Tricks of the Trade

Dave Porter G4OYX

The use of a single antenna to broadcast simultaneously two or more services on MF was described in the last ToTT **[1]**. It was mentioned that the 1946 MF 583 kHz/1013 kHz diplexer at Droitwich was possibly the earliest dual-channel system used by the BBC. Further research appears to disprove this statement.

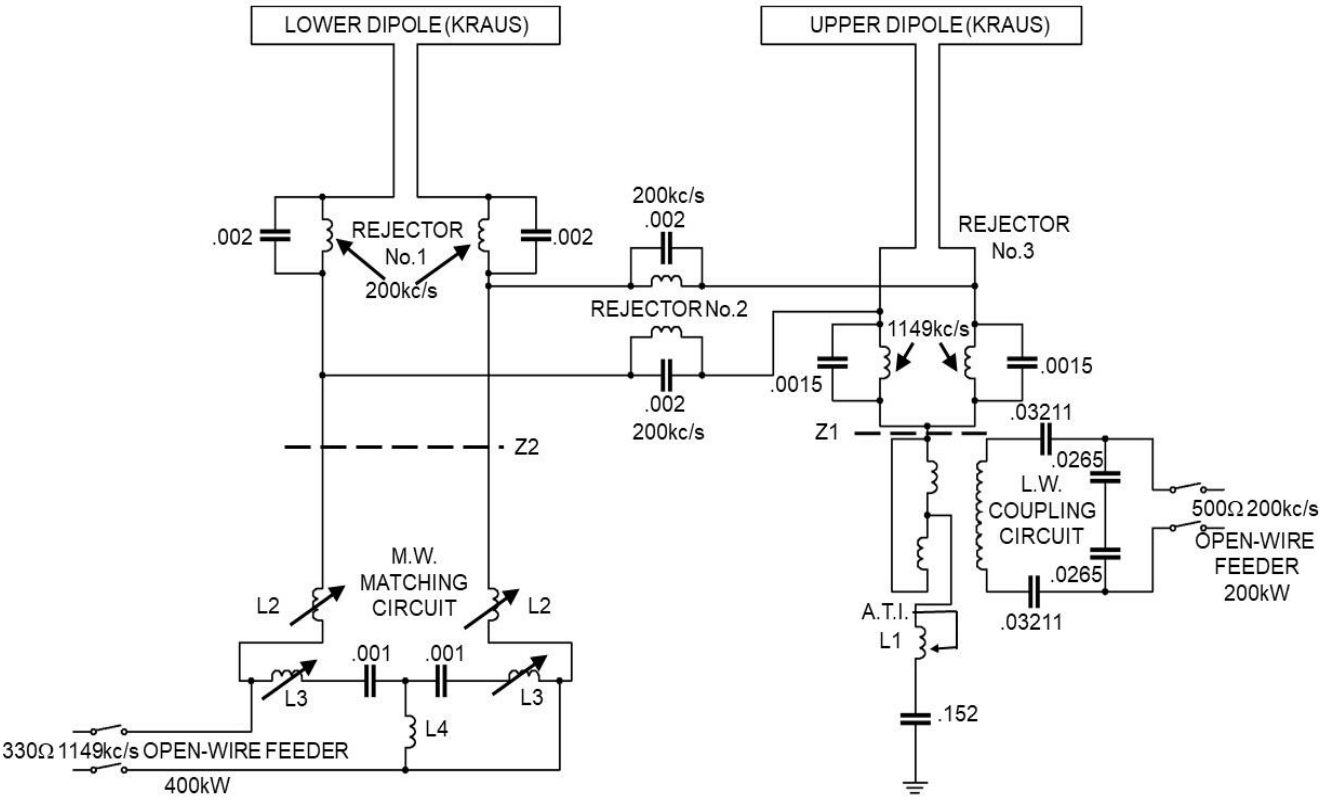

Figure 1. HPMW and 5GB (LF) Antenna Tuning House circuits for combining and matching

LF and MF together…

From 1942 there was run, again from Droitwich, the HPMW 400 kW 1149 kHz European service into two Kraus folded dipoles suspended one above the other, between the 700'-foot masts, which produced a signal with no upward radiation. This lack of upward radiation meant that the signal could not be used for direction finding by enemy aircraft flying at high altitudes.

