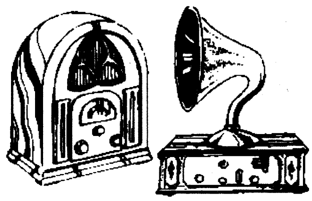
Vintage Radio



by PETER LANKSHEAR

Ancestral Electronics — 1

1995 was a significant year in the history of electronics, as it was the centennial of the young Marconi's taking the generation and detection of Hertzian waves out of the laboratory to experiment in their practical use. But so far, there has been remarkably little commemoration of his achievements, from which grew one of the greatest engineering sciences. Here's a look at the existing technology that Marconi was able to build upon.

This coming year continues the Marconi anniversary, as it was during 1896 that he made his first application for a patent, and gave public demonstrations in Britain of transmission and reception of wireless telegraph signals.

I suspect that one reason for the lack of fanfare is that no exact date can be put on the occasion when Marconi was actually fired up with the idea of using electromagnetic radiation for communication. Nor on his experiments which made the transition from repeating the investigations of scientists such as Hertz and Lodge, to the realisation of a practical system of wireless telegraphy.

Marconi is generally credited as being the first to create a working system that evolved into a commercial operation, building on the findings of previous research. As Oliver Lodge is reported to have remarked, "We all knew about the egg; but Marconi showed us how to stand it on its end".

We know too that initially Tesla in America, and Popov in Russia were probably ahead of Marconi with their development work, but did not have the same business acumen or backing. Marconi had a head start by having the foresight to be born into an affluent family, with very influential connections in both Italy and Britain. In 19th-century society this provided invaluable advantages in achieving recognition.

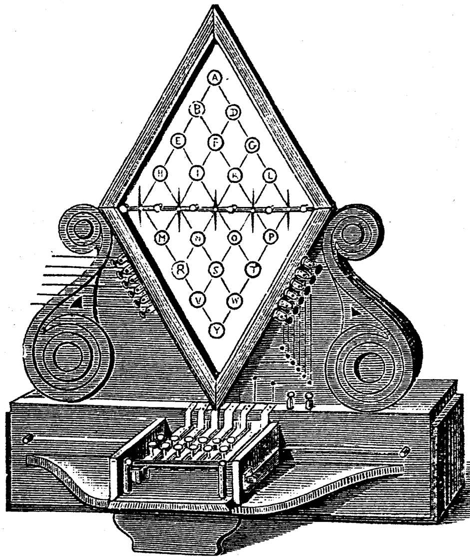


Fig.1: The first electric telegraph in commercial operation was the five needle Cooke and Wheatstone, of 1837. Any one letter of 20 could be selected by the deflection of two needles, controlled by the keys at the base of the instrument. Note the six line wires at the left of the face.

Electronics engineering is sometimes thought of as having its birth in the wireless telegraph, but in reality its roots go back more than half a century previously to the invention of the electric telegraph — which by the middle of the 19th century was already well established world wide, with an advanced technology, and together with the railway had an enormous economic and social impact. In America especially, the study and collection of telegraph instruments is regarded as an important aspect of vintage electronics, all the more significant as the telegraph is now virtually extinct.

Although the value of Marconi's achievements should not be underestimated in any way, it is important to realise that he worked with an existing technology. In fact, his early equipment was essentially that of a basic electric telegraph, along with simple equipment to generate and respond to radio frequency radiations. His main object was to provide a wireless connection between conventional telegraph instruments. Had he first needed to have developed the telegraph instruments as well, his work would have been considerably more difficult.

Earlier origins

The origins of the electric telegraph go back a long way. In 1753, a correspondent in *The Scots Magazine* suggested electrifying wires to attract pieces of paper with letters or words printed on them or to ring bells. This was obviously not a practical system, but an indication of the early realisation that the ability of electricity to travel instantaneously through a long conductor could be used to convey intelligence.

