Mrs Goodman

POST OFFICE

tele communications

JOURNAL

ONE SHILLING AND SIXPENCE

AUTUMN 1962

John Logie Baird
(Courtesy of BBC)

Baird Was The First In 1928!

WHEN was the first television picture sent across the Atlantic? If you think it was on 11 July this year, by way of *Telstar*, you would be wrong.

It happened, in fact, 34 years ago and the man who sent it was John Logie Baird, the "father of television".

At midnight one February day in 1928, Baird set up his television "camera" in a London office and placed a ventriloquist's dummy in front of it so that the four men in Hartsdale, on the outskirts of New York, he had asked to watch their receiver could tune their set. The image of the dummy was first sent by telephone line to a house in Coulsdon, Surrey, and then transmitted across the Atlantic on a wavelength of 45 metres. The signals were bounced back off the ionosphere and picked up satisfactorily in Hartsdale.

The men in Hartsdale immediately sent a message to Baird to transmit more pictures and a number of people in the London office, including Baird himself, took turns in posing before the camera. Their images were all received in Hartsdale.

A month later, Baird repeated his coup by sending the picture of a woman from London to the ship *Berengaria*, 1,000 miles out at sea, and three years later transmitted the Derby from Epsom to London.

Why, then, were no television pictures transmitted across the Atlantic after Baird's remarkable success until *Telstar* came along? The answer is that Baird's system was of low definition using medium or short wavelength radio waves and when the broadcasting committees later had to choose a system for television they decided on a high definition system using much shorter wavelengths (very high frequencies), which meant that signals could not be bounced off the ionosphere. Baird's transmissions to America were possible only because he used low definition and operated on relatively long wavelength signals which the ionosphere can reflect and in view of the vagaries of the ionosphere reception was far from reliable.

What goes

ON a wild stretch of moorland at the western extremity of England, a huge radio aerial towers above a block of concrete buildings.

Here, at Goonhilly Downs on the Lizard Peninsula, is the Post Office experimental satellite ground station—Britain's first space communication terminal—which played a leading part in the recent series of trans-Atlantic tests with *Telstar* and which may in due course become part of an operational world-wide satellite communication system.

The Goonhilly station, its site chosen as far west as possible to obtain the maximum period of visibility to the United States and because the area is remote from sources of radio interference, is a remarkable technical achievement.

It was built in less than a year and cost only about £750,000, a quarter of the cost of the American ground station at Andover, Maine.

Continued on page 108

A FIRST FOR THE JOURNAL, TOO

THE editor of the Telecommunications Journal *was one of 24 British journalists to speak to the United States through* Telstar *when the first public demonstration of bouncing telephony signals off the satellite took place on Thursday evening, 19 July.*