The upper Kraus dipole could be used simultaneously as a 'T-aerial' for the long-wave transmitter by means of diplexing circuits. This arrangement is shown as **Figure 1**. Here, the 400 kW RF feed on 1149 kHz enters *via* a four-wire 330 Ω balanced feeder to an MF matching circuit. The output then goes to the Kraus dipoles, each *via* a 200 kHz rejector (Nos. 1 and 2). Meanwhile, the 200 kW feed on 200 kHz LF comes in *via* a 500 Ω two-wire open feeder up to a 1149 kHz rejector (No. 3) to feed the upper Kraus dipole only. So, while the 1946 MF diplexer was possibly the first *single* MF band unit, it is important to note that this LF/MF *dual* band unit does pre-date it.

Engineering-wise, it would have been a substantial high power (totalling 600 kW) arrangement and is testament to the design team that such a feat was possible, especially during a war with the shortages of components.

John Philips, a former Assistant Engineer in Charge at Droitwich relates a little more about the times…

Programmes in many European languages were radiated during the hours of darkness from HPMW, including the Voice of America with its signature tune 'Yankee Doodle Dandy', which was relayed from short-wave transmitters in the USA. For a period during the war, news was broadcast in Morse code for resistance and underground groups in the occupied countries, the only way to get information through the heavy jamming of transmissions.

A natural hazard for all transmitting stations, and Droitwich is no exception, is lightning. Fortunately, direct strikes on the aerial systems are rare although a 'hit' did occur on September 15th 1943 causing the Kraus dipoles to collapse into the field. This put HPMW and the European Service off the air for 24 hours while the reserve aerial was hoisted by the rigging staff. At that time, there was a new intake of trainees at the station for a technical course and they were pressed into service to help lay out the replacement aerial on the ground prior to erecting, thus saving time. The more usual effect during thunderstorms is arcing on the mast stay insulators caused by the high-voltage induction from a nearby lightning flash. The result, referred to as "static", is a series of loud cracks similar to repeated gun fire as the static flashes over the insulators to discharge to earth. In severe conditions, the flashover can be maintained by the pick-up of energy from the nearby transmitting aerials resulting in continuous arcing, emitting at high volume the modulation or sound of the programme being radiated. The transmitter has to be switched off momentarily to quench the arc, otherwise the heat generated tends to fracture the insulators. With present day installations, this problem does not exist as ultra-violet detectors fitted to the stays sense a discharge and cause the transmitters to be suppressed automatically. There is a story that, on one occasion during the war, arcing took place during transmission of a German programme much to the consternation of the residents of Wychbold. They feared that an invasion had taken place and that German troops were hailing the British to surrender! **[2].**

No doubt being modest, what John didn't say in that piece was that he was one of those new-intake trainees who laid out the reserve antenna!

With that postscript added we can move on to directional antenna systems for MF.

Directional antennas

It would appear that Start Point in Devon was the first BBC Regional transmitter in the UK to be provided with a directional antenna. Starting service on June 14th, 1939, literally a stone's throw from the English Channel, this antenna array was used to avoid wasting power over the English Channel and to enhance the signal to the west, north and east. It consisted of two 450-foot stayed lattice masts, the northern one being a mast radiator and the southern one a parasitic reflector. Both masts had a break at 310 feet to allow for the insertion of a loading coil. The spacing between the masts was a quarter-wave at the design frequency of 1050 kHz/285 m.

This driven and parasitic radiator approach formed the basis of many systems throughout the UK and overseas over the next 70 or so years. It afforded to the broadcasters the option to concentrate the RF radiation in a certain, but fairly broad, direction whilst preventing some radiation going to another. It is a cheap option but not always necessarily quite good enough for use on what later became the busy and overcrowded MF (and LF) bands.

