CUSTOMER APPARATUS

Telephone Instruments, Payphones and Private Branch Exchanges

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The major changes and additions which have occurred in customer apparatus and equipment in the UK over the 25-year period 1956–1981 are reviewed. The scene is one of steady evolution, mainly spurred by advances in semiconductor technology. The most significant changes have been in the introduction of electronic PABXs, but towards the end of the period micro-electronics were beginning to have an impact on the design of telephone instruments and payphones. Now, in 1981, market and technology forces are primed for the introduction of change across the whole field of customer apparatus.

INTRODUCTION

In this omnibus article, a review is made of the many changes and additions to the customer apparatus field over the past quarter century. In this period, the UK telephone station population has grown from 7 million stations in 1956 to some 28 million in 1981. This growth has been achieved while the economic health of the country has fluctuated and, for the most part, resources have been focussed on meeting demand by the provision of basic telephone apparatus.

Advances in technology have injected change into the scene. In 1956, quantity production of the simple transistor had just begun, and this factor made feasible some new customer apparatus products; for example, loudspeaking telephones and callmakers. In the early-1970s, medium-scale and large-scale integration semiconductor devices, including the first microprocessors, were appearing; from about 1975 onwards these applications started to have an impact on customer apparatus as confidence in micro-electronic reliability and fitness of use became established.

The UK General Post Office (GPO) became a State Corporation in 1969; this change of status affected relationships with the UK Telecommunications Industry where, hitherto, development and production of new products for the UK market had been largely carried out on a co-ordinated basis. Hindsight shows that, in the immediate years following 1969, a lull or false stability occurred while fresh commercial attitudes were being formulated. Subsequently, matters changed with the introduction of such items as proprietary PABX equipments and proprietary press-button telephone variants. Now, in 1981, attitudes have received further stimulation by the creation of British Telecommunications (BT) and by Government deregulatory measures which have been enacted by Parliament and which, predictably, are injecting new dimensions into the market forces pertaining to customer equipment.

Some of the mainstream customer equipment has appeared to change very little: the ubiquitous 1981 dial telephone strongly resembles the 1959 item, though with subtle value engineering changes; similarly, the current coin-collecting box (CCB), now known as the *payphone*, resembles the 1956 product, albeit in a more rugged form and with a decimal coinage capability. However, each of these products are now moving to the natural end of their life cycle, and there are replacement products currently on trial, or at advanced development stages. The PBX field though has seen more significant movement as the trend towards electronic solutions gained sway in the 1970s.

Some of the changes to telephone instruments and supporting apparatus, payphones, and PBXs that have occurred between 1956 and 1981 in the UK are now reviewed.

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TELEPHONE INSTRUMENTS

STANDARD DIAL TELEPHONES

Twenty-five years ago saw the introduction of the 700-type telephone to the UK telephone network. Prior to 1956, the 300-type telephone had been standard throughout the 1939–1945 war and the immediate post-war period.

Whereas the 300-type instrument was available in a variety of versions to serve specific situations and extension plans, the 700-type instrument was designed to be more omnipurpose and could be modified by field staff (for example, by the use of extra spring sets and buttons) to cater for the extension-plan variations.

The introduction of a rocking-armature receiver[1] (Receiver Inset No. 4T) to the 700-type instrument gave a transmission efficiency improvement which permitted longer subscriber lines to be used. However, the resulting high-sensitivity telephone was too loud on short lines and a regulator[2] was introduced.

The regulator chosen was an automatic current-sensing device consisting of a multi-element selenium rectifier, a resistance lamp and 2 resistors designed to introduce on the shortest lines approximately 6 dB loss in the send direction of transmission and 4 dB loss in the receive direction.

The 700-type first appeared in the guise of the 300-type instrument mouldings (see Fig. 1(*a*)) and used the Transmitter Inset No. 13 carbon microphone. In 1959, however, a new handset and complementing body shape (see Fig. 1(*b*)) was introduced and the 706-family of telephone instruments[3] was born. The regulator was made a plug-in replaceable item and a new carbon transmitter (Inset No. 16[4]) was developed.

The 706 telephone has provision for the addition of a single press-button, which permits shared service, PBX operator recall and simple extension plans to be catered for as well as the normal direct exchange line (DEL). A variant, the 710 telephone, was produced for more sophisticated arrangements requiring up to 4 press-buttons and 2 indicator lamps. A wall-

mounted version, Telephone No. 711, was also produced (see Fig. 1(*c*)). Secretarial facilities (Plan No. 107/105) of a switched main station with one or 2 extensions were achieved by development of a plinth unit (No. N625[5]) that is associated with the main 700-type instrument and a 12 V mains power unit.

In 1967, the 746-type telephones (Fig. 1(*d*)) were introduced; these are improved versions of the 706 range of telephones and offer similar facilities. The case styling and method of fixing is different from the range of 706 telephones in that the regulator components are permanently wired to the telephone circuit printed-wiring board, and the design of the induction coil has been changed. The wall-mounted version of the 746-type telephone is the Telephone No. 741.

More recently, selected improvements in the microphone, regulator and ringer have been instituted in the quest for improved performance and reliability; in particular, the microphone has received much attention, and various alternative solutions to the carbon microphone have been explored. Three transducer technologies—electret[6], moving coil and piezo-electric film—are being placed on field trial in substantial quantities. The field-trial microphones (Microphone Inset No. 21A) have been designed as drop-in replacements for the Inset No. 16. If the new replacement transducers prove viable, then a phased replacement of the carbon microphone is likely to take place during the 1980s. This action should give improved transmission benefits to the instruments already invested in the system and bridge the way for interworking with a new generation of electronic instruments.

In the current population of some 28 million telephone stations, the 700-type family of dial instruments represents the largest single proportion by type and is still the current standard. With various refinements it has been the standard for some 20 years, but its days are now numbered as evolving technology permits capability enhancement and customer demand for purpose-built press-button telephones increases.

PREMIUM INSTRUMENTS

Customers in the UK telephone network were not given any choice of telephone instrument prior to 1965, except for instrument colour (at extra cost) and wall-mounted variants. However, in 1965, an alternative-shape telephone, known as the *Trimphone*, was introduced as a premium option; this instrument was followed much later in the mid-to-late-1970s by *press-button* telephones, the *Compact* dial-telephone, and an expanding range of *special-range* telephones that had distinctive shapes.

Trimphone

The original Trimphone (Telephone No. 712[7]) was introduced in 1965; this model was followed in 1971 by an improved version, the Telephone No. 722 (see Fig. 1(*e*)). The transmission circuit is similar to the 746 telephone but, to cater for the unique styling of the miniaturized handset, the microphone is mounted behind the earpiece; sound from a talker's voice is conducted to the microphone via an acoustic tube in the hollow handset moulding.

The Trimphone was the first British Post Office (BPO) telephone in which the handset is kept over the dial when not in use. The handset-rest doubles as a carrying handle.

The Trimphone incorporates a tone caller instead of a bell, and the dial numbers are illuminated from behind by a tube containing radioactive tritium gas: the Trimphone derives its name from these two features—*T*one-*R*inging *I*lluminated *M*odel.

Compact Dial-Telephone

After field trials in the mid-1970s, the Compact telephone[8] (Telephone No. 776) was first introduced in 1977 as a limited edition in the colour 'Balmoral Blue' to mark the occasion of the Queen's Silver Jubilee. More recently, the Compact telephone has been made available in a choice of 2 colours: stone or brown. The Compact telephone is shown in Fig. 1(*f*).

The main distinguishing feature of the Compact instrument is its compact fore and aft dimensions, which permit it to be accommodated on a narrow shelf. The small instrument-size is achieved by mounting the bell unit in a separate housing. A special shelf-bracket has been devised to enable the Compact instrument to be wall-mounted; the bell unit may be housed within this bracket.

The Compact telephone uses the standard 746 telephone circuit, but opportunity was taken to introduce a new ringer unit, the Uni-Coil Bell No. 79. This ringer is now a component option with the 746 telephone.

