvious in 1957 that a practical magnetic system could be designed.

Several computers were available. Feasibility studies were made and several proposals from computer manufacturers were evaluated with help from the Armour Research Foundation during the early part of 1958. Each computer had its advantages and disadvantages but all of them had one thing in common--no satisfactory solution to the problem of printing labels. While 10,000,000 small magazine labels can be printed on standard tabulating type computer output printers, this solution is a compromise at best and is very expensive.

The label printing operation itself is an ideal application for special purpose equipment. The workload is almost constant from week to week, the form of the label shown in Fig. 1 is constant for long periods of time, and the paper on which the label is printed seldom changes. Therefore, rather than bend the system around to fit existing equipment which was designed for another purpose, separate proposals were solicited for new equipment designed primarily to print labels.

This equipment, of course, must cooperate with other elements in the overall system in order to achieve optimum results. The basic source of information for the label printing job is the master file of subscriber data. Activity to the file in the form of new subscriptions, renewals, changes of address, etc., are accumulated on a weekly basis and the file is updated just before the labels are to be printed. This insures that the labels are as "fresh" as possible. The arrangement of the file is geo-alpha, each record being identified by a code that is derived from the subscribers name and address. The code is constructed with the city-state portion major, followed by last name, first initial, street name, and house number.

Optimum file maintenance procedures dictate that certain inactive subscriber records be retained in the file for several months, including recently expired subscriptions and the old address in a change of address activity. An analysis of the list shows that on the average there is about one inactive record for every three active records.

On magnetic tape the records will appear as follows (Fig. 2):

(a) They will be grouped in blocks of somewhere between 10 and 20 records per block with 14 being the most likely choice in order to achieve an approximate balance between tape time and compute time.
In order to conserve tape and thereby to reduce process time, the city-zone-state portion of a subscriber's name and address, and the code for that city, will not be carried in the individual record but in a header record that appears at the beginning of each new city-zone-state grouping.

Header record and subscriber record formats are similar (Fig. 2b and 2c) and conform to the requirements of the IBM 7070 computer on which the file will be updated. Statistical information which is relatively constant is placed at the beginning of the record while, variable address information is placed at the end, allowing maximum conservation of tape. In other words, the record is terminated with the end of the address information and short addresses mean short records, long addresses mean long records. Specifically:

1. The record always begins with a delta.

2. The next character, called the indicative character, identifies the record as active, inactive, or header, as well as a special record classification called Suppress Header which is used for subscriber records that contain special city-state information, thereby, making the header unnecessary when printing labels.

3. A second delta signals the beginning of the alphabetical portion of the record.

4. After the second delta, the first 16 digits are part of the code that identifies the subscriber record. (The next four digits are ignored.)

5. The name line begins with the 21st digit. The first address line begins with the 41st digit. The second address line begins with the 61st digit.

6. The record may end with a record mark symbol in any multiple of five character positions after the twentieth position, or with no record mark if the record is a maximum length record.

7. The first 10 digits following the second delta of the header record are part of the code line.

8. The city-state line always begins with the 11th character.

Because of the importance of correctly identifying the header record, several checks are available in addition to the indicative character.

1. The first character following the second delta of the subscriber record will always be the initial letter of one of the months of the year, and the first character following the second delta of the header record will never be one of these eight characters.

2. The header information following the second delta will always be exactly 30 characters plus a record mark word, no more and no less.

In addition to the format characteristics listed above, there is available a programmed signal in the form of a special record called an "End of Roll" record. This record appears to the printer as an active record and the information contained in it, roll identification, number of subscribers in the roll, etc., is printed as though it were a label. It's distinguishing characteristic is a series of five Z's following the second delta. This is a signal to the printer to stop printing on that roll and to start a new roll. As a check on the performance of the printer, a count is kept of the active records going through the printer and this count is printed beside the computer count shown in the "End of Roll" record.

This arrangement of records is advantageous from the file maintenance standpoint, and it also makes feasible the printing of labels directly from the master file. The manner in which the problems of printing control and editing were solved is described in the following sections.

General Description of Label Printer System

A. B. Dick Company undertook the task of developing and constructing a label printer system meeting TIME Inc.'s requirements. From the outset this system was conceived to be a production machine fulfilling a vital role in the daily production of magazine address labels. As such, it has been designed to operate directly from the magnetic tape master file records without the necessity of using valuable computer time for the preparation of a pre-edited printing tape. It produces and delivers completed address label rolls ready for use by the magazine printers in their standard, label-affixing machines.

