

The Wireless Set No. 10 in North-West Europe

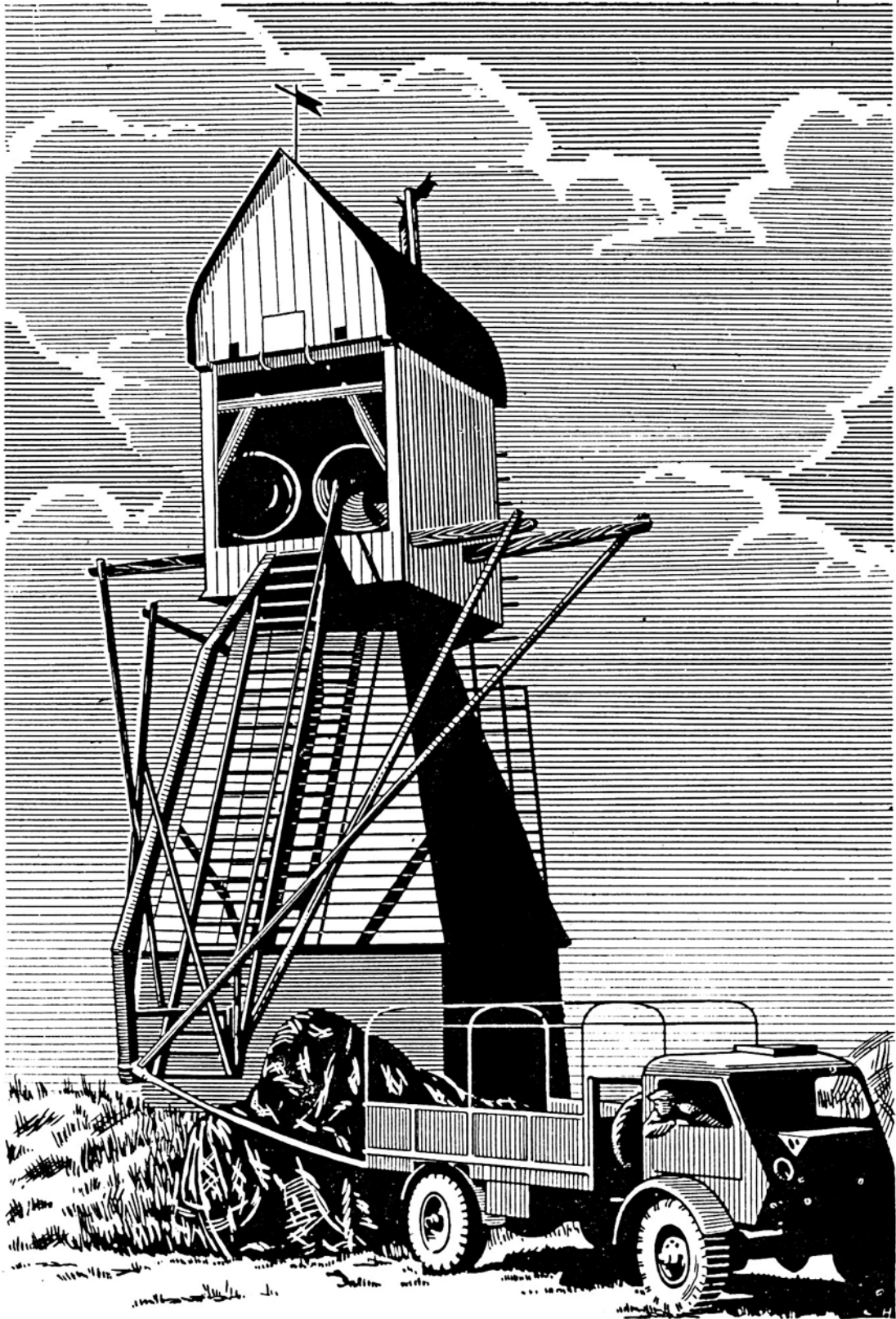
By J. G. MACMILLAN, M.B.E., SIGNALS RESEARCH AND DEVELOPMENT ESTABLISHMENT

ONE of the great advances in electronics accelerated by the recent war was the evolution of a new technique which made possible the radiation and reception of electro-magnetic waves at frequencies of the order of a few centimetres. The use of such short wavelengths made possible the concentration of radiation into narrow powerful beams by paraboloid reflectors of reasonable size. The first use of the new technique was in the development of the radar equipments which were to beat the night bomber and the submarine and, in the later stages of the war, the bulk of radar was working on centimetre wavelengths. It was not until these advances had been realised in successful radar equipments that the idea was put forward of using these ultra-short wavelengths for army communication purposes, and of employing radar pulse technique for a multi-channel duplex telephony link. An important feature of this new system was the use of relay stations, necessary owing to the restriction in general of the centimetre band to an optical path. It was fortunately possible, given favourable configuration of land, to obtain ranges over long optical paths because the paraboloids gave an increase of available power of nearly a million-fold over simple di-pole aerials.