PRESS-BUTTON TELEPHONE INSTRUMENTS

The advantages offered by a keypad compared to a dial were recognized from the very earliest years of telephony, and a variety of electromechanical-based systems were developed. However, none of these could compete with the low-cost dial, and keypad instruments were not produced in significant numbers. Press-button telephones[9] started to be viable only after the invention of the transistor. Two basic types dominate the world's output today: in the UK these are called *multi-frequency* (MF4) and *self-contained* (SC) keypads.

MF4 telephones were developed by the Bell Laboratories in the USA in the late-1950s. At that time, transistors were becoming commercially viable but they were expensive, and therefore the cost of each telephone could justify only one transistor. Bell Laboratories developed a system using voice-band frequencies and demonstrated that 2 tones per digit had advantages over a single-tone per digit. They developed a system that has stood the test of time and is now a CCITT† recommended standard. The two-tone-per-digit system was realized by oscillating a single transistor at 2 frequencies when loaded with a combination of capacitors and coils that are selected by a complex keypad, which has contacts for each button and common contacts that are closed when any button is depressed. With the MF4 system, specialized receivers are required at the exchange to decode the tones.

In the late-1960s, an alternative press-button system, known as *Code A* or *Code C* (depending on coding arrangements), was designed for PABX application. A combination of full earth or rectified earth signals were applied to each leg of the line from the instrument and detected by an electromechanical relay-set at the PABX. At the time, this system was cheaper than the MF solution, but cost trends of electronic devices have since reversed the position and Code A/Code C signalling has now been superseded.

In the same way that MF4 telephones required the invention of the transistor, so a true dial-replacement keypad telephone required the invention of the integrated circuit (IC). Designs of SC telephones are so called because, unlike MF4, they require no specialized exchange receiving equipment other than that provided to accept dial-type pulsing signals. The SC telephone requires IC technology because the signalling speed is identical to the dial at around 1 digit/s, whereas the user can key in digits at a rate that can reach up to 8 digits/s over short periods. Therefore, an SC telephone requires an in-built memory to remember digits keyed, as well as control and timing circuitry to transmit the digits at the slow dial-rate.

700-Type MF4 Telephones

The BPO was slow to adopt MF4 signalling since no receiving capability existed in the predominantly Strowger exchanges. With the introduction into the UK, in the late-1960s, of the first PABXs equipped with MF4, impetus was given to the introduction of an MF4 telephone. This was housed in a 700-type chassis and was provided with a keypad with a

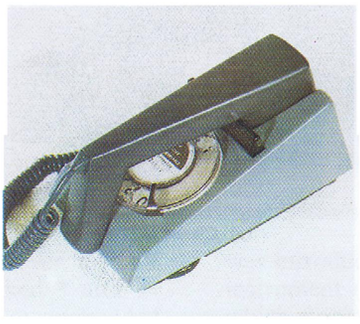
† CCITT—International Telegraph and Telephone Consultative Committee

(*a*) Telephone No. 700 (using 300-type case moulding)—1956

(*b*) Telephone No. 706—1959

(*c*) Telephone No. 711 (wall-mounted type)—1962

(*d*) Telephone No. 746—1967



(*e*) Trimphone (Telephone No. 722)—1971

(*f*) Compact (Telephone No. 776)—1977

(*g*) Telephone No. 724 (experimental press-button configuration—2 × 5)—1966

(*h*) Telephone No. 756 (self-contained press-button—3 × 3 + 1 configuration)—1975

(*i*) XPress callmaker (Telephone No. 772)—1978

(*j*) Telephone No. 786 (MF press-button Trimphone)—1979

(*k*) Ambassador (dial-type, Telephone No. 8100)—1981

(*l*) Ambassador (MF press-button type, Telephone No. 8300—1981)

FIG. 1—Standard and premium telephone instruments 1956–1981

(*a*) Astrofon (Thorn Ericsson)

(*b*) Contempra (GEC)

(*c*) Dawn (Northern Telecom)

(*d*) Ericofon 600 (Thorn Ericsson)

(*e*) Classic (STC)

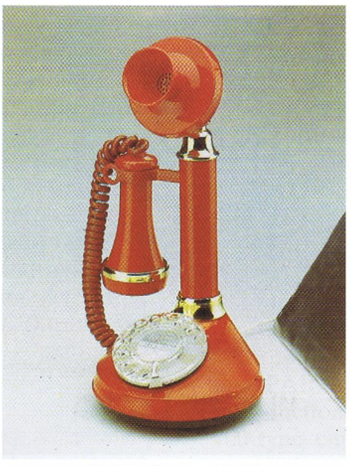
(*f*) Rhapsody (GTE)

(*g*) Ericofon 700 (Thorn Ericsson)

(*h*) Deltahpone (STC)

(*i*) Deltaphone-deluxe (STC)

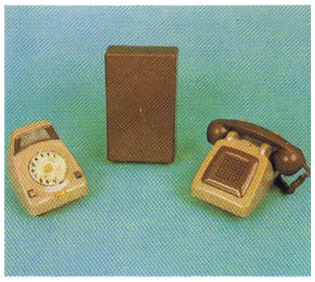
(*j*) Eiger (Webb and Wells Ltd.—Gfeller)



(*k*) Candlestick (STC)

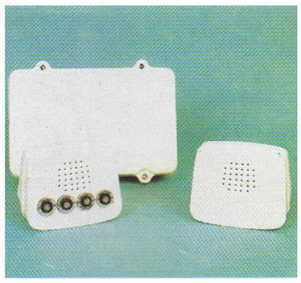
(*l*) Mickey Mouse (Plessey)

FIG. 2—Special-range telephones (1981)



(*a*) LST1

(*b*) LST2 (GEC Paymaster)



(*c*) LST3

(*d*) LST4D

(*e*) LST4E

(*f*) A and LS No. 11A (Doric—Northern Telecom)

(*g*) A and LS No. 12A (Harmony)

(*h*) LST8 (Accord)

FIG. 3—Loudspeaking telephones

2 × 5 button configuration (see Fig. 1(*g*)). However, a 3 × 4 format was rapidly adopted and buttons marked * and # were included. This format is now the CCITT recommended layout.

The early models used the bulky coil-capacitor circuitry originally developed by Bell, but later versions, introduced in 1979, used integrated circuit MF4 tone generators.

700-Type Self-Contained Telephones

The first designs of SC telephones were housed in a 700-type chassis (see Fig. 1(*h*)). After a brief courtship with a 2 × 5 keypad, a 3 × 3 + 1 configuration was adopted; large-scale production of this design commenced in 1975. Although the external appearance remained largely unaltered, the internal design progressed steadily through 10 versions.

The earliest versions had extensive packaging problems since a battery was needed to keep the memory circuit active during line breaks, and relays (to provide off-normal and line-pulsing functions) had to be housed inside the telephone. In due course, the batteries were replaced by capacitors, and the relays by transistors. From 1980, all SC production models used capacitors and transistors and are a direct wire-for-wire replacement for their equivalent dial telephone on all extension plan arrangements.

Xpress Telephone

Integrated circuit technology used to provide the press-button facility readily permits the very useful additional facility of storing and sending telephone numbers. This facility was introduced in the *Xpress* telephone in 1978. The Xpress instrument (see Fig. 1(*i*)) is an SC press-button telephone which stores up to 10 telephone numbers and which has the capability of repeating the last number dialled. A battery is required in the telephone to power the memory circuit during the ON-HOOK condition but, in due course, advances in semi-conductor technology should eliminate the need for the battery.

SC and MF4 Trimphones

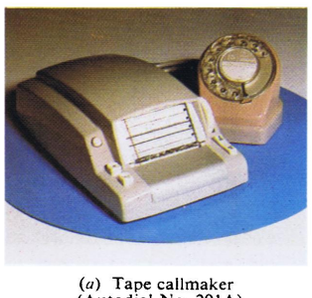
Although the first dial Trimphone appeared in 1965, it was 1977 before the first keypad version was in production. The delay was caused primarily by the problem of packaging the signalling electronics into the small volume of the Trimphone case. This problem was alleviated by marginally increasing the height of the case in keypad versions compared to the dial version.

The first design of Trimphone to achieve large-scale production was the SC version; this design incorporates relays, but no batteries are needed. Subsequent designs have eased the packaging problem further by eliminating the relays and introducing transistor pulsing.

