

THE HIGH POWER VERSION OF THE WS19

There are not a lot of working WS19HP systems about, so when we put one together for the special event station at Bletchley Park recently, it seemed timely to take a closer look.

A more serious wireless

The standard WS19 becomes a different animal when you add the Amplifier RF No.2. The rather measly RF output of the WS19 (1.2-2.5W AM, 3-5W CW, according to the specs) is boosted to a much more useful 10 – 14W on AM, and 25 – 30W on CW.

It also becomes a lot bigger and heavier, as may be judged from the standard arrangement shown in Fig.1. Something else that increases is the battery consumption. The amplifier is not known for its efficiency, and even the best one (the Mk.III) takes a whopping 18 amps from a 12V battery.

Note also in Fig.1 the rather rare accessories required: the special set-to-PSU lead, the battery connector, the Aerial Tuning Inductance No.1 and the aerial isolation capacitor. In practice the last two items are not essential. The tuning inductor, a roller-coaster type variable inductor designed to handle higher power levels than the variometer, is only needed for resonating short antennas such as whips. The capacitor was

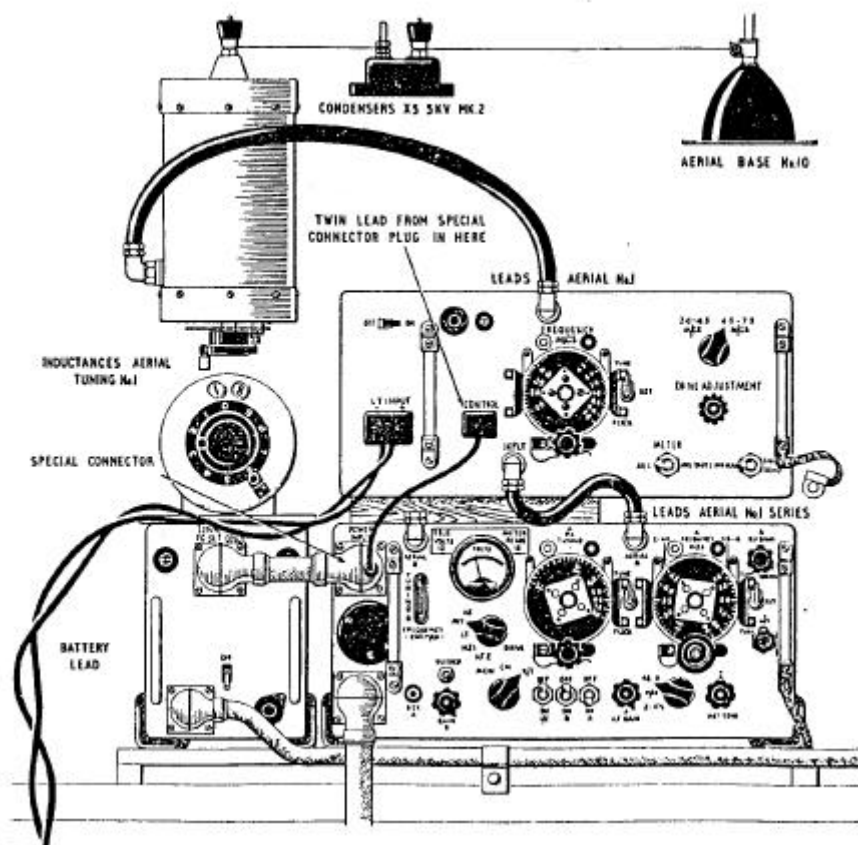
intended to save the equipment if the standard whip aerials used on vehicles came into contact with overhead power lines (the variometer includes this capacitor internally for the WS19LP).

The history of the various versions

The Mk.I amplifier started life as early as 1942 using 4x807 valves and no cooling system. The lack of cooling meant transmit time was limited to 20 minutes max in any one hour, which may have been an embarrassment for control stations, that would naturally tend to have the higher power set and have to talk a lot! By early 1943 the Mk.II came out, which included a cooling fan on the rotary transformer, and a conversion kit was provided to upgrade the Mk.I units.

These first units took an astonishing 24 amps from the battery, so in the early 50's a more efficient design was evolved, which became the Mk.III. Two of the four 807s are removed, and quite a few resistors, capacitors and tag strips are added or swapped out.

Fig.1: Typical layout of the WS19 with the Amplifier RF No.2



Is it easy to use?

Briefly – yes. The amplifier introduces a further set of tuning controls, but with metering of both drive from the WS19 and aerial current, this is easy to set up. Transmit/receive switching is automatic on AM, though somewhat less convenient on CW, where there is a separate “CW send” switch to be operated.