The supply of rubber for cables had become desperate at an early period of the war and some method of alternative communication on the Lines of Communication for the coming offensive in Europe was imperative. The proposal to use centimetre communication equipment was therefore carefully examined by the War Office in 1942 and the Director of Signals asked for the development of trial models. The first models were made in a surprisingly short time and the system showed great promise. This successful development in turn was merged into a production project and, by the end of the war, many hundreds of the sets had been made. This article is contributed by one of the designers who was later a user of the equipment and he describes the changing phases through which the use of the equipment passed in the campaign after the D-day landings in France, beginning with apparent failure but culminating in brilliant success.

The Wireless Set No. 10 is a mobile, self-contained station, housed in a four-wheeled trailer which takes the set and power unit, drawn by a lorry with house-type body which carries the detachment. The radio frequencies used lie in the 4,000-5,000 Mc/s (6-7 cm.) band so that continuous reception can only be obtained over an optical path. This band and the use of 4-ft. paraboloid reflectors, which at these frequencies give a beam dispersion of 3° - 5° , ensure a high degree of secrecy.

The carrier equipment is of the time-division, multiplex type which pulse-modulates the sender; audio modulation is applied by altering the pulse width. The advantage of



A No. 10 SET SITE WITH THE MIRRORS MOUNTED IN THE LOFT OF A WINDMILL

time-division multiplex over conventional frequency-division carrier equipment is the great reduction in size and weight, due to the almost complete absence of heavy channel filters of high grade. Plate 1 shows the time-division, multiplex equipment alongside the radio rack ; the senders and receivers are mounted in standard No. 19 Set boxes. Plate 2 shows the trailer set up ready for working ; it should be noted that the petrol electric sets are normally taken some distance away, and that the trailer is jacked up directly the siting has been proved. The whole station is powered by a $3\frac{1}{2}$ -kw. petrol electric generator. Plate 3 shows the layout of the generating sets in relation to the rest of the installation. Despite the compact size, almost 100 per cent. spares of essential equipment are carried.

The body in which the equipment is fitted can be removed from the trailer so that advantage may be taken of local resources, such as tall buildings or towers, which were widely used in the campaign. The sketch on page 22 is drawn from a photograph showing the set installed in a windmill. Plate 4 shows the set in action on the top of the Kaiser Wilhelm memorial at Minden.

As a twenty-four-hour continuous service was required, only optical paths could be used. Experience proved that this restriction also applied to the V.H.F. equipment available, to the No. 26 Set and to the American AN/TRC 1, 2 and 3 V.H.F. Sets, but as the No. 10 Set could be brought into action more rapidly, needed no complex frequency allocation and gave better security, it was at a distinct advantage over the other sets.

The first operational requirement was a link from Ventnor, Isle of Wight, to Cherbourg, as soon after D-day as possible, and it was established on D plus 22, three days after the fall of Cherbourg. This link was not optical and was most unsatisfactory at first owing to very rapid, deep fading. However, after Ventnor had been fitted with a simple form of spaced diversity, the link was good. Spaced diversity on centimetric waves requires only small aerial spacings, usually in the vertical plane, and in the case of the No. 10 Set the maximum spacing would be of the order of 30 ft. for ranges up to 70 miles. This smaller spacing is another very important advantage over equipment working the V.H.F. frequency band. The link was not used until about one month later, due to the lack of Line Construction Sections to lay the necessary cables from the site into the Cherbourg repeaters. 21 Army Group (Main) were now in Bayeux, and it was decided to extend the link there. This provided 21 A.G. with seven very valuable speech channels back to England for many months to come. The relay stations at Cherbourg were seven miles apart and this was the only occasion in the whole of the campaign when they were not back to back.