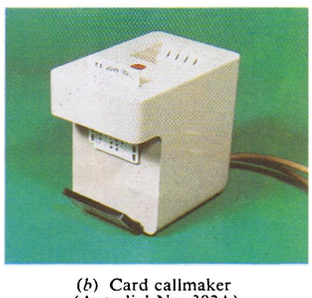
An MF4 design (see Fig. 1(*j*)) had to await the development in 1979 of an integrated circuit to replace the bulky coils and capacitors.

The Ambassador Telephone

The Ambassador telephone range[10], first shown at the Telecom '79 exhibition, Geneva, in 1979, is being introduced



(*a*) Tape callmaker (Autodial No. 201A)

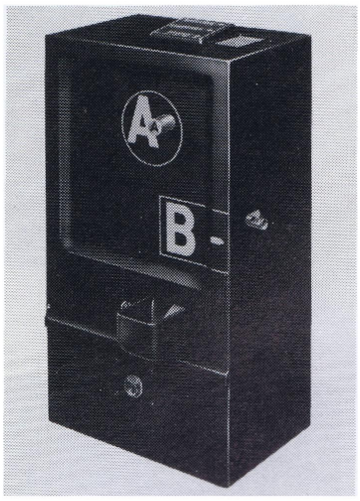


(*b*) Card callmaker (Autodial No. 302A)

(*c*) XL callmaker (Autodial No. 104A/105A)

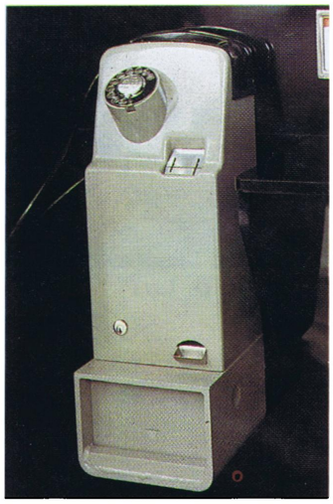
(*d*) Mono callmaker (Autodial No. 401A)

FIG. 4—Callmakers



(*a*) Pre-payment payphone

(*b*) Pay-on-answer payphone



(*c*) Pay-on-answer payphone (strengthened version)

FIG. 5—Public payphones

during 1981. The design has been styled for press-button applications, but dial options are possible (see Figs. 1(*k*) and 1(*l*)). The Ambassador telephone is conceptually different to the 700-type family of instruments in that it has been designed as a plug-and-socket install-as-issued telephone for most of its applications.

The range of instruments consists of three series, known as the *basic*, *plan* and *facility*, though at the present time only the basic and plan versions are being produced.

The basic series, which caters for single telephone installations and simple extension-plan applications, can have dial or press-button (MF or loop-disconnect) signalling, a bell or tone caller, and can be wall-mounted or table-mounted. The press-button versions incorporate the 10-address store facility or an on-hook dialling (OHD) facility, or both can be provided if required.

The plan series caters for the more complex multi-line/secretarial requirements; each plan instrument contains a microprocessor and additional lamps and buttons for signalling purposes. The instruments are connected via 4-wire cable to a central control unit (CCU), which is also microprocessor based. A CCU with plan terminals constitutes an electronic plan system (EPS). Three sizes of EPS have been developed:

(*a*) a custom-built, one exchange line and 3 stations (1 + 3),
(*b*) a custom-built 2 — 4, and
(*c*) a system which grows up to 5 — 10.

Each system provides incoming and outgoing exchange-line service, intercommunication, hold, transfer and divert facilities. Each instrument is programmable by a customer, both for selective exchange-line ringing and for diversion to any nominated station.

The basic and plan series have been designed to interconnect mechanically with a range of add-on-modules, which includes subscribers' private meters, Amplifier and Loudspeaker (A and LS) No. 12A, autodials and answering sets.

The facility series was conceived to incorporate modules within one wider-bodied package rather than to provide a number of external units; at present, the latter option has been left open. The realization of the facility service will depend very much on market demand arising from the basic and plan combinations.

The Ambassador telephone is the forerunner of a new range of telephones for the 1980s. The instruments can be regarded as a stepping stone between the modern telephone, which has evolved with conventional components from the 1930s, and the electronic telephone age. The electronic telephone with an electronic transmission circuit has been an attractive concept since the invention of the transistor. The economic arguments have hitherto been in favour of retaining the conventional induction-coil circuitry, but the position is now changing with modern electronic production technology.

The Ambassador telephone has been developed with both the conventional and electronic solutions in mind, but predictably it will be upstaged in due course by dedicated electronic solutions. Advanced electronic telephones are already at the prototype stage, and field trials of production quantities are expected during 1982 alongside the Ambassador telephone.

(*a*) Pay-on-answer wall-mounted payphone (CCB No. 700)—1959

(*b*) Compact pay-on-answer payphone (CCB No. 725)—1978

FIG. 6—Renters' payphones

(*a*) Blue payphone (self-contained)—1979

(*b*) Self-contained table-top payphone—1981

FIG. 7—New electronic range payphones

TABLE 1
Special-Range Telephone Instruments as at 1981

Instrument Type	Country of Origin	Comments
Astrofon	Sweden	Press-button instrument with electronic transmission circuit
Contempra	Canada	Mini-dial mounted in hand-set. Instrument can be wall-mounted
Dawn	Canada	Futuristic 'flying saucer' shaped dial-instrument
Ericofon 600 and 700	Sweden	One-piece dial and press-button telephone
Classic	UK	Antique style dial-phone
Rhapsody	Belgium	Optional table or wall-mounted press-button instrument
Deltaphone	UK	Leather-covered Trimphone. Dial and press-button versions available
Eiger	Switzerland	One-piece press-button instrument with repeat-last-number facility
Candlestick	USA	Similar style to the Telephone No. 150, but of plastic construction
Mickey Mouse	USA	Modelled after the image of the famous Walt Disney character

SPECIAL-RANGE TELEPHONES

To provide customers with a further choice of instrument types beyond the standard and premium range, an additional range of instruments termed *special-range* telephones was promoted in 1978. In general, this range of instruments embraces products with a shorter market life, variously following fashion, novelty and the latest technically innovative concepts. British Telecom† intends that the range will be changed systematically, with new products added and other products deleted as dictated by economic and market forces. This faster changing product line has required different measures to be instituted in stores-handling procedures compared to mainstream products. The 1981 range comprises telephone instruments from many different countries as well as those manufactured in the UK, as shown in Fig. 2 and indicated in Table 1. Most of the overseas instruments have needed modifications to provide the correct interface with the UK network and to meet BT planned transmission and signalling standards.

LOUDSPEAKING TELEPHONES

In the 1930s, the BPO carried out some work on loudspeaking telephones[11] (LSTs), but the Second World War intervened and it was not until the mid-1950s that a fresh approach was made to the subject. The fundamental problem of LSTs was to obtain an acceptable level of received speech comparable with the speaking voice without encountering instability and echo effects caused by part of the received speech re-entering the near-end microphone.

The LST 1[12] (see Fig. 3(*a*)), which was a line-powered item, was the first attempt at solving the problem and, by careful juxtaposition of the separate loudspeaker and microphone units, an acceptable speech connexion with a distant telephone instrument was possible. However, instability was very likely when the distant instrument was also a loudspeaking telephone, and the mains-powered LST 2, (see Fig. 3(*b*)) which incorporated a voice-controlled switch, was introduced to remedy the defect. Both the LST 1 and LST 2 became available to customers in 1960.

A waterproof cased version of the LST 1, the LST 3[13] (see Fig. 3(*c*)), was introduced in 1963 for use in a "hands-free" situation where washing down and disinfecting was necessary; for example, for use in hospitals. The LST 1 also formed the basis of the LST 5B and LST 7, which were specially devised to assist the handicapped.

A more versatile voice-switched LST, the LST 4[14] (see Fig. 3(*d*) and 3(*e*)), was introduced in 1966. The LST 4 has been the mainstay LST product throughout the 1970s, appearing in various press-button variant forms using DC Codes A or C, loop disconnect or MF4 signalling.