Inside the box

The circuit of the Mk.III is shown Fig.2. This is a fairly standard linear amplifier circuit, with the valves in parallel, and the anodes loaded by a parallel tuned circuit. The latter is tapped to provide a low impedance output to the aerial circuit, which would normally be a whip or long wire brought to $\lambda/4$ resonance by the aerial tuning inductor.

Somewhat less standard is the input circuit, which uses a

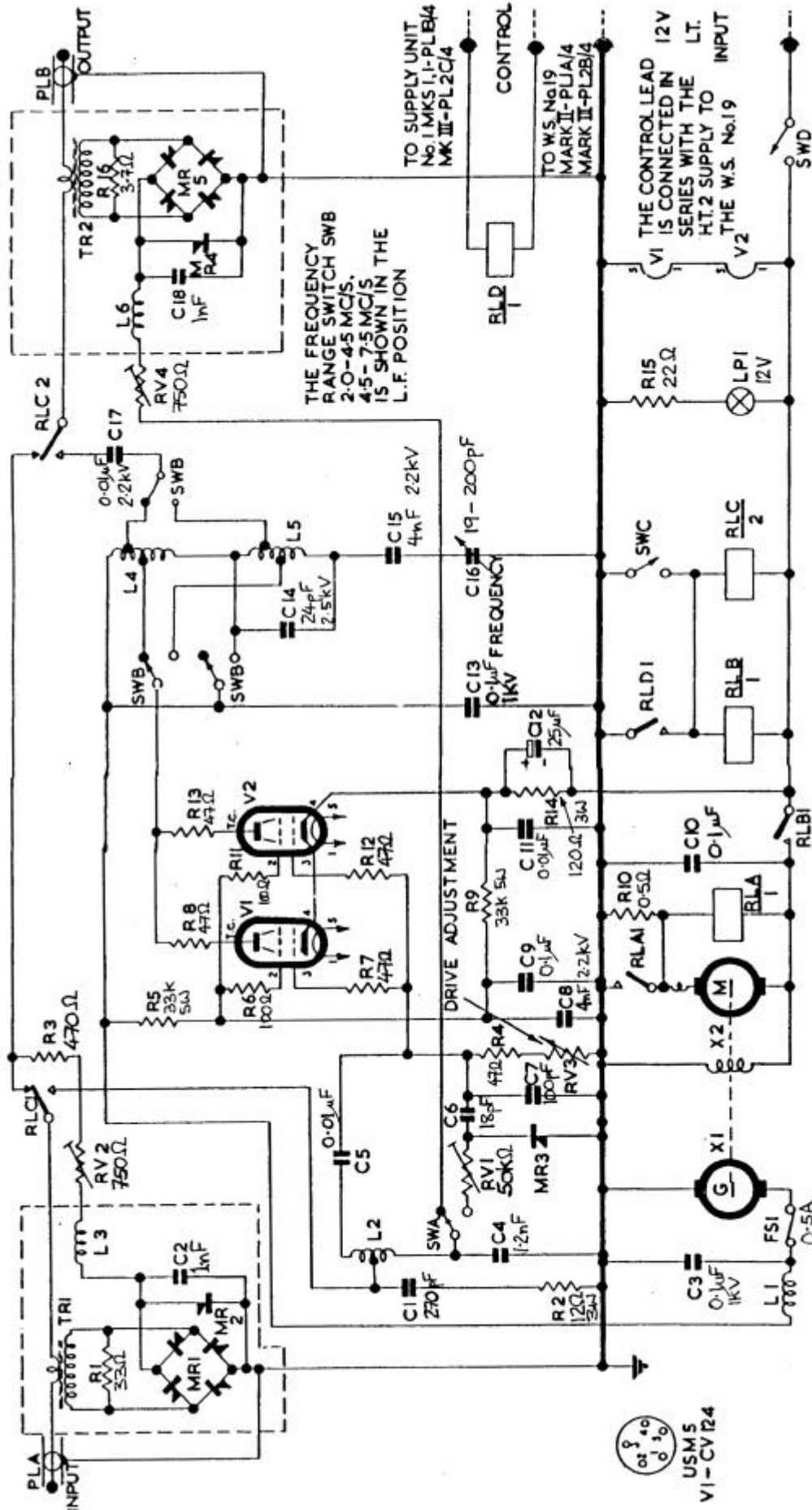


Fig.2: Circuit of the Amplifier RF No.2 Mk.III

fixed tuned circuit at 1.6MHz, slugged heavily by R2 (12Ω) to give a broadband response, peaking at the low frequency end of the range. L2 functions as an impedance step-up transformer from RF input to the valve grids. This arrangement is quite lossy, but is undoubtedly intended to ensure the amplifier remains stable under all conditions, including misuse by the average squaddy! "Stopper resistors" of 47 - 100 ohms on both grids and anodes, shows the designers were plainly worried about the possibility of parasitic oscillations occurring.

