FACSIMILE COMMUNICATION (FAX) SYSTEMS: PLANNING OF SYSTEMS FOR INTERNAL BELL SYSTEM APPLICATIONS

CONTENTS PAGE

1. GENERAL

1.01 This section discusses the basic considerations affecting the planning of facsimile communication (fax) systems for Bell System applications, and provides planning guidelines. It encompasses input/output considerations, transmission requirements, intersystem compatibility, and miscellaneous equipment selection criteria.

1.02 Whenever this section is reissued, the reason for reissue will be specified in this paragraph.

1.03 Its companion document, Section 006-400-100, provides a basic description of fax, discusses typical applications, and contains a glossary of some common terms associated with its technology and use.

1.04 These sections are issued because of the widespread use of fax systems within the Bell System.

1.05 Fax is the process by which a tangible copy (or facsimile) of a paper page is produced electronically from a transmitted signal. The term is also applied to systems that produce raster mode graphic hard copy from artificially generated picture signals, as in a weather chart transmission system in which the input device is a computer.

1.06 Fax systems that scan and transmit microfilm images (micro-images) and reproduce them remotely on either film or paper are generally called microfacsimile or microfax systems.

1.07 Fax systems intended primarily for the transmission and faithful reproduction of photographs (eg, news pictures and fingerprint records) are known variously as photofacsimile, telephotographic, or (in Europe) phototelegraphic systems. Section 314-715-100 describes telephotography from the Bell System standpoint and provides references to other related sections.

1.08 There is a tendency to refer generically to all fax terminals as ***Telecopiers.*** However, ***Telecopier*** is a registered trademark of the Xerox Corporation and applies only to fax devices manufactured and/or marketed by that firm.

1.09 The library community has traditionally referred to fax systems as telefacsimile or telefax systems. Though an acceptable substitute term, it is not generally recognized outside the library community.

1.10 The basic fax principle of converting a page image to electronic form by raster scanning, and then reproducing it in tangible form, is also applied in systems intended for electronic production of duplication stencils, color separation negatives, and printing plates.

1.11 Systems that reproduce electronically transmitted document images or still photographs in "soft" form on a viewing screen are gen-

erally regarded as slow-scan or freeze-frame television (or video) systems, although the term "soft fax" is sometimes loosely applied to such systems.

1.12 Systems that transmit handwritten messages or handdrawn sketches by remotely reproducing human manipulation of writing stylii are technically not regarded as fax systems, and will therefore not be covered in this section. The terminals of such systems are generically referred to as handwriting machines or manual graphic terminals. Two of the more familiar trade names for such systems are ***Electrowriter**** and ***Telescriber***†. The Bell System's GEMINI® Electronic Blackboard also belongs in this category.

1.13 This section and its companion section are primarily concerned with conventional voiceband fax systems of the kinds used in the Bell System.

2. SYSTEM PLANNING CONSIDERATIONS

2.01 The first consideration in planning a fax system should be the realization that several general trade equipment vendors offer a wide range of fax terminals that vary in price, size, technical attributes, and degree of intersystem compatibility. When a system plan has progressed to the equipment selection stage, the Administrative Services Department or an office communications organization within your company (or in AT&T) should be able to provide guidance in this regard.

2.02 Although not within the province of this document, budgetary considerations will almost surely play a role in equipment selection. Such considerations are probably best left until last, after all basic end requirements of the planned system have been determined. Thereafter, the system specification can be modified to fit the available funding, and equipment selection can proceed accordingly. The following paragraphs discuss specific selection criteria.

3. SYSTEM INPUT

3.01 ***Page Sizes:*** All fax terminals for general-purpose applications are arranged to accept letter size (8.5 x 11 inch or 216 x 279 mm) pages as input, and many will also accept legal size (8.5 x 13 inch or 216 x 330 mm) pages. Many terminals will accept pages 8.5 inches (216 mm) wide by virtually unlimited length. The smallest page accommodated by most terminals is approximately 5 x 8 inches (127 x 203 mm).

3.02 ***Automatic Reduction:*** Many terminals are arranged to accept input pages as wide as 11 inches (279 mm) and 16 or more inches (406 or more mm) in length. When interconnected with a compatible terminal limited to production of 8.5-inch (216 mm) wide output, the copy is automatically and proportionally reduced to fit the narrower output paper.

3.03 ***Paper Thickness:*** Most general-purpose fax terminals will accept input pages ranging in thickness from approximately 2.4 mils (60 micrometers) to approximately 9.0 mils (230 micrometers). However, the range is usually somewhat narrower (approximately 2.4 to 4.7 mils, or 60 to 120 micrometers for those units in which pages are fed from a stack by an automatic document feeder).

3.04 ***Scan and Feed Methods:*** There are basically two methods by which pages are input to the scan section of a fax terminal. One requires the page to be wrapped around a drum having a circumference slightly greater than the short (8.5 inch or 216 mm) dimension of a standard page; the other is a "through-feed" arrangement in which the page is inserted into a slot and is automatically transported through the scan section to an exit port. These two methods, plus a third, are described as follows:

(a) Drum Method: The drum method, in which the page is rapidly rotated while being scanned (Fig 1), is found primarily in less expensive, older technology terminals. The wrapping of the page around the drum is generally automated to some degree.

(b) Through-Feed Method: The through-feed method (Fig 2) is generally preferred to the drum method from the standpoints of physical stress on the input page and acoustic noise. It also lends itself better to automatic multipage feeding from a stack. This method is found on most newer, state-of-the-art terminals.

(c) Automatic Feeding: Most modern fax terminals have integral automatic page feeders that permit the preloading of 30 or more pages for sequential feeding into the terminal's scan section. A few such units permit the intermixing of pages of various sizes, and most permit the intermixing of

---

*Registered trademark of Infolink, Inc.

†Registered trademark of Telautograph Corporation.

pages of various thicknesses. The typical thickness range for automatic sequential feeding is 2.4 to 4.7 mils (60 to 120 micrometers). Input pages are returned, usually via an integral tray or accessory basket, in the same sequence in which they were loaded and scanned.

4. MESSAGE VOLUME

4.01 ***Speed/Quality Trade-offs:*** The two considerations governing fax system operating speed, other than cost constraints, are:

(a) Anticipated message volume

(b) Channel time consumed per page.

The significance of channel (or line) time varies. For example, if the terminals are interconnected via a dedicated circuit, and the volume of daily transmissions is relatively low, channel time is less significant than if the terminals are interconnected via dial-up voice or data circuits or communication satellite channels. In the dedicated, low volume situation, a slower (and presumably less expensive) system might suffice. In the dial-up or satellite situation, higher speed is preferred. To a degree, output quality must invariably be traded off for increased speed.

4.02 ***Analog Versus Digital:*** Basic analog fax systems are inherently redundant, hence slow, and have therefore lost favor among serious fax users. Nevertheless, although they are being replaced by newer, more efficient types, the majority of fax systems presently in use are of the basic analog variety, operating at transmission speeds of 4 and 6 minutes per letter-size page. (The 4-minute speed is obtained by reducing the scan lines per linear inch from a nominal 100 to a nominal 64, thus compromising output quality.) Modern fax systems employ band compression, variable velocity scanning, and digital data compression techniques to achieve higher transmission efficiency. The general trend in fax technology is away from the traditional analog techniques and toward total digital operation. The three basic efficiency-enhancing technologies applied in general trade fax systems being actively marketed in the U.S. in 1982 are:

(a) 2:1 analog band compression employing a kind of flip-flop technique, effectively reducing zero crossings by 50 percent in the scanner baseband signal, and thus permitting transmission at twice the normal speed.

(b) Analog skip technique, in which the scanner looks ahead and speeds up when it senses wide blank areas on a page.

(c) Digital run-length coding, in which the occurrence and locations of white-black-white transitions within a scan stroke are encoded, and the codes transmitted in place of a signal directly representing image details.

The 2:1 analog band compression and digital run-length coding techniques are the bases for the international (CCITT) group 2 and group 3 standards, respectively. The analog skip technique is nonstandard. Group 2 systems operate at a fixed transmission speed of approximately 3 minutes per letter-size page, and are thus capable of transmitting or receiving a practical maximum of approximately 140 pages within a single-shift work day. Group 3 systems operate at a variable speed, depending on the proportion of information to blank space on a page. The average transmission speed is approximately 40 seconds per page, resulting in a practical maximum volume of approximately 700 pages per single shift day. The typical daily volume for an analog system operating in the skip mode is approximately midway between the group 2 and group 3 volumes: about 300 pages. New digital fax systems currently under development for use in digital and wideband networks will be capable of much higher volumes than voiceband systems.