The printer operates at a basic rate of 6100 characters per second. This rate increases to approximately 7500 characters per second during the key line operation. These printing rates permit 36 labels per second to be produced and, with the automatic paper processing devices incorporated, permit the machine to produce five million labels per week during a standard 40 hour shift. Thus, two machines adequately meet the printing load faced by TIME Inc. with either machine capable of turn-
ing out the entire production if operated more than a single shift. Each machine provides standby service for the other.

To achieve this function requires two major units as shown in Fig. 3. The first, or lefthand one, of these units, 1) reads the magnetic tape records, 2) edits the information read, 3) stores the printing information until used by the printer, and 4) formats the printing data before transmission to the printer. This unit is called the Tape Reader-Buffer Unit, or TRBU.

The second unit, the one on the right, converts the digital codes received into printing signals and produces the magazine address labels. This unit is the Videograph Address Label Printer. This unit operates continuously with provisions for automatically changing paper supply rolls and for cutting off completed address label rolls and switching to a new spindle in response to input control pulses. These cutoff and transfer operations proceed without operator intervention and without machine stoppage.

The Videograph Process

Before proceeding with a description of the address label printer consider briefly the printing process itself. Fig. 4 and 5 diagrammatically illustrate this.

As shown in Fig. 4, a specially constructed cathode ray tube produces an electrostatic image on the treated surface of a moving paper web. The face of this electrostatic printing tube (or EPT) consists of a matrix array of small, closely-packed wires extending from the inner vacuum through the glass to the outside. By directing the electron beam to a point on this array and turning it on, a current is caused to flow through the wires selected to the surface of the paper, producing a charged area on the paper that is capable of later development. Thus, through control of the deflection signals, and suitable intensity modulation of the electron beam, any desired electrostatic image may be produced within the boundaries of the wire matrix array.

This printing process requires two characteristics of the paper. First, the surface must be capable of accepting and retaining an electric charge. This is accomplished by coating the surface with a thin layer of dielectric material. Second, the base, or body of the paper must be conductive to create a suitable ground plane near the imaged surface. This is accomplished by impregnating the paper with suitable materials. The resulting paper, therefore, does not depend upon photoconductive or other unusual properties, and is, incidentally, easily and economically produced.

Following the printing process, the latent image is developed as shown in Fig. 5 by dusting with a mixture of iron powder and a black toner dust.

The toner particles, in such a mixture, adhere to the negatively charged regions on the paper surface and are conveyed with the paper to the fixing station. The iron particles serve to impart a charge to the toner causing them to more readily adhere to the image. The iron becomes, through the charge interchange, oppositely charged and is repelled by the imaged areas. The iron, therefore, serves only as a carrier for the toner and is not used up in the process of development.

Following development, application of heat to the developed image causes the thermoplastic toner particles to fuse and attach themselves to the paper surface. The image is thus made permanent and will not smudge as a result of later handling.

Character Generation

In order to use the electrostatic printing tube for the printing of alphanumeric characters, some means must be provided for the conversion of digitally coded information into video-type signals. Many approaches were possible due to the flexibility of the printer tube.

The means selected utilizes a monoscope tube such as shown in Fig. 6. This tube is basically a cathode ray tube with an electrostatic deflection system. At the screen end of the tube a circular aluminum disc replaces the phosphor as the target for the electron beam. Immediately in front of the target is a somewhat more positive electrode for the collection of the secondary electrons emitted from the target.

Operation of the monoscope depends upon the secondary emission characteristics of the target surface. When the beam strikes the aluminum surface of the target, a secondary emission ratio of approximately two results. This causes an electron current to flow from the external circuitry into the target. This condition would be reversed should the surface be covered with a carbon-based ink having a secondary emission ratio of somewhat less than one.

The target for the monoscope used contains a square array of 64 characters on its front surface. Each character is etched into the aluminum surface. The remaining surface is covered with a carbon-based ink to form the background. As the primary beam scans a single character in a raster-like manner, the resultant current into the external circuit represents a video signal describing the character. By scanning the printing tube with an identical raster and intensity modulating the beam with the video thus produced, an electrostatic image of the character on the monoscope may be created on the videograph paper.

