'Hello Who's Calling?'

Bell's first telephone

by J.K. Hearfield Part 2

Central Battery Signalling

The earliest telephones were signalled by means of a 'magneto', or hand-cranked generator. Before making a call, the subscriber had to wind the magneto handle energetically several times in order to alert the switchboard operator, who then connected herself to the caller to find out what he wanted. This must have been rather a nuisance, but of course the subscriber had to do it or the call could never be placed. Once the call was finished, the subscriber was supposed to wind the handle again to let the operator know that she could clear the circuit. This procedure was known as 'ringing off', a phrase which survives long after its original meaning has disappeared. If the subscriber forgot, or didn't bother, there wasn't much the telephone company could do about it, and it must have been commonplace for circuits to be tied up long after calls had ended.

An obvious way to improve efficiency was to build into the switchboard some simple means of detecting when a caller finished speaking and hung up, and use this signal to alert the operator instead of relying on the caller to do it. Looking back from the vantage point of ninety years' steady improvement in technology, it seems perverse that the designers of the day chose to solve the problem in the way they did, but it should be remembered that relays were not always the cheap and reliable components they are today.

The solution chosen was to add what was effectively a third wire to the subscriber pair. Using the earth itself as one of the conductors had already been tried and found to be a bad idea, but using the earth as a third conducting path just for signalling was perfectly feasible, and continued to work well in one guise or another in the UK until at least the 1970s.

The magneto was itself not a low-cost item, and once it was no longer needed for 'ringing off', the way was open to remove it from telephones altogether, provided some equally straightforward way could be found for subscribers to initiate their calls. This proved remarkably easy. A telephone needs dc in order to work, and the earpiece is hung tidily on a hook when the telephone is not actually in use. So if the hook can be attached to a switch so that the circuit is broken when the telephone is 'on-hook' (another phrase from the distant past which inexplicably remains in common use, especially amongst telecommunications engineers) all the switchboard need do is monitor whether or not a dc path exists through the telephone. The current involved is quite small, because the power to energise the telephone's microphone is still drawn from the local battery, so the central battery need not be prohibitively large and expensive. This system was known as Central (or Common) Battery Signalling, or CBS. The logical next step of replacing thousands of small local batteries with one Central Battery (CB) was still however some way off, and will be discussed in the next article.

The Candlestick Telephone

Voltage detection at the exchange meant that the associated telephones could be smaller and 'portable' (within the limits of their cords). The classic candlestick telephone, typically as shown in Photo 1, exploited this freedom with a radically different shape. The transmitters in the first candlesticks were held in a rigid metal case, and users had the choice of either crouching over the instrument or picking it up (being careful to hold it vertical) in order to talk into the microphone. The user guide, which was engraved around the transmitter casing,

Photo 1. CBS table telephone.

Photo 2. Candlestick telephone, circa 1927.

often included a stern instruction to 'speak closely'. Later versions housed the transmitter in bakelite, an early brittle plastic, designed so that it could be swivelled to face the speaker. The weight of the earpiece operated the hookswitch, and the earpiece shape reflected that of the transmitter stand. The result was a functional and beautiful design which lasted for over fifty years.

The bellset was separate, and could be placed at the subscriber's (or his butler's) most convenient location. As well as housing the bell, it was a convenient termination point for cables from the outside world, the local battery, and of course the telephone itself. These bellsets, usually mounted high on a wall, survived for many years in houses where the telephone itself was modernised, and I was delighted to discover a beautiful example disguised by several layers of paint when I recently moved house.

The candlestick outlived the CBS system in the end, possibly because no-one could find a good reason for scrapping such a manifestly successful design. Candlesticks with dials became commonplace, see Photo 2, and if they were not as elegant as those without, they made up for it by providing a more efficient service.

CBS Telephone Systems

CBS telephones did not have dials, since all calls were still routed through the local manual exchange operator. The early CBS systems were intended for rural exchanges, and this restricted facility was all that was available for many years to some subscribers. And like the colour choice of the early Ford cars, Post Office subscribers could have any colour as long as it was black, though subscribers to the National Telephone Company could choose a nickel plated version.