4.03 ***Duplex Versus Half-duplex:*** In situations where transmission/reception volume slightly exceeds the capacity of a half-duplex fax transceiver, or where there is considerable two-way contention for the unit's single-channel connection, a duplex (or full-duplex) transceiver should be considered. Unlike the typical half-duplex unit which can send or receive alternately, a duplex unit can do both simultaneously. However, it requires a dual-channel connection (ie, a 4-wire circuit or two separate phone lines) to accomplish this. The choice of a single duplex unit versus two half-duplex units must be weighed against the potentially better backup provided by the latter configuration in the event of equipment failure.

5. TRANSMISSION CONSIDERATIONS

5.01 ***Bandwidths, Data Rates:*** From the late 1960s to the present, fax has been predominantly a voiceband medium with the majority of general trade systems using the Direct Distance Dialing

(DDD) network for interconnection. Although a trend in the direction of wideband analog and high bit rate digital operation is emerging, voiceband systems are expected to continue to exist in substantial numbers for several years. The situation with regard to bandwidths and data rates as of April 1982 is as follows:

(a) FM analog (group 1) voiceband systems operate within the frequency band of approximately 1500 Hz (white) to approximately 2300 Hz (black), the frequencies being continuously variable within that range. The modem is integral to the terminal.

(b) AM band-compressed analog (group 2) voiceband systems operate at a carrier frequency of 2100 (±10) Hz and utilize vestigial sideband filtering. White is represented by maximum carrier, and black by minimum carrier (at least 26 dB below white) or by no carrier. The 2:1 band compression technique is achieved with an integral modem of special design.

(c) Data-compressed digital (group 3) voiceband systems utilize phase modulation and operate at a carrier frequency of 1800 (±1) Hz. All such systems are designed to operate at data rates of 2400 and 4800 bps (4800 preferred), but many systems feature automatic step-down modems capable of operating at rates as high as 9600 bps. Modems are typically integral to the terminals.

(d) General-purpose data-compressed digital systems are available that operate at bit rates as high as 56 kbps.

(e) Highly specialized fax systems are available (eg, for high resolution transmission of newspaper page masters) that operate at bit rates as high as 1.54 Mbps.

5.02 ***Effects of Impairments:*** Impairments are present in any link interconnecting two terminals. However, it takes relatively high levels of the more common transmission impairments to noticeably degrade the output of a typical fax system. Moreover, fax is a sufficiently redundant process that an occasional impulse "hit" or signal distortion will have only a fraction of the impact it would have in a data system transmitting character codes. The following points discuss the impact of channel impairments on fax transmissions:

(a) The automatic control procedure that precedes actual image transmission in a modern fax system includes channel quality checking. When a highly impaired channel is encountered, an audible/visual fault indication will be given, precluding transmission and directing the terminal operator to redial.

(b) Digital systems operating at high bit rates (eg, 9600 bps) via voiceband channels are more susceptible to the effects of transmission impairments than are lower speed systems. Many modern systems feature step-down modems, which automatically adjust the transmission bit rate to a level compatible with channel condition.

(c) Many modern fax systems incorporate trouble reporting schemes in which the success or failure of each transmission is recorded in memory and reported, either automatically or on demand, via a paper printout.

(d) Circuit interruptions, or channel dropouts are one of the more common sources of trouble in fax systems. Most modern systems will continue to operate despite momentary interruptions of less than 0.5 second. However, longer interruptions are likely to cause a transmission to abort. Fig 3 shows the visual effect of a 0.8-second interruption on a group 2 transmission.

(e) Impulse noise, or impulse "hits" are likely to have a greater impact on high-speed digital transmissions than on analog. A sufficient number within a given period during a transmission will cause the transmission to abort. Fig 4 shows the visual effect of impulse noise on a group 2 transmission. The effect of an occasional hit on a group 3 transmission will be the loss of at least one entire scan line, and possibly as many as four, for each hit. (See Fig 5.)

(f) Excessively high levels of crosstalk (the presence of an interfering conversation from another phone line) and single-frequency interference (SFI) can blemish the output copy of a voiceband fax system. Fig 6 shows the possible effect of SFI on a group 2 transmission.

(g) Phase jitter, which results from accidental frequency modulation, usually in the channel banks of a long-distance carrier system, can cause the "jittery" effect shown in Fig 7, or, if

sufficiently excessive, may preclude or abort transmission.

(h) A sufficient degree of random, or Gaussian noise (manifested by a steady background hiss) will preclude transmission in most group 2 and group 3 systems. In older group 1 systems, it may be visible in the output copy as exemplified in Fig 8.

(i) Other common transmission impairments are echo, envelope delay distortion (EDD), and harmonic distortion. A sufficient degree of any of them will usually preclude transmission. However, if the degree is marginal and transmission proceeds, the usual result is a "smeary" appearance in the copy, as shown in Fig 9.

(j) Many modern fax systems feature a self-test mode through which the terminal itself can be tested as the possible source of transmission problems.

5.03 ***Hookup Options:*** Virtually all modern fax terminals designed for use on voiceband channels are equipped with a standard male plug compatible with BOC-installed modular "permissive" jacks (USOC RJ11). They are also equipped with either a male- or female-compatible connector to accommodate an existing telephone set. The normal installation procedure is to:

(1) Unplug the existing telephone set from the BOC-installed line jack

(2) Plug the telephone set into the fax terminal

(3) Plug the fax terminal into the line jack.

Exceptions to this typical arrangement are:

(a) Some group 3 and special-purpose fax systems may require connection to a "programmable" jack (eg, USOC RJ45) to optimize the fax output consistent with line conditions.

(b) Depending on local arrangements (eg, switchboard versus direct line connection) and regulatory considerations, other types of BOC-installed jacks may be required (eg, USOC RJ16).

(c) Some group 3 and special-purpose fax systems may provide an ANSI RS-232 output port for alternative use of an external modem.

(d) The line termination in some installations may consist of a "grandfathered" data coupler requiring connection of multiple leads from the fax terminal. Until data couplers have been entirely replaced by modular jacks, most fax system vendors can be expected to provide for this alternative hookup arrangement, if needed.

6. COMPATIBILITY

6.01 Concern over compatibility among various commercial brands of fax equipment has declined as vendors and users have increasingly embraced industry standards, notably those of the international CCITT (Consultative Committee on International Telegraphy and Telephony, part of the Geneva-based International Telecommunications Union). The principal compatibility considerations facing the planner of a modern fax system are:

(a) The reach of a dial-up fax system, in terms of the number and variety of other terminals with which it can readily intercommunicate, is determined by terminal flexibility. For example, a group 1 terminal (FM analog; choice of 4 or 6 minutes per letter-size page) can only intercommunicate with other group 1 terminals, the population of which is declining. However, a combined group 1/group 2 terminal has the advantage of being able to communicate with the growing number of group 2 terminals (AM band-compressed analog; 3 minutes per page) as well.

(b) The population of group 3 terminals (digital data compressed; subminute speeds) is certain to eventually exceed that of group 1 and group 2 terminals. Presently, the group 2 population exceeds group 3 and continues to grow, but is expected to level off eventually. During this analog-to-digital transition period, the best compromise in terminal flexibility for a dial-up fax system is a combined group 2/group 3 terminal.

(c) The CCITT T.30 Recommendations, which govern the control procedures ("handshake") for groups 1, 2, and 3 fax systems, are sufficiently flexible that there is no absolute guarantee of complete compatibility between two systems in the same group. Therefore, it is advisable to ask prospective vendors for lists of competing systems with which compatibility is assured.

(d) Some selectable operational modes are nonstandard and therefore compatible only

between terminals of the same brand. Examples are the skip (white space skipping) and fine detail (high resolution) modes included in some analog systems.

(e) CCITT group 4 Recommendations for high-speed, direct digital fax systems, which are presently under development, are expected to provide for optional group 3 voiceband compatibility.

(f) Compatibility is not a problem in strictly closed network applications, for which equipment selection for the whole network is under central control during planning.

(g) At present, no compatibility standards are in sight for wideband fax systems such as might be compatible with high-speed local network applications.

(h) Some modern fax terminals have the optional capability of functioning as character code printers, therefore being potentially compatible with TWX/Telex and word processing systems.

