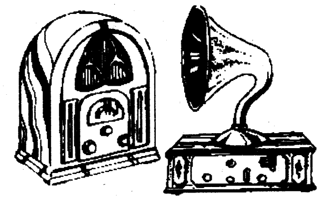
Vintage Radio



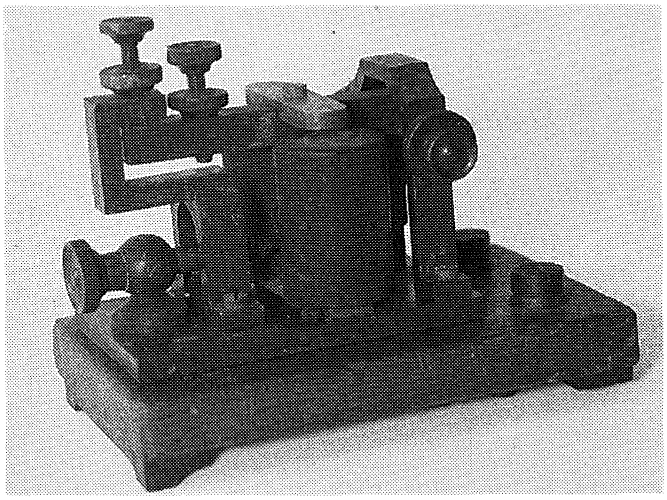
by PETER LANKSHEAR

Ancestral Electronics — 2

As we recalled last month, it is just 100 years since Guglielmo Marconi was able to demonstrate telegraphy without connecting wires. His rapid progress in developing his invention owed a lot to his building upon the existing and advanced technology of the electric telegraph. By then telegraphy had already been established for 50 years, and had suitable instruments readily available.

The world as we know it today would be impossible without rapid communication. Even had the telegraph not been in existence, I am certain that radio communication of some sort would have evolved before very long. One could speculate as to when and the form that it could have taken. Perhaps it would have been some form of telephone or maybe a facsimile system based on photography.

As to who, or when, we will never know. But one genius who had the necessary imagination was Nikola Tesla, an early specialist in alternating currents, and who in 1893 had demonstrated the transmission of RF energy. Tesla was to devote much of his life to researching a global network of wireless power transmission, and had the ability to visualise complete systems in considerable detail.



The Morse sound is a classic example of simple and functional industrial design that changed little over many years. This is a standard British Silvertown model.

There were four standard telegraph instruments that Marconi worked with in his original demonstrations. These were the Morse key, the relay, the register and the sounder.

As we saw last month, the register was a direct adaptation by Alfred Vail of Samuel Morse's original receiving instrument, and had the advantage of creating a permanent record on a paper tape — which, by the way, was the origin of the terms 'space' and 'mark'. However operators soon found that, rather than reading the code from the tape, they could translate it aurally in real time from the sound of the armature hitting its limiting stops. It was but a short step to eliminate the tape mechanism to make a compact and efficient classically simple little instrument, the Morse sounder.

An electromagnet attracted the armature mounted on the arm, whose range of movement was limited by the adjusting screws. On the downward stroke the screw in the arm struck the bridge, with a very audible click. When the current was broken the spring connected to its rear returned the arm, so that it made an equally loud sound hitting the top adjusting screw. The duration between the clicks denoted the dots and dashes.

Fundamental design of sounders did not change for more than a century. One popular model in the 1965 catalog of the major American manufacturer J.H. Bunnell was their '1892' Giant Sounder, basically an 1875 pattern!

Sounders commonly were wound to a resistance of around 20 ohms and required an operating current of 75 to 100 milliamps. To drive this order of current through a line more than a few kilometres in length would have required an inordinately high battery voltage. The solution to the problem was the relay, a device with many uses still. Relays enabled operation over lines several hundreds of kilometres in length to be achieved. Over greater distances the familiar open wire lines encountered problems from capacitance and inductance which slowed signalling speed, and leakage across insulators in damp weather could bypass a considerable proportion of the line current.

Telegraph relays were designed to be quick acting and were often fitted with make-before-break contacts. Polarised relays had a permanently magnetised or polarised core, to respond to current flow in one direction only.