Just before the conclusion of the battle of the Falaise Gap, it was decided to extend this link to Gace, some 50 miles from Bayeux, where the Commander-in-Chief (21 A.G. TAC) and Main 2nd Army were expected to make their headquarters. This extension was established just in time, for a few days later the Germans retreated, and were chased in four or five days right through France and Belgium into Holland. That contact was lost with 21 A.G. TAC and 2nd Army, was due partly to the inexperience of the Sections, but chiefly to there not being enough of them.

On arrival in Brussels, it was decided to establish a link to Eindhoven in Holland. This was done with two relay stations, one at Beersel and the other at Bergeleopold, both in Belgium. The terminal in Brussels was on top of the 21 A.G. (Main) building and the terminal in Eindhoven on top of the 180-ft. tower at the Philips radio works. Main 2nd Army went to Bergeleopold and 21 A.G. TAC to Eindhoven. This link, although extremely valuable in the early stages as no lines yet existed, was never very satisfactory as a link, due to a curious phenomenon at Brussels. The speech over the link itself was very good, but the channels were extended about one mile on a seven-pair cable to an existing German Command switchboard which already supplied extensions to the Army Group (Main) building. The loss in these extensions was in the order of 20 decibels and, due to the small depth of modulation, resulted in very good but quiet speech in Brussels and very faint speech on a noisy background in Eindhoven. Another difficulty was that the German board would not accept the No. 10 Set ringing, and 500/20 ringers were very scarce at the time. Some weeks later this was rectified by terminating the set on a F. and F. switchboard in the 21 A.G. building. This link was later superseded by lines but was left as an alternative route.

Up to this time the No. 10 Set had only been treated as something that might work and if it did, all well and good. No one really thought it reliable or had faith in it to the extent of relying on it without making sure of a covering line plan. This general feeling was due to familiar causes and human failings. Firstly, the only No. 10 Sets the Army had seen before D-day were the experimental versions which were most unreliable and difficult to operate and, unfortunately, gave a completely wrong impression of the value of the sets. The Sections were issued with the first production sets only a few weeks before going overseas, and never had time really to know them. The equipment itself still had a few teething troubles; but fortunately these were sorted out in Normandy and all subsequent sets were modified directly they arrived in the theatre. Lastly, there was the natural rivalry between lines and wireless personnel. When any faults occurred in the early line and wireless combined circuits, each party immediately blamed the other, not taking the trouble really to check their own equipment. A very human failing.

Apart from the main fight ahead, a private battle was started by the No. 10 Set Sections to prove that the sets were reliable, would get through, and could be treated just like any piece of line equipment. Fortunately, the proof of reliability came quickly, though in an unexpected manner. Some time after the Commander-in-Chief had been in Eindhoven he decided to move to Zonhoven in Belgium and naturally did not want the enemy to know of this move. It was therefore decided to leave all his H.F. wireless in Eindhoven and to key it remotely with two six-channel V.H. carrier equipments. A carrier quad was laid from Eindhoven to Zonhoven, and a No. 10 Set put in between Zonhoven and the existing site at Bergeleopold to act as a standby. It was very important that the V.F. equipment should be always through, as suspicion would automatically be roused if all the H.F. wireless sets went off the air at the same time. The carrier quad met its usual fate from the odd bad joint and occasional arguments with tanks and bulldozers which had strayed off the roads at night. Each time the No. 10 Set came in and