7. SYSTEM OUTPUT

7.01 ***Types of Paper***: The following three types of paper dominate in present fax systems:

(a) Thermal: The least expensive of the three. It produces high-contrast images, requires no additional chemicals, and is used in group 1, 2, and 3 systems. Its chief drawback is images that are somewhat unstable (tend to discolor slightly in time) and can be destroyed by exposure to temperatures exceeding 55°C (approximately 130°F). Thermal images are formed by contact of the paper with a linear thermal printhead array in the terminal.

(b) Dielectric: Used primarily in group 3 systems in conjunction with an electrostatic process similar to that used in office copiers. Separate chemical toner is needed to develop the latent electrostatic images. (Development and fusing are automatic within the terminal's printer module.) Processed images on dielectric paper are somewhat more stable and lightfast than thermal images. Also, the electrostatic process is capable of operating at higher writing speeds. The chief drawback is the need for separate toner, which must occasionally be replenished.

(c) Electroresistive (also called electrosensitive or burnoff): The most expensive of the three and, in some forms, produces offensive odors. Its use, therefore, is in general decline. Its traditional advantage has been the design simplicity of fax printers that accommodate it.

Other types of paper not as extensively used are electrolytic, plain bond, and silver photosensitive. Electrolytic, used primarily in weather chart systems, contains a liquid electrolyte that must be kept from evaporating prior to and during recording. Plain paper requires more complex, and therefore more costly, printing mechanisms (eg, laser/xerographic and ink jet). Silver photosensitive paper (notably dry silver) is used primarily in photofacsimile applications such as news picture distribution by wire services, criminal identification networks, and reception of cloud cover pictures from spaceborne weather satellites. It is the most expensive of all fax papers and has the added drawback of having to be carefully protected against exposure to light.

7.02 ***Paper Sizes:*** In the typical modern fax system, receive paper is automatically fed from a roll, the standard capacity of which is 328 feet (1000 decimeters). The standard width is 8.5 inches (216 mm), plus or minus approximately 2 percent. Manually operated systems and some automatic systems use precut sheets, nominally 8.5 x 11 inches (216 x 279 mm). In systems in which the scanner will accept input pages 10 inches (254 mm) or more in width, the copy is automatically and proportionally reduced to fit the narrower output paper in a compatible receive terminal.

7.03 ***Image Quality:*** The four principal variables governing output image quality in a modern fax system are:

(a) Resolution. For CCITT group 2 and group 3 systems, resolution along the horizontal (short) axis of the output copy is essentially fixed by conformance to basic standards, as is the vertical (long axis) resolution for group 2 systems. The vertical resolution for group 3 systems may be fixed at a single (medium) resolution or variable to a maximum of three fixed levels. The standards are as follows:

Group	Horiz (Short Axis) Resolution	Vert (Long Axis) Resolution (lines/in.)	(lines/mm)
2	827 pels (97.8 pels/in.)	97.8	3.85
3	1728 pels (204 pels/in.)	(a) 97.8	3.85
		(b) 195.6	7.7
		(c) nom.65	nom.2.56
1*	nom. 96 pels/in.	(a) 96	3.8
		(b) nom.65	nom.2.56

Note: Of the selectable vertical resolutions for group 3, (a) is medium resolution and is the primary standard; (b) and (c) are high and low resolution, respectively, and are optional.

In general, group 2 resolution and group 3 medium resolution are sufficient to legibly reproduce conventional typewriter fonts and 8-point and larger print fonts (small printed text fonts, excluding footnotes). Group 3 high resolution will legibly reproduce 6-point type (footnotes, form headings). Group 3 low resolution will legibly reproduce 10-point and larger fonts (pica and courier type, most conventional text fonts). Some group 3 systems offer an optional, dynamically variable resolution feature called ALDC (Automatic Line Density Control), which automatically varies resolution within a page according to the amount of detail being scanned. It is a nonstandard feature.

(b) Contrast. To a degree, increased contrast between print and background can compensate for reduced resolution, at least aesthetically. Inasmuch as the scanner output of most modern fax systems is thresholded (strictly black-white; intermediate tones eliminated), high contrast is generally preferred. In an electrostatic system, dry toning techniques will generally yield higher contrast than liquid toners. Fig 10 and 11 show low and high contrast output copy of the same input page.

(c) Tonality or Tonal Threshold. As previously noted, most modern fax systems do not reproduce intermediate (gray) tones in pictorial copy. Earlier analog systems were distinguished by their ability to reproduce a limited range of gray tones as well as black and white. However, modern analog systems have traded this capability for more efficient manufacture and transmission. Today, the need for tonal copy generally requires systems specially designed for that purpose. In virtually all thresholded systems, the threshold level is technician-adjustable. Set too low, it will cause background noise to be reproduced; set too high, it will cause loss of some low-contrast details on the input page. (See Fig 12.) The lack of tonality as a result of thresholding is obvious in Fig 3 through 7 and Fig 10 and 11.

(d) Tone and Texture of Paper. The types of paper required for different fax systems (see paragraph 7.01) will vary in relative whiteness and "feel," both of which can affect copy aesthetics and user reaction. Most modern fax papers have characteristics similar to those of plain bond. However, for economic or technical expedience, some vendors provide papers that have a silvery sheen or a gray cast or are thin and have a tendency to curl. These are generally undesirable characteristics from the user standpoint.

8. OTHER SELECTION CRITERIA

8.01 Since the advent of international (CCITT) standards for general-purpose fax systems and the increasingly widespread adherence to these standards by competing fax vendors, basic technical distinctions among available systems have narrowed somewhat. However, the following practical considerations remain as valid criteria for equipment selection:

(a) Price (and other economic considerations)

(b) Terminal unit compactness and styling

(c) Vendor prestige and reliability

(d) Flexibility

(e) Available options

(f) Degree of automation.

The last three criteria encompass a list of special, as well as more or less conventional, system capabilities, some of which have already been discussed in this or Section 006-400-100 (eg, multimode operation, unattended reception, automatic reduction, automatic page feeding, white space skipping, duplex operation). The following paragraphs describe some specific, miscellaneous technical capabilities, any one or combination of which could constitute the pivotal basis for equipment selection, particularly in the planning of a fax system for a special application. Some of the capabilities may be included in the standard configuration of a given system, some may be available as added-cost

*Group 1 data is shown for information only.

options, and some may be the primary capability of a special-purpose system.

8.02 ***Polling:*** One of the more common capabilities of modern voiceband fax systems; may be defined as unattended transmission initiated by a call from a compatible receive terminal. Built-in security measures generally insure against unauthorized polling. Some modern systems apply the polling capability in an automatic turnaround mode to avoid a separate call to the same terminal, ie, a terminal operating in the send mode will, upon completion of its transmission, automatically revert to the receive mode and poll the terminal with which it is already interconnected. A possible drawback of turnaround polling is that security could be compromised.

8.03 ***Automatic Dialing***: An increasingly available feature of voiceband fax systems; generally implemented by use of a special card on which the phone number of the terminal to be reached is recorded in mark sense form. The special card precedes the actual pages into the scanner and, by optical coding, switches the scanner momentarily to a mark sense mode, in which it converts the marks to dial pulses. Most such arrangements buffer the dial pulses so that they are repeatable for multiple tries. After a preset number of unsuccessful tries, the dial card and pages that follow are ejected into the terminal's return bin. Most such arrangements also allow for multiple call packages to be loaded into an automatic feeder and for a timer to be set for delayed initiation of the first call.

8.04 ***Automatic Terminal Identification:*** The automatic printing and/or display of a terminal identifying code at the terminal to which it is interconnected. This is a desirable and increasingly available capability, intended to enhance security and to minimize the need for separate voice coordination of fax messages. It can function in one (or both) of two ways: (a) receive terminal identifies itself via a visual alphanumeric display at the send terminal; (b) send terminal identifies itself via alphanumerics printed in a preselected spot on the received page.

8.05 ***Coded Character Output:*** Known variously as data mode, character printing mode, TWX/Telex interface, word processing interface, etc, this feature permits a fax terminal in the receive mode to function alternatively as a nonimpact printer of character-coded messages (eg, alphanumeric messages sent in ASCII or EBCDIC codes). Thus a single terminal unit can do the work formerly requiring separate units.

8.06 ***High Resolution***: Although many CCITT group 3 fax systems provide for compatible resolution matrices as high as 204 x 195.6 pels per inch (8 x 7.7 pels per mm), even higher resolutions may be required for specific applications. At present, genuinely high resolution is scarce among general trade products. However, the CCITT group 4 recommendations now being developed promise to fill this void.