In the mid-1970s it was decided to seek an improved form of voice-switched LST that avoided the abrupt and near total switching of the LST 4. This led to the selection of a proprietary add-on loudspeaking unit, the A and LS No. 11A (also known as *Doric*): this design (see Fig. 3(*f*)) incorporates a soft switching technique, which is less intrusive to the two-way speech connexion. More recently the circuit elements of the A and LS No. 11A have been repackaged in the style of the Ambassador telephone, both as an add-on unit, the A and LS No. 12A (known as *Harmony*, see Fig. 3(*g*)), and an integral unit, the LST 8 (known as *Accord* see Fig. 3(*h*)). The A and LS No. 12A and LST 8 instruments will become available during the latter part of 1981.

Although further performance improvements are possible, the present state of the art is that this can only be achieved by much more sophisticated circuitry. The economies of large-scale integrated circuits will undoubtedly make this happen during the 1980s.

AUXILIARY APPARATUS

The use of semiconductor devices has permitted the creation of a number of auxiliary items to complement the basic telephone; for example, callmakers and answering machines.

Callmakers

Callmakers are devices that can store a selection of telephone numbers. In the 1930s, a mechanical contrivance of cams and levers was developed to achieve this function, but the first significant commercial item was the Autodial No. 201A[15] (see Fig. 4(*a*)), which was marketed in the UK in 1970; this device uses a metal-oxide tape to store up to 400 numbers. The Autodial No. 302A (see Fig. 4(*b*)) was introduced in 1971; this device is a card callmaker in which the telephone number is stored as punched holes on a plastic card, one card is used for each telephone number.

The callmaker range was enhanced in 1979 with 3 additional models all using integrated solid-state devices: the Autodial No. 104A (known as the *XL callmaker*, see Fig. 4(*c*)), which stores up to 46 telephone numbers, and has a repeat last-number facility and a loudspeaker to monitor call progress; the Autodial No. 106A, which has the capability of storing 31 numbers; and the Autodial 401A[16] (See Fig. 4 (*d*)), which stores a single number only. The latter unit was designed to aid disabled users and to provide service at unattended premises; for example, to provide a calling facility from an airport foyer to a car hire service, or to arrange a hotel booking.

Callmakers, either in their own right or as an integral part of the modern telephone, are likely to become increasingly popular during the ensuing years.

Answering Machines

The Answering Machine No. 1A was introduced in 1958. This device permits a telephone call to be answered automatically with a pre-recorded message of up to 20 s duration sent to the caller. A continuous loop of tape is used for recording the message.

† British Telecom is the trading name of British Telecommunications

TABLE 2

Auxiliary Apparatus Introduced During the Period 1956–1981

Date	Apparatus
1956	Faultsman's Handset No. 280
1959	Subscriber's private meter (stimulated by the need to provide additional metering information on the introduction of subscriber trunk dialling)
1961	Flameproof telephone
1963	Pendant telephone
1968	Linesman's Telephone No. 704A
1969	Weatherphone
1973	Linesman's Telephone No. 704B
1979	Faultsman's Handset No. 281
1981	Subscriber's private meter (an electronic update of the 1959 product in the style of the Ambassador telephone and exploiting microelectronics coupled to a liquid-crystal display)

In 1963, the Answering Machine No. 1A was followed in production by the Answering Machine No. 2A. This machine is similar to the earlier model but has a message-length facility of between 30 s and 4 min. The Answering Machine No. 3A, which uses a tape cartridge as the storage medium, was introduced in 1979.

The Answering and Recording Set No. 101A was introduced in 1981. As well as providing a pre-recorded message facility, this equipment also permits the caller to record a message. A caller's message is recorded on a modified C60 compact cassette.

Some of the other auxiliary apparatus introduced in the period is given in Table 2.

AIDS FOR THE HANDICAPPED

In this historical survey of telephone apparatus over the past 25 years, reference must be made to the various aids for the handicapped. This year, 1981, has been designated the *International Year of Disabled People*, but the significance of the telephone service to handicapped people has been recognized for many years and, since 1960, the range of aids available has been expanding almost continuously. For a severely handicapped person, modifications and supplements to the standard equipment may be tailored to suit individual need. However, for those handicapped to a lesser degree, selected arrangements from a standard range of accessories are often highly satisfactory. Thus, the loudspeaking telephone enables hands-free operation; the callmaker range permits the convenient setting up of pre-selected telephone numbers; press-button telephones require less dexterity than a dial; strategically placed extension bells or a trimphone with its distinctive tone caller can assist the selectively-deaf person to more readily identify an incoming call; and watch receivers or headsets can be added to help overcome various disabilities.

A supporting range of purpose-built items to assist the handicapped have been produced in the period, as given in Table 3.

The transition since 1956 from cord switchboards to a prominence of the cordless type has stimulated work to assist blind operators. This work has principally involved the substitution of lamp indicators by tactile indicators; a number of switchboards have been approved for this adaptation. For the future, there is prospect that high technology can assist by the application of voice-synthesis units to give a blind operator audible prompts that will indicate the changing status of the switchboard.

High technology is also expected to benefit other categories of disabled users. The so-called *intelligent telephone* terminal, perhaps fitted with simple touch controls, could well evolve to meet the needs of particular users. Visual-display terminals should certainly assist the totally deaf; a visual facility for communication with the deaf, the *conversation page*, has already been devised for the Prestel service.

TABLE 3

Telephone Aids for the Handicapped

Date	Instrument
1960	Handset No. 4 (amplified handset)
1960	Sender No. 1 (for operator-assisted calls)
1961	Amplifier No. 143A (faint-speech amplifier)
1969	Loudspeaking Telephone No. 5B, latterly known as the *Servophone*, for use with equipment supplied by the Department of Health and Social Security
1975	Label No. 479C (enlarged dial-ring)
1978	Loudspeaking Telephone No. 7A (superseding the LST 5B)
1979	Coin-insertion guide for coin-collecting boxes (payphones)
1980	Receiver Inset No. 1/3T (inductive coupler for use with hearing aids)
1981	Press-button finger guide (to facilitate location of the required press button)
1981	Auxiliary Handset No. 1A (a hands-free handset)

PAYPHONES

Although payphones have been available almost since the advent of telephony, new generic designs of payphone have been introduced in the UK relatively infrequently. Not surprisingly, each new generation of payphones has differed significantly from its predecessors and has marked a major step forward either in policy, design philosophy, network capability or technology.

PAY-ON-ANSWER PAYPHONES

Towards the end of the 1950s, the then familiar black *Button A and B* pre-payment payphone (see Fig. 5(*a*)) began to be superseded by the first versions of what has become known as the *pay-on-answer* (POA) payphone system[17, 18] (see Fig. 5(*b*)). The POA design was made necessary by the introduction of subscriber trunk dialling (STD), and its introduction to service was phased to coincide with STD access. To offer a fully automatic service to payphone users, the POA system has to work in conjunction with local-call timing and multi-metering equipment, and has to enable subscribers to extend calls by inserting additional coins during the progress of a call. The other significant difference between the POA system and its predecessor was the change from pre-payment to post-payment. This was considered the most pragmatic approach with the technology available, and was aimed at minimizing fraud and enabling simple operation.

It was not practicable to house the control logic within the POA payphone, and thus a two-part system was adopted: the payphone with its coin-validation mechanism is linked to a controlling relay-set situated in the local exchange. The exchange relay-set, designated the *coin-and-fee check* (C and FC) equipment, carries out the control functions on receipt of the coin-value signals from the payphone and the signal pulses from the network which convey the appropriate tariff information. The two-part approach in design allows economies in that the C and FC equipment can be provided in a traffic-sharing group on a grade-of-service basis.

The POA payphone is essentially a mechanical device and the C and FC unit is an electromechanical relay-set, although experimental electronic C and FCs were put on field trial in the late 1970s with a view to their introduction into electronic public exchanges. Many detailed design changes have been

made to the payphone to combat vandalism and theft, including the introduction of various strengthened casings, over the period 1966–1973. The model shown in Fig. 5(*c*) is now almost in universal use where an armoured version is necessary.