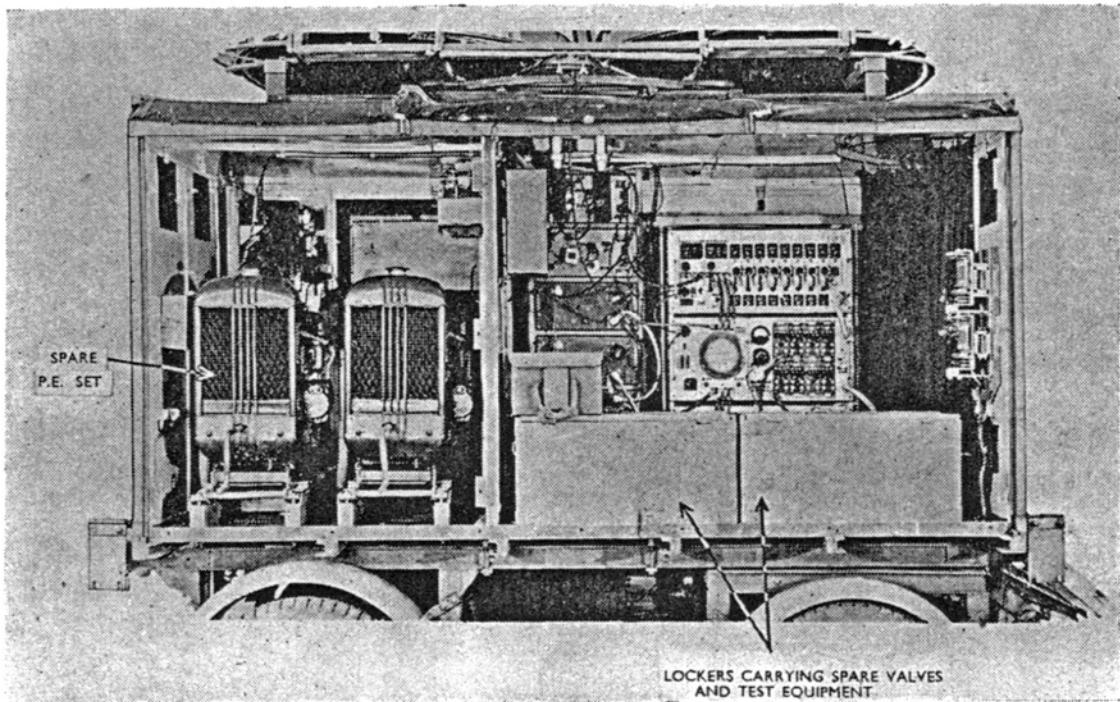


PLATE 3

LAYOUT OF GENERATING SETS

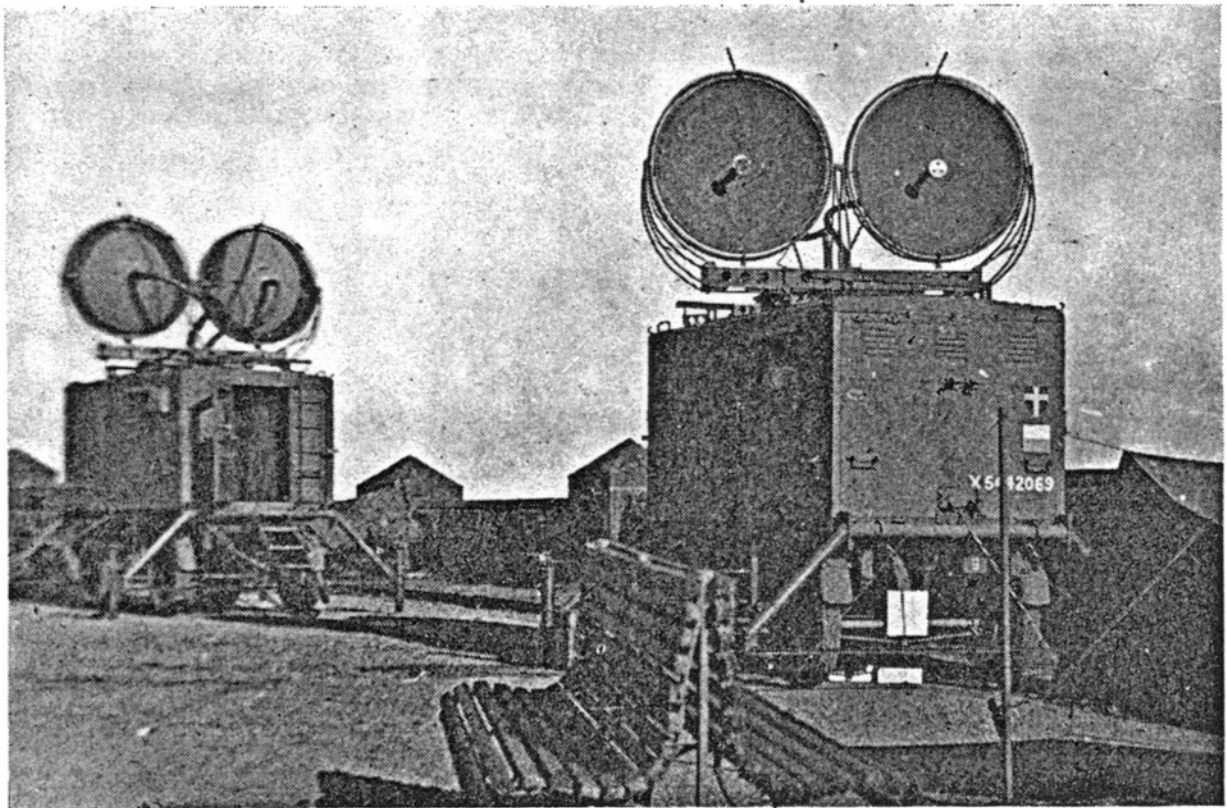


PLATE 4

RELAY STATION AT MINDEN

put the V.F. equipment through, until one day some one suggested leaving the No. 10 Set working and using the line as a standby. This was agreed to and the No. 10 Set carried on happily for three months until the next move.

While all this was going on, the crossing of the Maas and the Rhine, and the drive into Germany were being planned. The Commander-in-Chief expected this to be of similar speed as the drive up to Brussels, and the lines staff stated that they could not possibly guarantee to keep up with an advance of such speed. The decision was taken to use wireless and follow up as quickly as possible with well-built lines.

The next question to be decided was the type of wireless to use. The choice lay between the No. 10 Sets, No. 26 Sets and the American AN/TRC 1, 2 and 3 V.H.F. Sets, all of which would probably have filled the bill. The Signal Security Staff settled the issue by forbidding the use of any V.H.F. equipment carrying speech traffic within 100 miles of the enemy, a wise decision as we found out after VE-day.

During the next few weeks, a complete re-organisation took place. All the No. 26 Set Sections were retrained as No. 10 Set Sections, and all sections were trained to a standard operational drill, drawn up by the Chief Signal Officer, 21 Army Group. The most important change was to put all these sections into the Line Construction Company of 21 A.G. Signals, a change which probably had more to do with the successful operations to follow than anything else. For the first time line and wireless were all one, with one common aim clearly in view. A R.E.M.E. detachment