The remaining instrument, the Morse key, is so familiar as not to need any description. There was an enormous range and variety made, and whereas most radio keys are single circuit, some telegraph keys had multiple contacts. There is a very active collecting fraternity, especially in America.

Century old diagrams

The two basic telegraph circuits are shown in Fig.1. By the way, some of the circuit symbols may seem a little strange, but these diagrams are reproduced from books printed more than a century ago. *EA* does not often print such out of date material!

Open circuit operation had the advantage of not using any current when inactive, and was best suited to Leclanche or dry batteries — whereas the closed circuit system was better for Daniel batteries, which deteriorated if left idle. An advantage of the closed circuit system was that the batteries, being in series, were flexible as to location, and if divided along the system, leakage was minimised as the line voltage to earth at any one point was reduced.

Telegraph lines are very expensive to build and maintain and as traffic increased, efforts were soon being made to increase line capacity. The first was the *duplex* system, which was based on the Wheatstone bridge. An essential method of obtaining the correct balance of all bridge duplexes was by means of the artificial line, which had the same characteristics of resistance and capacitance as the main line.

If a relay has two balanced windings, as in Fig.2, a current introduced at the centre tap will flow equally and in opposition through the windings and core magnetisation will be cancelled. However, a current coming in from the line will energise the core by flowing to earth through one winding directly via the back contact of the key, or both windings via the artificial line. The result is that the relay will respond only to the key at the other end of the circuit, and simultaneous traffic is possible in both directions. This is known as the 'single current' differential duplex system. By suitably tensioning the relay return spring, the relay can be made to respond only to currents greater than a selected minimum.

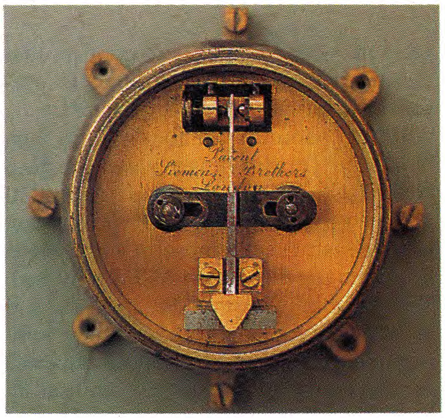
A polarised relay is used for a 'double current' duplex system as in Fig.3. A special sending key, or in some cases a relay, with reversing contacts selects the polarity depending on whether a mark or space is required. Voltages across the windings will deflect the relay tongue to one side or the other depending on their polarity, and irrespective of their strength.

Poser answered

There were, therefore, two basic duplex systems: one current dependent, the other polarity dependent. This is the basis of last month's poser of how to transmit four independent signals over a single wire, using direct currents only.

Duplexing could double the signal capacity of a simplex circuit, but with the increase in traffic as the telegraph became established, congestion was still a problem. In 1873 Thomas Edison — who was, incidently, in his younger days a crack telegraphist — patented the quadruplex system which could transmit the traffic for eight operators, four sending and four receiving, over one wire.

What Edison did was to combine the



Telegraph instruments were good examples of the 19th century brass and mahogany tradition, as the top view of this more than 100 years old Siemens polarised relay shows. Telegraph instruments are very collectable.

two basic duplex systems. The intensity dependent single current system was adjusted to respond to relatively heavy currents, while the double current duplex worked with weaker currents. The single current system depended on changing intensity, the double current system on changes in polarity. Fig.4 shows the essentials.

An interesting exercise is to work out all the combinations and currents which can exist depending on which keys are down. It is important to remember that only one current can flow in the line, and this is the algebraic sum of all transmitted currents.

Actually, it is the changes in the balances of the network which actuate the correct relays, and it is quite possible for the current through a relay winding to change during the duration of a mark signal. Setting up a quadruplex system was a skilled exercise, the more so as only very primitive measuring instruments were available!

Heroic enterprise

As well as establishing vital communication between Australia and the rest of the world, one epic project in telegraph engineering played a major part in Central Australia's development and settlement. This was the famous Overland Telegraph, completed in 1872, and which for the next 60 years, operated over the nearly 3000 kilometres of line between Port Augusta and Darwin.