The introduction of decimal coinage in 1970 resulted in some fundamental changes to the design of the payphone mechanism, which had been built in the early-1950s to take up to 3 different duodecimal coins in the value ratio 1:2:4. However, to use decimal coinage, a 1:2:5 value ratio was required and, to achieve this, modification to both the payphone and the C and FC circuitry was necessary. When decimal coinage was introduced, the unit fee of the payphone was changed from 6d to 2p, and a considerable amount of anticipatory design and piece-part manufacture was necessary prior to the availability of the new coins. In the event, the challenge of 'D' (decimal) day, 15 February 1971, was met by the combined efforts of the BPO and Industry with a near total change of the whole payphone system in the space of 3 weeks.

Whereas the number of public call-offices has grown only slowly in the last 25 years, the number of rented payphones in private premises has increased substantially. A number of variants have been introduced for this market to supplement the original renters version, (see Fig. 6(*a*)). The latest variant (see Fig. 6(*b*)), which was introduced in 1978, is a compact version that can be wall-mounted, fitted to a trolley or used in a portable mode. In addition to changes in the coin values accepted to keep pace with inflation, new techniques are still being applied where beneficial; for example, a new paint finish has recently been adopted as a standard to improve appearance and durability and to allow easier removal of graffiti.

The bulk of payphones in service in 1981 are still of the POA type, but it became apparent during the 1970s that the viable life of the system was limited. Inflation had exposed a need to provide for greater flexibility in design to cope with tariff adjustment and to obtain the unit fee charge from a given combination of coins. As metering rates have increased (particularly with the widespread availability of International Direct Dialling (IDD)), the enforced breaks in transmission while additional coins are inserted have become more obtrusive. Furthermore, as the system has aged, the two-part concept has not assisted the quick localization of faults between the payphone and the exchange-based equipment.

NEW ELECTRONIC PAYPHONE RANGE

Plans were made in 1978 to update the whole system by exploiting the advantages of electronic technology. In planning the change, note was taken of the need to harmonize the operating characteristics with the majority of other European countries. The BPO has decided that the new system will be based on a pre-payment approach, with refund of unused coins where appropriate: it was also decided to dispense with the two-part concept of POA and to opt instead for an integral design with logic control vested in the payphone itself.

A replacement program was instituted aimed at the introduction of 3 different designs of payphone to cover specific market sectors. The 3 designs are as follows:

(*a*) A payphone for high revenue-earning applications; this design offers maximum customer facilities and will be introduced into the service as quickly as possible.

(*b*) A mainstream or medium revenue-earning design for general application; this design will be as cost effective as is possible. Two variants of this design are envisaged: the first to be heavily armoured for call-office use; the second to be less heavily armoured, as required for most rented applications.

(*c*) A small portable design, exclusively for renters application where some supervision of usage is possible.

As the first step in the implementation of this programme, a trial commenced in 1979 of a high-revenue-earning payphone (see Fig. 7(*a*)). This payphone, an adaptation of a Swiss design, is known as the *blue payphone* and is now being introduced in significant quantities throughout the UK.

Trials of a UK-designed renters' portable payphone (see Fig. 7(*b*)) will take place in late 1981, preparatory to general introduction to the UK network in 1982. Prototypes of the replacement medium-revenue-earning payphones are undergoing evaluation and are scheduled for introduction in early 1983.

During the 1980s, it is intended to make a significant penetration into the payphone market using these 3 designs. The instruments are expected to give customers easier usage and improved facilities. British Telecom should also benefit from improved operating features and reliability.

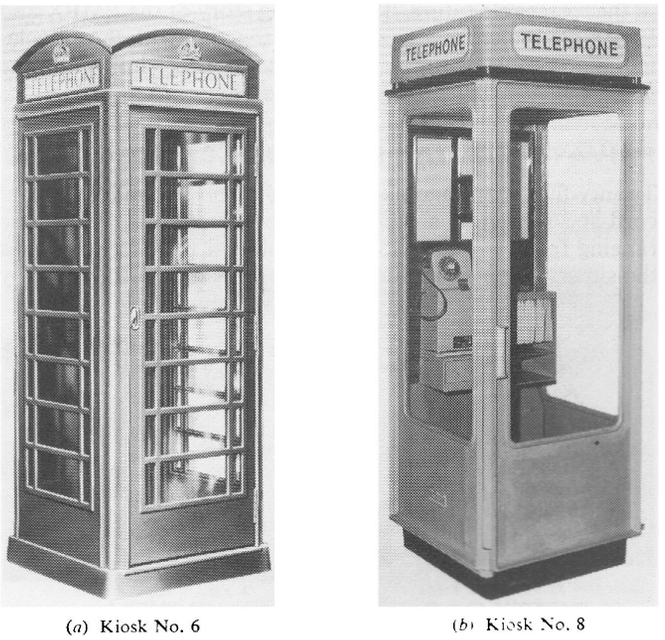
KIOSKS

During the past 25 years, call offices (kiosks) have changed very little in design. They have always been rugged and long lasting, and the Kiosk No. 6 has remained the most used item. This design (see Fig. 8(*a*)), originally introduced in 1936, was constructed mainly of iron castings with wooden doors.

In the early-1960s, the BPO, recognizing that the styling of this kiosk was becoming dated, commissioned a number of design studies. An evaluation was also made of aluminium castings in lieu of iron, but this idea proved uneconomic at that time. The design finally adopted, the Kiosk No. 8[19] (see Fig. 8(*b*)), is of a more modern style; the use of cast iron has been continued, apart from the door which is constructed of cast aluminium. Large panes of toughened glass replace the small windows of the earlier design. Overall, the kiosk is extremely robust. It was introduced into service in 1969, but its penetration has been slow because the longevity of its predecessors and the relatively small growth factor of call offices.

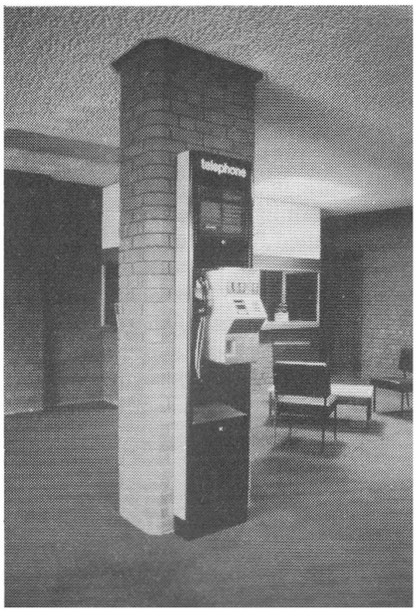
More recently, further design studies have been commissioned that embrace a range of payphone housings for both outdoor and indoor use. The range includes a full kiosk, an open booth and a stand-alone pedestal. In addition, a design with special consideration for wheel-chair users has been commissioned. First experimental prototypes of these items (see Figs. 9(*a*), (*b*) and (*c*)) became available in 1981, but decisions to order them in significant quantities have not yet been made.

The standard kiosks have in some ways become an integral part of the landscape, and there is considerable depth of public opinion on their appearance. At present, there is public



(*a*) Kiosk No. 6 (*b*) Kiosk No. 8

FIG. 8—Public call offices



(*a*) Pedestal-type kiosk

(*b*) Weather-proof kiosk

(*c*) Disabled persons kiosk

FIG. 9—Experimental call-office prototype kiosks

debate as to whether the kiosks should be reidentified with British Telecom on its split from the Postal Business, by using a colour different from the traditional colour red. Limited trials of yellow coloured kiosks are being carried out, but any final decision will be influenced by the consensus of public opinion.

PRIVATE BRANCH EXCHANGES

In 1956, the private manual branch exchange (PMBX) provided the dominant private switching-system. In 1981, the number of PMBX installations is still greater than the automatic types (PABX). However, as technology reduces both the cost differential between the 2 methods and provides the opportunity for greater sophistication, the wind of change towards the PABX method of operation predominates.

The PMBX provides the more personal supervision and service, and currently has a capital cost advantage over the PABX (particularly at small-size installations) and, because of this aspect, is unlikely to be completely eclipsed by the PABX in the forseeable future. The evolving story of the PMBX and PABX equipment is now described, together with the associated and complementary switching equipments known as the *house exchange systems*, and *key-and-lamp units*.