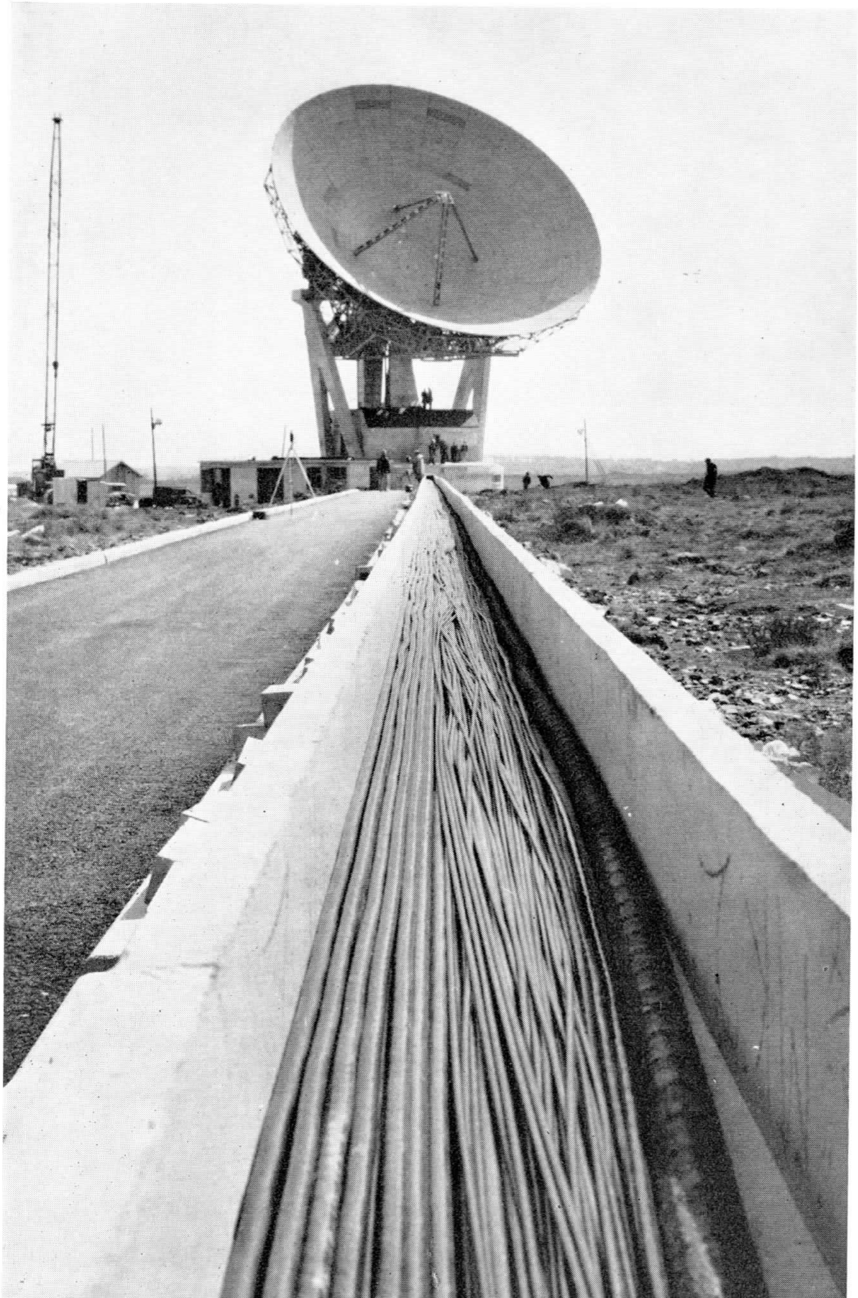
It was 9.41 p.m. when, at the Fleet Building in London, John Grove, the Journal *editor, picked up a telephone and said: "Good-evening, how are you?" to Mr. George E. Schindler, editor of the* Bell System Technical Journal, *sitting in an office 3,000 miles away in New York.*

The two editors spoke to each other for five minutes, discussing Telstar's *achievements and potentialities and exchanging greetings on behalf of their two publications.*

Although the voices had to travel up to and down from a satellite racing at 16,000 miles an hour at a height of 2,500 miles, reception both in London and New York was excellent. "It was as clear," says the Journal's *editor, "as speaking to a subscriber just across the road."*

on at Goonhilly...

Near the spot where Marconi sent the first radio signals to America, Post Office scientists and engineers are working to make a system of world-wide communications by satellite a reality within the next few years



The gigantic steerable dish aerial at Goonhilly, showing the mass of cables leading back into the station control room. The dish is 85 feet across and is made up of 365 separate sections. Though the rotating part of the aerial weighs over 800 tons it can be moved by a 2 horse-power motor in good weather.

The aerial steering room in the Control Tower at Goonhilly. From here an engineer keeps watch over the station, corrects faults indicated by the instruments in front of him and, if necessary, steers the giant aerial.