was made available, equipped with one "Z" lorry and several "T" Cars with spare equipment. Their duty was to call on every site once a day, do any minor repairs and change any major equipment which had broken down. This arrangement worked very well and played an important part in the coming successful run.

The Commander-in-Chief was accurate in his estimate of the rate of advance, both for the crossings of the Maas and the Rhine, and the drive through Germany. The No. 10 Sets were always well ahead of the lines which slowly caught up and replaced the No. 10 Set chains. Only some two months after VE-day did the Commander-in-Chief find himself once again at the end of a line. The No. 10 Sets served 21 A.G. TAC for several months. During this time, only one hour's service was lost, and that towards the end, when the petrol electric sets were almost worn out after nearly a year's service.

The employment of centimetric multi-channel radio links marked the beginning of a new epoch in Army and Civil telecommunications. For such a novel equipment the success was remarkable, and it is satisfactory to know that it was projected and developed primarily in a Government establishment. Recently the U.S.A. have acknowledged that their successful models of similar types of equipment were initiated after information was obtained, in 1942, about British proposals to employ such systems. There is little doubt that later models will embody advances in technique to give a greater number of channels, improved signal to noise ratio and increased security. The evolution of this system was a major contribution to the mobility of a modern Army, which in future may be made independent of the delay imposed by the building and maintenance of long lines.