Prior to 1872, Australasia was very isolated. The only communication was by sea, and by the time they were received, news reports and mail from Europe were weeks or even months old. Some improvement was possible after 1860, with the connection of India and Ceylon into the expanding world telegraph network. Ships often made their landfall in Western Australia, isolated telegraphically from the rest of Australia before 1877. Continuing on, they called at Adelaide, which had been linked by telegraph to Melbourne and Sydney since 1858. Extensive newspaper reports were then promptly transmitted to the news-hungry eastern cities, much to the financial benefit of the South Australian telegraph system.

In the late 1850's a British scheme proposed laying a cable from Singapore and Java, to connect by landline into the Queensland telegraph system from a terminal in Northern Australia or even the Queensland coast, and thence into the Australian interstate telegraph network.

However the impecunious South Australians did not think that this was a very good idea at all. Traffic for Adelaide would have to be handled on the way by Brisbane, Sydney and Melbourne, who would all extract their

At Alice Springs, seven buildings of the Overland Telegraph station have been carefully restored to provide some idea of what life was like for that isolated community. In the foreground is the telegraph office, housing a range of Morse instruments operating with recorded messages. The pole at the left carried the lines from the battery building, which housed four operational batteries and one spare set — each comprising 100 Daniel cells.

tolls instead of the other way round. A better scheme for the South Australians, prompted by the reports from the explorer John McDougall Stuart, was suggested by their 'live wire' Superintendent of Telegraphs and Chief Astronomer, Charles Heavitree Todd, who accompanied by his wife Alice had arrived from London in November 1855.

Various early explorations had led to the belief that access to Central Australia was barred to the south by the salt lakes, and that the country beyond was extremely inhospitable. However reports from the intrepid John Stuart on his early expeditions, which were financed by prospective graziers, painted a different picture.

In 1859, after reading Stuart's latest promising report, Todd suggested building an overland telegraph line north from the existing terminal at Port Augusta to intercept the cable on the northern coast of Australia at the Victoria River. This would guarantee for South Australia the transit fees for all traffic.

Six expeditions

Although in indifferent health, Stuart continued his valiant and persistent efforts to cross the entire continent and now had the additional commission to find a route for a telegraph line. Finally, on the 24th July 1862, during his sixth expedition, he reached the northern coast at Chambers Bay near what is now Darwin — and was able to confirm that construction of a line appeared to present no insurmountable difficulties.

After some manoeuvring, the Northern Territory was annexed from New South Wales to South Australia, and the next few years were spent trying to establish a settlement to exploit the new country that Stuart had discovered. The trouble was that the pattern and effects of the wet and dry seasons were not understood, and the whole business of the Northern Territory colonisation ended in a fiasco.

Meanwhile, submarine cable technology was having its own problems, with several of the early cables failing. There were to be three Atlantic cables laid before success was achieved in 1866, and the cable to India had failed. Any plans for an Australian extension were on hold.

Eventually, in June 1870, after some tough bargaining and attempts at political sabotage, especially from Queensland, a contract was made between the South Australian Government and the British cable company — but there were some very stringent conditions. South Australia agreed to complete a telegraph system between Port Augusta and the new settlement of Port Darwin by the end of 1871. There were to be heavy penalties if the line was not completed by the due date. South Australia shrewdly insisted on a counter clause of a similar penalty if instead the submarine cable failed.

Today, even with modern mechanisation, 18 months to complete such a project would be a tall order. In 1870, with only animal transport and no maps other than John Stuart's reports, this enterprise can only be described as a classic example of nineteenth century engineering optimism.

