A PORTABLE TRANSMITTER and RECEIVER

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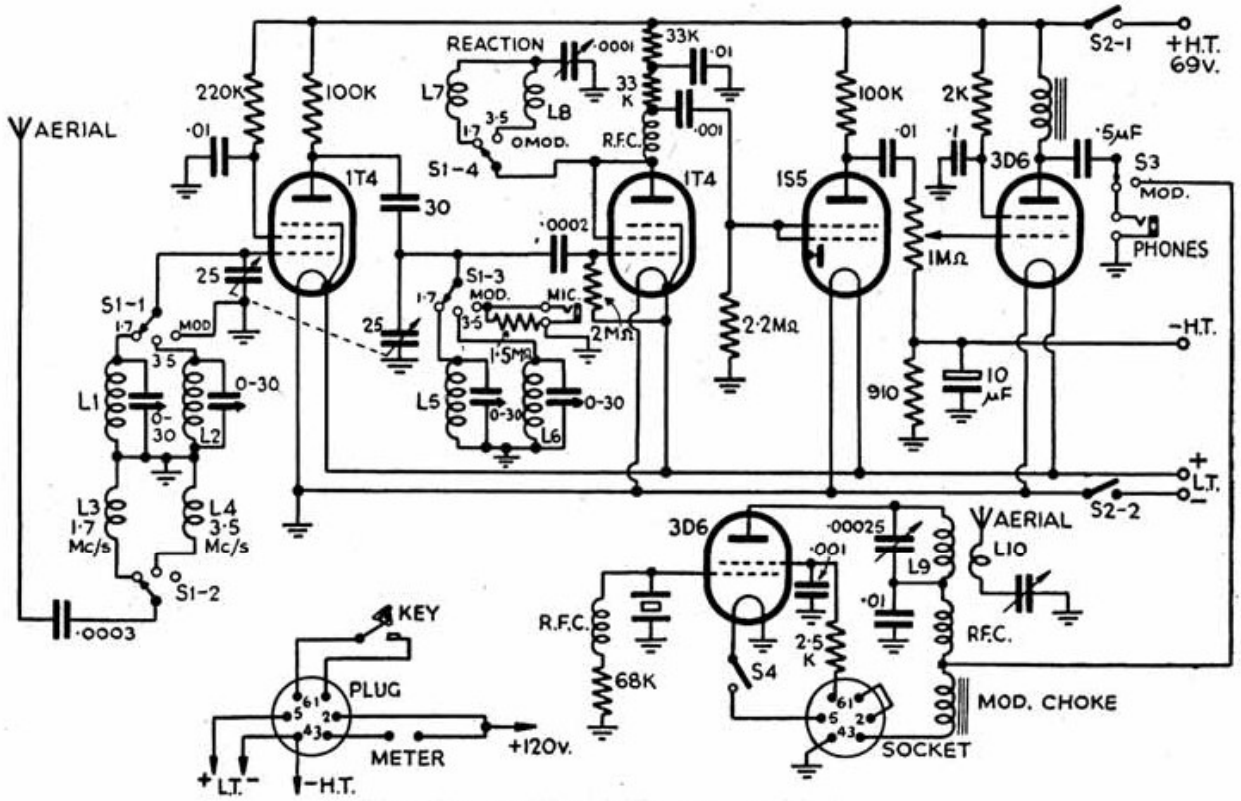
In an age when the emphasis is frequently on high power and elaborate receivers, results achieved with compact equipment warrant consideration. This article describes the construction of an effective portable station which, during the 1949 National Field Day, gave numerous contacts to competitors. The whole station was erected single handed in 33 minutes.

THIS equipment was originally designed as a dry-battery operated portable receiver for use at the Bromley, Kent, N.F.D. "A" station in 1948. A subsequent alteration in the rules rendered the use of such a receiver unnecessary but by this time, constructional work was well advanced and so it was decided to complete the set and retain it as a standby, making sufficient space available in the box to include a small transmitter as well.

accessories. The D.C. Avominor is used as anode current meter for the transmitter and station trouble-finder combined.

The Receiver

No special precautions were necessary regarding layout, except that the R.F. and detector tuned circuit coils are mounted on opposite sides of the steel sub-chassis.



Circuit Diagram of Portable Transmitter and Receiver.