In 1809 in Germany, Samuel Sommering demonstrated over a distance of 600 metres a telegraph which had an electrolyte filled glass vial for each letter of the alphabet. Bubbles of gas indicated the required letters. The system might have worked, but with a wire for each character, constructing connecting cables of any length would have provided a daunting obstacle. The signalling speed would also have been very slow.

Andre Ampere, whose name is immortalised in the unit of current, in

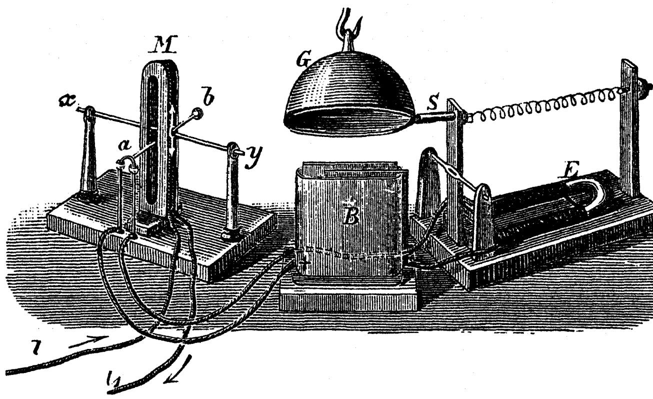


Fig.2: To obtain sufficient current to operate the needle telegraph alarm bell, Wheatstone invented the first relay. A galvanometer coil M surrounded a magnetised needle carrying a pair of contacts a. When the needle was deflected, the contacts touched the surface of some mercury in the two little cups, completing the circuit of the battery B and the electro magnet E. This activated the bell striker S.

1820 came up with a much more workable method by suggesting the use of galvanometers.

A galvanometer is essentially a compass needle deflected by currents flowing in a surrounding coil of wire, and is the ancestor of moving iron and moving coil meters. Ampere proposed using one instrument for each character, but again the logistics of constructing such a system ruled it out.

In one of those coincidences of the type that has happened several times in the history of electronics, in 1837 no fewer than three independent inventors announced workable systems. Carl Von Steinheil in Germany demonstrated a single galvanometer system which relied on a code using combinations of left and right deflections of the needle.

It is unclear as to what extent, if ever, that Steinheil's system was used, but he did make the invaluable discovery that the earth can be used as a conductor of virtually zero resistance. This useful property halved the amount of wire and battery power that would otherwise have been required for telegraph circuits.

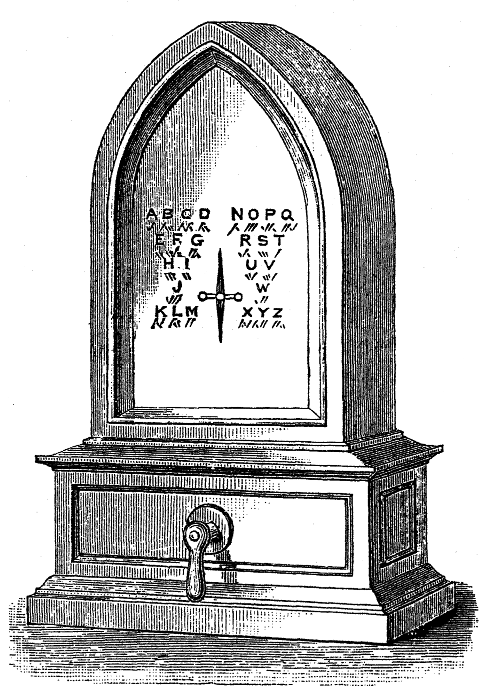


Fig.3: Cooke and Wheatstone's telegraph was ultimately simplified to a single needle, controlled by the handle in the base. It was often used with a form of the Morse code, with left deflections equalling dots and right deflections dashes.

