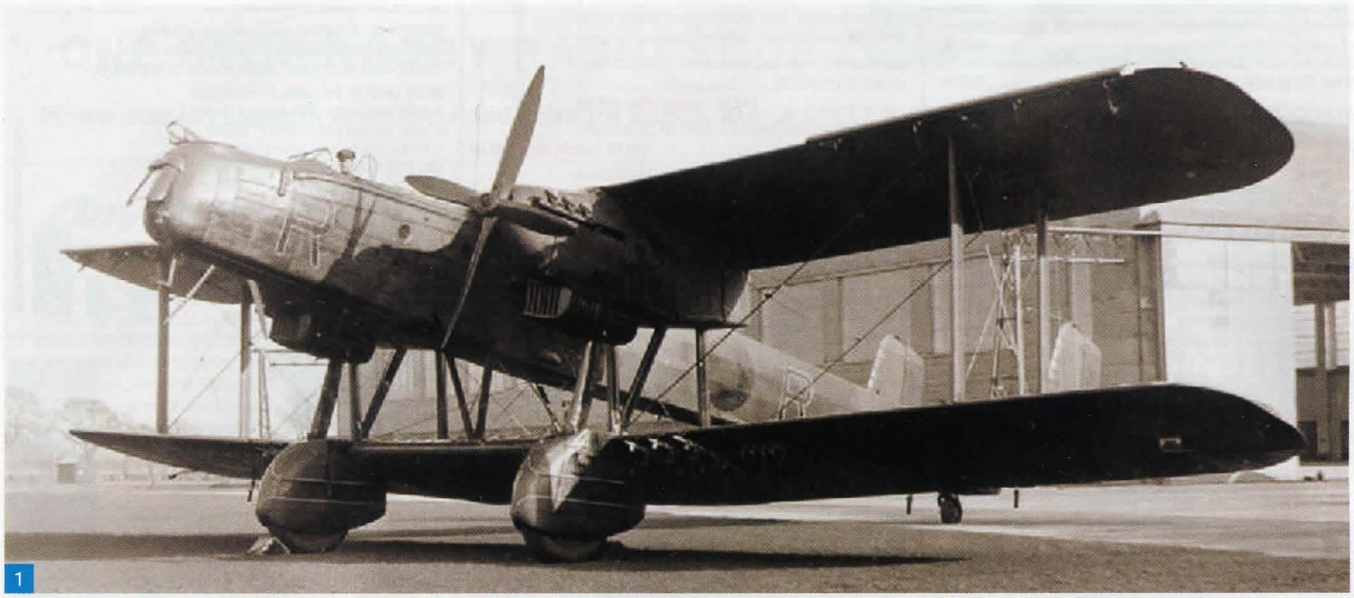

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Clockwork Radio!

Tony Smith G4FAI describes the RAF's first active IFF system.

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'Pip-Squeak' was an early RAF IFF (Identification Friend or Foe) system used with the TR9 transmitter-receiver. It was introduced in 1939 following the shooting down of two 56 Squadron Hurricanes in error by Spitfires of 74 Squadron.

It was the first active system used to identify aircraft for Ground Controllers and followed an earlier passive system trial. The name was derived from a popular comic strip *Pip, Squeak and Wilfred* published in the *Daily Mirror*.

Passive Trial

The earlier trial used a simple dipole antenna, resonant with the ground radar frequency, mounted on the unusually configured lower wings of a Handley Page Heyford biplane night bomber, **Fig. 1**.

Switching the antenna, from open to shorted status, resulted in a corresponding fluctuation of the ground radar echo, enabling the aircraft's position to be identified. With only a short range, and operating on only a single frequency, however, this was unsatisfactory, and the trial was abandoned.

How Pip-Squeak Worked

In the Pip-Squeak system, a Master and a Remote Contactor switched an aircraft's TR9 radio on to transmit a 1kHz tone signal for 14 seconds in every minute. Ground direction-finding stations could then triangulate and locate the aircraft's position. Four aircraft could use the same frequency in any one minute with transmissions following each other at one second intervals.

The Master Contactor was a spring-driven clock, hand-wound every 12 hours, which controlled the Remote Contactor, **Fig. 2**. The Master unit had a thermostatically-controlled heating coil to ensure a constant temperature irrespective of altitude or ambient temperature. It was fitted in a Paxolin box lined with sponge rubber, and the box was mounted in a suspended crate.