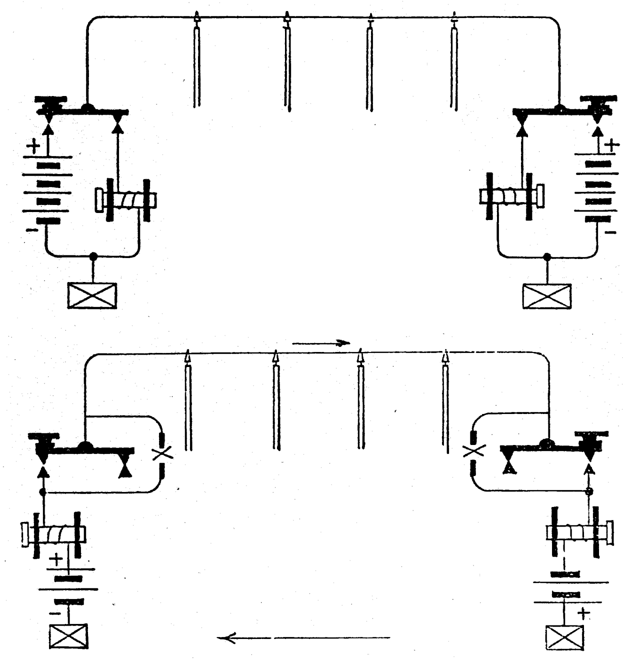
Overall supervision of the project was by Charles Todd, who split construction into three sections. Private contractors were used at the northern and southern ends, and Government teams for the central section, which was from just north of Oodnadatta to Tennant Creek.

Impressive logistics

The logistics involved were most impressive. Somehow provisions, 36,000 poles, insulators and pins and several hundreds of tonnes of eight-gauge iron wire had to be obtained and then transported and erected, and the line maintained and operated. Ten repeater stations and depots had to be established in the wilderness. Transport required hundreds of horses, bullocks and camels, and materials for the northern section were sent by a long sea voyage from Adelaide to Darwin.

As an instance of the travel times involved, a round trip for a bullock team from Port Augusta to the Central depot at the junction of the Finke and Hugh Rivers took four months, and the team building the section from Barrow Creek to Tennant Creek was eight months on the trail after leaving Port Augusta, before they arrived on site!

Most northern repeater stations took



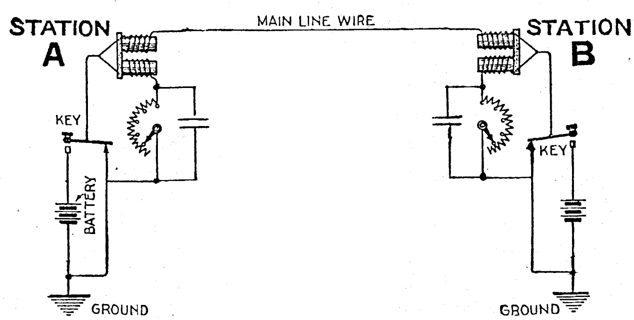
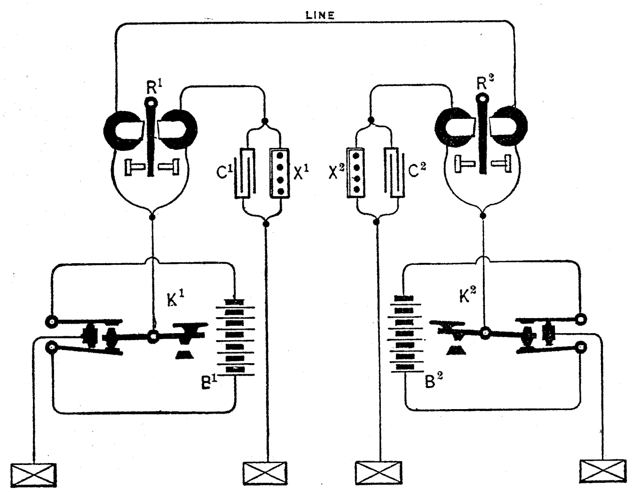


Fig.1 (left): The two basic simplex systems, with the open circuit type shown at top. This system was suited to dry cell batteries and low traffic densities. With serious operation, shown below, the closed circuit system required only half the number of cells, and was best suited to continuous current batteries.

Fig.2 (above): A simplified diagram of the single current duplex system. The sending current from the key was ignored locally, as it split equally through the relay windings, cancelling any magnetic effect. For simplification, local sounders are not shown in the multiplex diagrams.