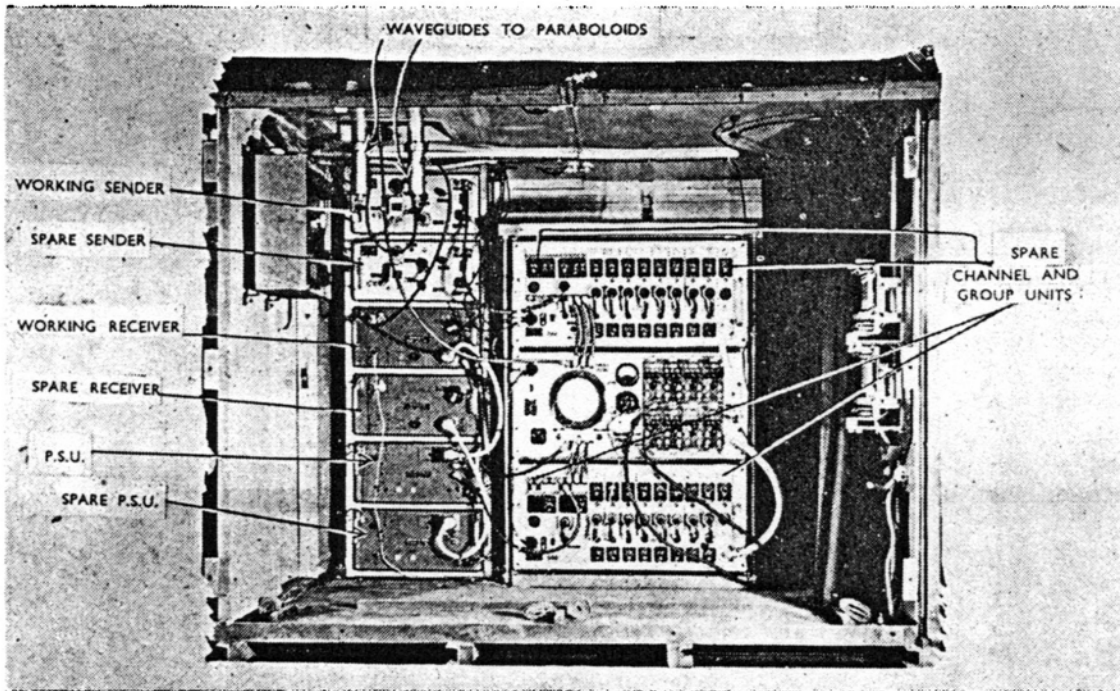


PLATE 1

NO. 10 SET IN TRAILER

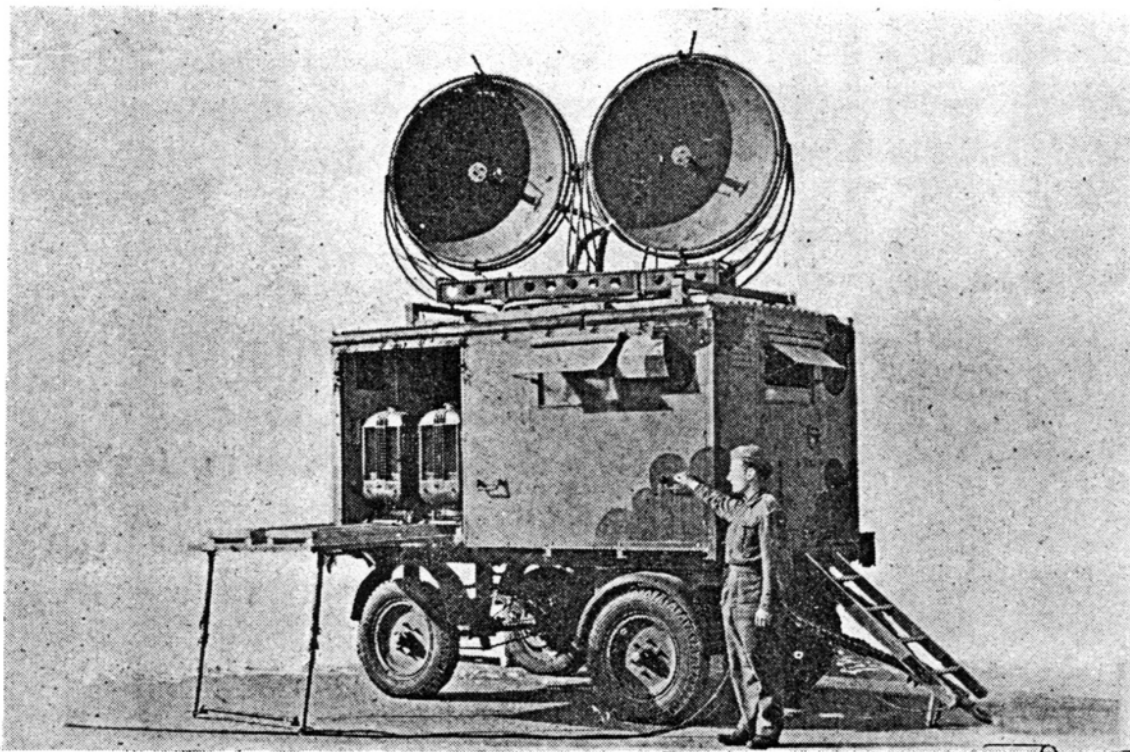


PLATE 2

TRAILER READY FOR WORKING