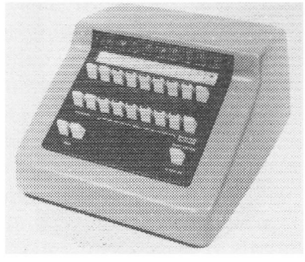
PRIVATE MANUAL BRANCH EXCHANGES

Twenty-five years ago, key-and-indicator switchboards and cord-and-indicator switchboards predominated, with size ranging from 1 + 3 to 15 + 60. The first major change was the supersession of the indicators (mechanical dolls-eyes) by lamps, and this change led to the present range of lamp-signalling switchboards. Requirements for large multiple switchboards were met by the PMBX 1A (a development of the PMBX 1 cord-and-lamp-signalling switchboard), which catered for up to 1200 extensions.

The 2/xxx series PMBX[20], introduced in the late-1950s, caters for a range of small-size installations. These units are key-and-lamp-signalling switchboards; 2 + 6, 3 + 12 and 4 + 18 versions are available; Fig. 10(*a*) shows the 2 + 6 unit. Each extension is wired with 4 wires: 2 wires are used for speech and 2 are used for signalling to the switchboard. These PMBXs have proved to be highly successful, and large numbers are still in use. They are rather basic but extremely cheap, and remain cost effective and hence difficult to replace, even with the latest technology. A 3/xxx series panel-version having a capacity of 5 + 25 was also introduced; these designs are used for mounting in custom-built desks and consoles.

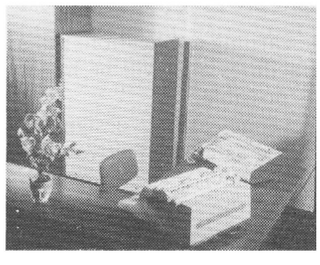
The PMBX 4/1A cord-and-lamp-signalling switchboard[21] was introduced in 1967–68 to cater for the market sector requiring 20–100 extensions. This design, which is shown in Fig. 10(*b*), can be used as a multiple switchboard, but such application is difficult to achieve because of the amount of equipment needed inside the rear casing. Hence a variant, designated the *PMBX 11*, was designed for the multiple situation. This design gives a capability of up to 800 extensions and effectively supersedes the PMBX 4/1A for all but the largest installations.

The latest addition to the PMBX range, introduced in 1978, is the PMBX 12, a cordless switchboard with a 10 + 48 capacity. It is essentially an operator-controlled reed-relay matrix and offers improved performance over earlier PMBXs

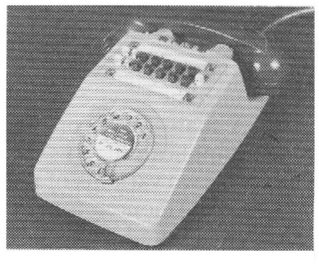


(*a*) PMBX 2/2A (2 + 6)

(*b*) PMBX 4



(*c*) PMBX 12 (Premier)



(*d*) HES 4

FIG. 10—Manual switching systems

in that it provides automatic clearing and direct outward dialling from extensions. This PMBX is, in some ways, the first (and probably the last) of a new generation of PMBXs in that it moves close to the PABX concept of operation by using automatic switching, albeit under manual (operator) control. In addition to easier operating procedures, maintenance is much reduced and the product is aesthetically attractive in an office environment (see Fig. 10(*c*)).

House Exchange Systems

House exchange systems (HESs) are multi-wired press-button key systems; they equate to a small distributed PBX with the switching function resident in each terminal, providing named button-calling for internal communication and conference calls. In 1956, the systems available were the HES 1[22] (1 + 6) and HES 2 (2 + 11), packaged in a variant form of the 300-type telephone. In the early-1960s the range was superseded by the HES 3[23] and the HES 4, which were based on 700-type circuitry and case styling; the HES 4 is shown in Fig. 10(*d*).

Key-and-Lamp Unit

A key-and-lamp unit (K and LU) is a multi-way line terminating unit that provides a means of connecting a number of telephones to a selection of exchange lines, PBX extensions or private circuits. In 1956, a pre-1940 design of K and LU was in use; it comprised a polished mahogany cased assembly of lever keys. In 1964, a new K and LU[24] in the style of the PMBX 2 series cordless switchboard was introduced. Like the HES, the K and LU is still in current use, but many of their applications are being displaced by alternative electronic equipment solutions, notably the Ambassador electronic plan-system and the Herald switching system.

PRIVATE AUTOMATIC BRANCH EXCHANGES

Twenty-five years ago, the BPO and the UK telecommunications industry were operating under joint agreements for the development and supply of equipment, and PABX designs naturally followed the techniques used in main-exchange switching because this arrangement gave economies in piece-part production, stores holding and staff training. Most of the PABXs in service therefore were of the Strowger type. At this time, smaller PABXs of less than 50 extensions (PABX Nos. 1 and 2) were produced in packaged form, installed by the BPO and rented to the customer. However, larger sized PABXs (PABX Nos. 3 and 4) that had uniquely tailored hardware solutions were, for investment reasons, permitted to be supplied direct to the customer by approved suppliers.

With the cessation of the joint development activity with industry in 1969, and the changing switching technology taking place in the public exchange domain, the BPO decided to introduce a PABX liberalization policy allowing proprietary offerings. The aim of this liberalization policy was to increase customer choice of PABX types and to permit alternative technologies. This led in the early-1970s to an increase in the number of approved PABX suppliers and to the emergence of a variety of large PABXs that used common-control techniques with crossbar, rotary and reed-relay switching systems. The techniques used were not directly translatable to small PABXs of less than 50 extensions without incurring a high cost overhead for the common equipment; thus the BPO's rental range PABXs continued to employ Strowger techniques.

As the costs of producing electronic equipment were reduced and the cost for producing corresponding mechanical items increased, the mid-1970s saw a move towards electronic solutions for large and small switching systems alike. The microprocessor era had arrived. Reduced cost of the common-control overheads, in conjunction with rapidly improving integrated circuit techniques, enabled greater sophistication to be achieved.

The BPO's standard range of electromechanical PABXs, the range of common-control proprietary systems, and the newly emerging range of rental electronic PABXs are now described. Reference is also made to the unfolding inter-PBX signalling scene.

Standard Electromechanical PABXs

In 1957 there were 3 standard PABXs (designated *PABX Nos. 1, 2 and 3*), and they are still in current use. The first 2 are of unit-type construction with capacities of 10 exchange lines and 49 extensions; they differ in design mainly in the type of manual switchboard used. The PABX 1[25] uses a cordless board, and the PABX 2[26] uses a cord board with the option of an additional 30 manual extensions. The cordless board for the PABX 1 was modernized in 1966 to bring it into line with the then new range of cordless PMBXs. The PABX 3[27] is a large step-by-step open-rack exchange with a cord manual-board which limits the extension capacity normally to 1200, but which can be extended by using specially designed positions.

About 1958, the demand for facilities more sophisticated than those offered by the PABX 3 led to the introduction of large cordless PABXs[28]. Initially, these were equipments designed by the PABX manufacturers for the export market, but a standard version, the PABX 4[29], became available in 1965; the PABX 4 is shown in Fig. 11(*a*).

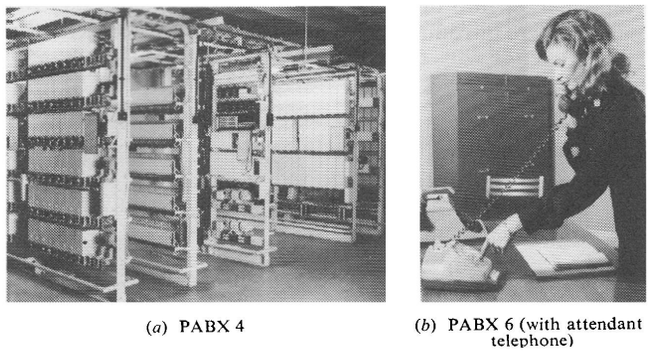
The first small unattended PABX (PABX 5) was introduced in 1963 and this was followed in 1966 by the PABX 6[30]. Both of these PABXs have capacities of 5 exchange lines and 20 extensions; they differ mainly in the design of the equipment cabinet. Incoming exchange calls are answered by designated extensions and connected as required by using a transfer facility. The PABX 6 is shown in Fig. 11(*b*).