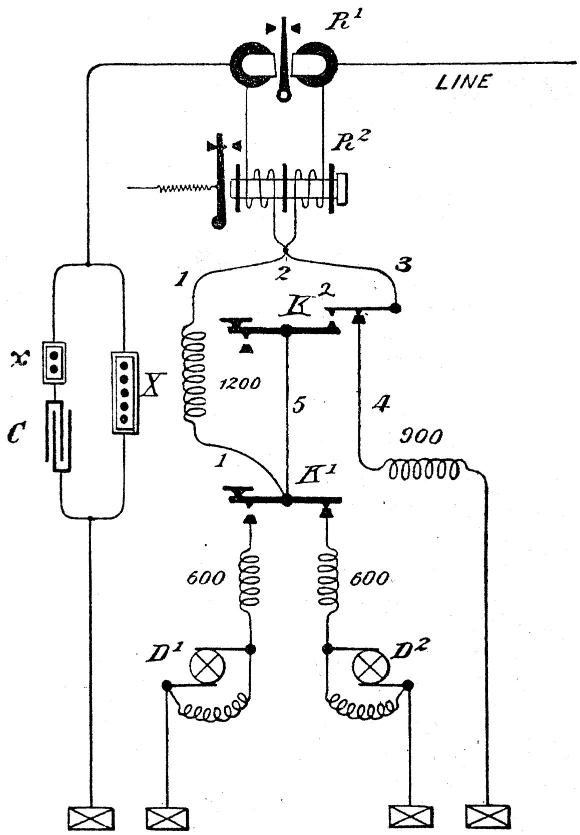


Fig.3 (above): The basics of double current duplex, which was based on polarity rather than current changes. Operation was much like the single current system, but polarised relays were used.

Fig.4 (right): Quadruplex telegraphy combined the single and double current duplex systems to permit the simultaneous transmission of four messages, two in each direction. Dynamos were used to supply the relatively high voltages and currents required by the single current section.

the name given by John Stuart to a nearby geographic feature, but there is one notable exception. As Stuart's route through the McDonnell Ranges was not suitable for wagons, Surveyor W.W. Mills searched to the east for an easier path through the barrier, eventually finding a passage with a water course. These he named Heavitree Gap and the Todd River, in honour of his boss. Today, the telegraph line has gone, but Heavitree Gap still carries the river, and alongside it the Stuart Highway and the Central Australia Railway.

Following the water course about 5km upstream, Mills found a fine waterhole — which, to make naming a family affair, he called Alice Springs, after Mrs Todd. Here, situated at about the mid point of the line, was built what was to become the most important of the repeater stations.

The southern and central sections of the Overland Telegraph were finished just in time for completion of the cable laying. But inept administration and continued lack of understanding of the monsoon weather delayed completion of the northern section until August 22, 1872.

The delay was getting South Australia into trouble, with the cable company threatening to shift the terminal to Queensland. But fortuitously the submarine cable failed, on the 24th June. This gave a welcome breathing space for the Australians, and their cheeky counterclaim clause provided a welcome refund of the penalties. Finally, the cable was repaired on October 21st 1872, and Australia's isolation was over.

The system provided a vital link with the outside world, and at first messages were repeated manually along the line. But as technology improved, automatic repeaters were employed. As well as successful telegraph operations, the stations provided a vital social service until the line was closed in 1932.

Today there is little left but the remains of some of the buildings at repeater sites. Alice Springs Station has been skilfully restored as a museum, depicting life at the lonely outpost and, complete with working instruments and friendly personnel, it is well worth a visit.

This has been a very brief summary of an epic story. A much fuller story was published by Frank Clune in 1955. Titled *Overland Telegraph* there is a detailed account of the history, politics and difficulties of exploring and constructing one of Australia's great nineteenth century engineering achievements.

An excellent, well illustrated booklet *Telegraph Stations of Central Australia* has been prepared by the Northern Territory Conservation Commission and is available from the Alice Springs museum.

Satellites have now revolutionised long distance communications, making Morse a dying language commercially. A few months ago the American Coastguard announced that they were ceasing all code operations. Some amateur radio operators keep the tradition alive, but it can be only a matter of time before Morse ceases to be mandatory, even for ham tickets. ❖