Character selection signals originate in a highly stable circuit generating one out of eight voltage levels
for both the horizontal and the vertical deflection plates. An input, six-bit digital code, representing the desired character, controls the selection circuits in such a manner that the first three bits of this code select the vertical position, and the second three bits select the horizontal position of the character to be scanned. By this means, the positioning of the characters on the monoscope target decodes the input and eliminates the need for further logical circuitry.

Since no cutouts or stencils of the letters are involved, and since the plates may be easily produced from original artwork by photo-etching techniques, almost any type font may be chosen. In fact the type font may be varied by switching tubes to meet special printing needs in the future.

Electronic System of Printer

Using the printing process and the character generator described above, the electronic system of the Videograph Label Printer produces an electrostatic image of the labels on a continuously moving web of paper. The operation of this system is shown in the block diagram of Fig. 7.

Digital signals from the TRBU trigger the character generator once for each input character. In this unit the selection circuits select the character to be printed and the raster-scan circuit causes this character to be scanned. The same raster signals are transmitted to the vertical deflection coil of the printer tube and through the horizontal deflection circuitry to the horizontal coil. In addition, an unblanking signal and the resultant video signal modulate the beam of the printing tube so as to produce the latent image of the scanned character.

The raster signals used for the character scan consist of a 200 kc vertical sine wave that is continuously applied to both the monoscope and the printer tube. During the generation of a character, a 100 micro-second horizontal sawtooth signal produces the slower horizontal scan in the monoscope and controls the horizontal movement of the beam in the printer tube. The resultant horizontal signal for the printer tube, therefore, consists of a stepwise signal combined with a sawtooth. The stepwise component provides the character by character separation, and the sawtooth controls the writing of individual characters. The horizontal circuitry is reset for the beginning of each line by the pulse supplied from the TRBU.

The First Line Pulse modifies the horizontal deflection circuitry so as to compress the key line as shown in Fig. 1. This compression occurs as a result of reducing the magnitudes of the horizontal sawtooth and step signals in the horizontal deflection circuitry. The compression circuits are reset by the next "Beginning of Line" pulse from the TRBU.

The motion of the paper controls the printing of labels so that each label will be accurately centered between holes. The paper control circuitry, therefore, produces a label demand pulse and transmits this pulse to the TRBU to initiate the printing of each new label. At the end of each label roll, as determined by information from the master file tapes, an "End of Roll" pulse is sent to the printer from the TRBU. This causes an interruption in the transmission of the label demand pulses for 2.5 seconds in order to create a blank strip of paper between label rolls. At an appropriately later time the web is cut and caused to start rewinding on a separate spindle.

Paper Processing System

The mechanical paper processing system consists of three basic modules. These are shown in Fig. 8. From left to right these are 1) the Unwind module, 2) the processing module and 3) the rewind module.

The unwind module contains two supply rolls of paper, a flying splice mechanism and a supply elevator. The upper supply roll normally feeds paper into the printer while the lower roll is in standby. When the upper roll is depleted, as detected by a feeder arm and cam, the splicer stops the flow of paper. During the splice operation, the supply elevator supplies paper to the printer so that actual printing does not stop. After the paper motion stops at the splicer, the old web is cut off and the leading edge of the new web attached to the trailing edge of the old. The web is then released and the new roll commences to provide the system. The entire unwind mechanism then revolves, bringing the new roll to the top and placing the empty spindle on the bottom for loading of a new roll of paper for standby.

In the central, or processing, module, the paper passes in front of the EPT where the electrostatic image is created in its left surface. It then proceeds through the developer and around the fuser unit. From this point it proceeds to the rewind module. The operations of the printer tube have already been described. The developer unit conveys the iron powder-toner mix to the paper surface to develop the image. The fuser uses rf to create a corona discharge to the paper surface causing a very rapid surface heating for the fusing operation.

In the rewind module, there is a primary paper drive-punch unit, a rewind elevator and a six spindle rewind assembly. The primary drive-punch unit uses hardened dies in the drive drum meshing with soft steel punches on an adjacent drum. These elements of a rotary punch are on one inch centers and create the holes in the label strips as shown in Fig. 1. In addition, this unit generates pulses in synchronization with the hole punching operation to initiate the printing of each label. Since the distance from this drive unit back to the printer tube remains fixed, this exactly locks the
position of the printed labels with respect to the holes punched.