In operation, the Master Contactor STOP-RUN switch was switched to the RUN position before take-off. A demonstration of the high quality of the mechanism and a view of it working can be found on YouTube at: **https://tinyurl.com/ycmxx5kt**

Not Entirely Satisfactory

The Remote Contactor rotated at one revolution per minute and for 14 seconds of each cycle it closed an electrical contact, through relays in the radio, to activate the IFF transmission.

In use, the leader and one other aircraft of each airborne fighter squadron had an operational Pip-Squeak on board, enabling the control room to monitor the squadron's position and direct its movements as required.

Although a significant step forward, the Pip-Squeak was not entirely satisfactory. Its greatest drawback was that a pilot could not use his transmitter or receiver during the 14 seconds of every minute that the IFF signal

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Fig. 1: Handley Page Heyford night bomber.
Fig. 2: Clockwork Master Contactor.
Fig. 3: TR9 command radio in case.
Fig. 4: Circuit of TR9 transmitter.
Fig. 6: Remote controller. Fig. 5: Hawker Hurricane. The wire aerial indicates that it is fitted with a TR9. Fig. 7: A.M. (Air Ministry) nameplate on US SCR-522A equipment.
Fig. 8: Advertisement in PW, March 1951.

was being transmitted. If he was mid-way through a radio transmission at that time, he would simply be cut off.

In appropriate circumstances, in combat for instance, IFF switching could be disabled by switching the Remote Contactor's ON-OFF switch to the OFF position, leaving the Master Contactor clock running.

TR9 Transmitter-Receiver

The TR9 command radio, **Figs. 3** and **4**, was designed in the early 1930s, primarily for use in single-seater fighter aircraft, to provide two-way communication with the ground over a distance of 35 miles, or five miles air-to-air.

It was used in Spitfires, Hurricanes and other fighters before and in the early part of WW2, including the Battle of Britain. When fitted in a two-seater aircraft, it could also provide an intercom facility.

It had a 12W output, two-valve, R/T (speech) single-channel transmitter, with a frequency range of 4.3 – 6.0Mc/s. Its six-valve regenerative receiver was pre-tuned to the transmitter's frequency.

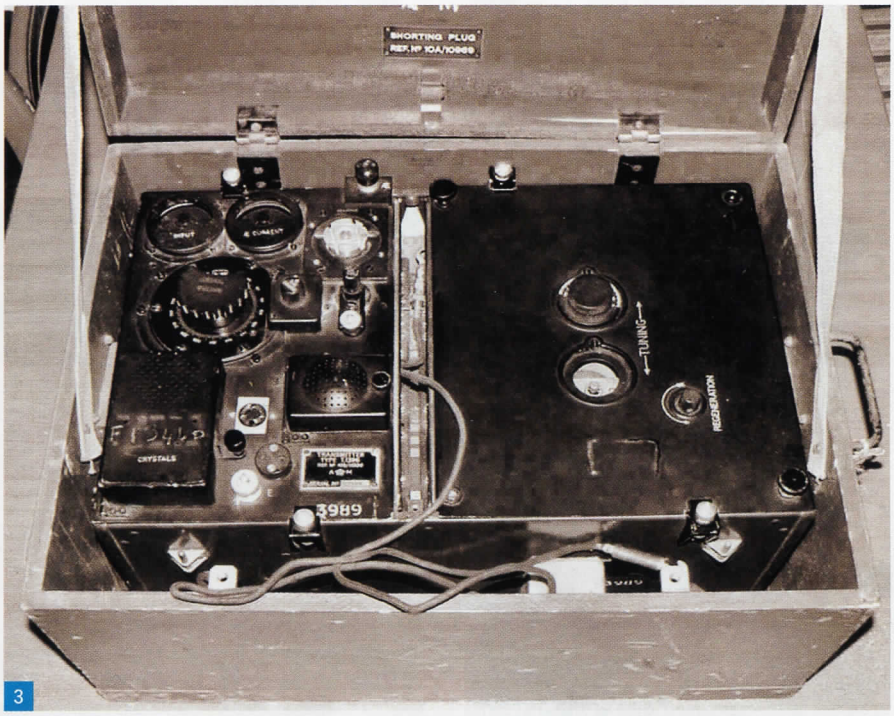
Power for both the transmitter and receiver was supplied by a 120V HT dry battery and a 2V LT, 20Ah, accumulator. Two grid bias batteries (one 15V and one 4.5V) biased the modulator valve of the transmitter and the output valve of the receiver.

Different Versions

In 1937, because of frequency drift caused by vibration and temperature changes during flight, crystal control was installed in the TR9, which was then re-designated as the TR9C.