Start Point was QRT at the outbreak of war but, after tests by BBC Research Department in October 1939, it was the prototype site for horizontally polarised non-DF transmissions on 877 kHz throughout 1940, reverting to 1050 kHz again with non-DF service in October 1940 until nearly the end of the war.

Stuart Frost, a former Engineer-in-Charge at Start Point picks up the story…

When the second front became imminent in May 1944, the STC transmitter was closed down. We didn't know exactly why, but we could guess that it was something to do with the forthcoming second front landings. Start Point was chosen because of its location.

The functions of the mast radiators were to be swopped over, the south mast was to be used as the radiator and the north a reflector, this was to transmit across The Channel to France.

The transmitter power was increased from the original designed 100 kW to 180 kW. This was quite an engineering feat. It required the four output stage water-cooled valves (STC 4030C) to be increased to eight by using the spares, subsequently other spare components were brought into service to avoid overheating.

On the completion of setting up the transmitter, we were told that it was in readiness for transmitting a Forces programme to the second front. It was on standby for many weeks, closed down until D-Day plus 2 when we had one of those urgent priority messages to transmit this Forces programme.

The programme was the Allied Expeditionary Forces Programme (AEFP). I remember it being a bright and cheerful opening and directed to all the armed forces taking part in the landings. There were three main bands, the British Band of the AEF, the American Band of the AEF (Glen Miller) and the Canadian Band of the AEF. Dance music in plenty, light entertainment, comedy, war reports and news were the main ingredients. It was a jolly good mixture of English, American and Canadian programmes. It transmitted for almost 24 hours a day with maybe a short break at night for essential maintenance. Occasionally, coded information was transmitted in the way of innocent prose.

As for myself, I continued on shift, listening and enjoying this uplifting cheerful AEF programme for a few months before being sent to Maida Vale and Droitwich on the Technical Assistant A1-B1 courses. On my return to Start Point, I was put on night shift immediately. All hands were needed to change frequency from 1050 kHz to 583 kHz to increase the ground wave range to keep up with the allies advancing into France and Germany.

This change in frequency had to be done over one night because the troops were informed that we were changing the frequency on the next day and to retune to receive their AEF programme. I do remember that night vividly, more adjustments to coils and capacitors within the transmitters and ATHs (Aerial Tuning Huts). We finished about 0600 just in time for the arranged start-up; indeed we were all very weary, as it was a very hot night.

Start Point was the only transmitter that transmitted the AEF programme from the UK. However, much later as the allies advance progressed, relay stations were used, receiving Start Point and re-transmitting from mobile low power transmitters positioned in France and Germany. The service continued until the cessation of hostilities in Europe **[3].**

After the war the 1050 kHz/1052 kHz pre-war pattern two mast directional service resumed and continued, even after both masts were replaced (due to salt air corrosion) in 1958, until the Geneva Plan changes in 1978 when Start Point became a two-frequency station, about which more later.

More post-war adjustments

Readers will recall from ToTT **[4]** that two antennas had been provided for the two services at Moorside Edge in 1931. These were a Tee for the 626 kHz (later 668 kHz) Regional Service between Mast 1 and Mast 2 and a single vertical multi-wire cage for 995 kHz (later 1149 kHz) National Service between Mast 2 and Mast 3. With three isolated-from-earth masts, two omnidirectional service areas resulted.

With the site being between Leeds/Bradford and Manchester/Liverpool it was proposed after the war that a directional antenna system be employed to boost the field strength in those conurbations of what was by then the 50 kW 1149 kHz and later the 1214 kHz Light Programme.