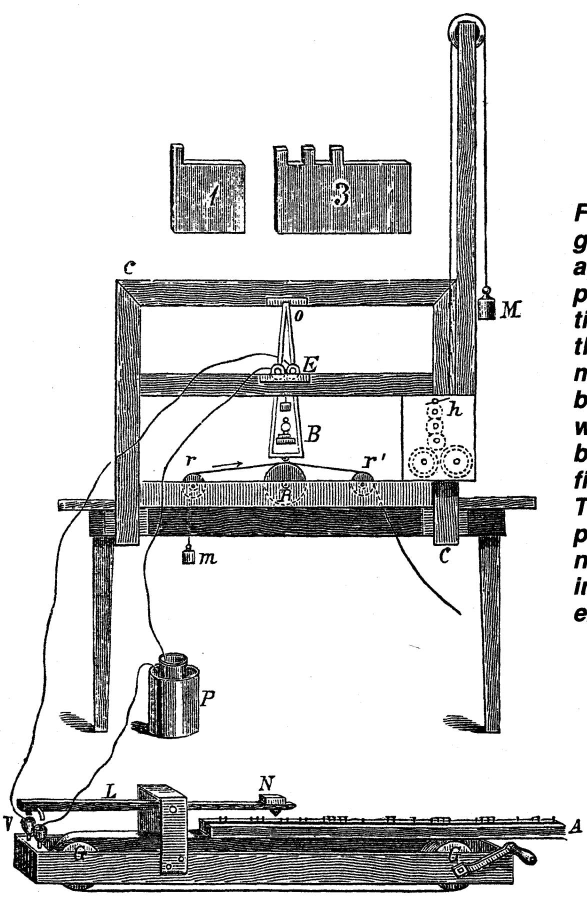


Fig.4:The first Morse telegraph. Although it bore no apparent resemblance, it possessed all the essentials of the practical system that remained in use for more than a century. At the bottom is the transmitter, in which level L was actuated by teeth on movable type fixed in the carrying strip A. There were nine different patterns, to provide the necessary number of teeth; in the drawing, 1 and 3 are examples.

In England Charles Wheatstone, (later knighted for his many engineering achievements) teamed up with William Cooke to construct the first successfully operational electric telegraph. Again, this was based on the galvanometer, and over the years it went through at least three developments. Wheatstone made several important contributions to the telegraph, and one of his greatest, the relay, came from his work with the needle telegraph. Another of major importance, the principle of which is still important today, was the introduction of the Christie Bridge, often called the Wheatstone Bridge.

Cooke and Wheatstone's first system of telegraphy used a row of four and then five needles. By deflecting two needles at a time, any one of 20 characters arranged in a diamond shaped grid could be selected. This system was installed over a distance of 2.5km between two London & Northwestern Railway stations and in 1840, the Great Western Railway installed a line 63km long. This