8.07 ***Photo Quality Output:*** The ability to reproduce a wide range of gray tones in the output copy generally requires fax equipment specially intended for that purpose. Such equipment is available but not compatible with conventional systems complying with CCITT recommendations. A small number of general-purpose fax systems offer a limited tonal capability.

8.08 ***Store-and-Forward:*** Although it sacrifices the traditional desirability of real-time communication, a store-and-forward (S&F) capability effectively circumvents certain obstacles to information flow, namely (a) busy lines, (b) terminal-to-terminal or terminal-to-line incompatibilities, and (c) wastage of after-hours transmission potential. The S&F function is typically accomplished via magnetic buffering (eg, cassette or disk). It can be applied to automatic dialing (see paragraph 8.03) to permit immediate return of original pages, despite delayed transmission, and recycling of call packages.

8.09 ***Security***: For applications requiring higher transmission security than is possible with standard signaling, an encryption capability may be required. It is optionally available with some group 3 systems and integral to some special-purpose systems. In either case, it adds substantially to equipment cost. It utilizes a switch-selectable digital key, known only to authorized persons.

8.10 ***Broadcasting*** (multipoint reception): a useful capability in situations where the same documents must be fax-dispatched to multiple recipients. Basically, multiple simultaneous reception is implied; however, the term is also applied to automatic sequential transmission of the same input, usually via an automatic dialing capability (the reverse of automatic polling.) Simultaneous broadcasting poses problems with the handshake phase of a fax transmission.

8.11 ***Editing:*** The ability to send preselected segments of a page rather than the full page. This can be achieved to some degree with drum-type systems merely by the positioning of margin controls. More flexible and automated editing capabilities available in some modern fax systems use mark sensing techniques to bypass selected page segments.

8.12 ***Micro-image Input:*** Presently, few fax systems are available that will accept microfilm images as input (microfacsimile systems). However, this is a technologically feasible and relatively inexpensive capability. It applies to situations where it is impractical to reproduce and distribute a physical microfilm file, but where there is a high demand for access to the file at remote locations (eg, a central patent file in microform).

8.13 ***Portability:*** At present, few general trade fax systems can be accurately described as portable. Portability is useful in situations where a person on a business trip must dispatch time-sensitive documents back to his office and needs to be assured of the ready availability of a fax terminal for the purpose. In this situation, the fax terminal provides the graphics capability lacking in portable phone-coupled keystroke terminals.

9. REFERENCES AND SUPPLEMENTAL MATERIALS

9.01 The following documents and supplemental test aids may be useful to the fax system planner:

ITEM	TITLE OR DESCRIPTION
Section 314-715-100, Issue 3, June 1975	"Telephotography -- General Descriptive Information"
AT&T Booklet, "FAX" (1978)	Guidelines for Bell System Representatives and Product Managers to help business customers plan fax systems (available from AT&T Marketing)
BTL Specification X-74288, Issue 3, November 1976	"Standards for, and Procedures for Evaluating, General Purpose Voicegrade Facsimile Communication Systems for Internal Bell System Use"
AT&T PUB 41004	"Data Communications Using Voiceband Private Line Channels," October 1973
AT&T PUB 41005	"Data Communications Using the Switched Telecommunications Network," May 1971
AT&T PUB 41008	"Analog Parameters Affecting Voiceband Data Transmission," July 1974
AT&T PUB 47001	"Electrical Characteristics of Bell System Network Facilities at the Interface With Voiceband Ancillary and Data Equipment," August 1976
AT&T PUB 47101 + addendum	"Standard Plugs & Jacks" (prelim.) September 1979 (addendum, December 1981)
BTL 74A Test Chart	Specially designed test chart for Bell System graphic reproduction & transfer applications. (Available from BTL Standards & Materials Engineering Dept)
IEEE Std 167A-1980 Facsimile Test Chart	The industry standard chart for testing fax and various other electronic graphic communication systems
Costigan, D. M. - "Electronic Delivery of Documents & Graphics," 1978	344-page general textbook on fax and miscellaneous electronic graphic communication systems (published by Van Nostrand Reinhold, N.Y.)