The last electromechanical PABX in the standard range is the PABX 7, which was introduced in 1969; it is similar in operation to the PABX 1, has a capacity of 20 exchange lines and 100 extensions and uses a cordless manual board. Its introduction marked an upwards change from 50 to 100 extensions in the demarcation size between the BPO rental range and the privately-supplied proprietary PABX.

Proprietary Common-Control PABXs

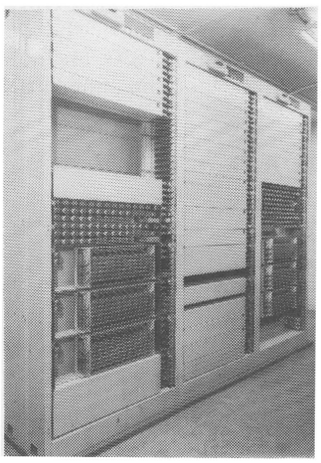
Around 1970, two new suppliers entered the proprietary PABX field with alternative electromechanical systems: Swedish Ericsson, who supplied the L. M. Ericsson Crossbar (ARD 561), and Pye Business Communications who supplied the Philips common-control rotary (UH 200/900) (see Figs. 12(*a*) and (*c*)). These proprietary offerings were quickly followed by a range of PABXs from Plessey based on the 5005 crossbar switch, and Pentomat PABXs from STC based on the Pentaconta Switch from ITT (see Figs. 12(*b*) and (*d*)). Mini-crossbar designs in the shape of the Ericsson *code switch* also arrived on the scene to improve space saving for the larger sized AKD 791 electromechanical PABX.

A third new supplier, IBM, appeared on the scene in 1970 offering a computer-based solid-state switching electronic

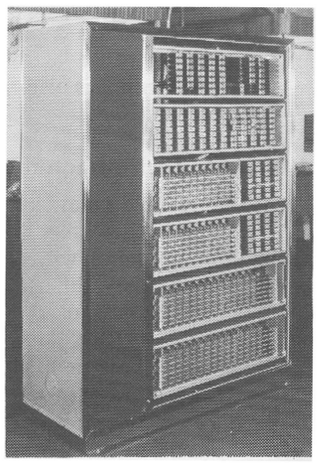


(*a*) PABX 4 (*b*) PABX 6 (with attendant telephone)

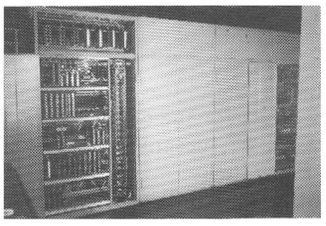
FIG. 11—Strowger-type PABXs



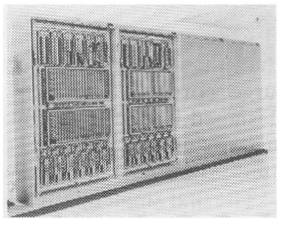
(*a*) ARD 561 (LME)



(*b*) PB 480 (Plessey)



(*c*) UH 200 (Phillips)



(*d*) P 200 (ITT)

FIG. 12—Common-control electromechanical PABXs introduced in the early 1970s

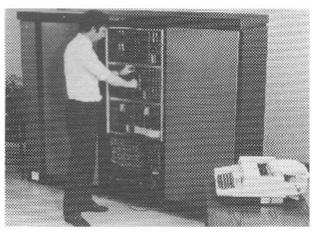
PABX 2750. This PABX, see Fig. 13(*a*), offered the market place the first stored-program-control (SPC) PABX—it was highly featured, and its capability could be modified or updated by software programming. The sophistication of the PABX 2750 posed radically new areas of experience for the field maintenance staff to cover. Operational experience with the PABX 2750 led to a uniquely packaged variant, the PABX 27SS, being produced to test the possibilities of dual maintenance; that is, IBM engineers serving the central processor control and BPO staff servicing the remainder of the PABX equipment.

The PABX 27SS was superseded in 1973 by the PABX 3750; this system more clearly addressed the problems of dual maintenance and was compliant with the evolving BPO requirements for SPC PABXs. The first PABX 3750s were jointly maintained in the same way as the PABX 27SS, but in 1976 the BPO took over first-line maintenance of the complete PABX.

By the mid-1970s, 2 other electronic PABXs had appeared on the scene: the REX80 from GEC, and the EPB2000 from Plessey. Both of these electronic PABXs employ reed-relay crosspoint switches in a similar fashion to the TXE2 public exchange.

Electronic technology was also being grafted into the other suppliers' PABXs: Ericsson introduced a programmable electronic marker into their AKD code-switch systems, and MF registers were introduced into many of the electromechanical

(*a*) IBM 2750
(first UK SPC PABX)



(*b*) Plessey PDX
(first UK digital PABX)

FIG. 13—Proprietary electronic SPC PABXs

TABLE 4

Large PABXs

Manufacturer	System	Extension Capacity	Switching Technology
	Electromechanical Systems		
UK Industry Standard	PABX 3	1500	Strowger
UK Industry Standard	PABX 4	1500	Strowger
Thorn Ericsson	ARD 561 2	270 540	Crossbar
Thorn Ericsson	AKD 791 2 3	9000	Code switch
ITT	P200	200	Crossbar (Pentaconta)
ITT	P1000 CT	1000	Crossbar
ITT	P1000 T2	9000	Crossbar
Pye/TMC	UH 200/900	200/800	Common-control rotary
Plessey	PB 480	480	Crossbar (5005)
Plessey	PB 1000/8000	1000/8000	Crossbar
	Electronic Systems		
ITT	4080	2400 plus	SPC solid-state space
GEC	REX80	600	Common-control reed switch
GEC	SL1 LE	1000 plus	SPC digital
IBM	3750/1750	2516/760	SPC solid-state space
Plessey	EPB2000	2000	Common-control reed switch
Plessey	PDX800	800	SPC digital
Pye/TMC	EBX8000	8000	SPC reed switch

systems to permit press-button MF4 working.

Towards the end of the 1970s more electronic PABXs were introduced: the Plessey PDX (see Fig. 13(*b*)) and the GEC SL1 digital switching systems; Philips introduced a large SPC space system (the EBX8000[31]) that uses reed-relays in the speech path; IBM offered the PABX 1750, a SPC space-switched PABX similar to the PABX 3750, but with different central control and catering for a smaller number of extensions.

In the late-1970s, STC also introduced an electronic SPC PABX, the Unimat 4080: this PABX uses distributed microprocessor control of a semiconductor space switch.

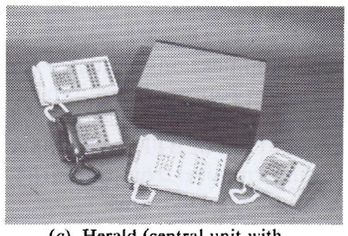
By 1981, all the approved UK suppliers were offering SPC electronic PABXs in the above-100 extension size range, thus offering the UK business customer a considerable choice of supplier and system.

The main large PABX systems that have been approved for connexion to the network over the last 25 years are listed in Table 4. This list is not exhaustive; there were also a number of special-purpose PABXs and experimental prototypes installed in the period. Some of the PABXs have been superseded, but all of the PABX types listed are currently connected to the UK public switched telephone network (PSTN).

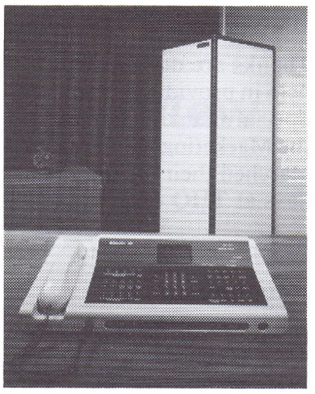
Rental-Range Electronic PABXs

In 1976 the BPO decided to initiate development of a modern range of electronic PABXs† to complement and eventually supersede the standard Strowger series. The complete size range of 6–100 extensions could not be covered economically by one system design, and so 2 development projects were started: one catering for the lower end of the range now covered by the PABX Nos. 5 and 6 and the HES series; the second to displace the larger-size PABX Nos. 1 and 7. The 2 resulting systems, known as *Herald* and *Monarch 120* respectively, have been in quantity production since 1980 and formal marketing on a national basis commenced in 1981. A third system, the *Regent*, was also introduced in 1981 to increase customer choice of product and features. These SPC call-connect systems are shown in Fig. 14.