No attempt was made to purchase special miniature components nor to compress the layout into the smallest possible space. The whole equipment was built up on a panel and sub-chassis and fitted into the steel case of an ex-Army Type 102 tester. A container of this type has the advantage of a deep lid which allows plenty of clearance for the various knobs protruding from the panel and leaves sufficient room for a set of spare valves, the transmitter coils, a pair of headphones, the power plug and cable, a miniature Morse key, hank of aerial wire and the earth lead. In fact the entire station can be carried inside the case, which measures 10¾in. wide, 8¼in. back to front, 6in. deep and an extra 3in. depth of lid, the only exception being the transmitter H.T. battery, a D.C. Avominor and the aerial and its

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For reasons of economy and simplicity a 4-valve straight receiver with regenerative detector is employed having a 1T4 R.F. amplifier; 1T4 detector, triode connected; 1S5, triode connected first audio and 3D6 tetrode output. After extensive tests, the triode-connected detector with condenser reaction proved to be best for quiet silky reaction, consistent with reasonably good sensitivity. The 1S5 was used merely because it happened to be lying spare. The 3D6 was chosen for the same reason. The latter is a "loktal" base valve, rather larger than its B7G counterpart the 3A4. The additional 20 mA. of filament current taken is negligible compared with the cost of a new valve.

To conserve internal space, and to give as great a degree of band-spread as possible, the receiver has only one tuning control (a 25 μμF. condenser)

and this just spreads the two low frequency bands over 180 degrees. The actual spread is from 1700 to 2020 kc/s. and from 3500 to 3790 kc/s. As the receiver is primarily intended for the reception of C.W., the "loss" of 10 kc/s. at the H.F. end of 3·5 Mc/s. is regarded as unimportant. A slightly larger variable condenser would provide a greater coverage if required.

Perusal of the circuit diagram (Fig. 1) will show that there is nothing unconventional in the design—trick circuits have a habit of going wrong at inappropriate times! Although the large *Muirhead* dial may seem to be an extravagance it has proved to be well worth-while in practice.

The components were placed where they fitted most conveniently and were the smallest suitable available in the "junk box" at the time. A small metal screen is placed between the R.F. amplifier and detector valves; this, apart from the separation of the tuned circuits, is the only screening precaution taken. It is therefore quite unnecessary to copy exactly the layout shown and any convenient box can be used to accommodate the equipment.

series-tuned to earth on 1·7 Mc/s. The rather large variable condenser is the aerial tuning condenser, approximately ·00075 μF. This will be changed later for a fixed condenser and smaller variable condenser in parallel. Keying is effected in the screen grid lead and is clean and free from clicks. The transmitter can be operated on 1·7 Mc/s. and be entirely inaudible 50 kc/s. away on a communications receiver in the same room.

The 120 V. H.T. battery for the transmitter is external to the set. This, together with the Morse key and anode current meter are connected by means of a six-way cable and plug which can be seen at the top right-hand corner of Fig. 2. Provision is also made for the quick external connection of a new L.T. for the transmitter if required.

A general view of the inside of the set is shown in Fig. 3, mainly as a rough guide to the comparative sizes and location of some of the components and the layout. The transmitter is to the right of the centre partition, the valve being under the base plate. The four valves of the receiver and other components can readily be identified.

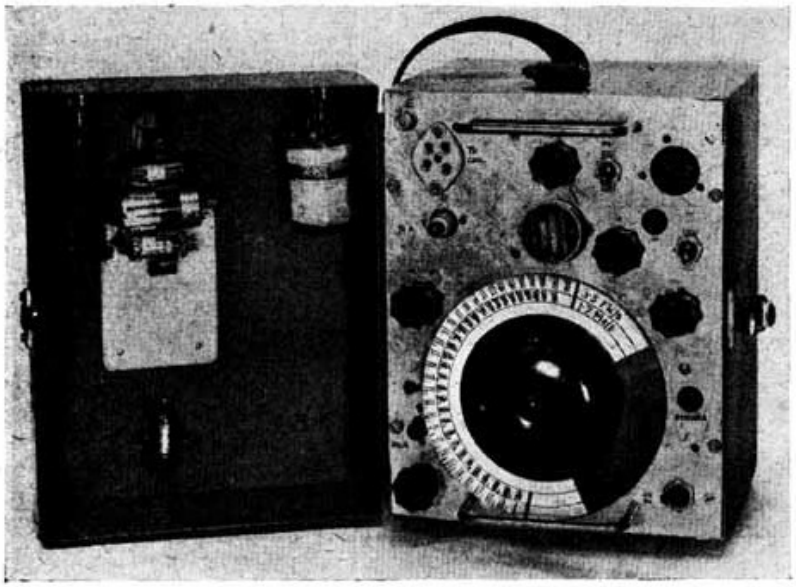

Fig. 2.