Valve operating conditions are described variously as class A[2], or class B[3]. Surprisingly, the EMER gives the anode current as 65mA per valve[1]. This puts the anode dissipation well over the 807's 25W rating: these valves are well known to withstand abuse, but this is unusual for the normally conservative military designers. One can see why the addition of the cooling fan came out so soon after initial deployment!

Traps for the unwary

I pass these tips on for anyone using the WS19HP, as I could have done with them myself. Firstly, don't expect the WS19 to transmit if the tail from the special dogbone lead coupling the WS19 set and PSU is disconnected from the amplifier. The amplifier Tx/Rx relay coil completes the WS19 HT2 line.

You need the correct battery lead, with two separate conductors (see Fig.1), if you want to achieve the rated power output. There are varieties of this lead around that use a single cable with two cores: this type is too thin, and means that the battery voltage is down by about a volt by the time it gets to the rotary, and this in turn means a low amplifier HT rail and reduced RF output.

Some interesting faults

Its always the way, isn't it.....just when you have something tricky to do – like getting a new Society off the ground – something breaks down and needs fixing. And our sample of WS19HP for Bletchley Park was true to form: two rather odd faults were found, one in the main set and the other in the high power unit.

The set itself showed the following problem on transmit. It would happily go to send, producing some 3 watts of output, and modulate normally. After about 20 seconds, however, the RF output would

suddenly fall to zero, although the rotary transformer continued to run, and there was plenty of drive to the PA. It would do this consistently, almost as though a timer had been installed to limit the transmit time!

While I was still scratching my head, Mike, G1EDP, suggested that as the PA valve heated up, the temperature rise could be causing a valve pin to socket contact to be failing, or a dry joint in the vicinity to be giving a similar effect. This is plausible, because there is around 15W just heating up the 807 anode. The fault did not reappear once 807 pins were cleaned and joints touched up.

An amplifier that didn't

The amplifier appeared at first sight to be operating normally, with the rotary transformer running, and meter readings looking OK. A power meter on the output showed, however, that no more than about 5W was coming out. In other words, our amplifier failed to live up to its name – we expected some 15 to 20 watts, but it produced no worthwhile increase in power at all.

That 'arch' fixer, Mike Hazell, G1EDP took a look at the fault on the amplifier. He quickly found that the HT rail, expected to be around 600 volts, was only at 250 volts, hence the low output. A check on the 12 volt input showed this to be OK, but only about 6 volts was actually reaching the motor side of the rotary. About half the battery voltage was being dropped across the surge limiting resistor R10 (0.5 ohms) in Fig.2.

Surge limiting – the whys and wherefores

Large DC motors, like the one in the rotary here, have the unfortunate characteristic of appearing to be virtually a dead short when they are stationary. When the 12V DC is applied a huge surge current (200 – 300 amps has been recorded) would flow for a short time while the motor is still thinking about running, if nothing were done to limit it. This level of current would

do serious damage (e.g. weld them closed!) to any contacts carrying this current, such as those of the relay, RLB1 or switch SWD (see Fig.2).

The amplifier has a simple but effective surge limiting circuit (Fig.3).

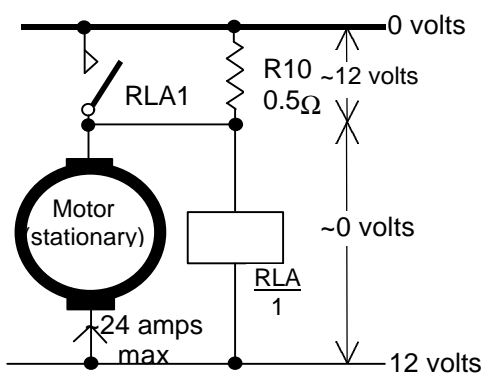


Fig.3: Circuit conditions at the instant battery voltage is applied to the rotary

At the instant battery voltage is applied, RLA1 is open so virtually all the battery voltage appears across R10, limiting the surge current to $12/0.5 = 24$ amps max. As the motor picks up speed, the voltage across it and the coil of RLA increases, and at some point RLA operates, shorting out R10. This applies the full DC input voltage to the rotary, which then increases its speed to the maximum.

The surge limiter fixed

OK – that's the theory. Mike found that relay RLA had simply stiffened up with age, so that it was failing to actuate, leaving the rotary always running with R10 in circuit. He cleaned up the relay and added a few drops of light machine oil, which fixed things nicely. Once operating

normally, the rotary transformer has two quite distinct speeds of operation, and the pitch of its whine can be heard to increase markedly as RLA cuts in, about half a second after first pressing the transmit button.

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References

- 1 EMER series numbered 'L38x'
- 2 "Low power wireless sets", Trade Training Notes, Part 9. 1st Training Regiment Royal Signals
- 3 "Wireless for the Warrior", Vol.2, Louis Meulstee.