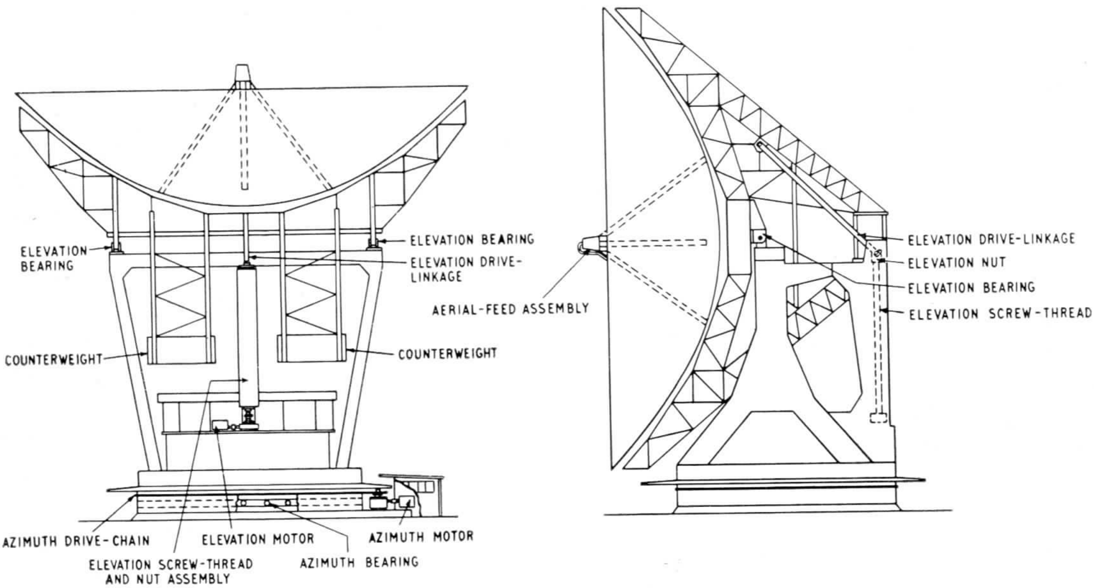
Almost all its complex equipment, including the huge dish aerial—the most accurate radio aerial in the world—is of British design and construction. Much of the electronic equipment has been built with the full co-operation and help of the British electronics industry by the Post Office Engineering Department.

How does Goonhilly station transmit and receive radio signals by way of an active satellite such as *Telstar?* Briefly, and simply, by pointing its radio aerial at the satellite as it moves across the sky and sending signals which are amplified by the equipment in the satellite and re-transmitted to a distant station. Signals from a distant station are received in the same manner.

But this is an over-simplification of the many difficult problems that have to be overcome, as the *Telecommunications Journal* discovered when it visited Goonhilly recently.

Since the signals from a satellite are very weak and a large collecting area is needed, one of the most vital parts of the equipment at Goonhilly is the massive radio telescope aerial—a steerable dish 85 ft. in diameter—which is used both for transmitting and receiving. It is designed to operate at radio frequencies up to 8,000 Mc/s and its transmission signal power is concentrated into a narrow beam only one-fifth of a degree wide. For this reason and because satellites move rapidly across the sky the aerial has to be able to track with great precision. Hence, to enable it to operate accurately even in high winds, the aerial has to be a very sturdy construction.

In spite of its size, the aerial is so well balanced that its rotating part, weighing more than 870 tons, can be steered in reasonable weather by a 2-horse-power motor, although two 100 h.p. electric motors are provided to allow for high winds. The mechanical arrangements for steering provide for variation of the azimuth by rotating the complete aerial structure on a circular horizontal turntable and for elevation variation by tilting the dish above a horizontal axis. The maximum speed of movement is one degree per second elevation and two degrees per second azimuth, maximum acceleration being 1.33 degrees per second per second.



These simplified drawings of the Goonhilly steerable aerial show how the instrument is rotated and elevated.

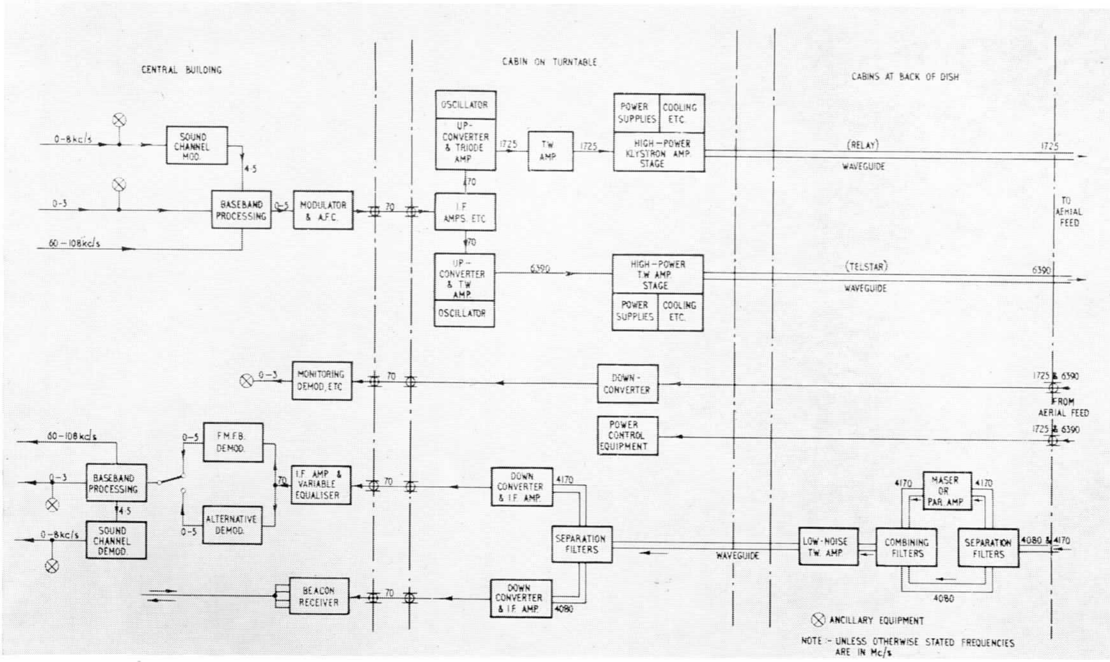
As was the case with *Telstar*, orbital information for steering the aerial is obtained over a teleprinter circuit from the Goddard Space Flight Centre in the United States and fed into a computer which turns it into second-by-second tracking instructions.