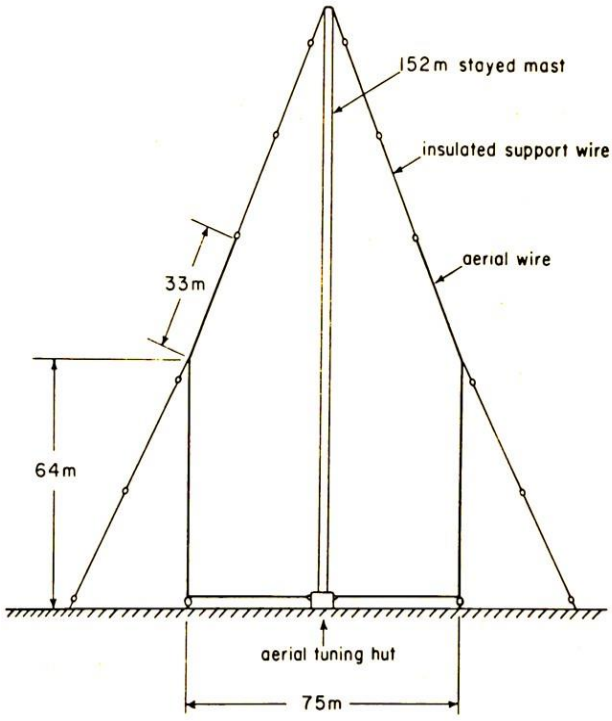

Figure 2. 1149 kHz/1214 kHz antenna suspended from a 500-foot mast at Moorside Edge

Figure 2 shows the 1149 kHz/1214 kHz antenna which consists of two wires suspended from a 500-foot mast. The two wires were driven in anti-phase giving a figure-of-eight (Fo8) pattern with maxima directed to the main population centres of Lancashire and Yorkshire and minima in directions served by co-channel transmitters. The mast was earthed and had no influence on the radiation pattern because the currents induced in it by the two wires are in anti-phase and cancelled one another

Mast replacement at Moorside Edge was carried out in the late 1950s and again in the late 1960s as a result of corrosion due to the industrial environment, unlike that at Start Point which was caused by the salty seaside environment. At Moorside Edge, the opportunity was taken to make the new 1214 kHz antenna an exact replica of the post-war one. The plane containing the vertical wires lay on a bearing of 63°30' ETN. At 1214 kHz the horizontal spacing between the wires was 0.31 λ and their height 0.39 λ; satisfactory operation of the antenna was possible from 1000 kHz to 1600 kHz.

In addition to the new mast and antenna, the earth system was upgraded and, for 1214 kHz, two sets of radial wires, originating from points below the vertical sections of the antenna wires, extended out 160 feet except where they would overlap. The wires were buried to a depth of 12 inches and were 12 SWG, 2.6 mm bare copper. Copper plates and rods were also buried at the central points.

After the Geneva Plan changes in 1978, Moorside Edge was the last station to be fully modernised and, by 1986, all services were housed in a new building. Again, significant changes were made to the antennas. For the 200 kW 909 kHz Service, one of the two masts was used as a conventional omnidirectional mast radiator. Uprated wire antennas to the long established antiphase-fed Fo8 pattern were suspended round both masts to take the 1089 kHz and 1215 kHz commercial services. Rather than single wire, now four wire drops were used (to increase the bandwidth) and, because of that, one would hazard a guess that both frequencies were combined so that reserve facilities were available; that is, either a wire (Fo8) antenna for the directional services or one or other mast for the 909 kHz service.

Brookmans Park was also upgraded just post-war as a Wincharger™ mast was added to the south side for 1149 kHz/1214 kHz as a parasitic reflector for the south Tee to push the signal into London and the South East. In 1979, the north Tee was joined by the 'Mini-Tee', again as a parasitic reflector for the 150 kW 1089 kHz service. One notes in the documentation, that power increases of +3 dB over that which was published by the BBC (who just quoted TX output power) are quoted when in commercial service.

Next time

We will examine further the impacts and use of directional antennas both for BBC high-power and particularly those employed by the IBA in the rapid development of the commercial radio networks in the early to mid-1970s where a dire shortage of MF channels necessitated some clever solutions to re-use, many times, the same frequencies.

References

1. D Porter G4OYX. Tricks of the Trade. *Signal* 2019, **52** (August), 19–23.
2. http://www.bbceng.info/Operations/transmitter_ops/Reminiscences/Droitwich/droitwich_calling.htm
3. http://www.bbceng.info/Operations/transmitter_ops/Reminiscences/start_point.htm
4. D Porter G4OYX and C Pettitt G0EYO. Tricks of the Trade. *Signal* 2018, **48** (August), 33–35.

~ ~ ~