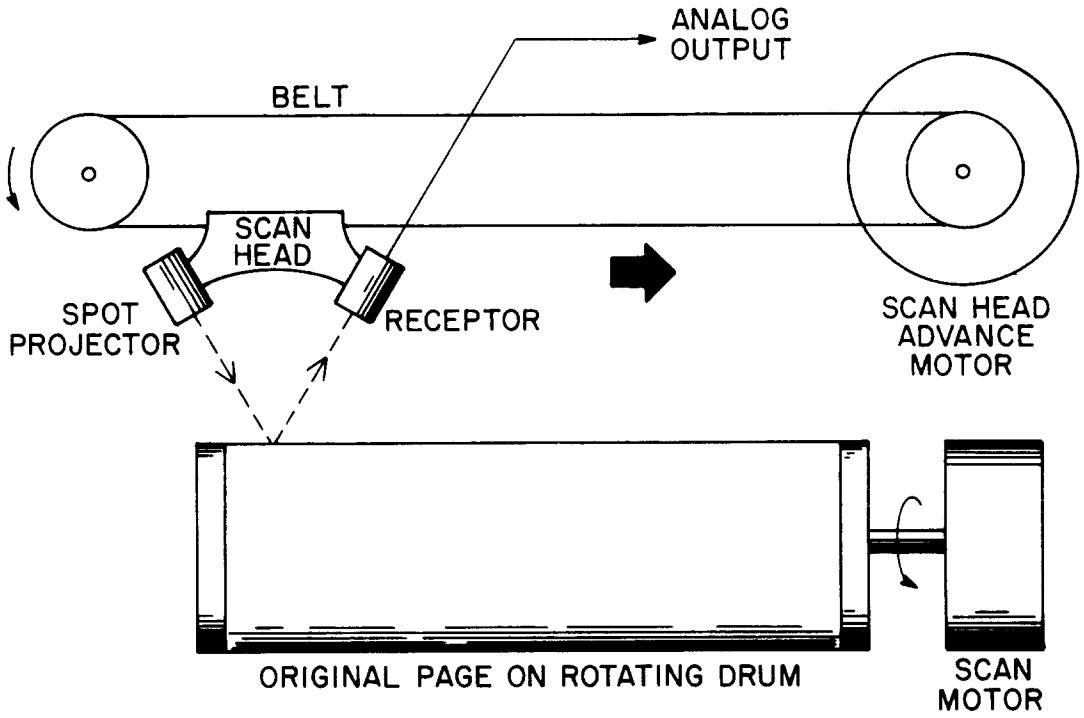

Fig 1—Drum Method of Fax Scanning

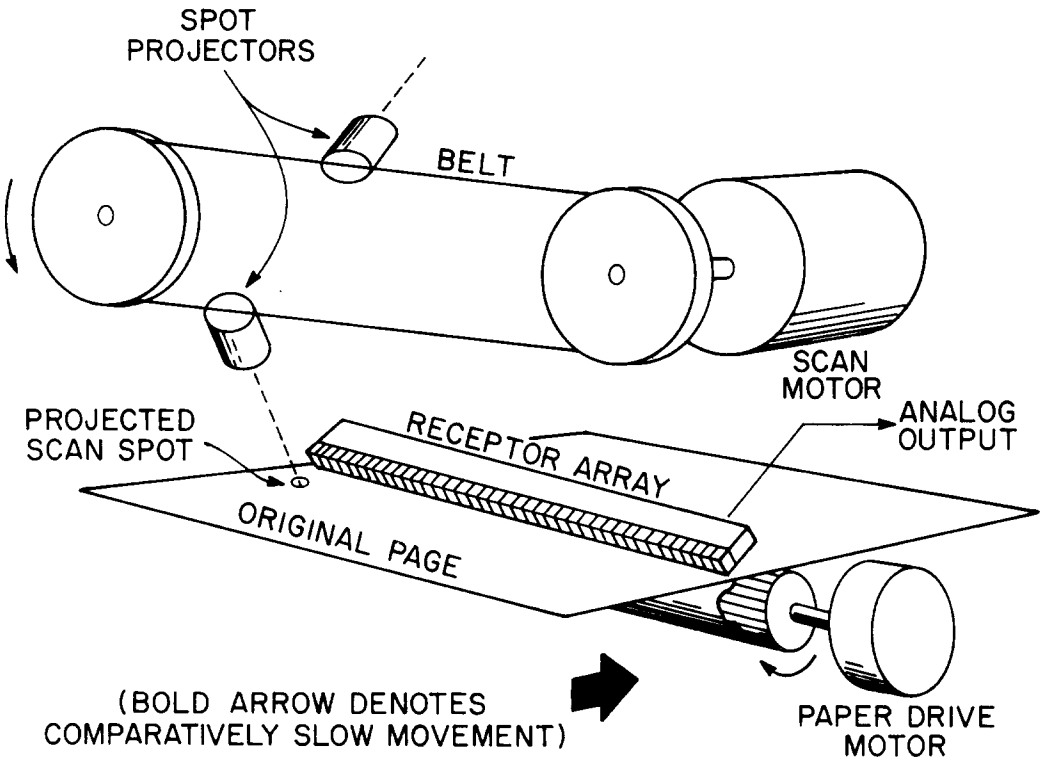

Fig 2—Through-Feed Method of Fax Scanning

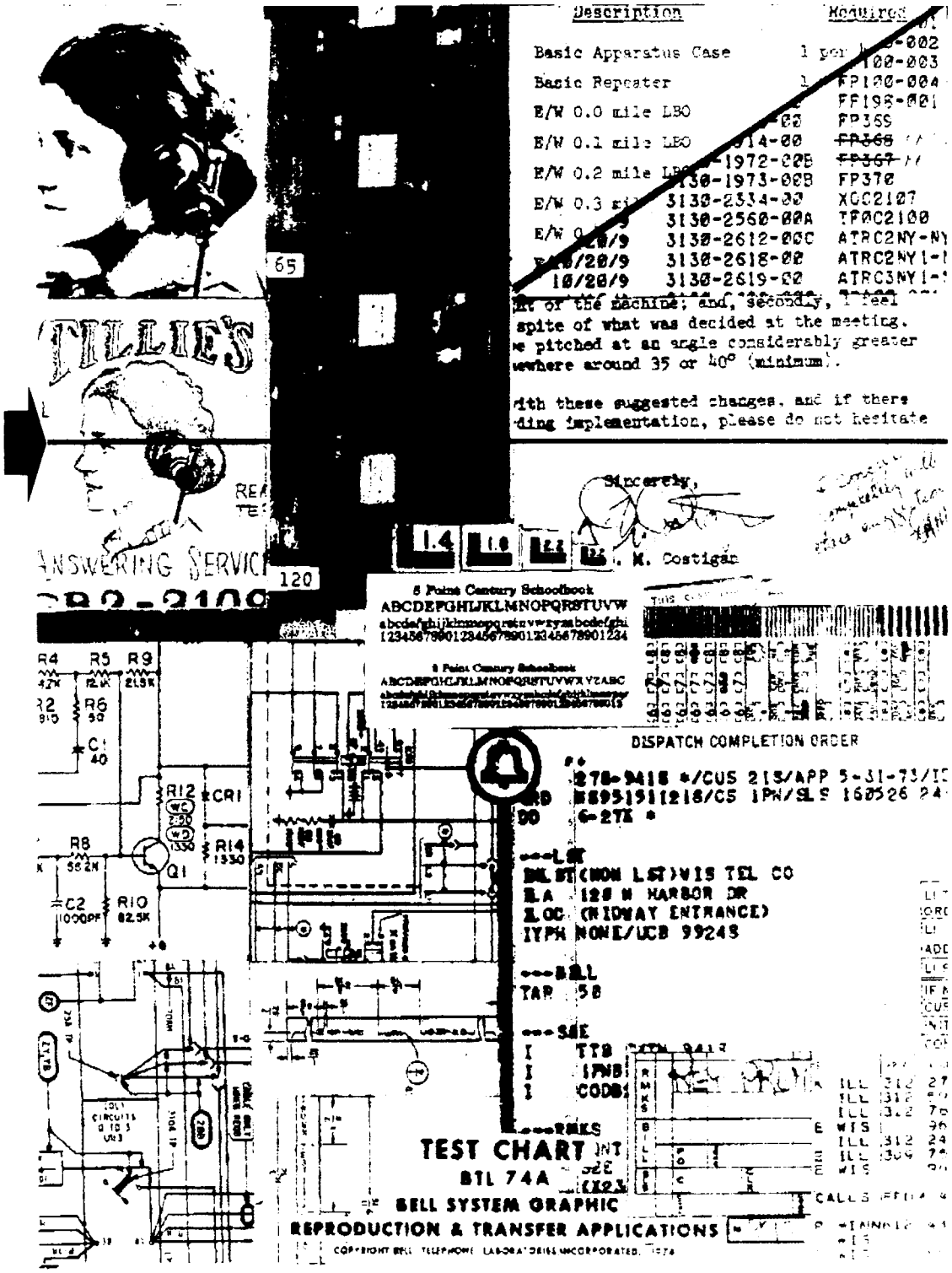

Fig 3—Visual Effect of 0.8-second Interruption (arrow) on a Group 2 Transmission

Fig 4—Visual Effect of Impulse Noise on a Group 2 Transmission