A further modification, designated TR9D, was the addition of a second crystal-controlled channel, allowing R/T contact to be maintained through one channel while IFF D/F signals were transmitted via Pip-Squeak through the other channel.

In a further version, the TR9F, for multi-seater bombers, the second frequency could also be used for inter-communication between crew members. An aircraft equipped with a TR9 could be identified by its wire aerial, which was strung between a stub mast and the tailplane, **Fig. 6**.



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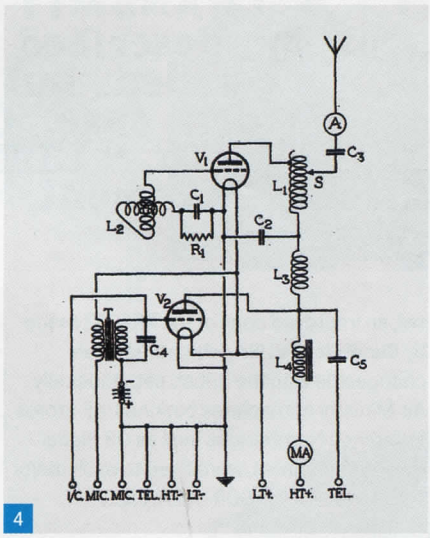

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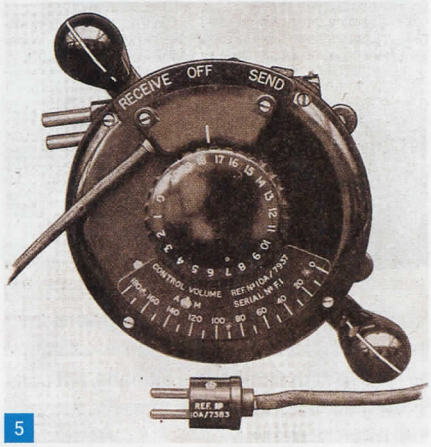

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Remote Control

The pilot operated the set by remote control, using a three-function control unit, **Fig. 5**. This controlled the send/receive switch and (in the TR9C and later versions) fine tuning of the receiver up to 200kc/s on either side of the transmitter's crystal-controlled spot frequency.

These functions were linked by Bowden cables while the volume control was linked by an extension lead from the receiver to a potentiometer in the control unit.

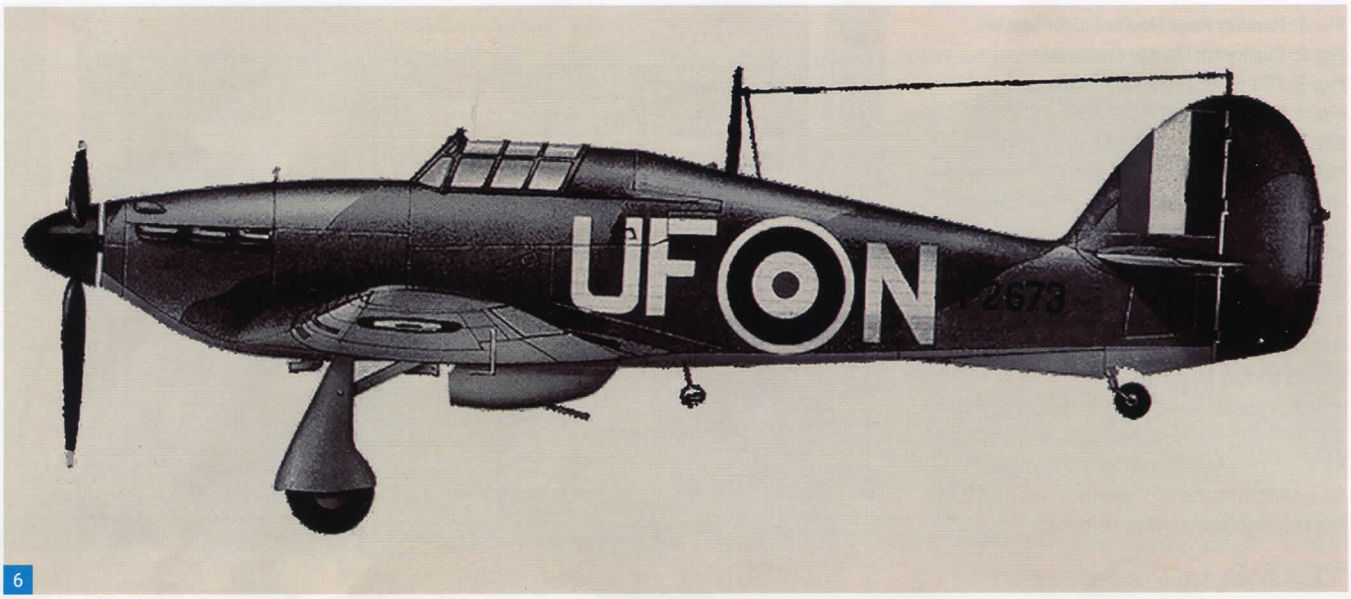
The combined transmitter-receiver measured approximately 19½ x 13¼ x 9½in (495 x 336 x 241mm).