The paper web normally travels over the left most spindle of the rewind station and is wound on the lower left spindle as shown. At the end of a roll, a cutting knife opposite the left most spindle cuts the web and a roller, together with a vacuum in the spindle, causes the rewinding to commence on the left most spindle. The mechanism then rotates 60° counterclockwise, returning the system to its original state. The completed roll is conveyed to the lower right position where it can be removed by the operator and a new core placed on the spindle.

Operation of the Tape-Reader-Buffer Unit

From the preceding it may be seen that the printer operation proceeds in a most conventional manner but at a very high rate of speed. It could just as easily be recording data directly from the computer as an "on line" device or could be printing the text of the congressional record. However, the TRBU converts this conventional printer to a TIME Inc. printer system. This unit contains the editing, logic, and buffer circuits necessary to permit this printer to be driven directly from the master file records produced by the computer.

With the tape organization described previously, the TRBU's input control circuitry can, as shown in the block diagram of Fig. 9, edit the incoming information from the tape. Information read a block at a time from tape 1 in the figure, passes sequentially through S1 and the two character storage to S2. While in this limited storage, the characters are examined by the input logic control circuits in order to check the parity of the characters as read and to control the setting of the switch, S2, at the input to the main buffer storage unit.

Switch S2 normally is in the lower position so that no information enters the buffer. When the first delta symbol is received from the tape, the input logic circuit examines the numerical digit immediately following it. If the record is a non-printing subscriber record, the control circuitry leaves S2 in the open position throughout the remainder of that record. If the record is that of an active subscriber, or a header, S2 connects with the character storage input at the second delta symbol in the record and enters into storage the second delta symbol together with the portion of the record following it. S2 immediately returns to the open position at the instant the next delta symbol, signifying the start of the next record, is detected by the input logic circuitry.

A parity error detected by the input logic circuitry is counted and added to the total count of such errors stored in the 144 character buffer unit. In addition, S2 and the special symbol generator inserts the code for a question mark for the character misread. Normally the detection of a parity error does not stop the machine since a few such errors will still permit delivery of the magazine. A label is a very redundant item, especially when coupled with the postman's memory. Such an error will stop the machine, however, when its frequency exceeds a present amount, or when it occurs at a critical point where confusion is likely in the handling of the header.

The 2184 character main storage buffer has a minimum capacity of approximately 26 combinations of header and subscriber records. When the number of records in storage drops below approximately 12, the input tape drive control causes the tape unit in use to read the next block. By this means the main buffer is kept loaded and the tape reading rate is under the control of the printer and its operations. At the end of the first tape, S1 automatically switches to Tape 2 and operation continues as before while the operator reloads Tape 1 with a fresh tape.

The time required to read a block of information from the input tape is approximately 50 milliseconds. The time to empty the main buffer by printing operations is approximately 300 milliseconds. Thus, approximately 6 blocks of information could be read from the input tape before the buffer would be emptied by the printer. As a result, there could be a series of up to 84 consecutive inactive records without causing the printer to print a blank label because of insufficient input information. However, no useful information is lost as a result. Operational studies of the master files at TIME Inc. indicate that such a series of inactive records will almost never occur.

At the output of the 2184 character buffer, S3 and S4, under the control of the output logic circuitry, determine the sequence of characters coupled to the printer. For the printing of a subscriber address, the data denoting the specific subscriber constitutes the subscriber record and is obtained for the printing operations directly from the main buffer. For this the switch S3 is positioned in its center position. The last seven characters of the key line and the last address line are associated with the city-zone-state and are part of the header record as stored in the 144 character buffer in the block diagram. For the printing of these characters, S3 and S4 are in their lower-most positions. This causes the output of the smaller buffer to be delivered to the printer and at the same time to circulate back into the input of the buffer so that the same header information will be available for the printing of the next label. The two spaces and the "Beginning of Town" marks are supplied from the special symbol generator with S3 in its uppermost position. The "Beginning of Town" marks are only placed on the first label in each new city-zone-state series.

The delivery of data to the printer commences with the receipt of a "Label Demand" pulse from the
printer and continues at the character writing rate of 6100 characters per second until the label is completed. Completion of a label is normally determined in one of three possible ways. These are:

1. detection of a delta symbol out of the main buffer.
2. detection of a record mark out of the main buffer.
3. completion of a full label character count by counters in the output logical circuitry.