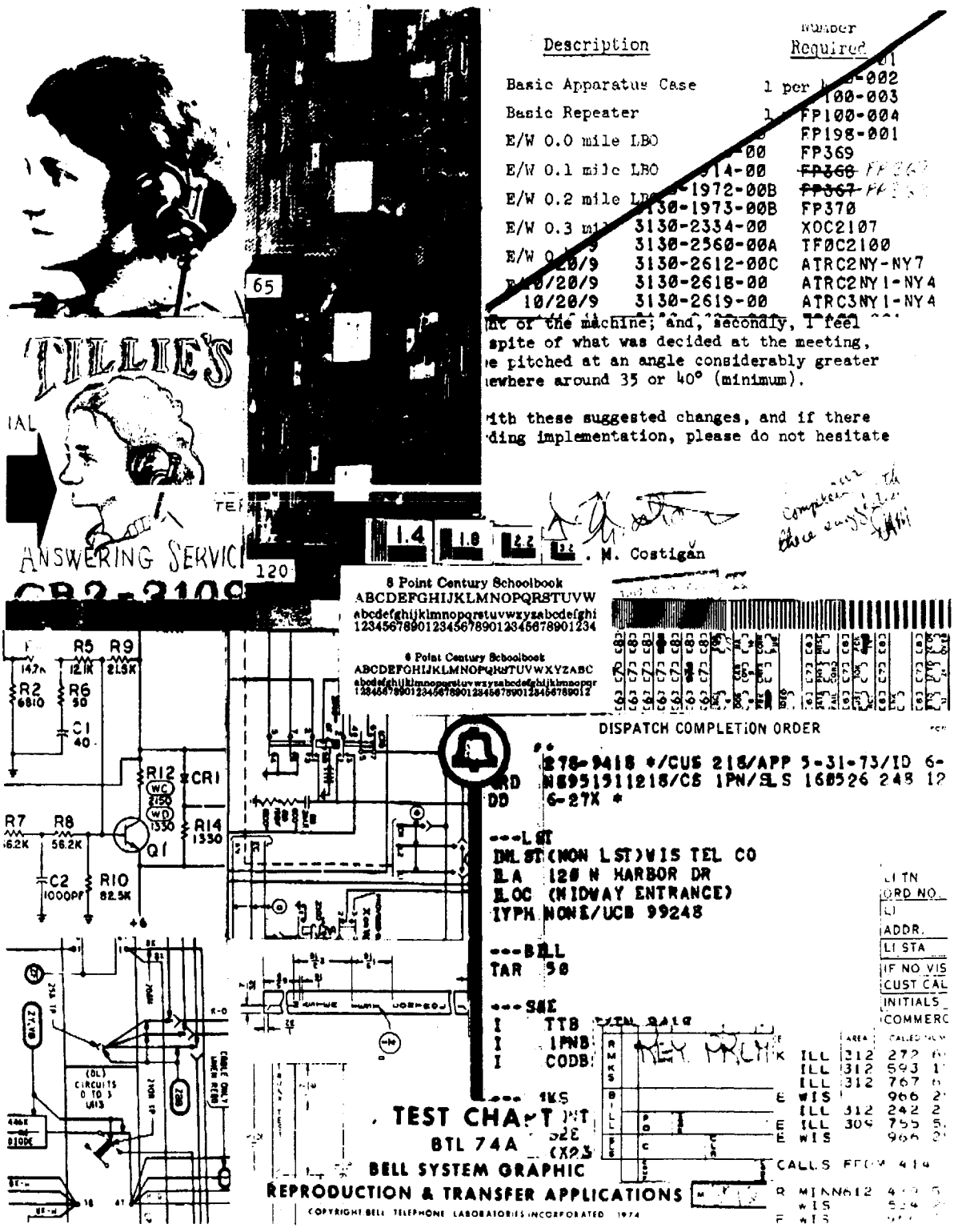

Fig 5—Visual Effect of an Impulse "Hit" (arrow) on a Group 3 Transmission

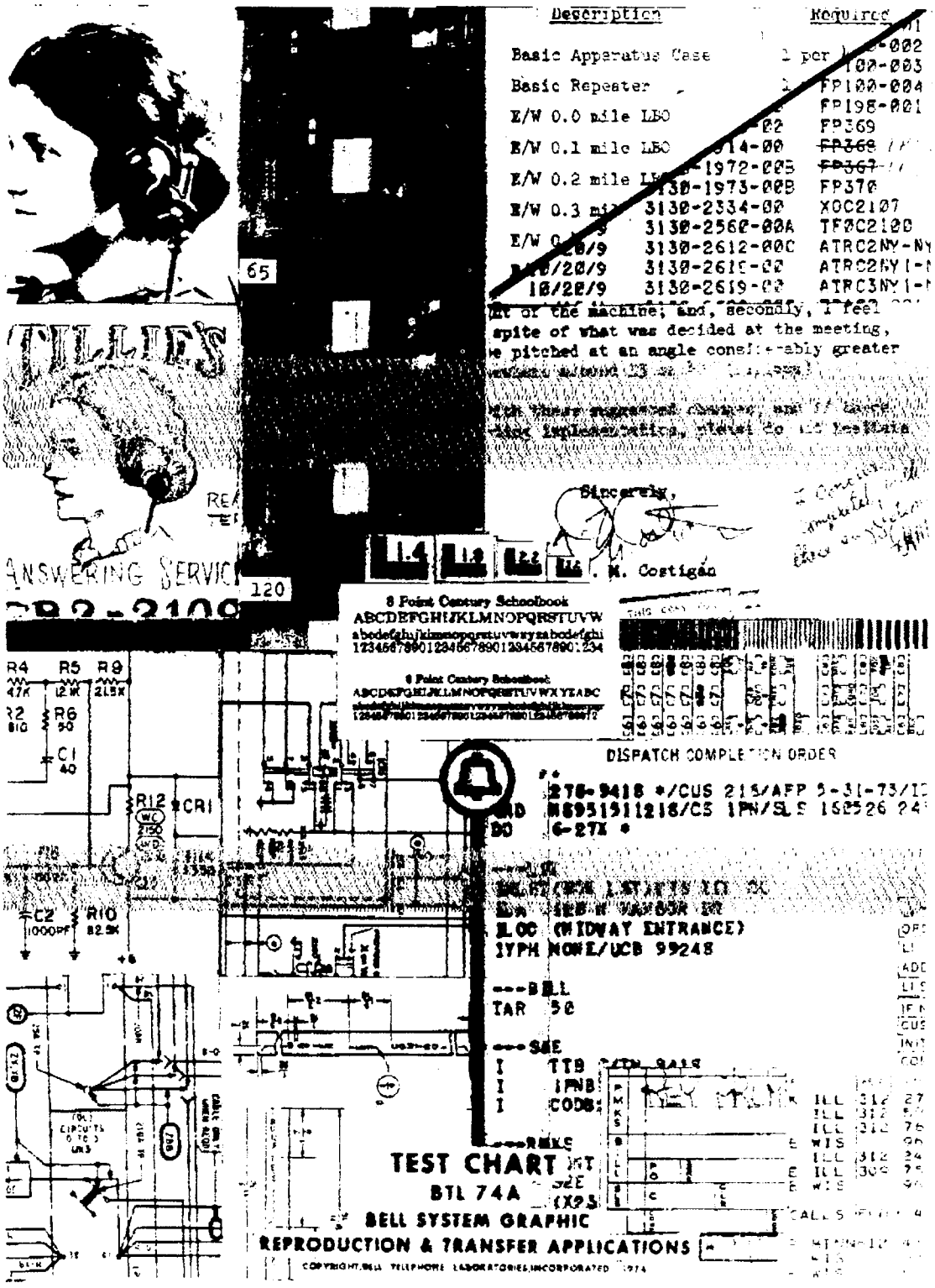

Fig 6—Visual Effect of High-Level Single-Frequency Interference (SFI) on a Group 2 Transmission

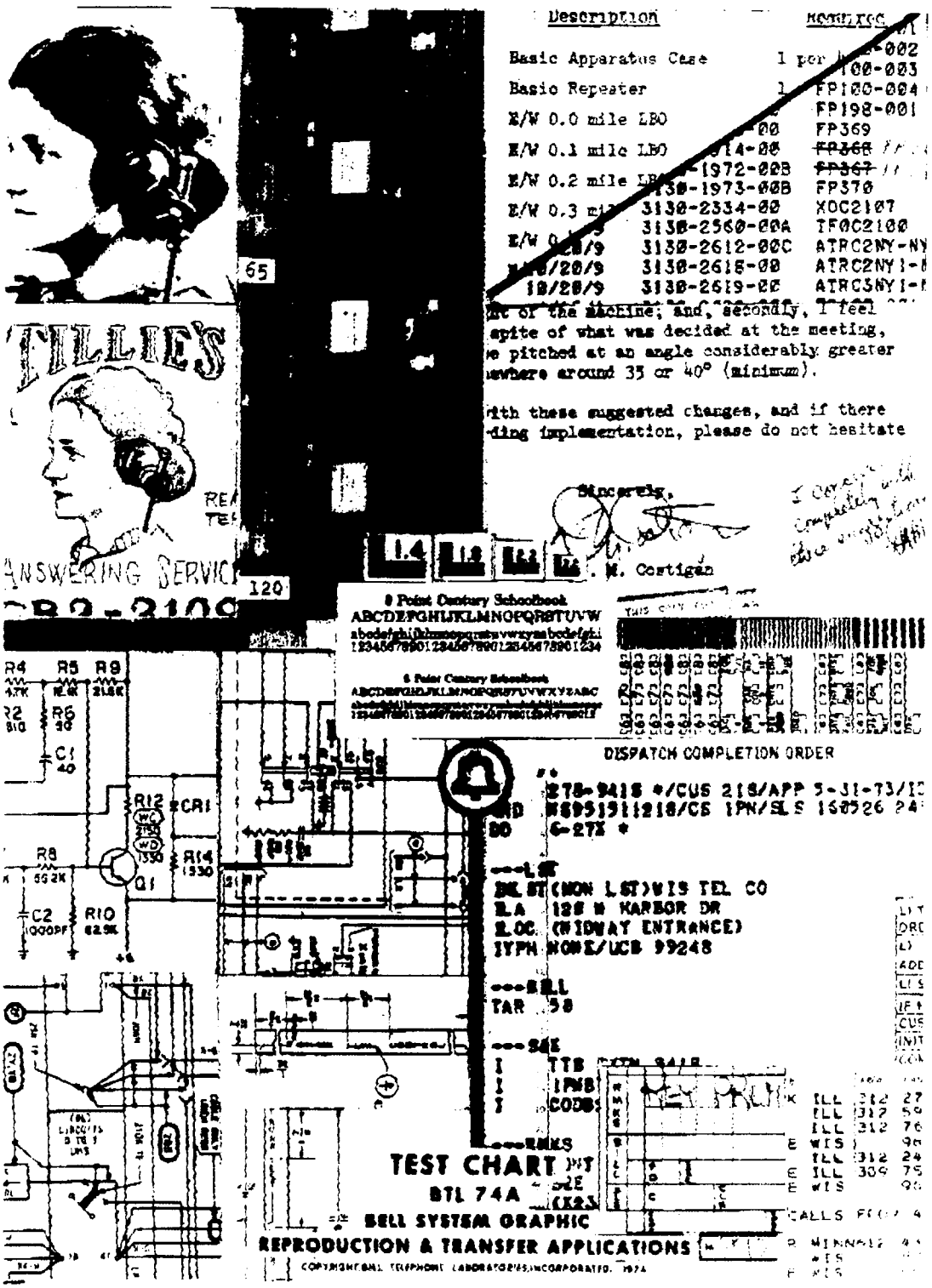

Fig 7—Visual Effect of High-Level (40 degree) Phase Jitter on a Group 2 Transmission