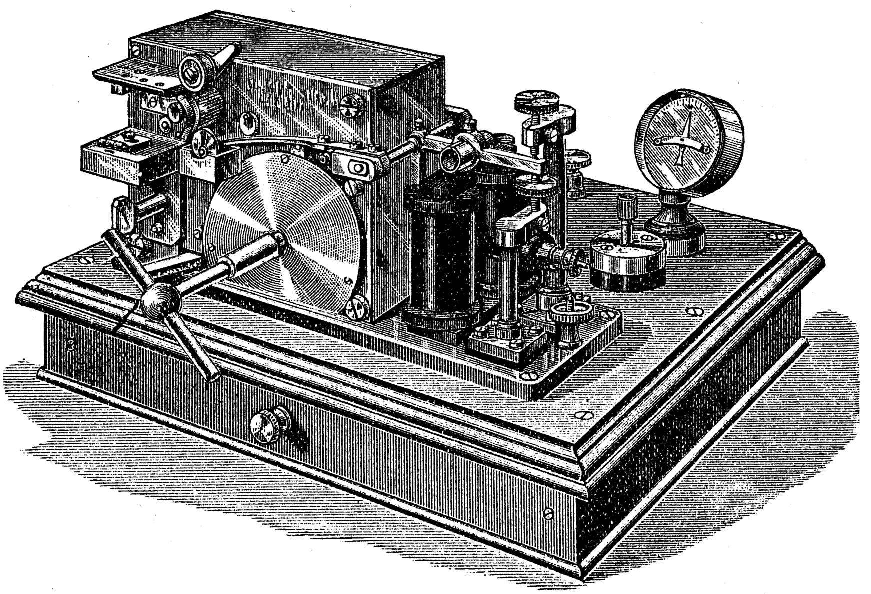
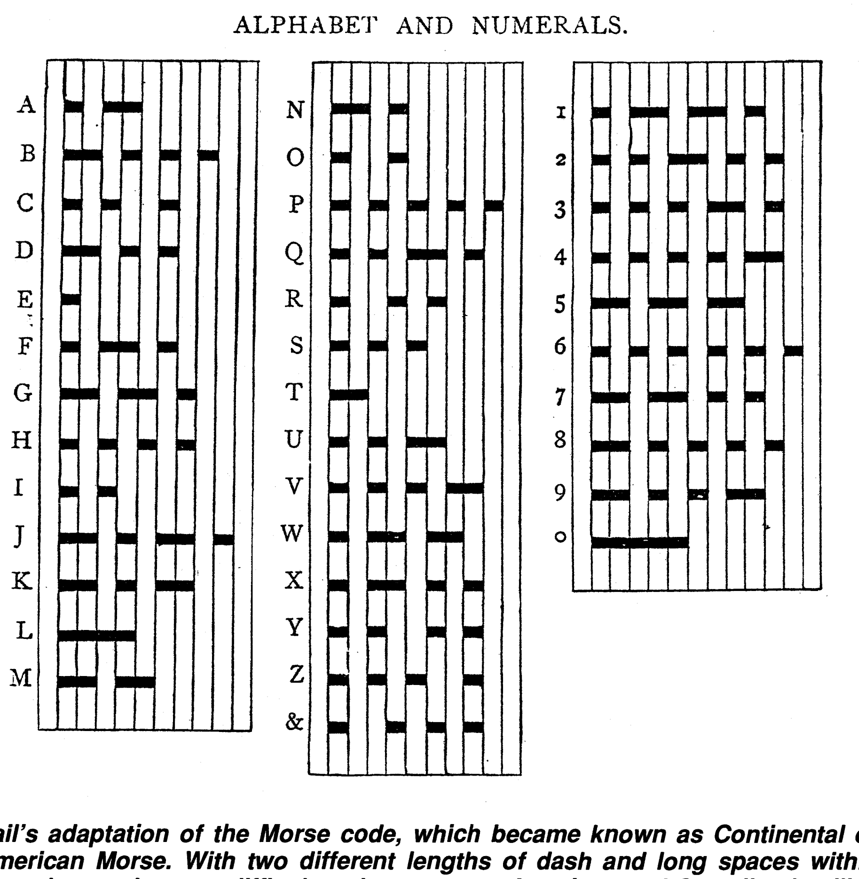


Fig.5: The Morse register, recorder or inker was developed directly by Alfred Vail, from Samuel Morse's picture frame receiver. Operators found that they could read the messages by listening to the sound of the armature hitting the limiting screws, and so the sounder was developed.



Vail's adaptation of the Morse code, which became known as Continental or American Morse. With two different lengths of dash and long spaces within some letters, it was a difficult code to master. American and Canadian landline operators refused to adopt the more familiar International Morse code, although it was used by their radio counterparts.

became quite a wonder, and the public was charged a shilling to watch it in operation.

This original Wheatstone and Cooke telegraph was successful, but it required five or six wires between stations, and needed two operators — one reading and the other writing down the messages. The restricted signalling speed also meant that it was soon superseded. Single-needle and double-needle adaptations were used quite extensively in England, and for communication between signal boxes, these instruments survived on some railway systems into the second half of this century.