Because the signals from the satellite are very weak—less than one millionth of a millionth of a watt—they must be amplified many times. This is done by a travelling-wave "maser" amplifier fitted into a cabinet at the back of the dish aerial. The "maser", part of which is an artificial ruby, operates at 4,170 Mc/s and to be efficient must be kept at a temperature of only a few degrees above absolute zero with liquid helium and liquid nitrogen. The evaporated helium is recovered, compressed and stored for further use. The "maser" amplifier has a gain in excess of 25 db and a bandwidth of more than 25 Mc/s. Initially, it has a permanent magnet but this will be replaced by an electro-magnet using super-conduction.

In a cabin behind the reflector are filters for separating the beacon signal (4,080 Mc/s) from the communication signal (4,170 Mc/s) so that the latter can be amplified separately in the "maser". Complex waveguide assemblies, with rotary and flexible joints, connect the feed at the focus of the reflector with equipment in the cabins and on the aerial turntable. On the turntable is an apparatus room accommodating two high-power transmitters —one 10 kW, 1,725 Mc/s, the other 5 kW, 6,390 Mc/s—the low-power drive equipment for them and some of the frequency shifting equipment. The turntable itself rotates only up to plus or minus 250 degrees so that cable loops can be used instead of slip rings.

The aerial has two separate feeds, each for simultaneous transmission and reception, mounted at the focus in the aperture plane of the dish. Both are designed for circular wave polarisation. One was used for the *Telstar* tests and the other will be used for tracking the satellite *Relay* when it is launched later this year. The feeds are mechanically movable so that the direction of the beam can be adjusted in addition to the adjustments achieved by moving the whole dish. A diplexer combines the 6,390 Mc/s transmitter output and the 4,170 Mc/s receiver input for connection to the *Telstar* aerial feed. So that its mechanical alignment

OVER



A simplified block diagram of the receivers and transmitters at the Post Office satellite ground station.

can be periodically checked, the aerial is fitted with a boresight telescope for ranging on to local and distance points whose bearings are accurately known.

A quarter of a mile away from the giant aerial and connected to it by a mass of cables and wires contained in a conduit, is the Control Room, topped by a tower in which an engineer, sitting in front of a battery of instruments and dials, keeps watch over the whole of the station site. Though the aerial steering is fully automatic, the operator is there to observe faults, to apply corrections and, if necessary, over-ride the automatic system.

Below the Control Tower are the rooms, separated by glass partitions so that visitors may see what is happening without interfering with the operators, which form the brain of the system. In one, a Controller and his staff, all provided with consoles, carry out such tasks as aerial steering and transmitter and receiver supervision. The room contains base-band and frequency-changing equipment, receivers for the "off-to-air" reception of television broadcast signals; measuring equipment; magnetic tape and other recorders; satellite beacon signal receivers and microwave, video and multi-channel telephony terminals. A wide range of measurements and subjective tests can be made with the measuring equipment on the transmission of multi-channel telephony, television, telegraphy and data signals and scientific experiments can be carried out to determine the variation of propagation characteristics, changes of noise temperature with the bearing of the radio beam and the physical conditions in the troposphere. Automatic equipment is available for recording and processing data in conjunction with the computer.