The normal equipment consisted of a Telephone No.4 and a Bell Set No.5, and the standard CBS No.1 telephone installation is illustrated in Figure 1. The circuit of the telephone itself is shown in Figure 2 as it would have appeared at the time and redrawn with modern symbols. It differed from earlier telephones chiefly in its use of a lower impedance bell, connected not across the A and B wires but from the A wire to earth.

An earth connection on the A wire meant 'clear', because the earth could only be there when the telephone was on-hook. To make a call, the subscriber lifted the receiver earpiece from the hookswitch and the subsequent loop current was sensed at the exchange. In-coming calls were signalled when the exchange applied a large alternating voltage between the A wire and earth, causing the bell to ring. When the subscriber lifted the earpiece, the hookswitch was released, the ringing current path was broken, and the circuit back to the exchange was completed via the A and B wires.

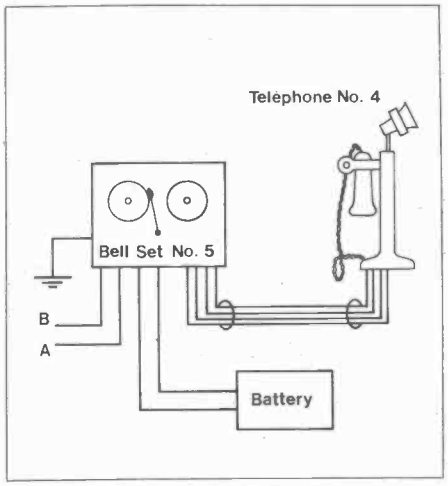

Figure 1. A standard CBS No.1 telephone installation.

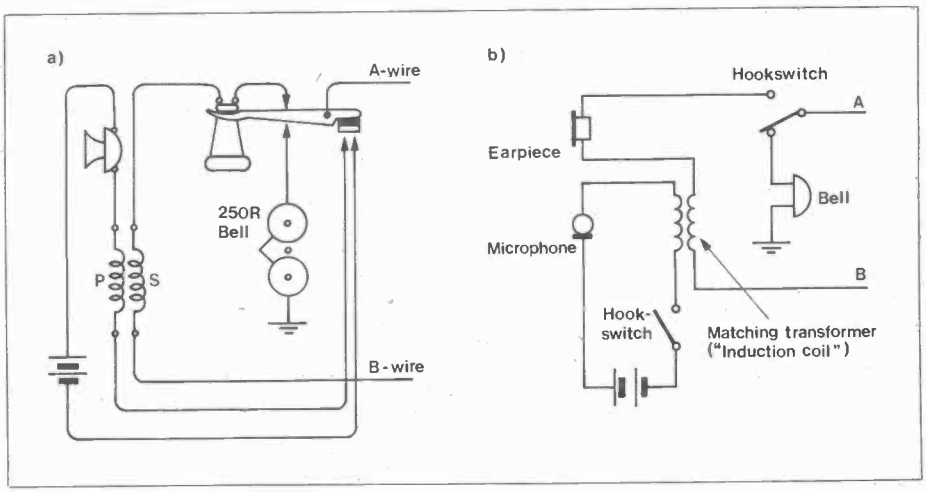

Figure 2. Principle of the CBS No.1 telephone, shown in both contemporary and modern styles.

There were disadvantages to this system. The bell would never ring if the A and B wires were acccidentally reversed anywhere along the route from the exchange to the subscriber's premises (a mistake it was all too easy to make). More importantly, the reliability of the system was governed to an uncomfortable degree by the quality of the earth resistance at the subscriber's premises. Telephone engineers had to explain to disbelieving subscribers that it was vital to water their earth connections in dry weather!

Photo 3 shows another early CB telephone. This elegant instrument not only incorporated its own bell, making a separate bellset unnecessary, but also provided an additional earpiece (for people with two ears, perhaps). The hookswitch design was less impressive, relying as it did on a long leaf-spring inside the handset cradle base which in practice was temperamental and difficult to keep in adjustment.