Artist's obsession

The third system announced in 1837 was to revolutionise communications and dominate telegraphy well into the 20th century. This was of course the telegraph invented by portrait painter Samuel Morse, who although he knew little about electricity, was inspired to overcome enormous difficulties to do so. He received invaluable practical assistance from Alfred Vail, who has not always been given due credit, and the two eventually entered a partnership. Morse ran into problems in operating his receiver over long connecting wires, and enlisted the aid of Professor Henry, who explained the importance of sufficient ampere-turns on an electromagnet.

Previous systems had worked by some method of pointing to or indicating individual characters, but the genius of the Morse telegraph was that it used instead a binary code which could be used to represent an unlimited number of characters.

Initially, the Morse transmitter used nine different patterns of movable lead type, adapted from the printing industry. Instead of a typeface, each had a number of notches corresponding to the code pulses representing one of the numbers 0 to 9. For transmitting messages these 'types' were mounted on a bar, which was moved under a lever fitted with a set of contacts.

The prototype Morse receiver, which was built on a frame from a painter's canvas, consisted of an arm or pendulum actuated by an electromagnet. A pencil fastened to the end of the pendulum was in contact with a moving paper tape. Pulses from the transmitter caused lateral deflections of the pendulum, whose movements were registered on the tape as a serrated line from which the transmitted numbers could be read. These were then interpreted with the aid of a code book. For example, the sentence 'SUCCESSFUL ATTEMPTS WITH TELEGRAPH' was transmitted as 215, 36, 2 and 58.

Vail's Morse code

Alfred Vail now took over, and as a skilled and gifted technician, he refined the equipment to the stage where Congress could be persuaded to grant an appropriation for a line between Washington and Baltimore. The first message was sent on May 24, 1844 with the project hailed as a triumph.

For sending, Vail discarded the movable type and substituted the familiar manually operated key, while the ungainly receiver was transformed into the 'Register' which embossed or marked the paper tape by the vertical motion of a stylus or inked wheel. Of even greater significance was Vail's revision of the code, which now represented each character directly and did not need a code book.

There were seven elements in the new Morse code, with the basic unit of time the *dot*. The other elements were the short dash = two units; the long dash = four units; the space between elements of a letter = one unit; the letter space = two units; the word space = three units; and finally the sentence space was six units.

Readers familiar with the International Morse code will know that dashes are today three times the length of a dot, and may be puzzled by the reference to the long dash. The fact is that there were *two* Morse codes. Vail's original code, known generally as 'American Morse', was used exclusively on the extensive landline systems of the US and Canada. As can be seen from the table, it is more complex and demands greater skill than International Morse, and with some letters containing a double space, ambiguities were possible. For example, EE could be confused with O.

Within a few years, Morse himself campaigned for the adoption of a simpler code; but the operators refused to give up American Morse, which, according to some authorities, was faster than the International code. Eventually, the short dash was lengthened to three units, and, until teleprinters, computers and fax machines made the telegraph extinct, American Morse remained the standard code for North American landlines.

Elsewhere in the world, the International Morse code had become standard. This presented a problem as marine radio became established, requiring American radio operators, including amateurs, to use the International code. One outcome was that operators dealing with both line and radio telegraphy had to become 'bilingual'. It appears too that at one stage, the US Navy used yet another code.

Birth of the Sounder

The Morse register provided a permanent record on a paper tape, and for this reason was favoured by Marconi for his early equipment. But deciphering the marks on the paper was time consuming and operators soon learned to read the messages, as they were received, from the sound of the armature lever striking the limiting stops. A similar practice was developed by operators of the needle telegraphs, with the added advantage that a second person was not needed to transcribe the messages.

It was only a short step from this to the development of the most familiar of all telegraph instruments, the Morse sounder — but a fuller description of this will have to wait until next month. As well we will recount some of the story of Australia's own heroic enterprise, the Overland Telegraph, and look at some of the complex technology involved in Morse telegraphy.

As an example of this complexity, I will leave you with a question that could be a candidate for one of Peter Phillips' 'What?' puzzles: 100 years ago, how could four messages be sent simultaneously and independently over one wire, using DC technology only? Time sharing and diodes were not used. Look for the answer next month... ❖