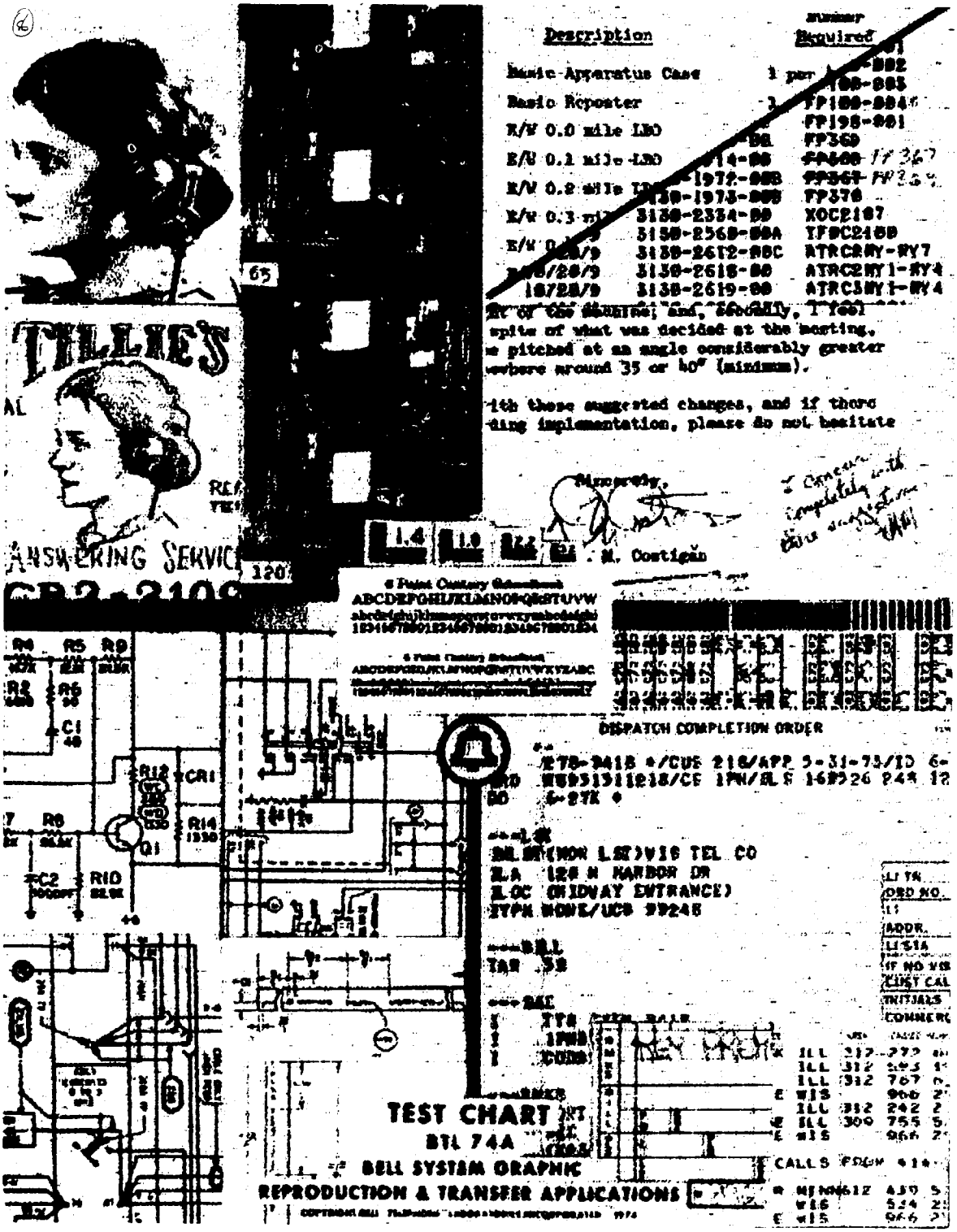

Fig 8—Visual Effect of High-Level Random (Gaussian) Noise on a Group 1 Transmission

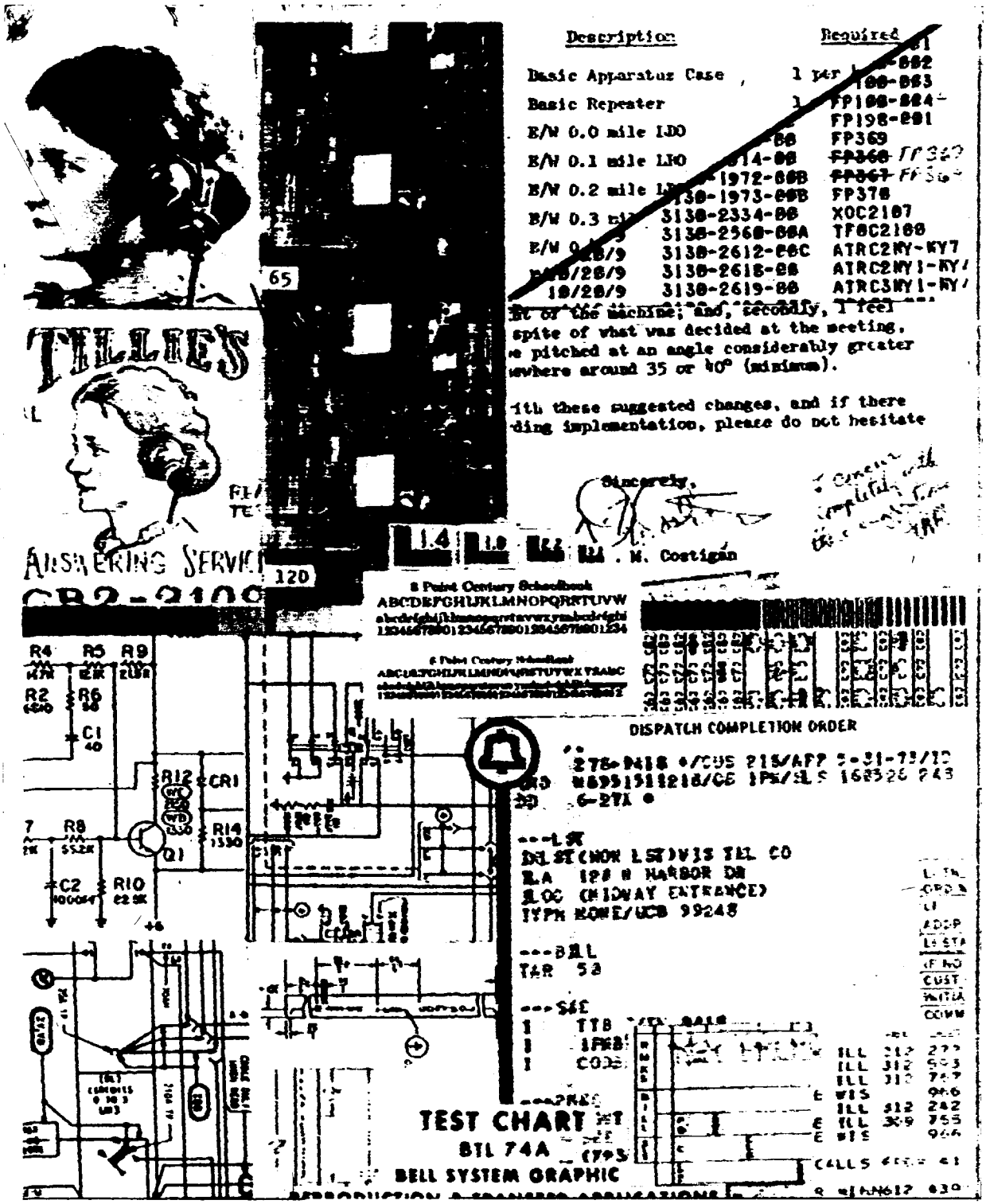

Fig 9—"Smeary" Appearance in Analog Fax Output Copy Caused by Transmission Impairments Such as Echo, Envelope Delay Distortion, and Harmonic Distortion