Its total weight, including HT battery and grid bias batteries, was approximately 44lb (19.958kg). It was housed in a case of canvas covered wood and installed behind the pilot's cockpit on runners to facilitate easy withdrawal by ground crew for maintenance and battery replacement.

The HT battery was tested frequently and if its reading was less than 100V on load, it was replaced. The LT accumulator was also charged frequently. Both could be inspected and checked without removal from the aircraft. The two grid bias batteries were also checked periodically to ensure that their voltages were normal. It was all rather basic and time-consuming compared to the technology of today, but of course reflected the practices of the time.

VHF Replacement

In 1937, the RAF laid down a minimum range requirement for air-to-ground communications of 100 miles for aircraft flying at 5000ft (1524m). The TR9 fell far short of this re-



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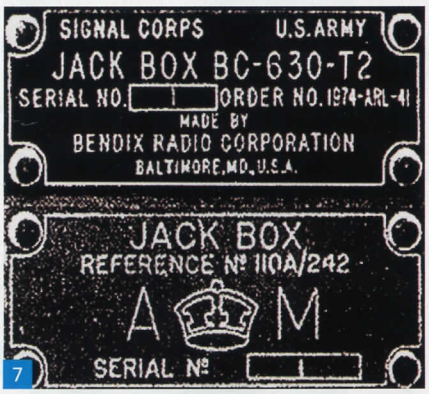

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quirement, so its effective air-to-ground range of 35 miles was extended by additional mobile direction-finding stations, approximately 30 miles apart, connected to the control room by landline.

A VHF set, the TR1133, with a much greater range, was designed to replace the TR9. It was to be physically interchangeable with the TR9 so that installation could be changed from VHF to HF, and vice versa, at short notice. It was also to be controlled by the Pip-Squeak.

By the end of 1940, 41 fighter squadrons had been re-equipped with the TR1133, which had four selectable spot channels in the frequency range 100-124M/cs.

At this point, the Air Officer Commanding in Charge (AOC-in-C) of Fighter Command gave instructions for the remaining squadrons in the Command to be changed over to VHF operation by 1 March 1941, signalling the end of the TR9's operational life.

When the TR1133 was permanently installed in an aircraft, the TR9's wire aerial was removed, leaving the stub mast to be adapted and utilised as a VHF aerial.

By 1942, the RAF also had the SCR-522A set, an improved copy of the TR1133 made by Bendix in the USA, which was interchangeable with the British set. Unusually, Air Ministry nameplates bearing RAF Stores Reference Numbers, as well as US Signal Corps nameplates, were fixed to each major component of the SCR-522A, **Fig. 7**.

Ready for Change

The Pip-Squeak and TR9 are examples of early radio technology being overtaken by faster developments in other fields. Looking back, it seems very strange that radio communication with Spitfires, Hurricanes and other fighters until 1940/41 was dependent on a clockwork mechanism, a two-valve single-channel transmitter, and a regenerative receiver. Add to that an HT battery needing regular replacement, and an accumulator needing frequent recharging. Coupled with its very limited range, the entire system was ripe and ready for change.

The changeover to VHF was a significant step forward in aircraft communication. The TR9 played its part in the process and, not surprisingly, its limitations were partly instrumental in hastening the change.

After the War

The abandoned TR9s, and new stock not yet issued, complete in their wooden cases, eventually appeared in the government surplus market.

Prices advertised in *Practical Wireless*, **Fig. 8**, from 1947 to 1951 varied, according to condition, from 16/- (sixteen shillings or 80p) to £6.00. Articles in the April and August 1951 issues of the magazine described the set as being of compact design and exceptionally well made.

They suggested modifications that could be made to it by radio amateurs for QRP operation, suggesting that with a really good ground aerial, as opposed to the short inefficient aerial fitted on a fighter aircraft, some surprising results could be obtained.

Although now extremely rare, examples can occasionally be found in the collectors' market, but at prices somewhat higher than those charged just after the war!

Further Reading

Air Publication 1186 Vol 1, Transmitters-Receivers T.R.9 and T.R.11.