The simplicity and low cost of the CBS No.1 system ensured its survival for almost half a century, long after fully automatic CB systems had come to be taken for granted by most telephone users. Its disadvantages centred mainly around its use of an earth return path for signalling, and the CBS No.2 system attempted to get round these by introducing a blocking capacitor to separate the ac ringing path from the dc speech path. Figure 3 illustrates the essential difference between the two systems. In CBS No.2, ringing current flows through the 2μF capacitor and the bell, whilst dc current flows through the speech circuit. It was necessary to increase the resistance of the bell, which is effectively in parallel with the speech network, but this was easily done by wiring the 500Ω bell coils in series rather than in parallel. Capacitors cost much less by 1940 than they had done in 1900, so the economic effect of the change was not excessive, and CBS No.2 had the great merit of still not requiring a large and costly central battery.

Pay-Phones

Pay-phones for public use were available from an early date. In the 1880s

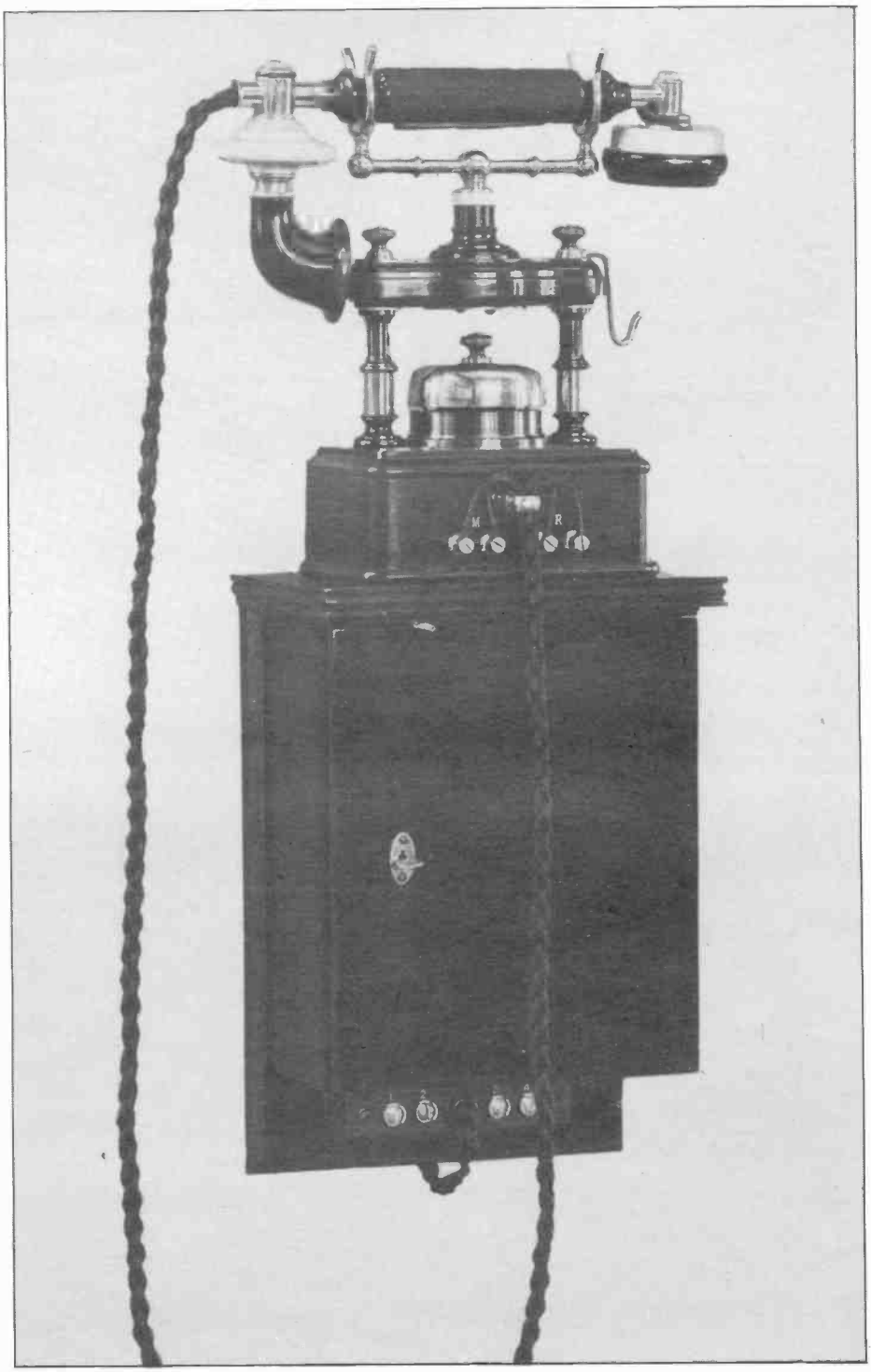

Photo 3. CBS telephone No.26.

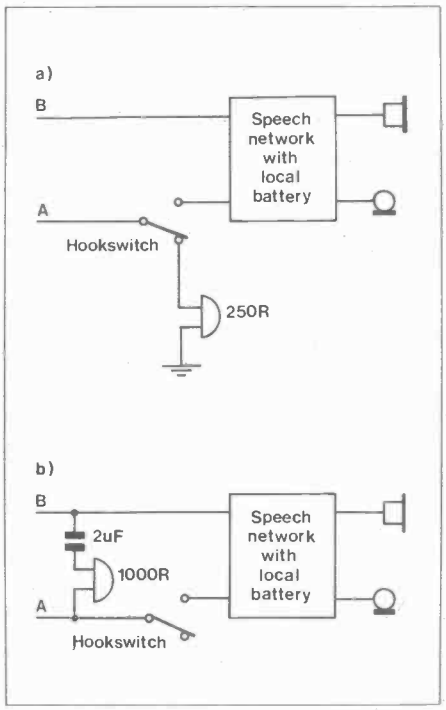

Figure 3. CBS No.2 replaced CBS No.1 about 40 years ago.

there were about twelve thousand private telephones in use, mainly by businesses, and in 1884 the Postmaster General authorised the telephone companies to create public call offices. The early pay-phones were installed in shops, post offices and railway stations, but telephone kiosks arrived in the streets as early as 1900. Some had coin-slots in the door, others had an attendant to collect the money, but whichever method was used it was possible for anyone with 2d to make a telephone call. Such permanent additions to the street also changed its appearance, sometimes to the dismay of the local council. After a number of unsuitable, grotesque or just plain ugly call-boxes had been installed by the various telephone companies, a design competition resulted in Sir Giles Gilbert Scott's classic red telephone box being introduced in 1927.

Style and Applications

Although most people will be familiar with the old types of domestic telephone many different designs were produced for different applications. House telephones and office intercoms used internal wiring to call instruments in another part of the building and were therefore cheaper to use than telephones connected to the public exchange. Railway companies used special telephones which needed little maintainance and could work cheaply over long distances. For many years the railways' private network was as large and complex as the public network. Gasworks and mines used special spark-proof telephones.

With greater use of the telephone, style and fashion became more important. As well as the nickel-plated instrument already mentioned, other inducements were used to persuade the subscriber. One Post Office telephone, similar in style to the Type 26, used