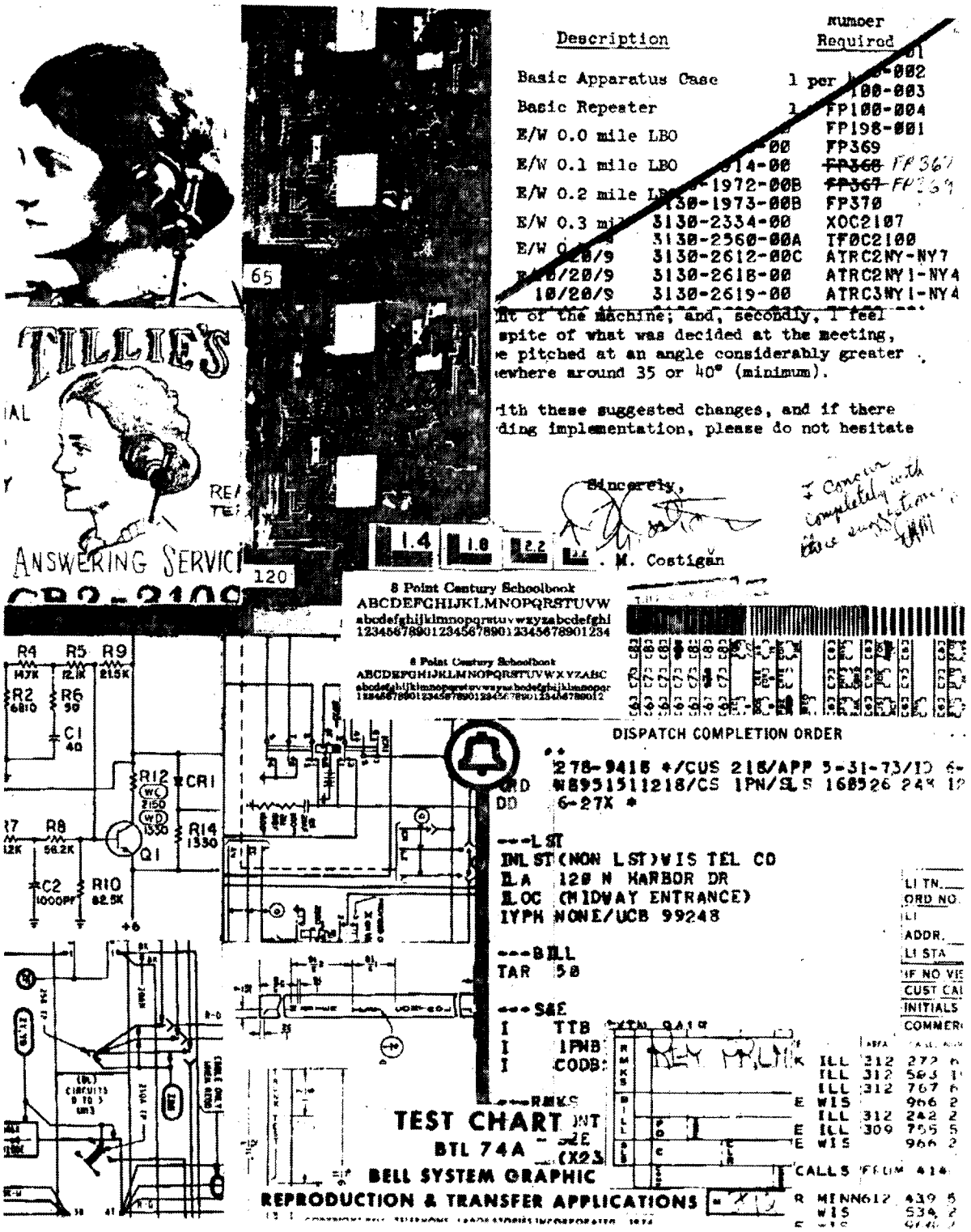

Fig 10—Low Contrast Output from a Group 3 Fax System

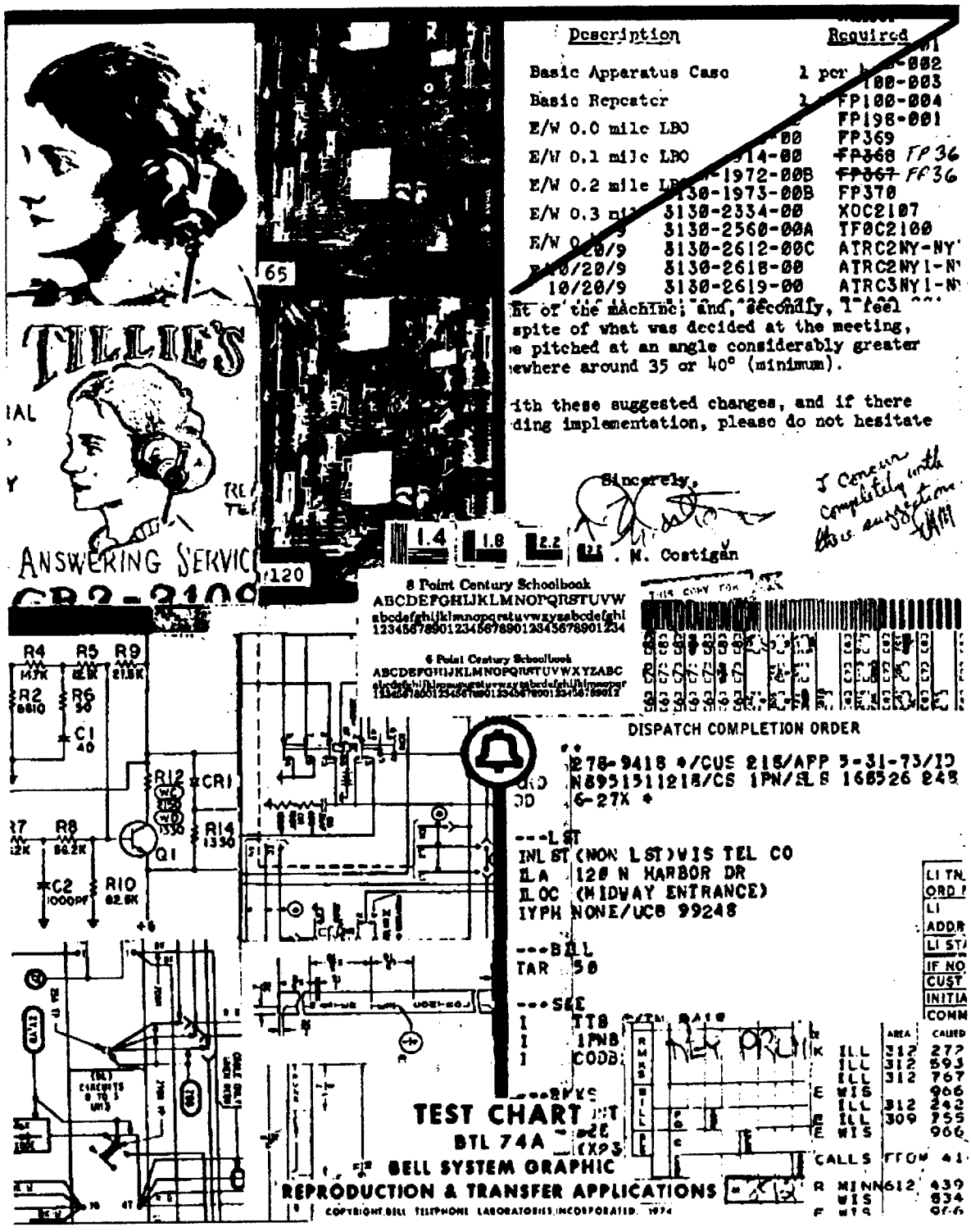

Fig 11—High Contrast Output from a Group 3 Fax System

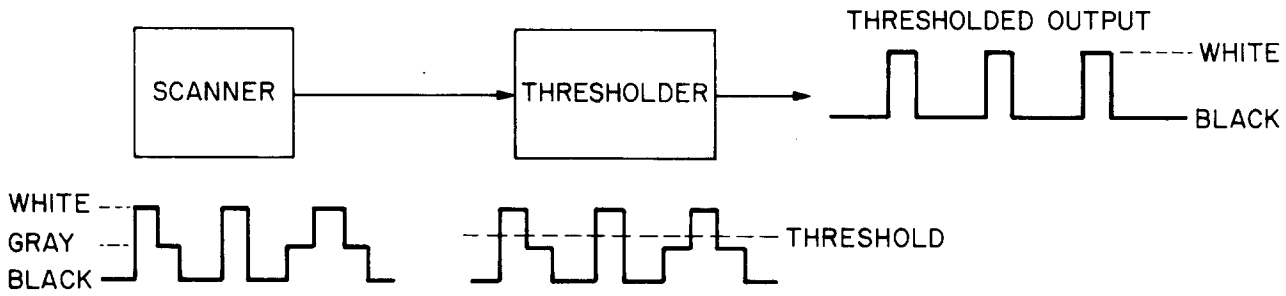

Fig 12—Effect of Thresholding on Scanner Output