View of the complete equipment showing at the left how spare coils and valves are stowed-away in the lid. Note the method of calibrating the Muirhead dial to give direct readings every 10 kc/s. on both 1·8 Mc/s. and 3·5 Mc/s. bands.

The switch S1 has four sections and six positions, only three of which are in use. Position 1 is for the 1·7 Mc/s. band, position 2 is for the 3·5 Mc/s. band, while position 3 short-circuits the aerial input and connects the microphone jack to the grid of the detector valve, thus turning the last three valves of the receiver into a modulator, to be discussed later. The switch S3 connects the output of the receiver either to the headphone jack or to the transmitter.

A word of advice to the constructor; make sure that the components used are not faulty. Several hours of wasted effort would have been avoided if all the condensers and resistors had been tested on the Megger beforehand. A faulty detector grid leak and a leaky coupling condenser in the audio section, combined to produce a puzzling fault which was extremely difficult to trace.

The power supply for the receiver is a "Batterymax" B114, 1·5 V. + 69 V. which is housed on a shelf of the sub-chassis, part of the original tester. The method used for biasing the output valve is of interest as it obviates the need for a separate bias battery.

The Transmitter

The transmitter consists of a single 3D6/1299 valve as crystal oscillator with its filaments connected in series operating from an ordinary "twin" cycle lamp battery. The aerial is tapped directly on to the tank coil for 3·5 Mc/s. operation and is

Accessories and Field Tests

The original intention was to carry the accessories for the station in a duplicate of the set case. In field use these are as follows: D.C. Avominor, H.T. battery, aerial insulators and guy ropes, earth pin, tent pegs, mallet, pliers, screwdriver, log-pad, pencil and portable licence. The combined weight about balances the set itself which makes for ease of transport. When the set was completed and preliminary tests had been made, the possibility of using telephony on the transmitter was investigated. As good quality was desirable and a crystal microphone was available, a switch (already mentioned) was included to transfer the output of the receiver *via* a modulation choke, to the transmitter. At the same time an extra position of the wave-change switch was used to bring in the microphone which is plugged into the socket provided on the front panel. With this rather unorthodox modulator excellent quality speech has been transmitted on the 1·7 Mc/s. band up to 20 miles and up to 100 miles on 3·5 Mc/s.

Practical Operation

Apart from a few tests at the home station, the first opportunity to give the set a work-out in the field occurred when it was included with the rest of the baggage on the writer's annual vacation in the so-called summer of 1948. An aerial some

75ft. long and about 15ft. high was erected and the results obtained exceeded all expectations. Many contacts were made, both on 1·7 and 3·5 Mc/s. with an S9 at 160 miles as one of the outstanding reports. Tests were made with a small vertical aerial from a beach châlet on the sands at Cliftonville, near Margate, Kent, and several stations were worked on "top band" despite terrific QRM from North Foreland Radio only about one mile distant.

With the coming of the milder winter weather and the long evenings, the set was left on one side until N.F.D. of 1949, when it was decided to operate as a truly portable station with the self-imposed restriction that the entire station, exclusive

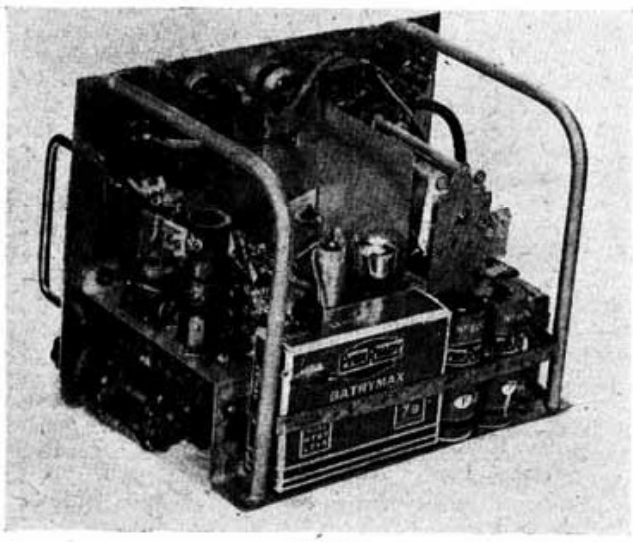

Fig. 3.
Rear view showing position of main tuning components, valves and batteries.

of tent and any other extras, must be transported to and from the site by one man on a pedal cycle; said bicycle to be pedalled, not pushed. The expression "entire" station to include one 30ft. mast.