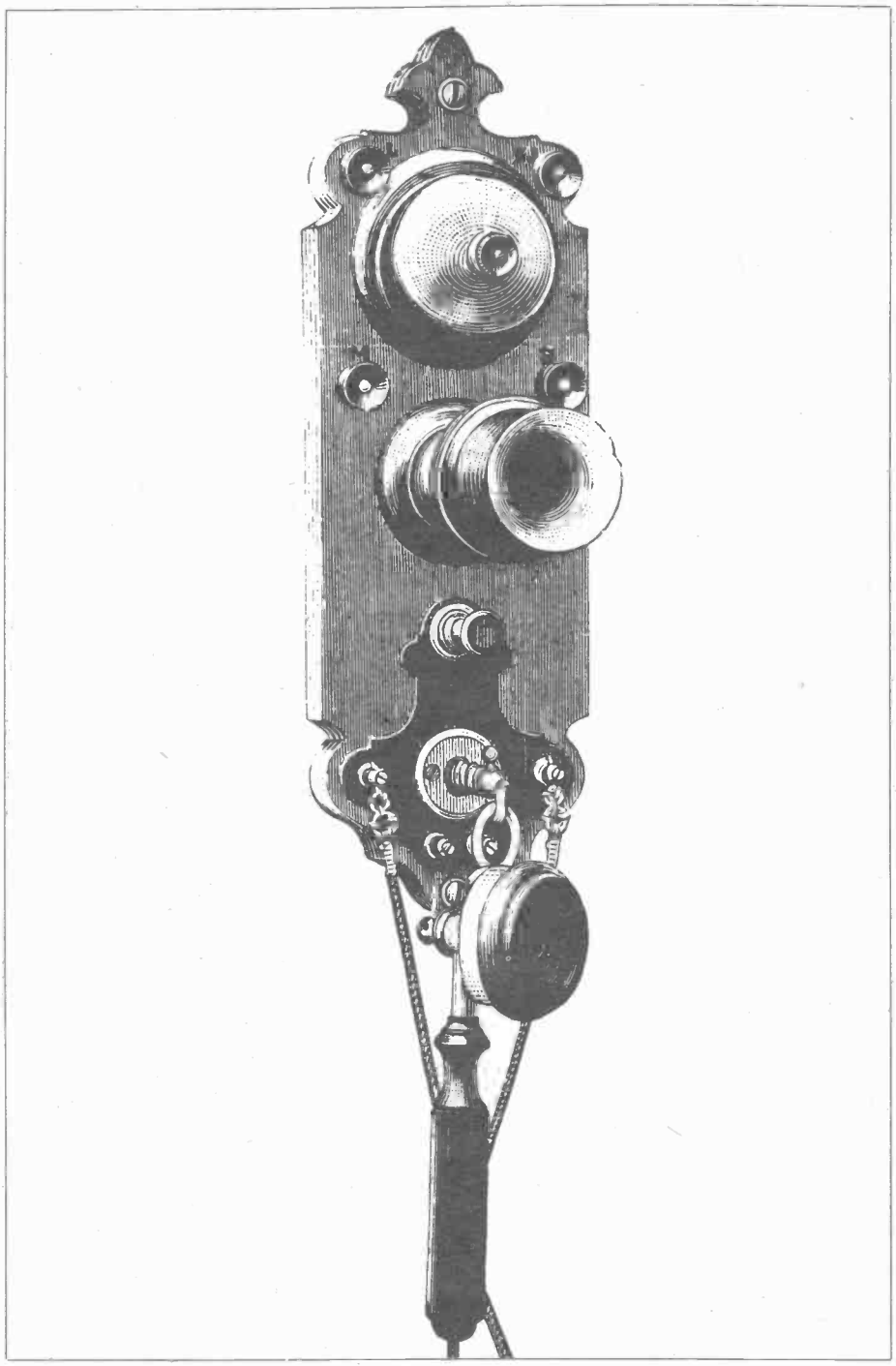

Photo 4. Combined servants call bell and telephone.

stained and varnished wood where possible and printed a woodgrain pattern on the remainder of the metal case. Another early telephone used small cow-gongs instead of bells to summon the subscriber. Some prosaic black telephones were made more up-market by the use of gold filigree transfers. If a household had to have one of these new-fangled instruments, then some effort was made to allow it to be as discreet, or as brash, as the subscriber wanted. In large houses where bellpushes were used to call the staff – see Photo 4 – it was sometimes possible to use the existing wiring to convert the system. 'Ringing for the cook' meant that it was possible to talk to the cook in her kitchen, instead of discussing menus in person, and the subscriber could call for the car without the need for the chauffeur to walk half a mile from the garage to the study.

Ownership of a telephone was however still rare. The industrialisation which followed the first World War created a much greater demand, which was satisfied by the more reliable mass-produced telephones to be discussed in the next article.

Acknowledgement: All telephone illustrations are reproduced by courtesy of the archivist at The Telecom Technology Showcase.

Further reading: Old Telephones by Andrew Emmerson, published by Shire Publications Ltd., Cromwell House, Church Street, Princes Risborough, Aylesbury, Bucks HP17 9AJ. Cover prize £1.25.