The occurrence of any one of these causes the output to switch to the 144 character circulating buffer for the printing of the city-zone-state line.

In the event that other than a delta symbol terminates the printing, the main buffer advances to the next delta symbol. The digit immediately following this delta is then examined by the output logic circuitry to determine the type of this record. If this record is a header record, S4 switches to its upper position and the new header is rapidly transferred to the circulating buffer to replace the old. If this record is a subscriber record, the operations stop until receipt of the next "Label Demand" pulse from the printer. If this record is an "End-of-Roll" summary record, the output logic circuitry causes the next record, a summary for the label roll just completed, to be printed upon receipt of the next "Label Demand" pulse and also:

1. causes the error and label count registers in the 144 character buffer to be printed with the summary record, and
2. sends an "End-of-Roll" pulse to the printer following the printing of the summary record.

The other signals shown in Fig. 9 are for the purpose of controlling the printer's operation in the manner previously described. It may be mentioned at this point that the clock controlling the printing rate is part of the output logic circuitry of the TRBU and for this reason the printer is under control of the TRBU once printing commences.

Summary

Little has been said of the built-in checks in both the TRBU and in the printer to assure the operator that the entire system has and is working properly. Space does not permit a discussion of these features. Suffice it to mention that they do exist and will sound alarms or stop the machine depending upon the severity of the malfunction. This system differs, however, from many other systems in regard to the treatment of errors. It is essential to the welfare of the magazine that each subscriber obtain his regular copy. It is not necessarily essential that every label be perfect to obtain this result. Thus, certain errors are permitted in the operation of the system and a count is maintained of the number of such occurrences. The system stops only if the number of such events becomes too numerous, or until the operators feel that the system should be serviced.

The principle advantages of the Videograph printing and character generation processes are their speed and flexibility. Neither the printing tube nor the character generator operate near their limits in producing the 36 labels per second. Each could function at twice the present rate although little would be gained in TIME Inc.'s application by doing so. Their label printing requirements can be met, together with anticipated growth, with two machines operating on a single shift and a portion of a second shift.

The TRBU makes possible the operation of the label printer direct from the information contained in the master file records. This eliminates the need for using computer time in the preparation of edited tapes for printing purposes. This saving is an operating cost saving and its magnitude more than offsets the additional cost of the TRBU.

The flexibility of the system and the process makes possible the compression of the key line, quick changes in type font or input digital coding, easy reversal of the printed image for heat transfer applications, and a minimum of circuitry capable of rapid adaptation to future changes and applications. Thus, the system developed amply meets the requirements set forth by TIME Inc. and, in addition, provides them with a system capable of expansion and modification to meet their future needs.

Acknowledgements

As with many modern developments, the Videograph process and, specifically, the Videograph Label Printer System described in this paper, has been the result of a cooperative effort on the part of many companies and individuals. In particular, mention should be made of the contributions of Stanford Research Institute in the development of the process and many of the circuits under the sponsorship of A. B. Dick Co. and Telemeter Magnetics, Inc. for the design and construction of the TRBU.
Figure 1
FORMAT OF MAGAZINE LABELS

MAGNETIC TAPE & RECORD ORGANIZATION

From the collection of the Computer History Museum (www.computerhistory.org)
LATENT IMAGE

electrostatic printing tube
horizontal deflection plates
vertical deflection plates
electron gun

dielectric coating
wire matrix
ground plane

wire ends receive charge in response to modulated electron beam

sweep of electron beam

FIGURE 4
basic principle of VIDEOGRAPH printing with matrix type cathode ray tube
**FIGURE 5**

image development in VIDEOGRAPH printing

1. **LATENT IMAGE**
   - Electrostatic printing tube
   - Completely charged to attract toner

2. **TONER APPLICATION**
   - Toner attracted to latent image
   - Carrier repelled

3. **FIXING**
   - Resin in toner melts under heat to fix image

From the collection of the Computer History Museum (www.computerhistory.org)
Figure 6
VIDEOGRAPH CHARACTER GENERATOR TUBE

Figure 7
VIDEOGRAPH LABEL PRINTER-ELECTRONIC BLOCK DIAGRAM