A quantity of 1in. high-tensile dural tubing was to hand and a suitable mast was constructed from six 5ft. lengths of this material. Short sleeves were fitted on to each section into which the next section fits and each section was secured by a piece of threaded rod and a thumb screw. This makes the finished mast a continuous electrical connection throughout and serves as a satisfactory vertical receiving aerial.

The transmitting aerial (a 132 ft. long-wire) was secured to a tree at the end remote from the tent, the dural mast being erected by the side of the operating position.

The station was operated for approximately 10 hours out of the available 24 with a resulting "score" of some 240 points, which compared favourably with some of the "A" station scores put up by the actual competitors. The writer operated the station throughout the event and no transmission was made between 10.30 p.m. and 6 a.m., in fact no great effort was made to keep going all the time; the whole thing being treated more as a day's outing than a serious test. Of the 50 odd contacts made, none was lost due to QRM at the G2MI/P end and no inconvenience was experienced because of the lack of selectivity normally associated with a "straight" receiver. Despite the fact that only three spot frequencies were available in each band, the use of crystal control did not prove to be such an embarrassment as was forecast. The entire station was put up and was on the air in 33 minutes and was dismantled and properly packed in 28 minutes.

Later in the year, the equipment, including the dural mast, was again taken to the Isle of Thanet during summer vacation. This time a rather oddly-shaped 132ft. aerial was put up and as the mast had to be remote from the set, a separate 10ft. vertical aerial was connected to the receiver.

S6 telephony signals were exchanged with G3AEX of Bromley on 3·5 Mc/s. as an opening ceremony. During the remainder of the two weeks, most of the contacts were made on C.W. and several regular schedules were maintained. In addition contacts were made with places as far away as Pembroke, Prestatyn, Liverpool, Jersey, Germany, Holland and Belgium. The best times for operation were between 0600 and 0800 B.S.T. and between 1800 and 1900 B.S.T. After about 1900 B.S.T. QRM, it must be admitted, usually swallowed and strangled the 1 watt signal! One contact with G3AA of Bristol was made with 40 volts H.T. (·22 watt).

It is of interest to note that the same 120 V. H.T. battery which did duty during N.F.D. was used throughout the vacation fortnight. It measured 109 V. at the end. The receiver battery has been changed only twice since the set was built and the transmitter L.T. only once.

To conserve battery power, the receiver is normally switched-off during transmission and *vice-versa*; but 100 per cent. break-in is possible if desired.

The experience gained with this little set has encouraged the writer to further efforts and a second unit is now under construction which will incorporate a number of minor refinements and will cover 7 and 14 Mc/s. as well as the two lower frequency bands. Experiments are also in hand to develop a reliable V.F.O. drive using small directly-heated valves. The spare set of valves and other extras will be carried separately. The H.T. for the transmitter will be housed in the lid and will be of the modern layer type dry cell.

Anyone building such a set may rest assured of much interest and satisfaction in its use and quite a lot of fun during any field day event. The design and construction of equipment using dry battery power has been sadly neglected both in this country and in the U.S.A. There is not a single example of the practical application of the B7G series of battery valves in the A.R.R.L. or Radio Handbooks. There may be a general impression that their capabilities are such as to be useless for reliable communication. This, most certainly, is not the case.

Additional Uses

Two supplementary, though quite fortuitous facilities, are also afforded by the little set described in this article. It can be used as a highly effective emergency deaf-aid and with the wave change switch turned to position 4, *i.e.* with the grids of the R.F. and detector valves untuned, good readable reception is possible of the GBR transmissions from Rugby on 16 kc/s. We have yet to find out just why!

Coil Data

Coil.	Diameter.	Turns.	Wire.	Winding.
	inches			
L1	1	82	32 D.C.C.	Close wound.
L2	1	20	"	"
L3	1	26	"	"
L4	1	8	"	"
L5	1	82	"	"
L6	1	22	"	"
L7	1	30	"	"
L8	1	20	"	"
L9 (1·7 Mc/s.)	1½	56	28 D.C.C.	"
L9 (3·5 Mc/s.)	1½	32	26 Enam.	Spaced one diameter'
L10 (1·7 Mc/s.)	1½	11	28 D.C.C.	at earthy end.