The received signals reach the building as a wide deviation carrier centred on 70 Mc/s. The carrier-to-noise ratio is extremely low and the recovery of video and multi-channel telephony signals with a satisfactory signal-to-noise ratio has meant devising two alternative forms of demodulator One employs frequency-modulation negative feedback and the other a system of tracking the frequencies of maximum energy and varying the instantaneous band-width.

In the Telegraph Room separate teleprinters are provided for the reception, on a private wire basis, of the orbital prediction data from, and operational traffic with, the Goddard Space Flight Control Centre and the satellite ground station at Andover, Maine; for telex facilities; and for receiving meteorological information.

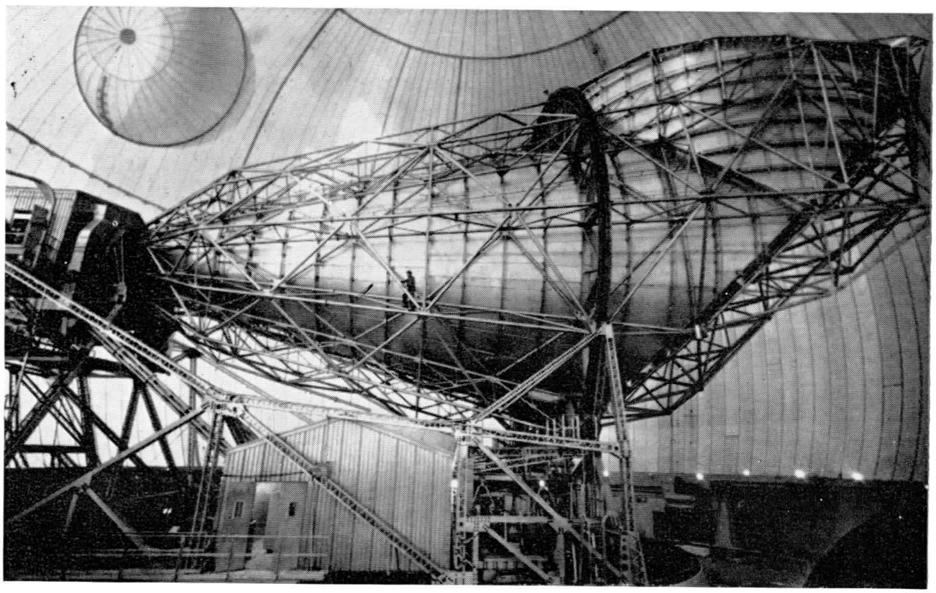
In another room, completely air-conditioned, is an electronic computer which processes the orbital prediction data into punched-tape aerial steering instructions, making allowances for changes of apparent satellite bearing due to atmospheric refraction and applying any other systematic corrections. Telegraph-type tape readers and data recording equipment are also provided for processing the orbital data and preparing the aerial steering tapes.

Instructions from the computer are passed into the aerial steering equipment in the form of punched paper tape which is "read" one second in advance, a second at a time, the tape-reading equipment positioning the tape for each reading operation from the "single cycle-start" hole which marks the beginning of each sequence. The time to which the start of each sequence refers is code-punched into the tape as hours, minutes and seconds. Then follow steering instructions, in binary code.

In the Aerial Steering Apparatus Room a comparison is made between the aerial steering input data in digital form and the digital signals derived from the read-out units on the aerial azimuth and elevation drives. This enables the servo feed-back loop to be completed. In a temperature-controlled annex are quartz-crystal oscillators of high accuracy which, in conjunction with time-signal radio receivers, provide a precise time source adjustable to Universal Time 2 (adjusted Greenwich Mean Time). Here, the steering tapes from the computer room to the aerial steering apparatus are received, the movement of the aerial depending on the synchronisation between the time recorded on the tape and that generated by the precise time source.

Before the Goonhilly station went into action in Project *Telstar*, it carried out a number of highly successful and comprehensive tests on a ground satellite set up at Leswidden, 20 miles from Goonhilly, to simulate a real satellite. The aerial was also beamed on the radio star Cassiopeia A to practise tracking signals.

AND THIS IS THE U.S. EAR



The Americans used this mammoth antenna—described as "the biggest ear in the world"—for transmitting and receiving signals during the recent tests with Telstar. *It weighs 340 tons, is 177-ft. long and is housed inside an enormous plastic bubble at Andover, Maine.*