† For marketing purposes, the term *call connect system* is now being used by British Telecom for this class of switching equipment.



(*a*) Herald (central unit with multibutton telephone)—1980



(*b*) Monarch 120 (central unit and operator's console)—1980

(*c*) Regent (central unit and operator's console)—1981

FIG. 14—SPC call-connect systems

Herald

The Herald electronic PABX system was developed for British Telecom by TMC; the system is a flexible multi-mode system that can be configured to function as a key system, a PABX system, or as a hybrid. The system was designed primarily to serve up to 50 extensions, although its flexibility allows larger sizes (70 to 80 extensions) to be served.

The central control is microprocessor based, and linked into custom LSI interfacing logic; custom LSI is also used for the analogue transmission crosspoint arrays. The central switching unit is modular and, depending on size, can be assembled from one, 2 or 3 shelves.

Ordinary 2-wire telephones may be associated for the PABX mode and 4-wire Herald featurephones for the key-system mode. The Herald featurephone also gives users single-button operation for a variety of system features, such as abbreviated dialling, diversion, conference, and named extensions.

Monarch 120

The Monarch system was derived from the Customer Switching System No. 1 (CDSS1), which was produced jointly by the BPO's Telecommunications Headquarters (THQ) Development and Research Departments in 1976; the design was engineered subsequently by GEC and Plessey Telecommunications. The Monarch system is a digital system that uses PCM coding and SPC.

The basic system[32] is targetted to provide a 120 extension capacity, but its digital trunking is inherently capable of dealing with larger system sizes. A fundamental design feature is the provision of the analogue-to-digital coding and decoding (CODEC) function at the extension line port, a feature which anticipates future interfacing with digital terminals and digital line plant.

The system is microprocessor controlled and backed by a substantial memory capability that permits an extensive range of PABX facilities previously associated only with much larger PABXs.

A separate microprocessor is also dedicated to the operator's console unit[33], which is provided with touch-sensitive keys and a dot matrix electroluminescent display.

After trials within the BPO, the first CDSS1, since named *Monarch*, was demonstrated at the Geneva Telecom Exhibition in September 1979, where it provided PABX facilities for the British stand.

Regent

The Regent electronic system was developed by the MITEL Corporation of Canada, where it is known as the *SX200*. An evaluation of the system and the changes needed to ensure compatibility of operation was carried out by Eastern Region staff on behalf of British Telecom Headquarters (BTHQ) and the resultant version, now titled *Regent*, is scheduled to be marketed in the UK during the second half of 1981.

The system uses space-division switching by means of solid-state crosspoints. The Regent system uses microprocessor SPC and provides a wide range of customer facilities. The capacity of the system is 120 extensions at typical UK business traffic-calling rates, but its extension capacity can be increased for low-traffic situations.

Inter-PBX Circuit Signalling

The increase in the number of PBXs in service since 1956 has naturally led to an increased community of interest between PBXs by means of private circuits. The periodic commercial take-overs and formation of conglomerates has also led to the establishment of significant private networks in the period.

In the early days of telephony, inter-PBX signalling (manual AC) closely followed the magneto method used for signalling between telephone and exchange. This was later complemented by manual DC signalling to avoid the use of ringing current on trunk circuits. It soon became apparent that automatic signalling had advantages over the manual method and, as DC line plant and PBXs evolved, contemporaneous automatic systems were developed.

Because DC signalling could not be used on frequency-division multiplex (FDM) line plant, an inband voice frequency (VF) 1VF signalling system, SSAC13, was introduced in 1965 for long-distance automatic dialling.

The 1960s and early-1970s saw a plethora of signalling systems in existence, each PBX needing its own signalling equipment version to match a particular signalling system. In 1973, a rationalization plan was produced by the BPO which stipulated that, for new work,

(*a*) DC signalling between PMBXs would be automatic balanced battery,

(*b*) DC signalling between PABXs, and between PABX and PMBX would be single commutated DC (SCDC), and

(*c*) AC signalling would be SSAC13.

In 1975, *E and M* signalling was introduced to exploit the outband signalling of groups of 12 speech circuits derived from 48 kHz wideband private circuits.

The increasing penetration of register-controlled PABXs in the mid-1970s created the need for an inter-register signalling system to exploit fast call set-up. This was achieved with the SSMF 5, a system which is similar to SSMF 2 used on the public network, but which has signal meanings appropriate to private network operation.

Another 1VF signalling system, the SSAC15, was introduced in the late-1970s, to supersede the SSAC13. The SSAC15 system uses the tone-on-idle signalling format, which is common in North America. The introduction of this system coincided with the creation of a "preferred signalling scheme" to provide a better match between PBX and line plant. The preferred line-signalling systems are

(*a*) SSDC10 (SCDC) for DC circuits,

(*b*) SSDC5 (E & M) for wideband private groups, and

(*c*) SSAC15 (1 VF) for use where a DC path is indeterminate.

Each of the above line supervisory signalling systems can support the SSMF5 inter-register system in addition to 10 pulses/s signalling.

All the present-day signalling systems have been devised for analogue-system operation, but they can be used on PCM transmission and switching systems and are expected to play

their part well into the digital era.

CONCLUDING REMARKS

This historical survey of the past 25 years shows that the repertoire of customer apparatus has steadily been extended. For the most part, progress, spurred on by technology, has been evolutionary rather than revolutionary. Some new concepts, however, were starting to be exploited towards the end of the period, one of the most significant being SPC. Initially applied to large processor-controlled switching systems, the SPC concept has blossomed with the appearance of the microprocessor, and has permitted mass produced hardware to be individualized to meet specific customer requirements.

Reference has been made to the intelligent terminal for which our transatlantic colleagues already have a name, the *Smartphone*. The Xpress telephone with its 10-address repertory memory and repeat-last-number feature is perhaps the first UK Smartphone. The emerging family of microprocessor-controlled payphones might also be considered in this category. At present, a microprocessor-controlled telephone, known as *Microtel*, designed by the British Telecom Research Laboratories, is being developed to a production stage, and no doubt such instruments will appear increasingly during the 1980s. Predictably, the future Smartphone with the association of voice-response and voice-interpretation modules can, with the correct schooling of a high density memory, lead to a very smart terminal indeed—effectively becoming a robot terminal.

The press-button terminal can be expected to play an increasing role in the cashless society, permitting the transfer of credit and verification numbers to a computer terminal with voice response.

In the payphone area, a debit-card payphone trial is now being conducted. The system under trial is based on a card with holographic coding that represents a quantity of meter units that are erased or debited from the card as the payphone call proceeds. Customer reactions are being sought during the trial, but it remains to be seen whether the cashless payphone of the future will ultimately be based on debit or credit methods.

Faster installation methods using both insulation displacement quick-connect wiring and plug-and-socket techniques have been adopted for the new range of PBX call-connect systems. The introduction of high-impedance ringers into the new range of Ambassador telephones, enabling the parallel connexion of plan instruments, has also allowed a simple plug-and-socket scheme to be introduced. The course has thus been set in 1981 to move generally towards plug-and-socket connected customer apparatus, thus permitting the apparatus to be marketed and installed in a way analogous to, say, an electric toaster or a television set.

Digital switching is another concept made feasible by micro-electronics, and has been pioneered in such PABXs as PDX, SL1 and Monarch. The next steps awaited are the digital linking of the digital PABX, both to the PSTN and to the extension telephones: implementation depends on economic issues only, for the feasibility has been established. When digital telephones are available, the communication path will have been laid for the merging of data and telephony terminals. Motivation for such merging already exists, as demonstrated by the trend towards the automated business office, local-area networks, electronic mail and the multiple-network access planned for System X.

The events of the immediate past suggest that, in 1981, only the tip of the technological iceberg is visible, and further stimulus will surely come. The UK Government's deregulatory measures in 1981 concerning customer apparatus can also be expected to stimulate change, hopefully to serve the best interests of customers and not to hinder progress. The author covering this subject in the prospective centenary issue of the *Journal* in the year 2006 can be expected to have some exciting changes to write about.

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